2017

JC2 H1 Physics

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3.	SA2 Dunman High School	
4.	SA2 Hwa Chong Institution	
5.	SA2 Innova Junior College	
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ANDERSON JUNIOR COLLEGE

2017 JC2 Preliminary Examination

PHYSICS Higher 1 8866/01

Paper 1 Multiple Choice **Tuesday 19 September 2017**

1 hour

Additional Materials: Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

Write your name, class index number and PDG on the Answer Sheet in the spaces provided.
Shade and write your NRIC/FIN.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **17** printed pages and **1** blank page.

[Turn Over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 What is equivalent to 2000 picovolts?

A 0.002 μJ C **B** 0.02 GV **C** 0.2 x 10^4 TV **D** 2 x 10^{-15} MJ C^{-1}

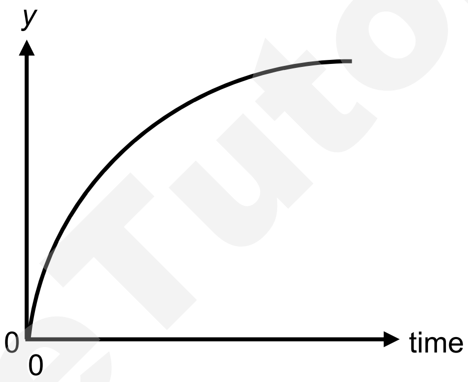
2 The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation

$$v = k\left(\frac{\Delta P}{\rho}\right)^n$$

where k is a constant that has no units. What is the value of n?

A $\frac{1}{2}$ **B** 1 **C** $\frac{3}{2}$ **D** 2

3 The graph below relates to the motion of a falling body.



Which statement is a correct description of the graph?

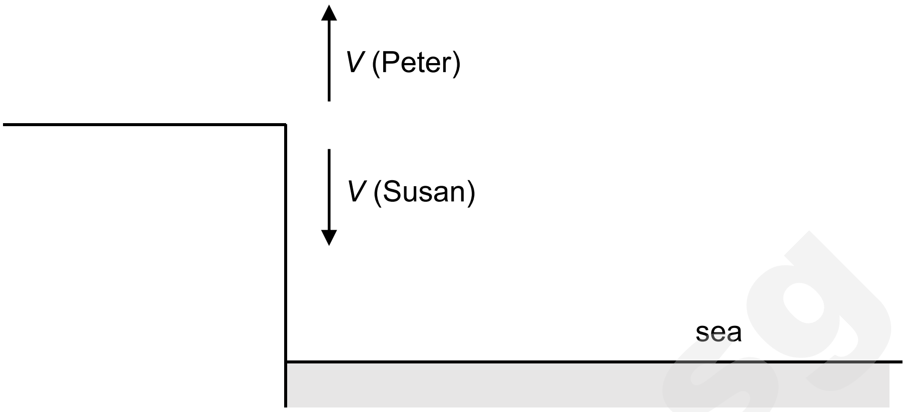
A y is distance and air resistance is negligible.

B y is distance and air resistance is not negligible.

C y is speed and air resistance is negligible.

D y is speed and air resistance is not negligible.

4 Peter and Susan both stand on the edge of a vertical cliff.



Susan throws a stone vertically downwards with speed V. At the same time, Peter throws a stone vertically upwards with the same speed V. Neglecting air resistance, which one of the following statements is true?

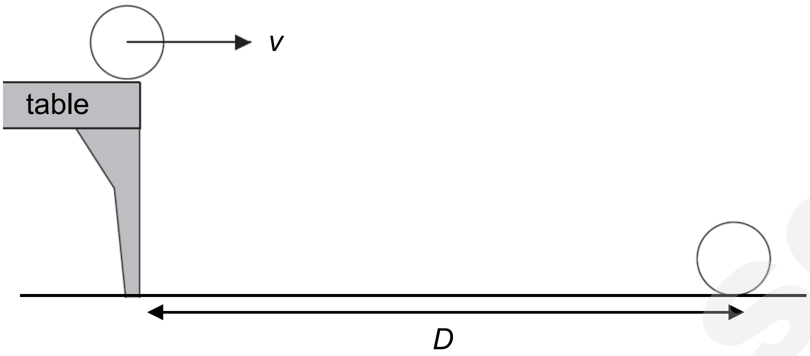
A The stone thrown by Susan will hit the sea first and with a greater speed than the stone thrown by Peter.

B Both stones will hit the sea with the same speed only when both stones have the same mass.

C The stone thrown by Susan will hit the sea first because it has a smaller displacement.

D Both stones will hit the sea with the same speed regardless of the height of the cliff.

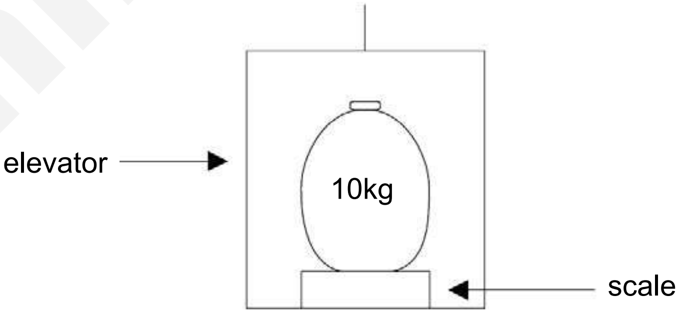
5 A ball rolls off a horizontally table with velocity *v*. It lands on the ground a time *T* later at a distance *D* from the foot of the table as shown in the diagram below. Air resistance is negligible.



A second heavier ball rolls off the table with velocity *v*. Which one of the following is correct for the heavier ball?

	Time to land	Distance from table
A	*T*	*D*
B	*T*	less than *D*
C	less than *T*	*D*
D	less than *T*	less than *D*

6 An elevator is used to either raise or lower sacks of potatoes. In the diagram, a sack of potatoes of mass 10 kg is resting on a scale that is resting on the floor of an accelerating elevator. The scale reads 12 kg.



Which of the following is the best estimate for the acceleration of the elevator?

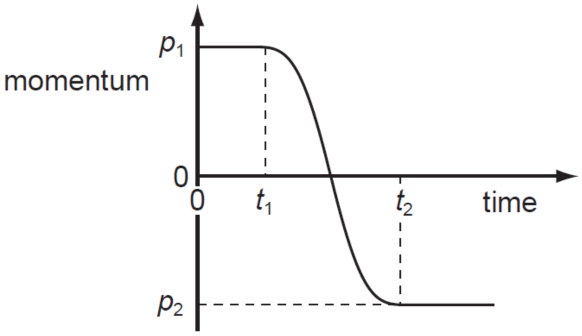
A 2.0 m s^{-2} downwards.

B 2.0 m s^{-2} upwards.

C 1.2 m s^{-2} downwards.

D 1.2 m s^{-2} upwards.

7 The graph shows the variation with time of the momentum of a ball as it is kicked in a straight line.



Initially, the momentum is p_1 at time t_1. At time t_2 the momentum is p_2.

What is the magnitude of the average force acting on the ball between times t_1 and t_2?

A $\dfrac{p_1 - p_2}{t_2}$ **B** $\dfrac{p_1 - p_2}{t_2 - t_1}$ **C** $\dfrac{p_1 + p_2}{t_2}$ **D** $\dfrac{p_1 + p_2}{t_2 - t_1}$

8 Two similar spheres, each of mass *m* and travelling with speed *v*, are moving towards each other.

The spheres have a head-on elastic collision.

Which statement is correct?

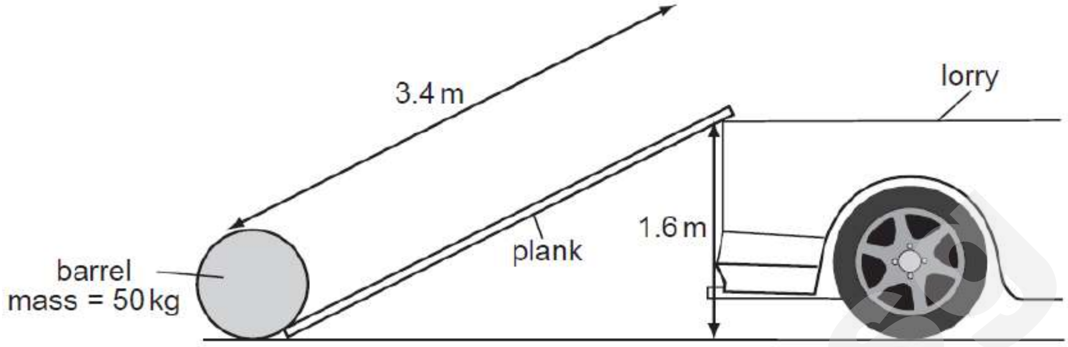
A The spheres stick together on impact.

B The total kinetic energy after impact is mv^2.

C The total kinetic energy during collision is mv^2.

D The total momentum before impact is $2mv$.

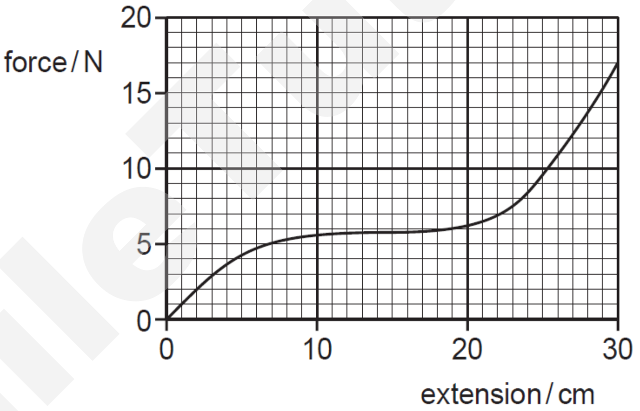
9 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a smooth plank 3.4 m long.



What is the minimum work done?

A 80 J **B** 170 J **C** 780 J **D** 1700 J

10 A rubber band is stretched by hanging weights on it and the force-extension graph is plotted from the results.



What is the best estimate of the elastic potential energy stored in the rubber band when it is extended by 30 cm?

A 2.0 J **B** 2.6 J **C** 5.1 J **D** 200 J

11 Which of the following is not true about two forces that give rise to a couple?

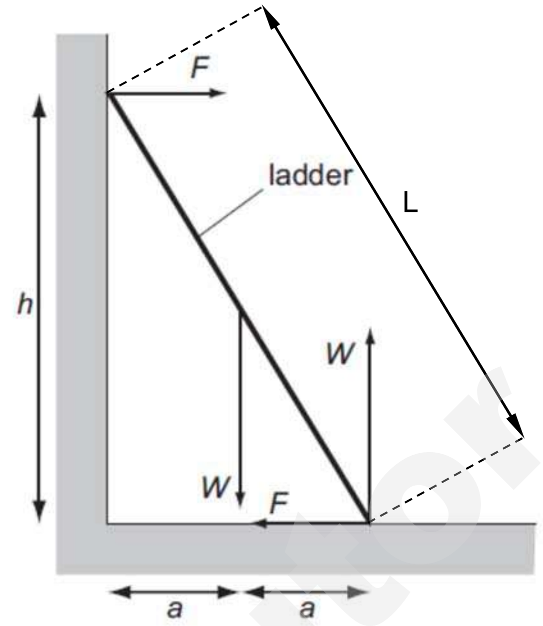
A They act in opposite directions.

B They both have the same magnitude.

C They both act on the same body.

D They both act at the same point.

12 A uniform ladder length *L* rests against a vertical wall where there is negligible friction. The bottom of the ladder rests on rough ground where there is friction. The top of the ladder is at a height *h* above the ground and the foot of the ladder is at a distance 2*a* from the wall. The diagram shows the forces that act on the ladder.



Which of the following equation is correct?

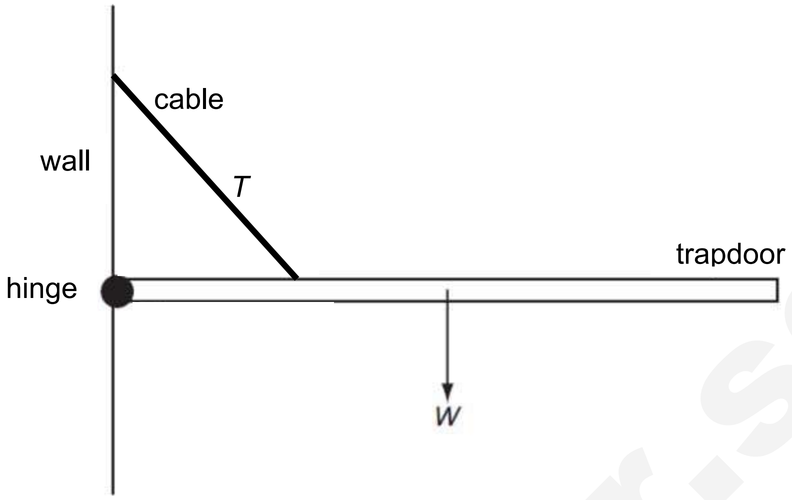
A ½ WL + FL = WL

B Wa + 2Wa = Fh

C Fh + Wa = 2Wa

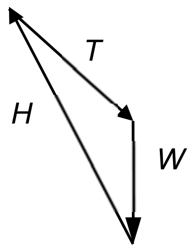
D Wa = FL

13 A hinged trapdoor is held closed in the horizontal position by a cable. Three forces act on the trapdoor: weight *W* of the door, tension *T* in the cable and a force *H* at the hinge.

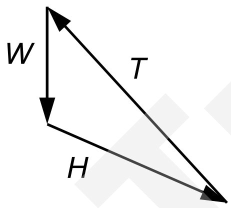


Which vector triangle could represent the forces acting on the trapdoor?

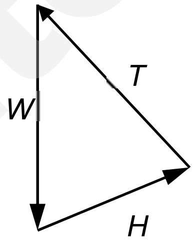
A



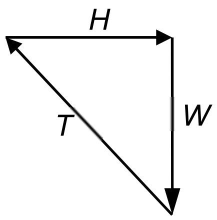
B



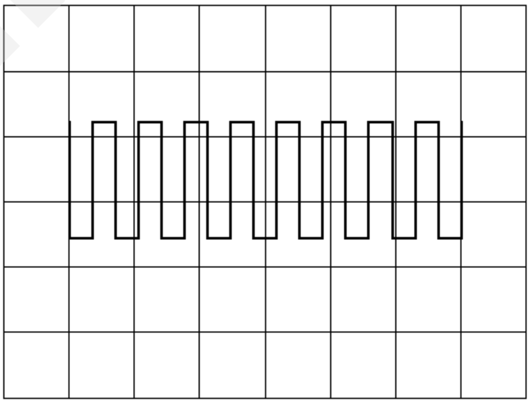
C



D



14 The diagram shows a square-wave trace on the screen of a cathode-ray oscilloscope with the time-base set at 10 ms per division.



What is the approximate frequency of the wave?

A 70 Hz **B** 140 Hz **C** 280 Hz **D** 1400 Hz

15 M and N are two electromagnetic waves.

The ratio $\dfrac{\text{wavelength of M}}{\text{wavelength of N}} = 10^5$.

What could M and N be?

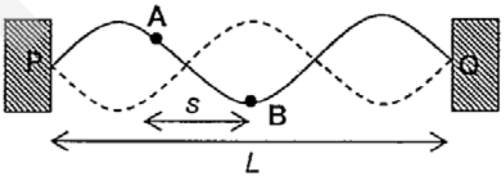
	M	N
A	microwaves	visible light
B	microwaves	γ-rays
C	γ-rays	microwaves
D	visible light	microwaves

16 A progressive wave is incident normally on a flat reflector. The reflected wave overlaps with the incident wave and a stationary wave is formed.

At an antinode, what could be the ratio $\dfrac{\text{displacement of the reflected wave}}{\text{displacement of the incident wave}}$ at any instant?

A -1 **B** 0 **C** 1 **D** 2

17 A guitar string of length L is stretched between two fixed points P and Q and made to vibrate transversely as shown.

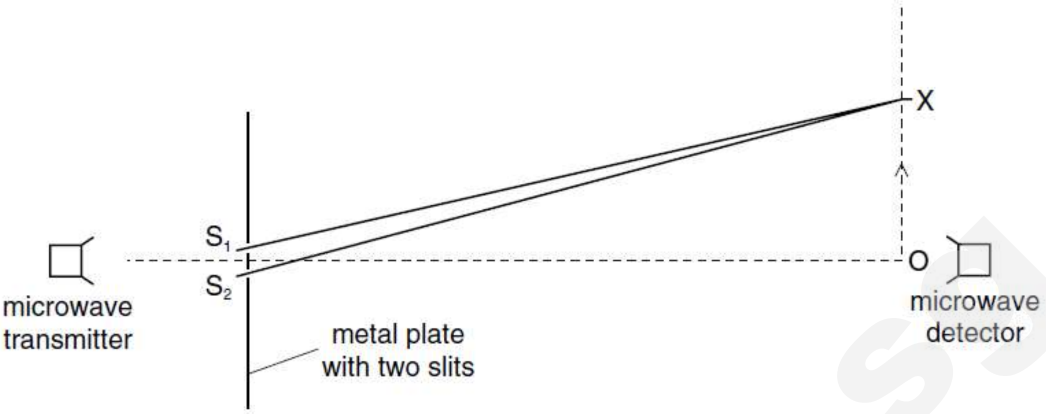


Two particles A and B on the string are separated by a distance s. The maximum kinetic energies of A and B are K_A and K_B respectively.

Which of the following gives the correct phase difference and maximum kinetic energies of the particles?

	Phase difference	Maximum kinetic energy
A	$\left(\dfrac{3s}{2L}\right)\times 360°$	$K_A < K_B$
B	$\left(\dfrac{3s}{2L}\right)\times 360°$	same
C	180°	$K_A < K_B$
D	180°	same

18 The diagram shows an experiment which has been set up to demonstrate two-source interference, using microwaves of wavelength λ.

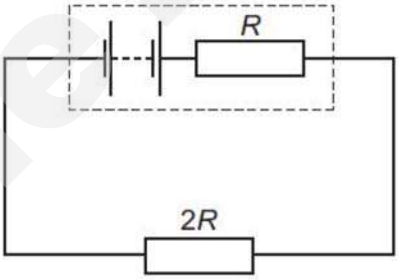


The detector is moved from O in the direction of the arrow. The signal detected decreases until the detector reaches the point X, and then starts to increase again as the detector moves beyond X.

Which equation correctly determines the position of X?

A OX = $\lambda/2$ **B** OX = λ **C** $S_2X - S_1X = \lambda$ **D** $S_2X - S_1X = \lambda/2$

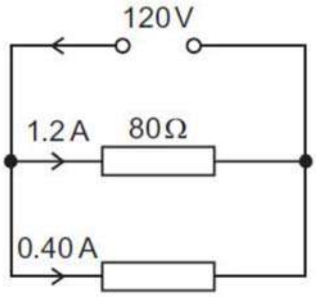
19 The diagram shows an electric circuit in which the resistance of the external resistor is 2*R* and the internal resistance of the source is *R*.



What is the ratio $\dfrac{\text{power in internal resistance}}{\text{power in external resistor}}$?

A $\dfrac{1}{4}$ **B** $\dfrac{1}{2}$ **C** 2 **D** 4

20 The electromotive force of a power supply is 120 V. It delivers a current of 1.2 A to a resistor of resistance 80 Ω and a current of 0.40 A to another resistor, as shown.



What is the internal resistance of the power supply?

A 15 Ω **B** 20 Ω **C** 60 Ω **D** 75 Ω

21 There is a current in a resistor for an unknown time.

Which two quantities can be used to calculate the energy dissipated by the resistor?

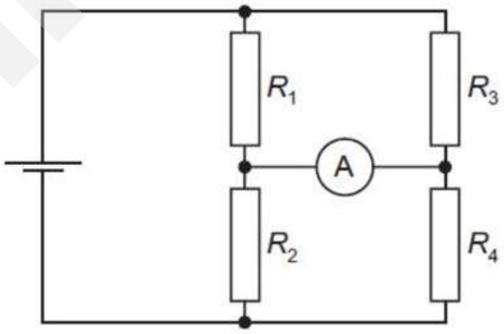
A The current in the resistor and the potential difference across the resistor.

B The resistance of the resistor and the current in the resistor.

C The total charge passing through the resistor and the resistance of the resistor.

D The total charge passing through the resistor and the potential difference across the resistor.

22 In the circuit shown, the reading on the ammeter is zero.



The four resistors have different resistances R_1, R_2, R_3 and R_4.

Which equation is correct?

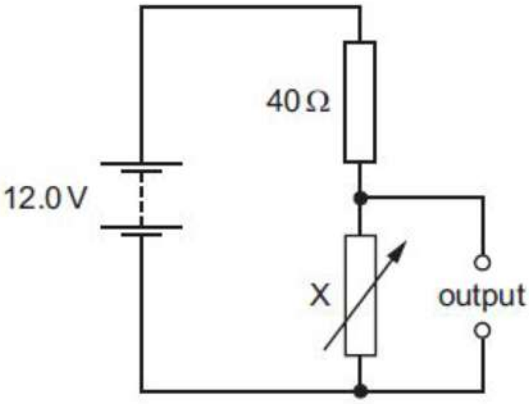
A $R_1 - R_3 = R_2 - R_4$

B $R_1 \times R_3 = R_2 \times R_4$

C $R_1 - R_4 = R_2 - R_3$

D $R_1 \times R_4 = R_2 \times R_3$

23 In the circuit shown, X is a variable resistor whose resistance can be changed from 5.0 Ω to 500 Ω. The e.m.f. of the battery is 12.0 V. It has negligible internal resistance.



What is the maximum range of values of potential difference across the output?

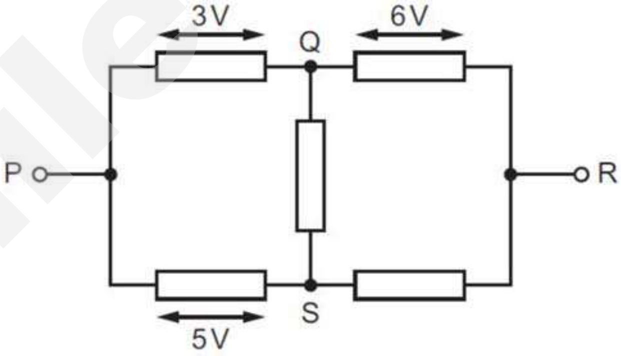
A 1.3 V to 11.1 V

B 1.3 V to 12.0 V

C 1.5 V to 11.1 V

D 1.5 V to 12.0 V

24 There is a current from P to R in the resistor network shown.



The potential difference (p.d.) between P and Q is 3 V.

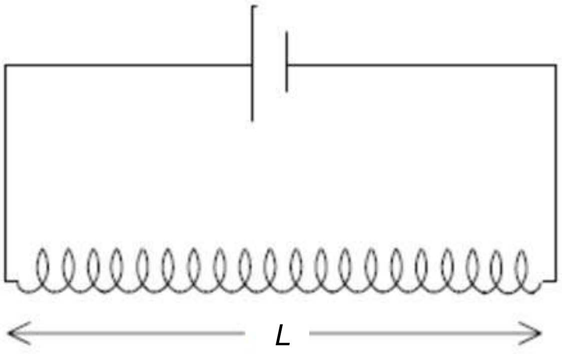
The p.d. between Q and R is 6 V.

The p.d. between P and S is 5 V.

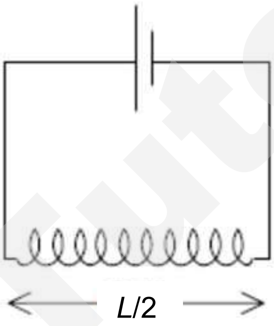
Which row in the table is correct?

	p.d. between Q and S	p.d. between S and R
A	2 V	4 V
B	2 V	10 V
C	3 V	4 V
D	3 V	10 V

25 The diagram shows a long solenoid of length *L* connected to a battery of negligible internal resistance. The magnetic field strength at the centre of the solenoid, *B* is given by $B = \mu_o nI$, where is μ_o is a constant known as the permeability of free space, *n* is the number of coils per unit length of solenoid, and *I*, the current through the solenoid.



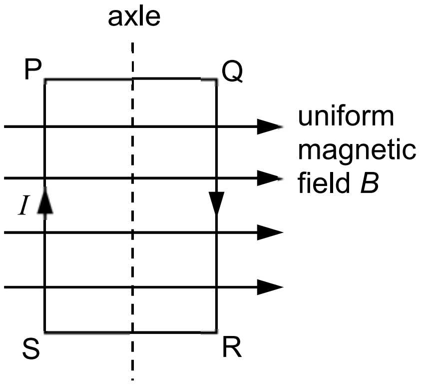
The solenoid is now disconnected from the battery and cut in half and one of the halves is reconnected to the battery as shown below.



What is the best estimate of the field strength at the centre of this solenoid?

A 0.5*B* **B** *B* **C** 2*B* **D** 4*B*

26 A coil, mounted on an axle, has its plane parallel to the flux lines of a uniform magnetic field *B*, as shown. A current *I* flows through the coil.



Which of the following statement is correct for the position of the coil as shown above?

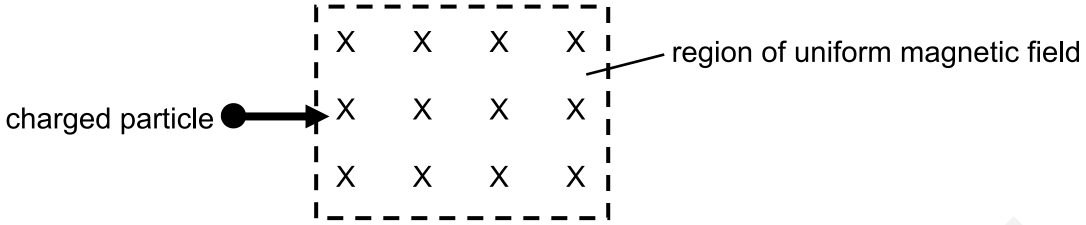
A Sides PQ and SR tend to attract each other.

B Sides SP and RQ tend to attract each other.

C There are no forces due to B on the sides PQ and SR.

D There are no forces due to B on the sides SP and RQ.

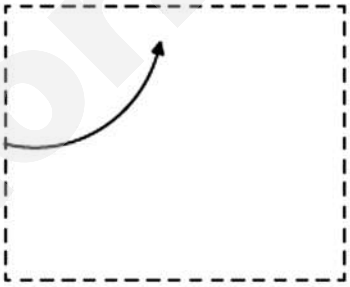
27 A negatively charged particle enters a region of uniform magnetic field. The direction of the magnetic field is into the plane of the paper as shown in the diagram below.



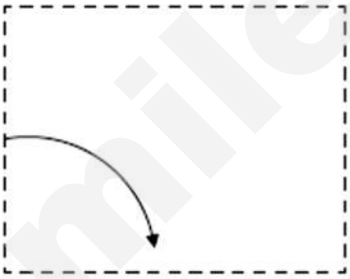
Which of the following diagrams correctly shows the path of the charged particle while in the region of magnetic field?

A

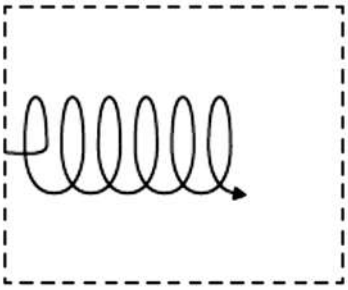
B



C

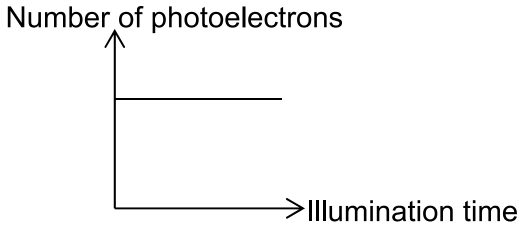


D

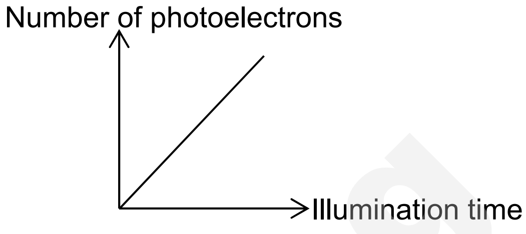


28 When electromagnetic radiation of frequency *f* falls on a particular metal surface, photoelectrons are emitted. Which graph is obtained when the intensity of the electromagnetic radiation is kept constant?

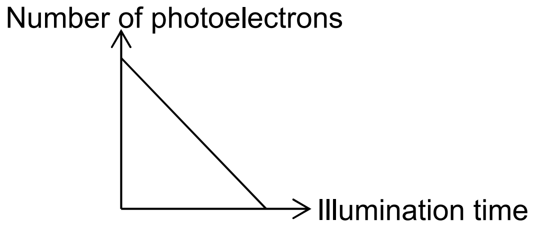
A



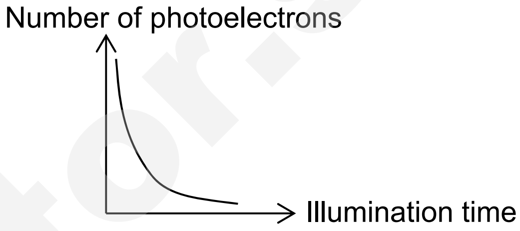
B



C



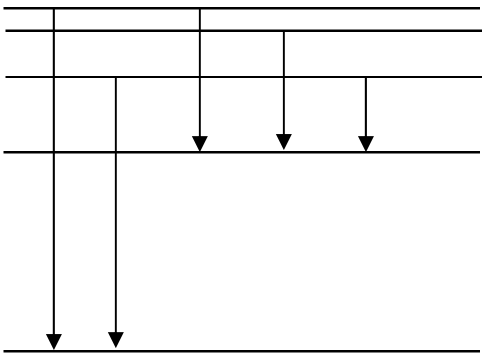
D



29 Let λ_0 be the de Broglie wavelength of an electron accelerated from rest through a potential difference of 10 V and let λ_1 be that of an electron accelerated from rest through a potential difference of 1000 V. What is the value of the ratio λ_0 / λ_1 ?

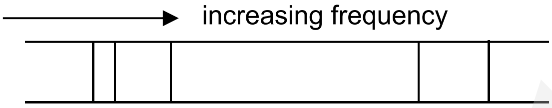
A 0.1 **B** 1 **C** 10 **D** 100

30 The figure below shows five energy level of an atom. Five transition lines are indicated, each of which produces photons of definite energy and frequency.



Which one of the spectra below best corresponds to the set of transitions indicated?

A



B

C

D

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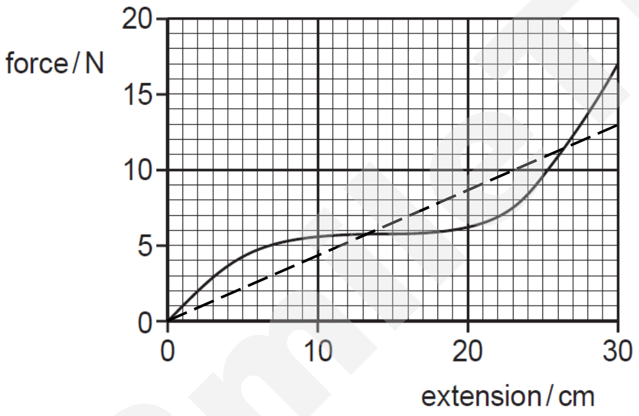
2017 AJC JC2 H1 Physics Prelim Solutions
Paper 1 (30 marks)

Answer

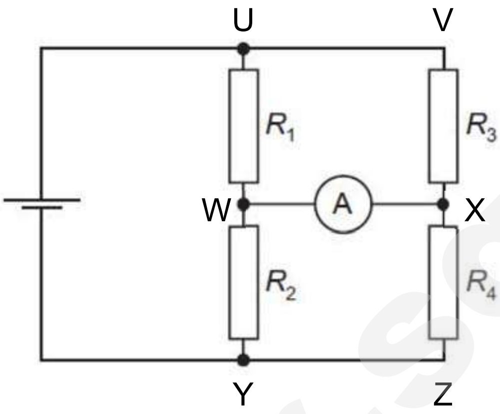
1	2	3	4	5	6	7	8	9	10
D	A	D	D	A	B	B	B	C	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	C	B	B	A	C	C	D	B	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	D	A	A	C	C	C	B	C	B

No	Answer & Solution
1	**Ans: D** 2000 pV = 2000 x 10^{-12} V = 2 x 10^{-9} V = 2 x 10^{-15} x 10^{6} V = 2 x 10^{-15} x M V p.d. = work done per unit charge, hence V is equivalent to J C^{-1}
2	**Ans: A** Unit of v = m s^{-1} Unit of $\frac{\Delta P}{\rho} = \frac{kg\,m\,s^{-2}\,m^{-2}}{kg\,m^{-3}} = m^2\,s^{-2}$ $\left(m^2\,s^{-2}\right)^n = ms^{-1}$ So n = $\frac{1}{2}$
3	**Ans : D** A falling object will continue to gain speed regardless of the effect of air resistance. Since speed is the gradient of distance-time graph, a distance-time graph of a falling object will have increasing gradient. With air resistance, gradient becomes constant at terminal velocity. Without air resistance, gradient will continue to increase. Hence quantity *y* cannot be distance, and Options A and B are wrong. Answer C is wrong because without air resistance, the body will be free-falling with constant acceleration = *g*. Speed will continue to increase at a constant rate. Answer D shows the speed increasing at a decreasing rate as air resistance increased. When air resistance is equal to weight, the body will fall with terminal velocity (speed).
4	**Ans : D** Let height of cliff be *h*. Both stones experience a downward acceleration of *g*. Taking upwards as positive. <u>Velocities when the stones hit the sea using $v^2 = u^2 + 2as$</u> For Peter's stone : $V_P^2 = (+V)^2 + 2(-g)(-h) = V^2 + 2gh$ For Susan's stone : $V_S^2 = (-V)^2 + 2(-g)(-h) = V^2 + 2gh$ Thus, both stones will hit the sea with the same speed regardless of the height and mass. Alternative method using COE : Total initial energy = Total final energy

	For Peter’s stone : $\frac{1}{2} m_PV^2 + m_Pgh = \frac{1}{2} m_PV_f^2$ For Susan’s stone : $\frac{1}{2} m_SV^2 + m_sgh = \frac{1}{2} m_SV_f^2$ We can cancel the masses on both sides of the equation, and thus V_f will be independent of mass, both stones have the same final speed. Time taken to hit the sea using v = u + at For Peter’s stone : $-V_P = (+V) + (-g)t_P$ $t_P = (V_P + V) / g$ For Susan’s stone : $-V_S = (-V) + (-g)t_S$ $t_S = (V_S - V) / g$ Since $\lvert V_p \rvert = \lvert V_S \rvert$, $t_S < t_P$. No information about the mass or height of the cliff is required.
5	**Ans : A** For the projectile motion, horizontal speed is constant, *v*. Vertical speed is zero initially and acceleration is *g*, downwards. Let the height of the table be *h*. Using $s = ut + \frac{1}{2} at^2$ $h = 0 + \frac{1}{2} gT^2$ $T = \sqrt{\frac{2h}{g}}$ *T* is independent of mass. Range, $D = vT$. Since both *v and T* are independent of mass, *D* will remain the same.
6	**Ans : B** The scale reads the contact force between the sack and scale. Since the scale reading is larger than the mass, the upward contact force must be larger than the downward weight. The sack experiences a net force and acceleration upwards. $(12 – 10) \times 9.81 = 10 \times$ acceleration acceleration = 1.962 ≈ 2.0 m s^{-2}.
7	**Ans : B** Average force = $\Delta p / \Delta t = \frac{p_2 - p_1}{t_2 - t_1}$ For magnitude, $\left\lvert \frac{p_2 - p_1}{t_2 - t_1} \right\rvert = \left\lvert \frac{p_1 - p_2}{t_2 - t_1} \right\rvert$
8	**Ans : B** For elastic collision, total KE is conserved OR relative speed of approach equals to relative speed of separation. Total KE before impact = $\frac{1}{2} mv^2 + \frac{1}{2} mv^2 = mv^2$ Thus, total KE after impact = mv^2. Answer C is wrong because during collision, KE is not conserved. It is converted to elastic PE then back to KE. Answer D is wrong because total momentum before impact = mv + m(-v) = 0

	Answer A is wrong because when the spheres stick together, it is already a perfectly inelastic collision. Also note that relative speed of approach = $u_1 - u_2 = v - (-v) = 2v$ (non-zero). If the spheres stick together, they will share the same speed and relative speed of separation will be zero.
9	**Ans : C** Work done is minimum if the force applied is just enough to overcome the barrel's weight on its way up the plank, with no change in speed. The barrel gains GPE without any gain in KE. Minimum work = Gain in GPE = mgh = 50 x 9.81 x 1.6 = 784.8 J ≈ 780 J Alternative method : Work done = Force x distance = mg sin θ x d = 50 x 9.81 x (1.6/3.4) x 3.4 = 784. 8 J
10	**Ans : A** EPE = area under force-extension graph ≈ area under triangle under dotted line ≈ ½ x 0.3 x 13 = 1.95 J Alternative method by counting big squares : Total area = 2 big squares x area of 1 big square = 2 x 0.1 x 10 = 2.0 J 
11	**Ans: D** All options are correct description of a couple except option D. If the two forces act at the same point, there will not be any rotational effect about that point.
12	**Ans: C** Taking moment about the top of ladder: Clockwise moment = anticlockwise moment F h + W a = 2W a Note: distance must be perpendicular to the line of action of the force.
13	**Ans: B** For equilibrium, all three forces must meet at a common point, which is a point below trapdoor along the line of action of *W*. Hence option C and D is wrong as direction of *H* is wrong. Tension must act away from the door, hence direction of *T* is wrong. So option A is wrong.

14	**Ans: B** 8.5 periods = 6 squares = 60 ms T = 60 ms / 8.5 Frequency = 1 / T = 8.5 / (60 x 10^{-3}) = 141.6 ≈ 140 Hz
15	**Ans: A** Wavelength of M $>$ Wavelength of N by 10^5. Wavelength of microwave (10^{-2} m or ~cm) > visible light (10^{-7} m or a few hundreds of nm) > γ – ray (<10^{-10} m)
16	**Ans: C** Reflected wave and incident wave have the same frequency and amplitude. At an antinode, displacement of reflected wave = displacement of incident wave at any instant.
17	**Ans: C** Since particles A and B are at two sides of a node of a stationary wave, they are anti-phase. Hence phase difference is 180° Maximum KE is proportional to amplitude. Since amplitude of A < amplitude of B, $K_A < K_B$
18	**Ans: D** First minimum occurs at X Hence path difference = $S_2X - S_1X = \lambda /2$
19	**Ans : B** Same current, I in series circuit. Use power, $P = I^2R$ ratio = $I^2R/ I^2(2R)$ = ½
20	**Ans : A** Terminal p.d. = 1.2 x 80 = 96 V ---(1) Terminal p.d. = 120 – (1.2+0.40) r ---(2) Equating (1) and (2), r = 15 Ω <u>Alternative method:</u> Let r be the internal resistance of supply and X the resistance of the lower resistor. p.d. across 80 Ω resistor = p.d. across the lower resistor, $X = \dfrac{1.2 \text{ x } 80}{0.40} = 240\ \Omega$ total current = 1.2 + 0.40 = 1.6 A = supply voltage/total resistance $1.6 = \dfrac{120}{r + \left(\dfrac{80 \text{ x } 240}{80 + 240}\right)}$ $r = 15\ \Omega$

21	**Ans : D** Energy = QV
22	**Ans : D** U and V have the same potential. Y and Z have the same potential. When the reading on the ammeter is zero, W and X have the same potential, same current, I_1 through R_1 and R_2. Same current, I_3 through R_3 and R_4 p.d. across UW = p.d. across VX $I_1 R_1 = I_3 R_3$ p.d. across WY = p.d. across XZ $I_1 R_2 = I_3 R_4$ Hence, $\frac{R_1}{R_2} = \frac{R_3}{R_4} \Rightarrow R_1 \text{ x } R_4 = R_2 \text{ x } R_3$ 
23	**Ans : A** <u>Method 1</u> – potential divider method $V_{output} = \left(\frac{V_X}{V_X + 40}\right) \text{x } 12.0 \text{ V}$ For min X = 5.0 Ω, V_{output} = 1.3 V For max X = 500 Ω, V_{output} = 11.1 V <u>Method 2</u> – same series current method $I = \left(\frac{12.0}{X + 40}\right)$, so $V_{output} = IX = \left(\frac{12.0}{X + 40}\right)(X)$ For min X = 5.0 Ω, I = V_{output} = 1.3 V For max X = 500 Ω, V_{output} = 11.1 V Hence, V_{output} is between 1.3 V and 11.1 V
24	**Ans : A** Let V_R = 0 V. V_Q = 6 V $V_P - V_Q = 3 \text{ V} \Rightarrow V_P = 9 \text{ V}$ $V_P - V_S = 5 \text{ V} \Rightarrow V_S = 4 \text{ V}$ Hence, $V_{QS} = 6 - 4 = 2$ V and $V_{SR} = 4 - 0 = 4$ V
25	**Ans: C** As the number of coils is halved, solenoid length is also halved, hence *n* does not change. As $I = V/R$ where $R = \rho L/A$, since *L* is halved, *R* will be halved and I will be twice as before. Hence *B* will be twice.
26	**Ans: C** No forces acting on PQ and SR due to *B* as *B* is parallel to the current in PQ and SR.
27	**Ans: C** Using Fleming's Left Hand Rule, force on the negatively charged particle is downwards.
28	**Ans : B** The number of photoelectrons emitted per second $(\frac{N}{t})$ is directly proportional to the intensity of incident radiation. Since the intensity of radiation is constant, the number of photoelectrons varies proportional with time.

29	**Ans : C** $qV = KE$ $qV = p^2/2m$ $\Rightarrow \quad p = \sqrt{(2mqV)}$ $\lambda = h/p \quad = \quad h/\sqrt{(2qmV)}$ since m and q same, $\lambda \, \alpha 1/\sqrt{V}$ $\lambda_0 / \lambda_1 = \sqrt{(1000/10)} = 10$
30	**Ans : B** $\Delta E = hf$ largest energy change ➔ largest frequency of radiation emitted

Name: ______________________________ (   )   PDG: ______/ 16

ANDERSON JUNIOR COLLEGE

2017 JC2 Preliminary Examination

PHYSICS Higher 1 8866/02

Paper 2 Structured Questions

Thursday 14 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class index number and PDG in the spaces provided above.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Paper 1 (30 marks)	
Paper 2 (80 marks)	
1	
2	
3	
4	
5	
6	
7	
8	
Significant Figure	
Total (110 marks)	

This document consists of **22** printed pages and **0** blank page.

Data

speed of light in free space,	$c = 3.00 \times 10^8$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows a trolley of mass 0.80 kg, on a bench surface, connected to a mass *M* by a string. The mass *M* is released and the trolley moves along the surface. Fig. 1.2 shows the variation of the velocity *v* of the trolley with time *t* for the motion from A to B.

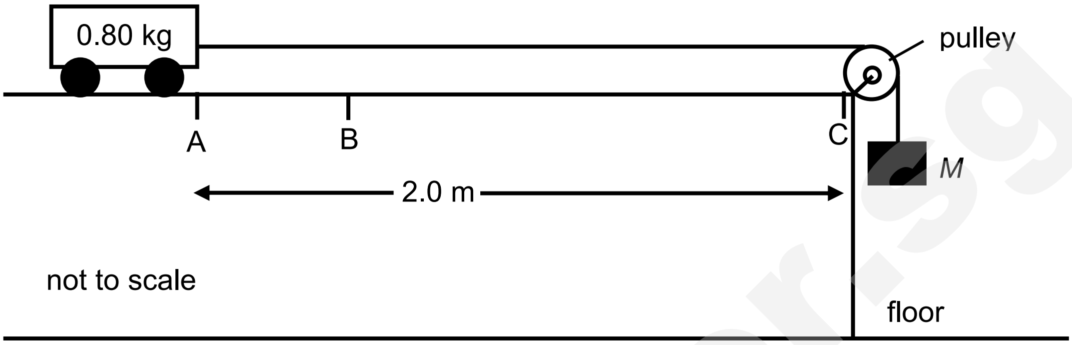


Fig. 1.1

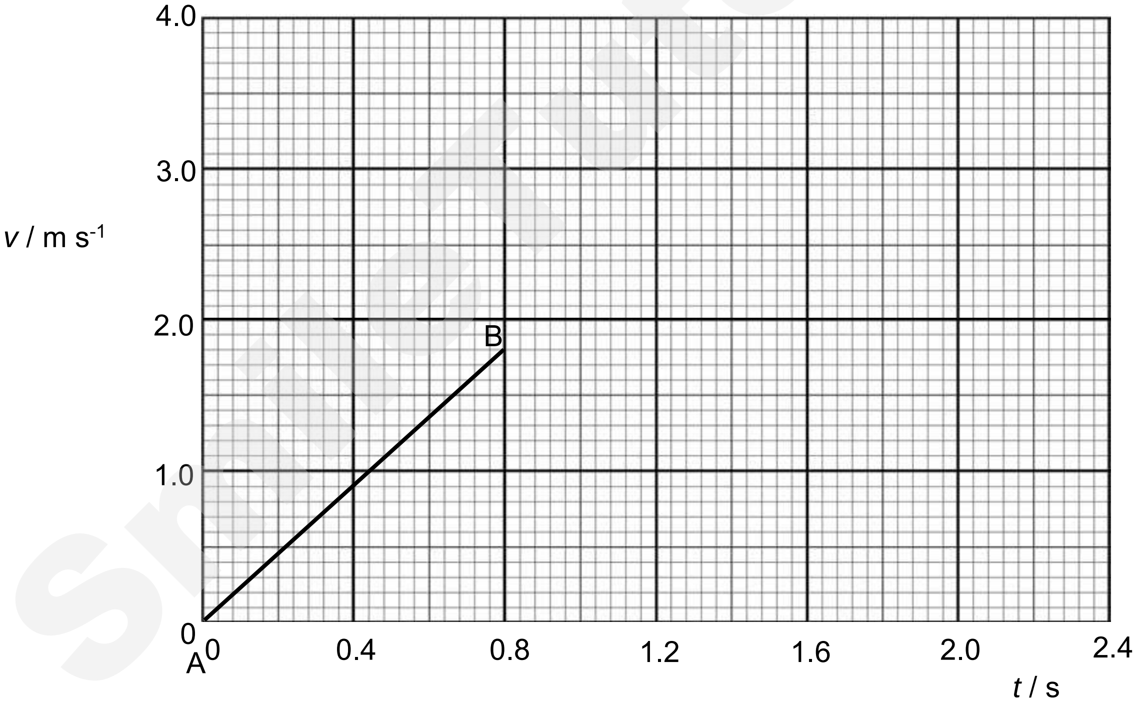


Fig. 1.2

(a) Calculate the acceleration of the trolley between A and B.

acceleration = …………………………….m s^{-2} [1]

(b) Show that the distance from A to B is 0.72 m.

[1]

(c) When the trolley reaches B the mass *M* has just reached the floor.

(i) Ignoring any resistive forces, calculate the time it takes the trolley to travel from B to C.

time = …………………………………..s [2]

(ii) On Fig. 1.1, complete the graph for the trolley moving from B and coming to rest at the pulley at C. [2]

(iii) Using energy considerations, determine the mass *M*.

M = …………………………………..kg [2]

2 **(a)** Apparatus used to produce stationary waves on a stretched string is shown in Fig. 2.1.

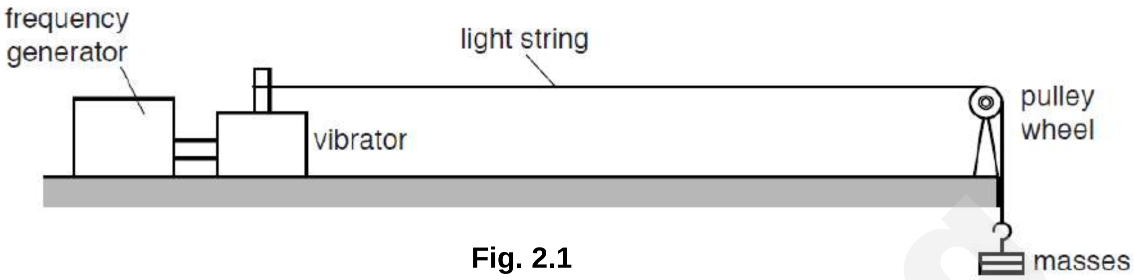


Fig. 2.1

The frequency generator is switched on.

(i) Describe two adjustments that can be made to the apparatus to produce stationary waves on the string.

1. ………………………………………………………………………………………………..

………………………………………………………………………………………………..

2. ………………………………………………………………………………………………..

…………………………………………………………………………………………….... [2]

(ii) Describe the features that are seen on the stretched string that indicate stationary waves have been produced.

…………………………………………………………………………………………….... [1]

(b) The variation with time *t* of the displacement *x* of a particle caused by a progressive wave R is shown in Fig. 2.2. For the same particle, the variation with time *t* of the displacement *x* caused by a second wave S is also shown in Fig. 2.2.

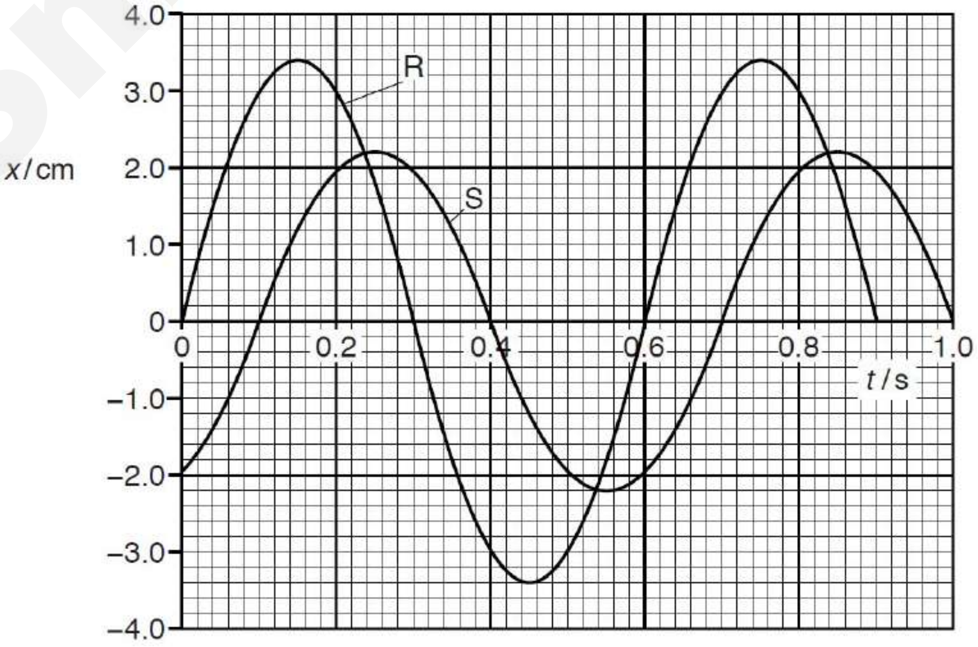


Fig 2.2

(i) Determine the phase difference between wave R and wave S. Include an appropriate unit.

phase difference = …………………………….. [1]

(ii) Calculate the ratio

$$\frac{\text{intensity of wave R}}{\text{intensity of wave S}}.$$

ratio = …………………………….. [2]

3 **(a)** State what is meant by the *diffraction* of a wave.

……………………………………………………………………………………………………..

……………………………………………………………………………………………..........[1]

(b) An arrangement for demonstrating the interference of light is shown in Fig. 3.1.

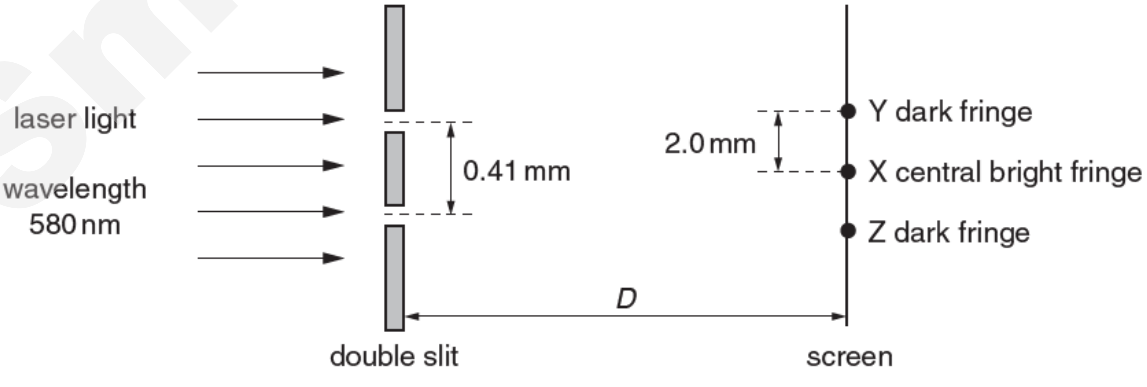


Fig. 3.1 (not to scale)

The wavelength of the light from the laser is 580 nm. The separation of the slits is 0.41 mm. The perpendicular distance between the double slit and the screen is *D*.

Coherent light emerges from the slits and an interference pattern is observed on the screen. The central bright fringe is produced at point X. The closest dark fringes to point X are produced at points Y and Z. The distance XY is 2.0 mm.

(i) Explain why a bright fringe is produced at point X.

………………………………………………………………………………………………..................

………………………………………………………………………………………………..................

………………………………………………………………………………………………..................

……………………………………………………………………………………………………..... [2]

(ii) Calculate the distance *D*.

D = ……………………. m [2]

(iii) The intensity of the light passing through the two slits was initially the same. The intensity of the light through **one** of the slits is now reduced. Compare the appearance of the fringes before and after the change of intensity.

………………………………………………………………………………………………..................

………………………………………………………………………………………………..................

………………………………………………………………………………………………..................

……………………………………………………………………………………………………..... [2]

4 A long, straight wire Z carrying a direct current of 2.0 A flows in the direction as shown in Fig. 4.1.

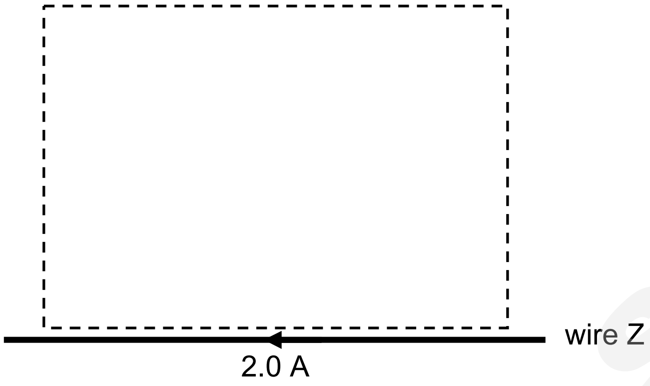


Fig. 4.1

(a) Using symbols X or ⊙ to represent the direction of magnetic field into or out of the paper respectively, draw on Fig. 4.1 the pattern of magnetic field produced by wire Z in the region indicated by the dotted box. [2]

(b) A similar wire Y is placed parallel to wire Z. The separation *d* between the two wires is 1.0 m. Wire Y is carrying a current of 1.0 A in the same direction as wire Z.

(i) Calculate the resultant magnetic flux density at the mid-point between the two wires. Given that the magnetic flux density *B* due to a long straight wire at a point is

$$B = \frac{\mu_0 I}{2\pi r}$$

where μ_0, the permeability of free space, is $4\pi \times 10^{-7}$ J s^2 C^{-2} m^{-1}, *r* is the perpendicular distance from the point to the wire and I is the current flowing through the wire.

magnetic flux density = ……………………………T [2]

(ii) Explain, with the aid of sketches, the direction of the forces which exist between the two wires.

……………………………………………………………………………………………………

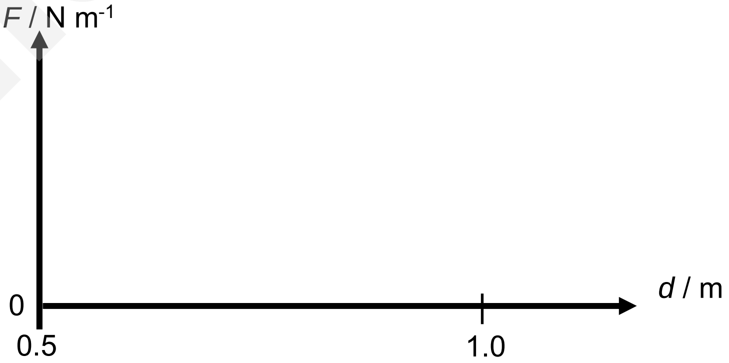
……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[3]

(iii) Wire Y moves towards wire Z such that the separation *d* of the two wires decreases from 1.0 m to 0.5 m. Wire Y is maintained parallel to wire Z throughout the motion. Sketch the variation with separation *d* of the force per unit length *F* experienced by wire Y due to the magnetic field of wire Z.



[2]

5 A mass *M* is moving at 5.00 m s^{-1} along a horizontal frictionless guide which bends into a vertical circle of radius r, as illustrated in Fig. 5.1.

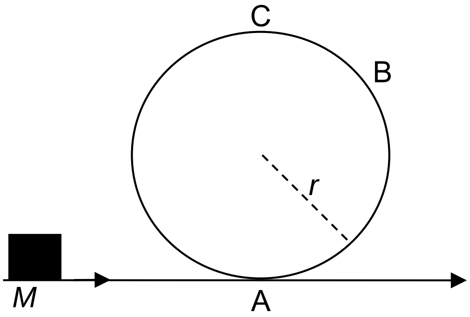


Fig. 5.1

Fig. 5.2 and Fig 5.3 show the velocity-time graphs for the vertical and horizontal components respectively of the velocity along the section ABC of the curve.

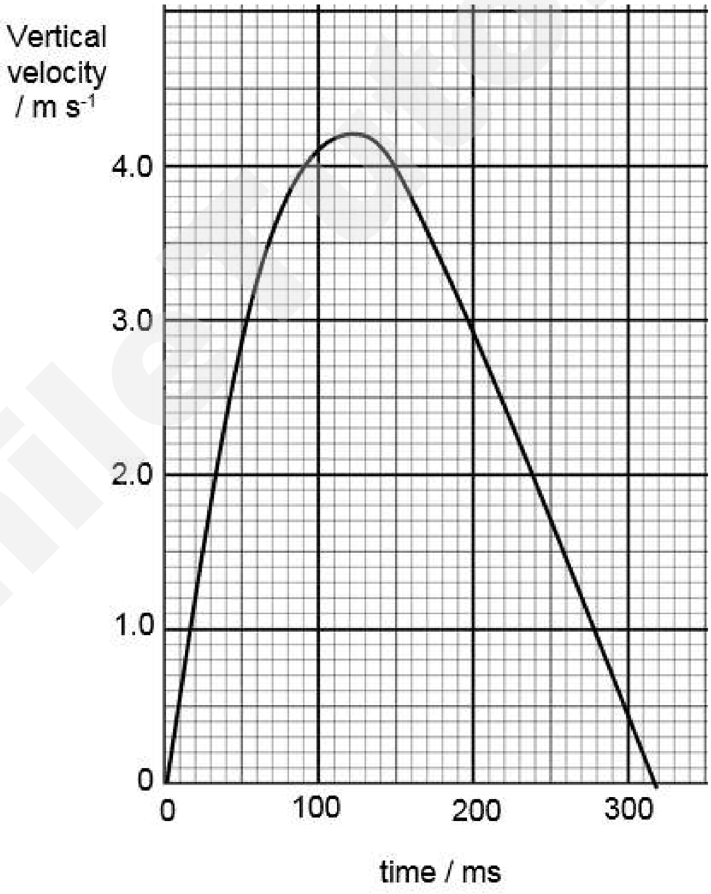


Fig. 5.2

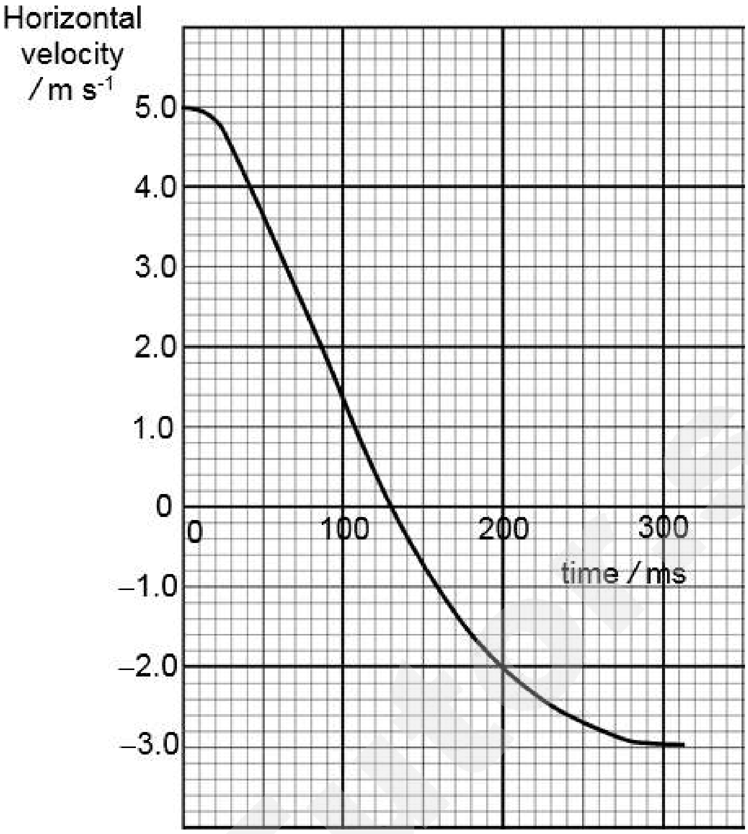


Fig. 5.3

(a) With the aid of Fig. 5.2, estimate the radius *r* of the vertical circle.

r = ……………………… m [3]

(b) **(i)** From Fig. 5.2 and Fig. 5.3, find the vertical and horizontal components of the acceleration of the mass *M* at B, 200 ms after it passes the point A.

vertical component of the acceleration = …..………. m s^{-2} [1]

horizontal component of the acceleration = ……..……. m s^{-2} [1]

(ii) Hence, find the magnitude and the direction of the resultant acceleration, made with the horizontal, of the mass *M* at B.

magnitude of acceleration = ……….……. m s^{-2} [1]

direction of acceleration = …………….……. ° [1]

(iii) On fig. 5.4, draw the resultant force acting on the mass *M* at B.

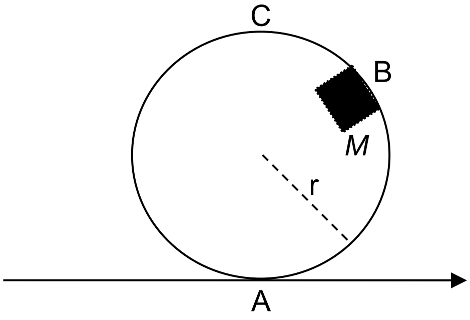


Fig. 5.4

[1]

(c) Without detailed mathematical calculation, deduce the area under the graph in Fig. 5.3. Explain your answer.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..[2]

Section B

Answer **two** of the questions from this section.

6 **(a)** Fig. 6.1 illustrates a model helicopter that is hovering in a stationary position.

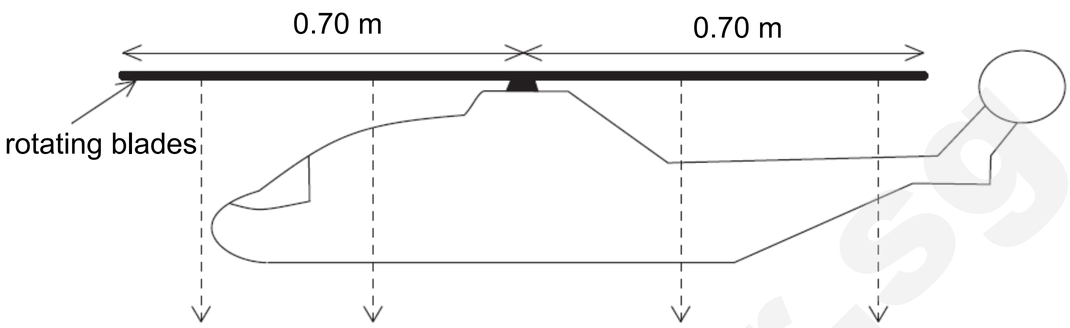


Fig. 6.1

(i) The rotating blades of the helicopter force a column of air to move downwards. Using Newton's Laws, explain how this may enable the helicopter to remain stationary.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(ii) The length of each blade of the helicopter is 0.70 m. Deduce that the area that the blades sweep out as they rotate is 1.5 m^2.

[1]

(iii) It is assumed that all the air beneath the blades is pushed vertically downwards with the same speed of 4.0 m s^{-1}. No other air is disturbed. The density of the air is 1.2 kg m^{-3}.

Calculate, for the air moved downwards by the rotating blades,

1. the mass per second.

mass per second = ………………… kg s^{-1} [2]

2. the rate of change of momentum.

rate of change of momentum = ………………… kg m s^{-2} [2]

(iv) Calculate the mass of the helicopter and its load.

mass of helicopter and its load =…………………. kg [2]

(b) A car and a truck are both travelling at the speed limit of 60 km h^{-1} but in opposite directions as shown in Fig. 6.2. The truck has twice the mass of the car.

Fig. 6.2

The vehicles collide head-on and become entangled together.

(i) Deduce and explain the final direction of the entangled vehicles after collision.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………...............[2]

(ii) Determine the speed of the combined wreck immediately after the collision.

speed = …………………… km h^{-1} [2]

(iii) Explain whether the acceleration of the car is greater, equal or smaller than the acceleration of the truck during collision.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………..............[2]

(iv) Both the car and truck drivers are wearing seat belts. Explain which driver experiences a greater restraint by the seat belt. (Assume that the masses of both drivers are approximately equal).

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………..............[2]

(v) The total kinetic energy of the system decreases as a result of the collision. Explain whether the principle of conservation of energy is violated?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………..............[2]

7 **(a)** Define

(i) resistance

………………………………………………………………………………………………..................

……………………………………………………………………………………………….... [1]

(ii) the ohm

………………………………………………………………………………………………..................

……………………………………………………………………………………………….... [1]

(b) Sketch the *I*–*V* characteristics of a metallic conductor at constant temperature on Fig. 7.1 and a filament lamp on Fig. 7.2. [2]

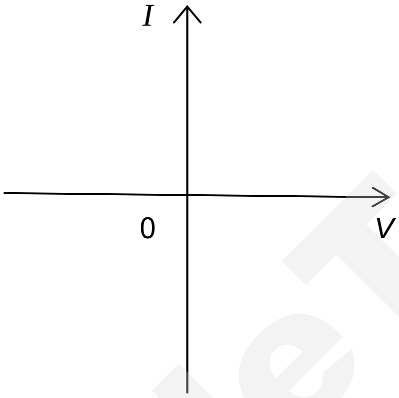


Fig. 7.1

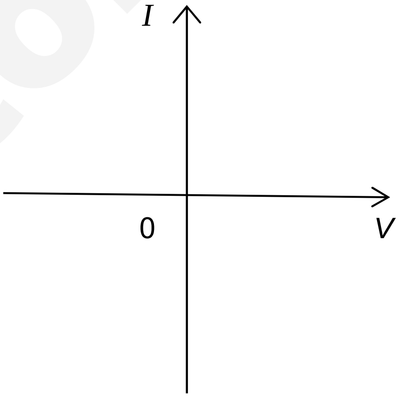


Fig. 7.2

(c) A copper wire of diameter 1.4 mm connects to the tungsten filament wire of a light bulb of diameter 0.020 mm. A current of 0.42 A flows through both of the wires. Copper has 8.0 x 10^{28} electrons per cubic metre and tungsten can be assumed to have 3.4 x 10^{28} electrons per cubic metre.

(i) The filament is 2.0 m long when uncoiled and has a resistivity of 5.5 x 10^{-8} Ωm.

For the filament bulb,

1. show that the resistance is 350 Ω,

[1]

2. calculate the power dissipated.

power dissipated = ………………………………W [1]

(ii) State **two** important properties of a conductor used to make heating elements.

……………………………………………………………………………………………... [2]

(d) A battery of electromotive force (e.m.f.) 14 V and negligible internal resistance is connected to a resistor network, as shown in Fig. 7.3.

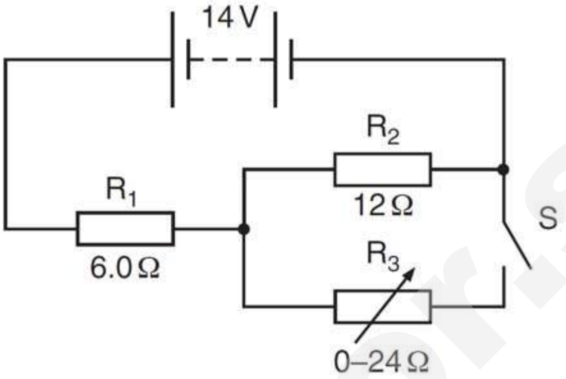


Fig. 7.3

R_1 and R_2 are fixed resistors of resistances 6.0 Ω and 12 Ω respectively. R_3 is a variable resistor.

Switch S is **closed**.

(i) Calculate the current in the battery when the resistance of R_3 is set

1. at zero,

current = …………………………….A [2]

2. at 24 Ω.

current = …………………………….A [2]

(ii) Use your answers in **(d)(i)** to calculate the change in the total power produced by the battery when the resistance of R_3 is changed from zero to 24 Ω.

change in power = …………………………….W [2]

(e) A thermistor has resistance 3900 Ω at 0 °C and resistance 1250 Ω at 30 °C. The thermistor is connected into the circuit of Fig. 7.4 in order to monitor temperature changes.

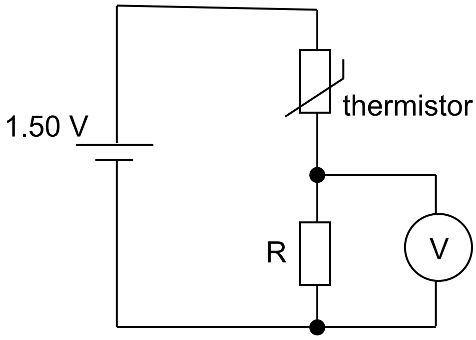


Fig. 7.4

The battery of e.m.f. 1.50 V has negligible resistance and the voltmeter has infinite resistance.

(i) The voltmeter is to read 1.00 V at 0 °C. Show that the resistance of resistor R is 7800 Ω.

[2]

(ii) The temperature of the thermistor is increased to 30 °C. Determine the reading on the voltmeter.

reading = ……………………………V [2]

(iii) The voltmeter in Fig. 7.4 is replaced with one having a resistance of 7800 Ω. Calculate the reading on this voltmeter for the thermistor at a temperature of 0 °C.

reading = ……………………………V [2]

8 **(a)** State and explain two relations in which the Planck constant *h* is the constant of proportionality.

1. ……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

2. ……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[4]

(b) Experiments are conducted to investigate the photoelectric effect.

(i) It is found that, on exposure of a metal surface to light, either electrons are emitted immediately or they are not emitted at all.

Suggest why this observation does not support a wave theory of light.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[3]

(ii) Data for the wavelength λ of the radiation incident on the metal surface and the maximum kinetic energy E_k of the emitted electrons are shown in Fig. 8.1.

λ /nm	E_k /10^{-19} J
650	-
240	4.44

Fig. 8.1

1. Without any calculation, suggest why no value is given for E_k for radiation of wavelength 650 nm.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

2. Use data from Fig. 8.1 to determine the work function energy of the surface.

work function energy = ... J [2]

(iii) Radiation of wavelength 240 nm gives rise to a maximum photoelectric current I. The intensity of the incident radiation is maintained constant and the wavelength is now reduced.

State and explain the effect of this change on

1. the maximum kinetic energy of the photoelectrons,

....

....

.... [2]

2. the maximum photoelectric current I.

....

....

.... [2]

(c) Some electron energy levels in atomic hydrogen are illustrated in Fig. 8.2.

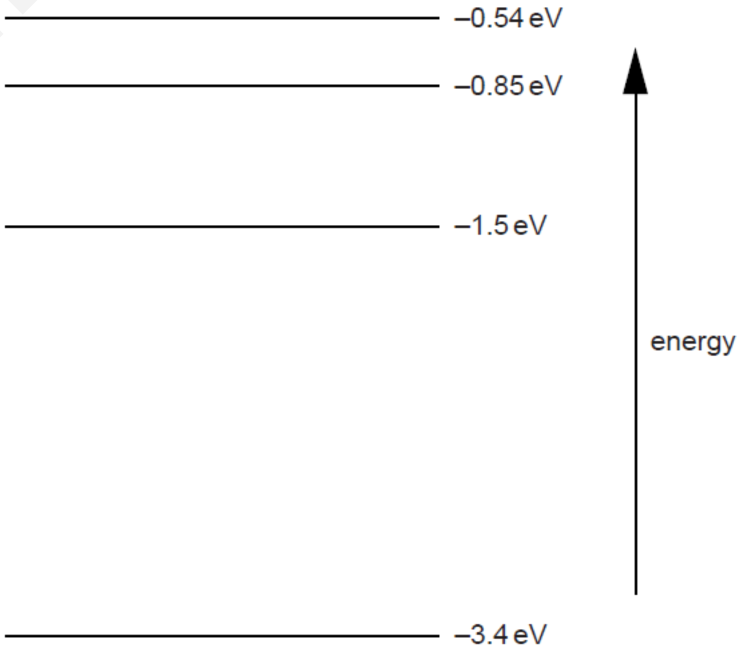


Fig. 8.2

The longest wavelength produced as a result of electron transitions between two of the energy levels shown in Fig. 8.2 is 4.0 × 10^{-6} m.

(i) On Fig. 8.2,

1. draw, and mark with the letter L, the transition giving rise to the wavelength of 4.0 × 10^{-6} m, [1]

2. draw, and mark with the letter S, the transition giving rise to the shortest wavelength. [1]

(ii) Calculate the wavelength for the transition you have shown in **(i) part 2**.

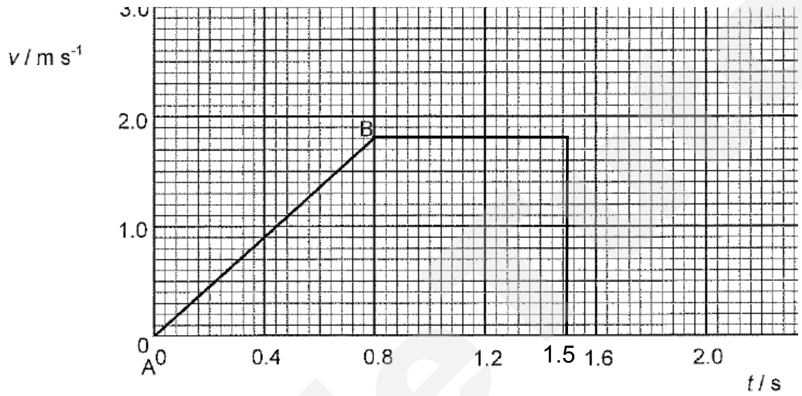
wavelength = ……………………………..m [2]

(iii) Photon energies in the visible spectrum vary between approximately 3.66 eV and 1.83 eV.

Determine the energies, in eV, of photons in the visible spectrum that are produced by transitions between the energy levels shown in Fig. 8.2.

photon energies = ……………………………..eV [2]

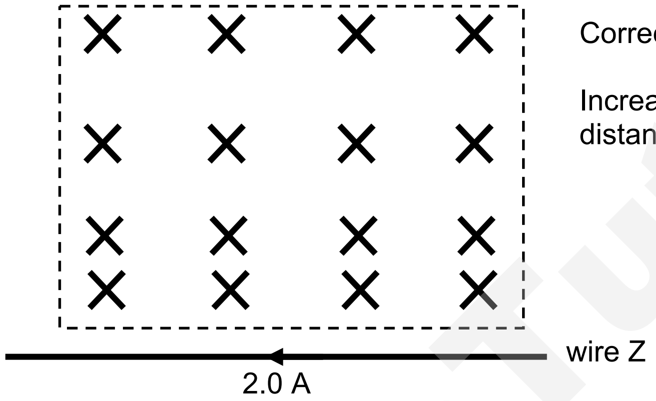
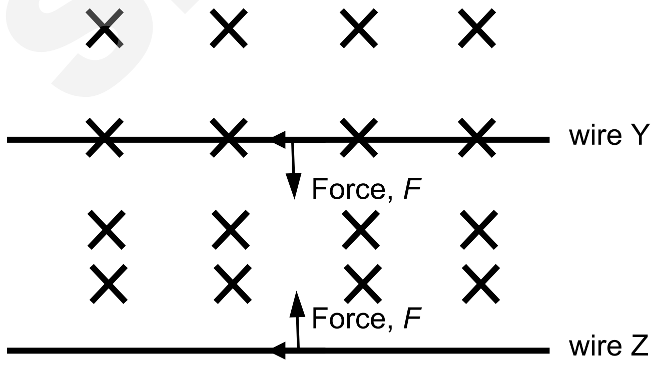
2017 AJC Prelim Physics H1P2 Solutions
Paper 2 (80 marks)

1a	Acceleration = gradient of graph = 1.80 / 0.80 = 2.25 ≈ 2.3 m s^{-2}
1b	Distance = area under the graph = (1.80 x 0.80) / 2 = 0.72 m
1ci	Time = distance BC / speed = (2.0 – 0.72) / 1.8 = 0.71 s
1cii	Straight horizontal line until 1.5 s Steep line to zero speed (ignore gradient) 
1ciii	KE gain by trolley and M = GPE loss by M ½ x (0.80 + M) x 1.8^2 = M x 9.81 x 0.72 M = 0.24 kg

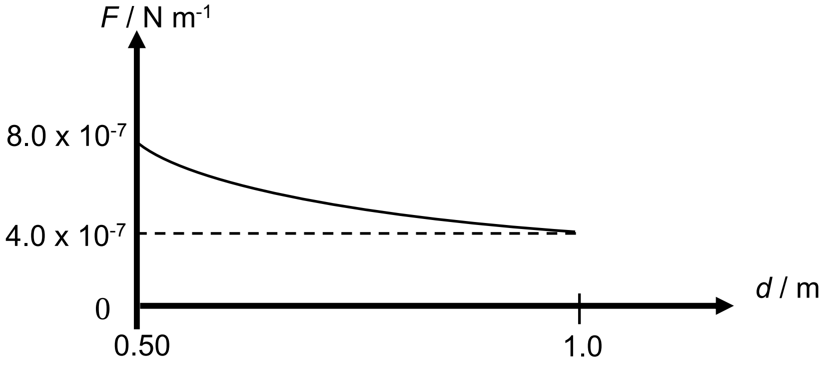
2ai	adjust distance of string from vibrator to pulley adjust frequency of generator
2aii	points on string have amplitudes varying from maximum to zero/minimum
2bi	$\frac{0.10}{0.60} x 2\pi$ = 60° or π/3 rad *or 1.05 rad*
2bii	ratio = [3.4/ 2.2]^2 = 2.39 = 2.4

3a	**Diffraction** is the spreading of waves when they pass through an opening or round an obstacle. (Diffraction effects are the greatest when the width of the opening is comparable with the wavelength of the waves.)

3bi	waves (from slits) overlap (at point X) path difference (from slits to X) is zero or phase difference (between the two waves) is zero so constructive interference gives bright fringe
3bii	$\lambda = ax / D$ $D = [0.41 \times 10^{-3} \times (\mathbf{2 \times 2.0 \times 10^{-3}})] / 580 \times 10^{-9}$ $= 2.8$ m
3biii	same separation/fringe width/number of fringes bright fringe(s)/central bright fringe/(fringe at) X less bright dark fringe(s)/(fringe at) Y/(fringe at) Z brighter contrast between fringes decreases *Any two of the above four points, 1 mark each, max 2 marks*

4a	 Correct direction of B Increasing spacing with increasing distance from wire Z
4bi	$B = B_Z - B_Y$ $= \frac{\mu_0 I_Z}{2\pi r} - \frac{\mu_0 I_Y}{2\pi r}$ $= \frac{(4\pi \, x \, 10^{-7})}{2\pi(0.5)}(2.0 - 1.0)$ $= 4.0 \times 10^{-7}$ T
4bii	 By right hand grip rule, the magnetic field produced by the current in wire Z acts perpendicular to wire Y. By FLHR, the direction of the magnetic force on wire Y is towards wire Z. By N3L, the direction of the force on wire Z is opposite to that on wire Y / towards wire Y.

4biii



Correct trend as $F \propto \frac{1}{d}$

F at 0.50 m is twice the amount at 1.0 m. (values not required)

5a

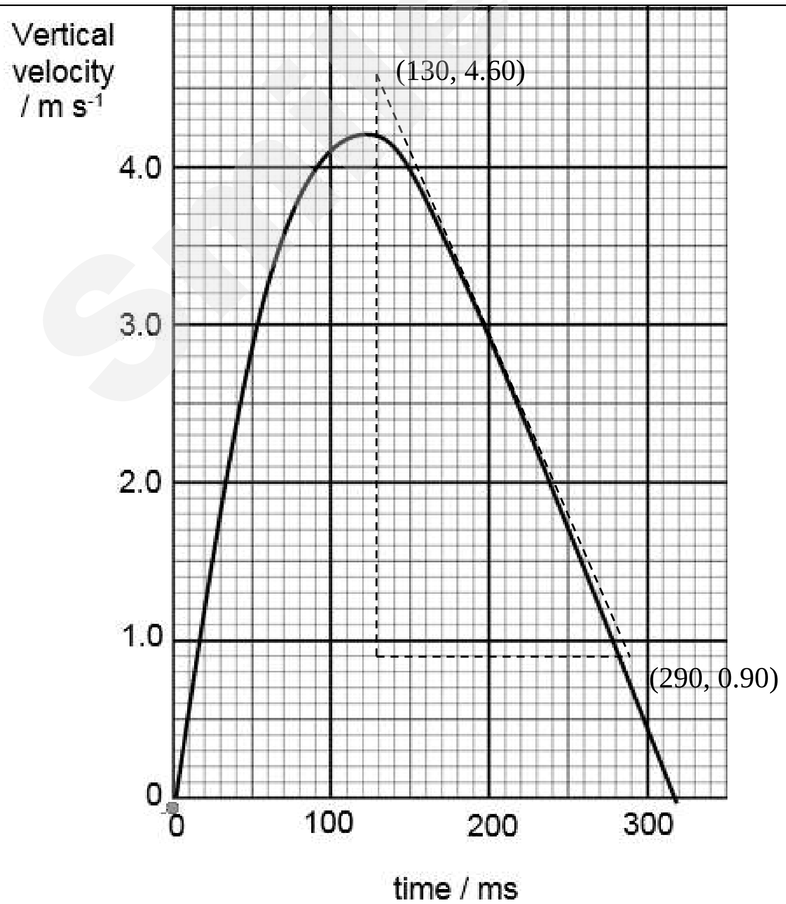
height of circle = vertical displacement travelled by mass from A to C
= area under the graph
= $32 \times (0.5 \times 50 \times 10^{-3})$
= 0.80 m

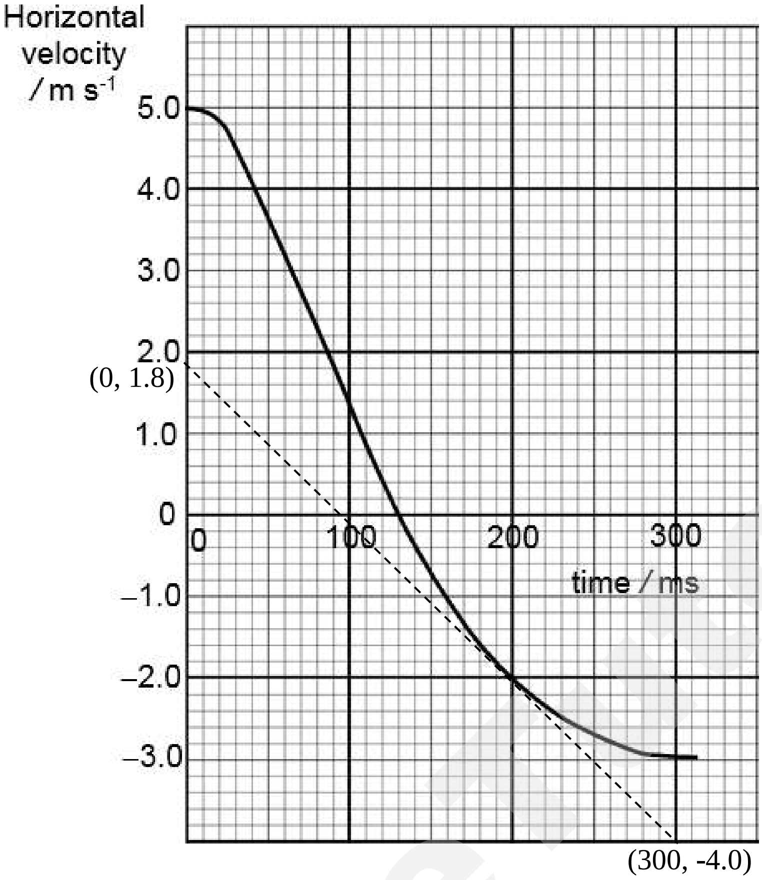
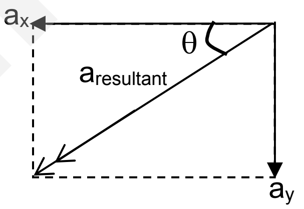
height of circle = diameter of circle

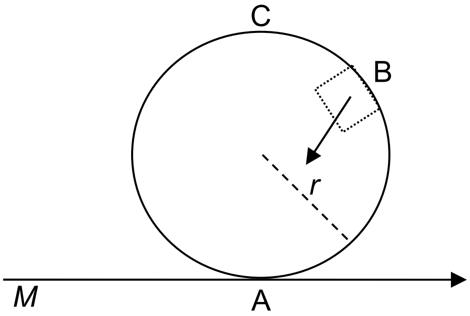
$\therefore r = \frac{0.80}{2}$
= 0.40

Accept $0.38 \le r \le 0.42$ m

5bi

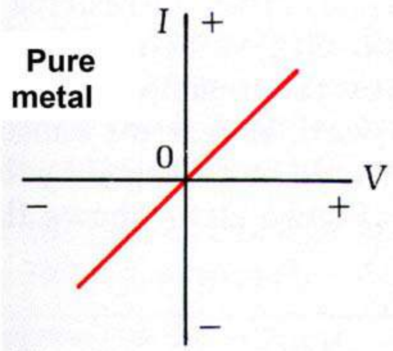
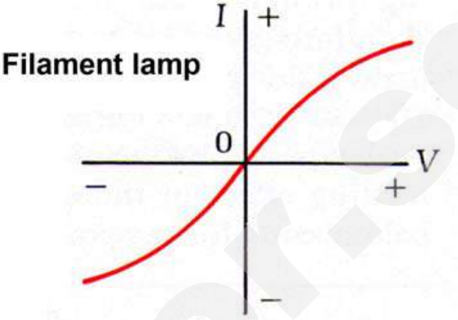


	$a_y = \dfrac{4.60-0.90}{(130-290)\times10^{-3}} = \dfrac{3.70}{-0.160} - 23.1\,\text{ms}^{-2}$  $a_x = \dfrac{1.8-(-4.0)}{(0-300)\times10^{-3}} = \dfrac{5.8}{-0.300}$ $= -19\,\text{m}\,\text{s}^{-2}$
5bii	 Resultant acceleration = $\sqrt{(23.1)^2+(19)^2}$ = 29.9 m s^{-2} $\theta = \tan^{-1}(\dfrac{23.1}{19}) = 50.6°$

5biii	 Note: arrow not passing through centre of circle (directed below centre) because angle from horizontal is more than 45°.
5c	The net horizontal displacement travelled by the mass *M* from A to C is zero. Thus, area under the graph is zero.

6ai	By Newton's 2nd Law, rotating blades pushes air and causes it to undergo a rate of change in momentum downwards giving rise to a downward force. From Newton's 3rd Law, the air exerts and equal and opposite force on the blades/helicopter. When this upward force equals the weight of the helicopter, resultant force is zero
6aii	Area = $\pi r^2 = \pi(0.70)^2$ $= 1.5\ m^2$
6aiii1	Volume of air per second = 1.5 x 4.0 Mass per second = volume per second x density = 1.2 x 1.5 x 4.0 = 7.2 kg s^{-1}
6aiii2	Rate of change of momentum = dm/dt x velocity = 7.2 x 4.0 = 28.8 ≈ 29 N
6aiv	Mg = force on blade = 28.8 N M = 28.8 / 9.81 = 2.9 kg
6bi	Total momentum of the system before collision is in the direction of the long truck By the conservation of momentum, (the total momentum after collision must be the same), the vehicles will move in the same direction as the long truck.
6bii	Total momentum before = total momentum after m x 60 – 2m x 60 = (m + 2m) V V = - 20 km h^{-1} (or 20 km h^{-1} to the left)
6biii	During collision, force on car and truck is the same but car has smaller mass Hence, acceleration of car is greater
6biv	Acceleration of car driver is greater than of truck driver. (For the same mass), force by seatbelt on driver is greater for greater acceleration The car driver will experience a greater restrain.

6bv	Some energy of the system is used to do work to deform the vehicles and lost as heat and sound The principle of conservation of energy is not violated

7ai	The **resistance** of a conductor is the ratio of the potential difference across it to the current flowing through it.
7aii	The **ohm** is the resistance of a conductor in which the current is 1 ampere when a potential difference of 1 volt is applied across it.
7b	 
7ci1	Use $R = \frac{\rho l}{A}$ $= \frac{(5.5 \text{ x } 10^{-8})(2.0)}{\left(\frac{\pi(0.020 \text{ x } 10^{-3})^2}{4}\right)}$ $= 350\ \Omega$
7ci2	power dissipated = $I^2R = (0.42)^2(350) = 62$ W
7ciii	Any two – high resistivity, high melting point, should not oxidise at high temperature (to ensure long life), non-corrosive
7di1	When $R_3 = 0$, circuit would be reduced to only R_3 connected to the e.m.f. Hence, current in battery $= \frac{14}{6.0}$ $= 2.3$ A
7di2	When $R_3 = 24\ \Omega$, effective resistance of R_2 and R_3 in parallel = $\frac{12 \text{ x } 24}{12 + 24} = 8.0\ \Omega$ total resistance in circuit = 6.0 + 8.0 = 14.0 Ω Hence, current in battery $= \frac{14}{14.0}$ $= 1.0$ A
7dii	When $R_3 = 0$, power produced by battery = 14 x 2.3 = 32.2 W When $R_3 = 24\ \Omega$, power produced by battery = 14 x 1.0 = 14 W Change in power produced by battery = 14 – 32.2 = –18 W (accept 18 W)

7ei	Mthd 1 resistance of thermistor at 0 °C = 3900 Ω using potential divider principle, $\left(\dfrac{R}{R+3900}\right)x1.50 = 1.00$ R = 7800 Ω Mthd 2 p.d. across thermistor = 1.50 – 1.00 = 0.50 V resistance of thermistor at 0 °C = 3900 Ω common current in circuit = $\dfrac{1.00}{R} = \dfrac{0.50}{3900}$ R = 7800 Ω
7eii	Mthd 1 resistance of thermistor at 30 °C = 1250 Ω using potential divider principle, $\text{voltmeter reading} = \left(\dfrac{7800}{7800+1250}\right)x1.50$ $= 1.29\text{ V}$ Mthd 2 resistance of thermistor at 30 °C = 1250 Ω common current, I in circuit = $\dfrac{1.50}{R+1250} = \dfrac{1.50}{7800+1250} = \dfrac{1.50}{9050}$ voltmeter reading = IR = 1.29 V
7eiii	resistance of thermistor at 0 °C = 3900 Ω effective resistance of R and voltmeter = 7800/2 = 3900 Ω (same as thermistor's) voltmeter reading = p.d. across X = 1.50/2 = 0.750 V

8 a 1. **2.**	photon is a packet/quantum of energy of electromagnetic radiation (photon) energy = h × frequency every particle has an (associated) wavelength wavelength = h / p , where p is the momentum (of the particle)
8bi	for a wave, electron can 'collect' energy continuously for a wave, electron will always be emitted / electron will be emitted at all frequencies after a sufficiently long delay
8bii 1.	either wavelength is longer than threshold wavelength or frequency is below the threshold frequency or photon energy is less than work function
8bii 2.	hc / λ = ϕ + E_k $(6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (240 \times 10^{-9}) = \phi + 4.44 \times 10^{-19}$ $\phi = 3.8 \times 10^{-19}$ J (allow 3.9×10^{-19} J)

8biii1.	photon energy larger so (maximum) kinetic energy is larger
8biii2.	fewer photons (per unit time) so (maximum) current is smaller
8ci1. **2.**	arrow from –0.54 eV to –0.85 eV, labelled L arrow from –0.54 eV to –3.4 eV , labelled S (two correct arrows, but only one label – allow 2 marks) (two correct arrows, but no labels – allow 1 mark)
8cii	E = hc / λ $(3.4 – 0.54) \times 1.6 \times 10^{–19} = (6.63 \times 10^{–34} \times 3.0 \times 10^{8}) / \lambda$ $\lambda = 4.35 \times 10^{–7}$ m
8ciii	–1.50 → –3.4 = 1.9 eV –0.85 → –3.4 = 2.55 eV (allow 2.6 eV) –0.54 → –3.4 = 2.86 eV (allow 2.9 eV)

Anglo-Chinese Junior College

JC2 Physics Preliminary Examination
Higher 1

A Methodist Institution
(Founded 1886)

PHYSICS

8866/01

Paper 1 Multiple Choice

29 August 2017

Additional Materials: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your Name and Index number in the Answer Sheet provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this Question Paper.
The use of an approved scientific calculator is expected, where appropriate.

This paper consists of 18 printed pages

Data

speed of light in free space, $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$

elementary charge, $e = 1.60 \times 10^{-19}\ \text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\ \text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\ \text{kg}$

rest mass of electron, $m_e = 9.11 \times 10^{-31}\ \text{kg}$

rest mass of proton, $m_p = 1.67 \times 10^{-27}\ \text{kg}$

acceleration of free fall, $g = 9.81\ \text{m s}^{-2}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\,\Delta V$

hydrostatic pressure, $p = \rho g h$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

1 What is the best estimate of the total number of beats a human heart makes in the life expectancy of the average Singaporean?

A 3×10^8 **B** 8×10^8 **C** 3×10^9 **D** 8×10^9

2 When comparing systematic and random errors, which of the following applies to random errors?

P_1: error can be eliminated
P_2: error cannot be eliminated
Q_1: error is of constant sign and magnitude
Q_2: error is of varying sign and magnitude
R_1: error will be reduced by averaging repeated measurements
R_2: error will not be reduced by averaging repeated measurements

A P_1, Q_1, R_2

B P_1, Q_2, R_2

C P_2, Q_2, R_1

D P_2, Q_1, R_1

3 A car accelerates uniformly from rest and reaches a speed of 30 m s^{-1} in 50 m.

If it continues to accelerate at the same rate, what is the time taken for it to travel another 250 m?

A 4.8 s **B** 7.5 s **C** 11.5 s **D** 14.6 s

4 A ball is thrown upwards vertically with an initial speed *u* and travels back to its original position with a final speed *v*. The time taken for it to travel upwards is t_{up} and the time taken for it to travel downwards is t_{down}.

If air resistance is **not** negligible, which of the following is true?

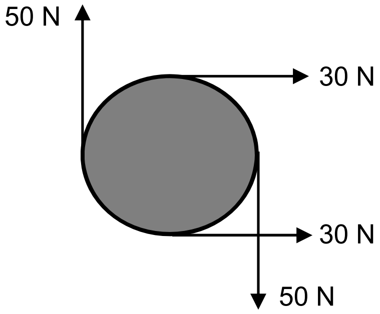
	time taken	speed
A	$t_{up} < t_{down}$	$u = v$
B	$t_{up} > t_{down}$	$u = v$
C	$t_{up} < t_{down}$	$u > v$
D	$t_{up} > t_{down}$	$u < v$

5 Different types of resultant force acts on different bodies in different situations.

Which row in the table shows the incorrect resultant force acting on the body when it experiences an action (indicated in **bold**)?

	body	action	resultant force on the body
A	A small metal ball	**rebounding** from the floor after falling vertically from a height	vector sum of normal contact force of floor on ball and weight of ball
B	A tennis ball	travelling horizontally and **rebounding** after hitting a vertical wall	normal contact force of wall on ball
C	The moon	**orbiting** around the earth	gravitational force of earth on moon
D	A suspended pendulum bob	**oscillating** in a to-and-fro motion	force of string on bob

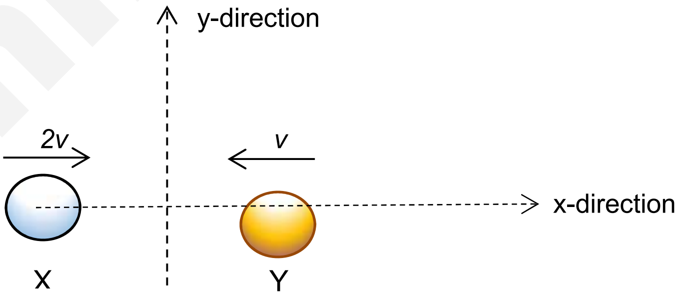
6 The diagram shows four forces applied to a circular object.



Which row in the table shows the resultant force and resultant torque acting on the body?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

7 Two identical smooth spheres X and Y have masses *m* and *3m*. They are projected on a smooth horizontal plane with speeds *2v* and *v* respectively towards each other. The two masses are involved in an elastic collision that is not head-on as shown.



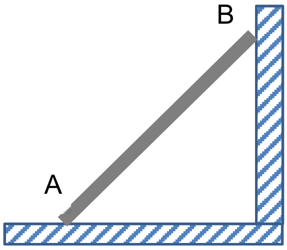
Which row in the table is correct?

	total momentum before impact in the x-direction	total momentum after impact in the y-direction
A	*mv* to the left	zero
B	*mv* to the right	zero
C	*mv* to the left	non-zero

[Turn over

D	*mv* to the right	non-zero

8 A uniform ladder is resting on a vertical wall. Friction between the ladder and the ground and also between the ladder and the wall prevents the ladder from slipping.

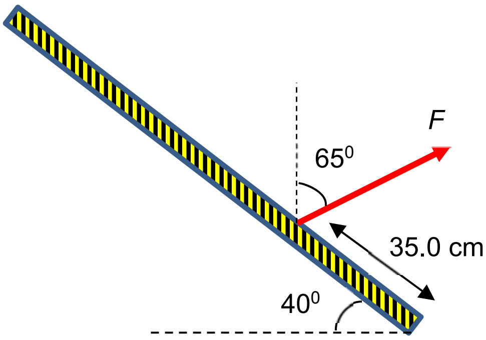


Which row in the table shows the direction of the contact forces on the ladder at points A and B?

	at point A	at point B
A	↖	↖
B	↗	←
C	↗	↖
D	↑	↙

9 As shown in the figure below, a 2.0 m long uniform fishing rod has a mass of 126 g. With his right hand, the man grips the handle at a distance 35.0 cm from one end of the rod and exerts a force *F* at an angle 65° from the vertical. The fish is 500 g and hangs motionless at the other end of the rod.

Source: www.123RF.com



What is the value of *F*?

A 2.7 N **B** 3.0 N **C** 14.5 N **D** 26.7 N

10 A submarine is cruising in the ocean at a constant depth of 50 m.

To balance the submarine’s weight, there is a resultant upward vertical force on the submarine due to the water.

What is the physical reason for this resultant upward vertical force?

A The thrust of the submarine’s propellers.

B The density of the water increases with depth.

C The drag force experienced by the submarine.

D The pressure of the water increases with depth.

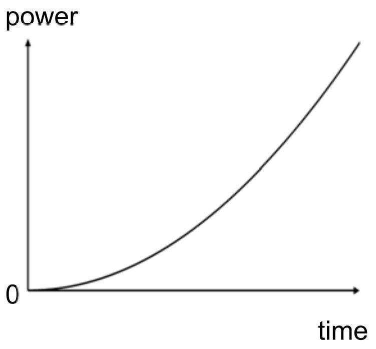
11 Which row in the table describes the possible motion of a charge for it to experience both an electric force and a magnetic force?

	electric field	magnetic field
A	charge is moving perpendicular to the electric field	charge is stationary
B	charge is stationary	charge is moving parallel to the magnetic field
C	charge is stationary	charge is moving not parallel to the magnetic field
D	charge is moving parallel to the electric field	charge is stationary

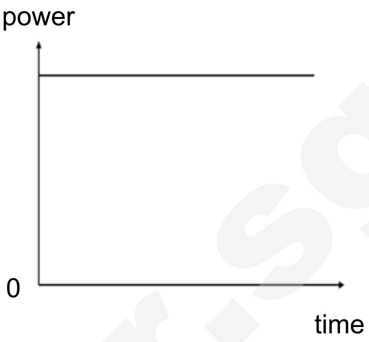
12 A constant force is applied on a box resting on a frictionless surface.

Which of the following graphs best represents the variation of power supplied with time?

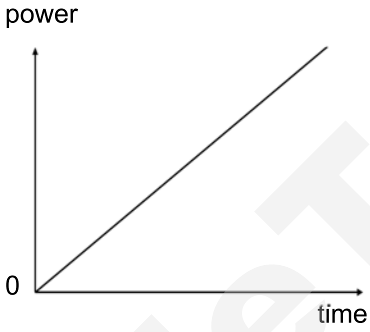
A



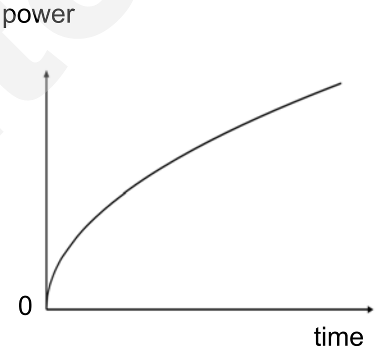
B



C



D



13 A girl on a swing is 2.5 m above the ground at the maximum height and at 1.5 m above the ground at the lowest point.

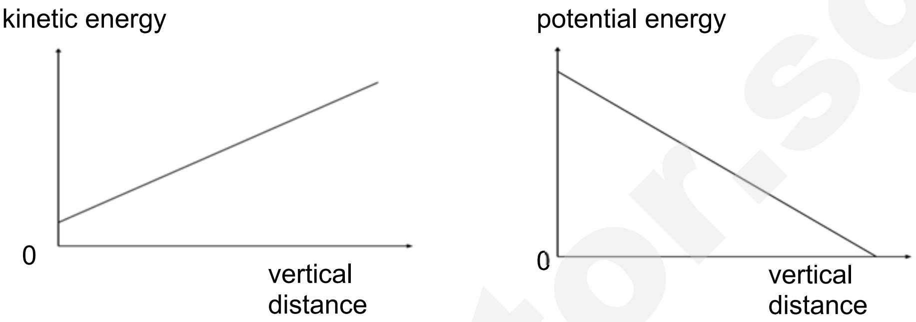
What is the maximum velocity of the swing?
(take g = 10 m s^{-2})

A $5\sqrt{2}$ m s^{-1} **B** $2\sqrt{5}$ m s^{-1} **C** $2\sqrt{3}$ m s^{-1} **D** $3\sqrt{2}$ m s^{-1}

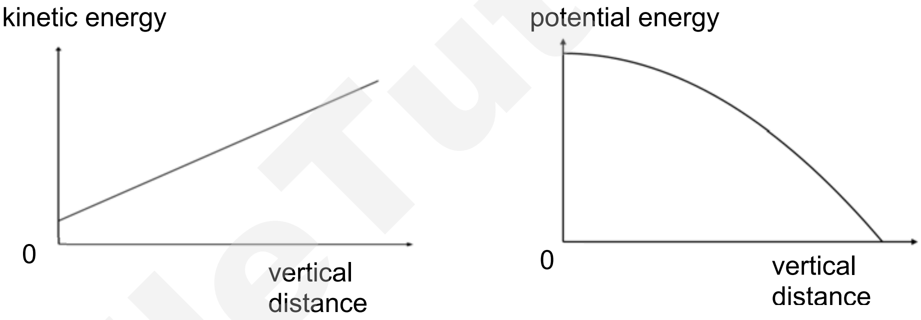
14 A stone was projected horizontally off a cliff as shown. Air resistance is negligible.

Which graphs represents the variation with the vertical distance of kinetic energy and gravitational potential energy of the stone?

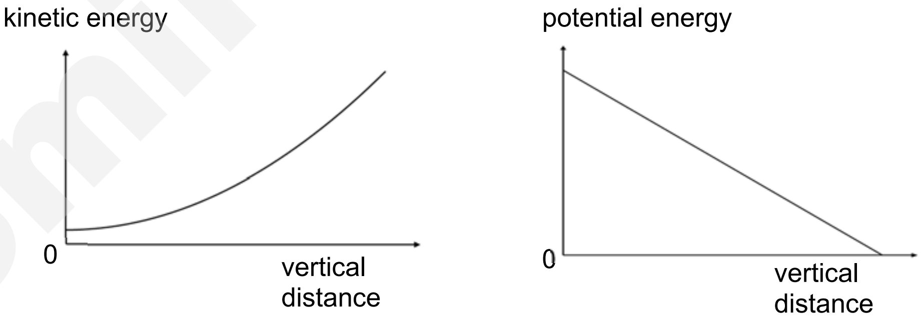
A



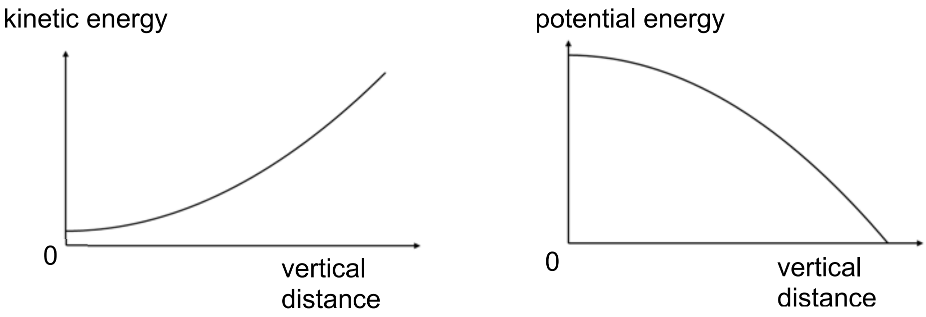
B



C

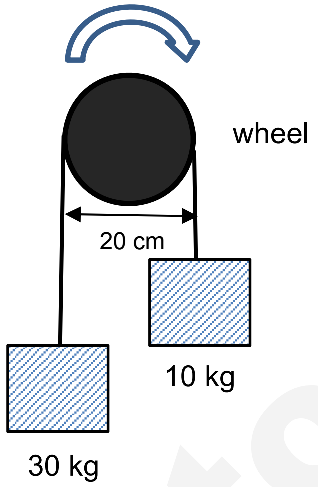


D



[Turn over

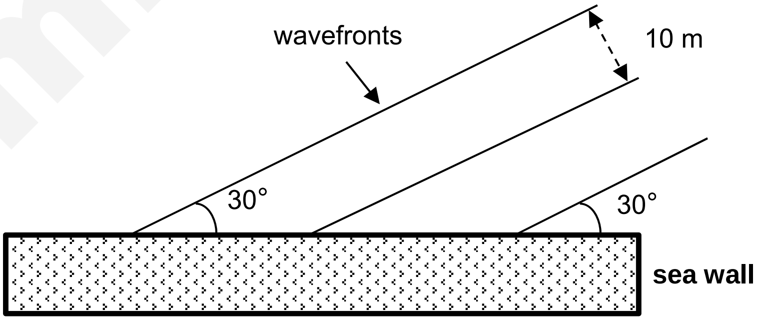
15 Two masses, 10 kg and 30 kg are attached to a light belt which hangs over a wheel that is mounted to the axle of an electric motor as shown. The belt is stationary and the wheel has a diameter of 20 cm. The motor has an efficiency of 70% and the wheel is rotating clockwise at a constant rate of 30 revolutions per minute.



What is the input power to the motor?

A 62 W **B** 88 W **C** 3700 W **D** 5280 W

16 Parallel water waves of wavelength 10 m strike a straight sea wall. The wavefronts make an angle of 30° with the wall as shown.



What is the phase difference at any instant between the waves at two points that are 5 m apart along the wall?

A 30° **B** 45° **C** 90° **D** 180°

17 Which of the following effects provides direct experimental evidence that light is a transverse wave rather than a longitudinal wave?

A Light can undergo diffraction and reflection.

B We can hear but not see around a corner.

C Intensity of light from a point source falls off inversely with the square of the distance.

D Glare reflected off the water surface of the lake is reduced by using sunglasses.

18 A string is set to vibrate between two fixed ends and a single antinode is observed between the fixed ends at a frequency of 225 Hz.

Which of the following is true when the same string is vibrating at 900 Hz?

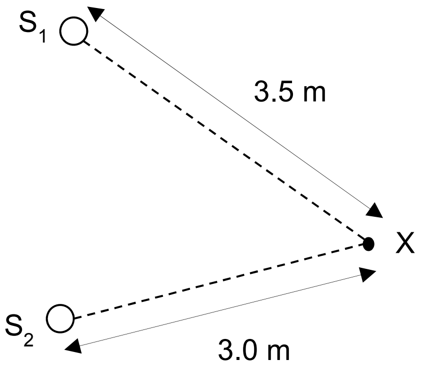
A It has 3 more nodes than the original wave.

B No stationary wave is observed.

C Its wavelength is 4 times the original wavelength.

D Its wave speed has increased by 4 times.

19 Two wave generators S_1 and S_2 produce water waves of wavelength 1.0 m. A detector is placed on the water surface at point X which is 3.5 m from S_1 and 3.0 m from S_2 as shown in the diagram. Each generator produces a wave of amplitude *A* at X when operating alone. The generators are operating together and producing waves which have a constant phase difference of π radians.



The resultant amplitude at X is

A 0 **B** *A*/2 **C** *A* **D** *2A*

[Turn over

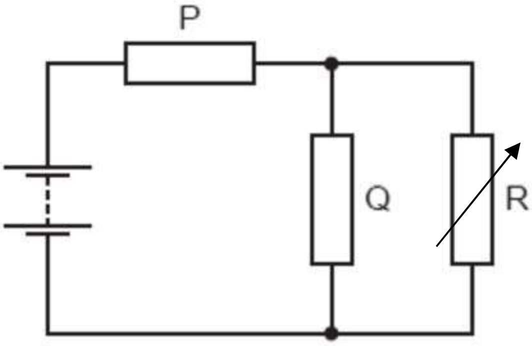
20 Which are the definitions of potential difference and e.m.f. in terms of energy transfer W and charge q?

	potential difference	e.m.f.
A	$\frac{W}{q}$	$\frac{W}{q}$
B	Wq	Wq
C	$\frac{W}{q}$	Wq
D	Wq	$\frac{W}{q}$

21 Which row in the table describes how the resistance of the electrical components varies when the potential difference across each component increases?

	semiconductor diode	filament lamp	metallic conductor at constant temperature
A	constant	decreases	increases
B	decreases	increases	increases
C	decreases	increases	constant
D	Increases	constant	decreases

22 The resistors P and Q in the circuit have equal resistance. R is a variable resistor.



If the battery has negligible resistance, which of the following statements is correct?

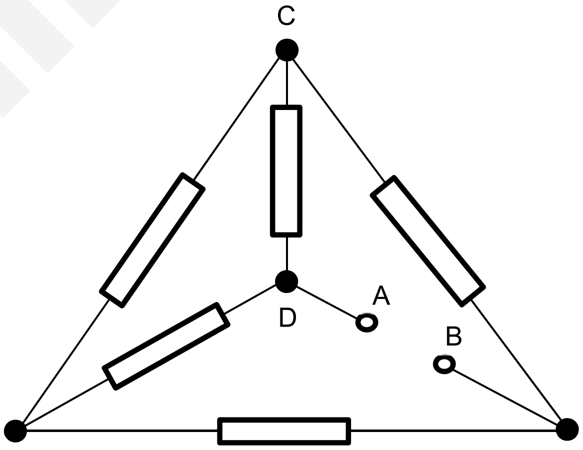
A The current supplied by the battery is fixed regardless of the value of R.

B The potential difference across P increases when R changes from 2 Ω to 4 Ω.

C There will always be an equal amount of current flowing through Q and R regardless of the value of R.

D The current in P is maximum when R is 0 Ω.

23 Five equal resistors, each of resistance *R*, are connected as shown. A battery of negligible internal resistance and e.m.f. *V* is connected between A and B.

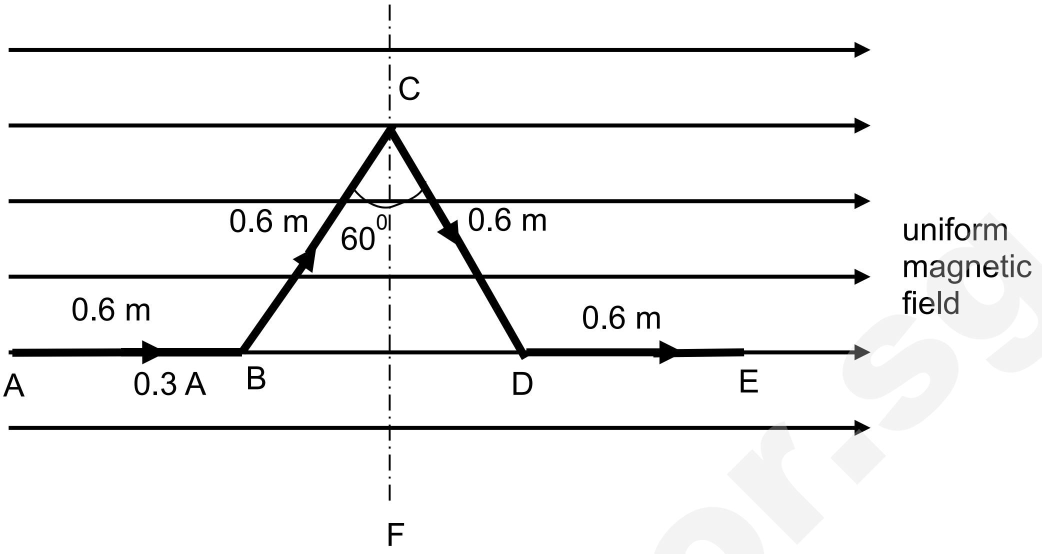


What is the current flowing in CD?

A $\frac{V}{R}$ **B** $\frac{V}{2R}$ **C** $\frac{2V}{R}$ **D** $\frac{2V}{3R}$

[Turn over

24 A current of 0.3 A flows in a conductor ABCDE that lies on the plane of the paper as shown.

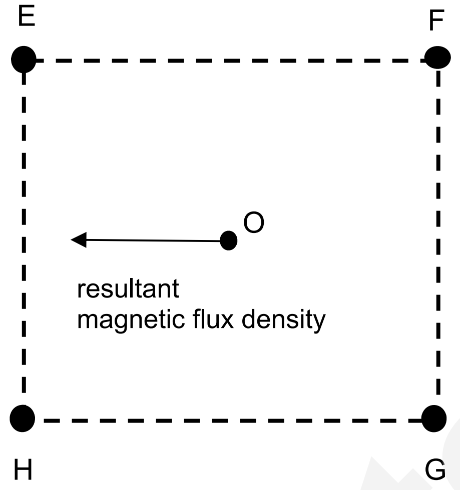


The conductor is inside a region of a uniform magnetic field having a magnetic flux density of 1.5 T. AB and DE are parallel to the magnetic field. Angle BCD is 60°. The lengths of segments AB, BC, CD and DE are 0.6 m each.

Which row in the table describes the resultant force and resultant torque on the conductor?

	resultant force	resultant torque (when viewed from the top)
A	0 N	clockwise about axis CF
B	0 N	no resultant torque
C	0.47 N	anti-clockwise about axis CF
D	0.47 N	no resultant torque

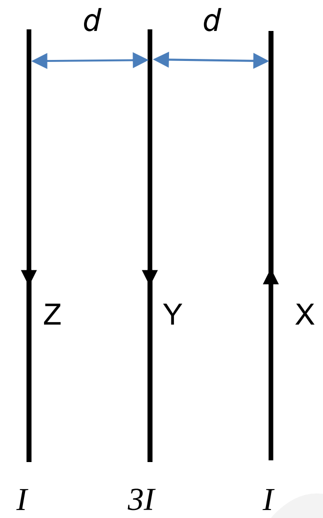
25 Four parallel conductors, carrying equal currents, pass vertically through the four corners of a square EFGH as shown in the diagram. In two conductors, the current is directed into the page. In the other two conductors, the current is directed out of the page.



In order to produce a resultant magnetic flux density at O in the direction shown, which row in the table shows the correct directions of the currents?

	current into the page	current out of the page
A	E and F	G and H
B	E and H	F and G
C	F and H	E and G
D	G and H	E and F

26 Three long wires X, Y and Z are placed parallel to each other and equally spaced apart as shown in the diagram. Wires Z and Y carry current downwards and wire X carries current upwards.



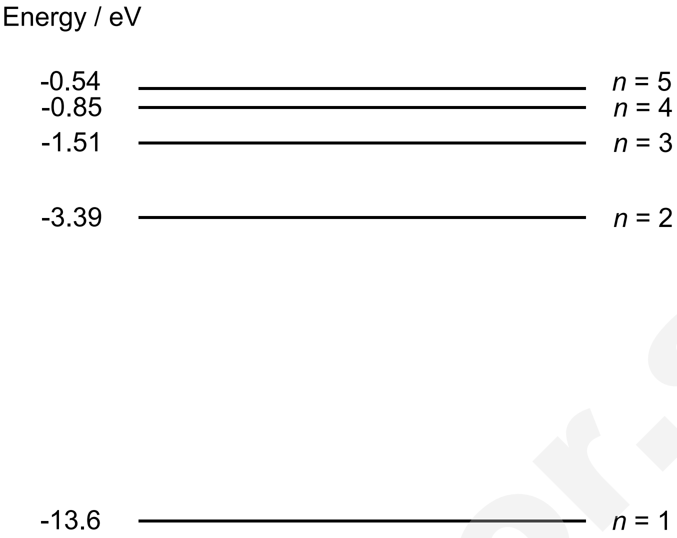
When wire X and Z are placed a distance *d* apart and each wire carries current I, each wire exerts a force per unit length *F* on the other wire.

What is the direction and magnitude of the net force per unit length acting on wire Z in the diagram?

[The force per unit length is given by $F = \frac{\mu_0 I_1 I_2}{2 \pi d}$, where I_1 and I_2 are the currents in the two parallel wires and *d* is the separation between the wires]

	magnitude of net force per unit length on wire Z	direction of net force per unit length on wire Z
A	F	away from Y
B	F	towards Y
C	$\frac{5}{2}F$	away from Y
D	$\frac{5}{2}F$	towards Y

27 The lowest five energy levels of a hydrogen atom are shown below. The electron is initially at $n = 1$.



A free electron with kinetic energy of 12.6 eV bombards the hydrogen atom.

What is the largest wavelength of light emitted?

A There are no photons emitted.

B 103 nm

C 122 nm

D 661 nm

28 A monochromatic beam of electromagnetic radiation is incident on a metal and electrons are emitted.

If the wavelength of the monochromatic radiation is halved but the number of incident photons per unit time is maintained, which of the following quantities is doubled?

A work function of the metal

B momentum of the photons

C maximum kinetic energy of the electrons

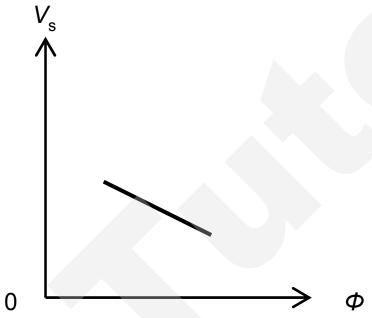
D number of electrons emitted per unit time

29 A beam of electrons and a beam of protons are accelerated across the same potential difference. They each then undergo diffraction through a crystal lattice to determine their de Broglie wavelength. The de Broglie wavelength of the electron is found to be 3.9×10^{-9} m.

What is the theoretical de Broglie wavelength of the proton?

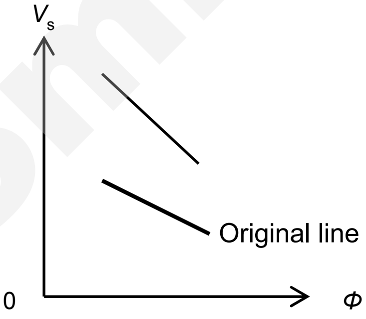
A 2.1×10^{-12} m **B** 9.1×10^{-11} m **C** 3.9×10^{-9} m **D** 1.7×10^{-7} m

30 Electromagnetic radiation of a fixed wavelength is incident on different metals. The stopping potential V_s for each metal is plotted against the work function Φ of each metal to obtain the following graph.

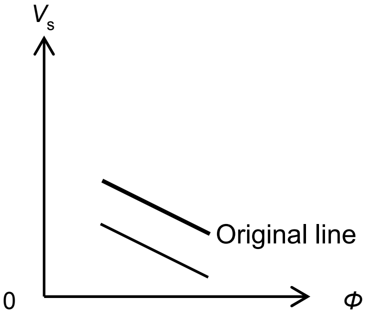


If both the wavelength and the intensity of the electromagnetic radiation is doubled, which of the following graphs reflects this change?

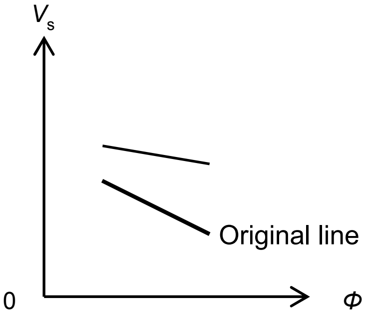
A



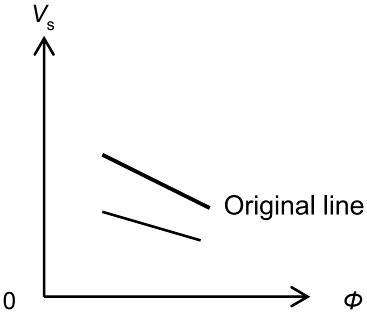
B



C



D



J2 H1 Physics
Preliminary Examination P1 Guide

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
C	C	A	C	D	D	A	C	D	D	C	C	B	A	B
16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
C	D	A	D	A	C	D	B	A	A	D	D	B	B	B

H

Anglo-Chinese Junior College

JC2 Physics Preliminary Examinations
Higher 1

THE BEST IS YET TO BE
A Methodist Institution
(Founded 1886)

CANDIDATE NAME		FORM CLASS	
CENTRE NUMBER	S 3 0 0 4	INDEX NUMBER	

PHYSICS

8866/02
11 August 2017

Candidates answer on the Question Paper.
No Additional Materials are required.

2 hours

READ THESE INSTRUCTIONS FIRST

Write your index number, name and form class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use Only	
Section A	
1	/ 5
2	/ 7
3	/ 4
4	/ 5
5	/ 8
6	/ 4
7	/ 7
Section B (two questions only)	
8	/ 20
9	/ 20
10	/ 20
Total Marks	/ 80

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\,\Delta V$
hydrostatic pressure,	p	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 A student wants to determine the density of a solid circular cylinder by measuring its dimensions with a ruler and its weight using a mass balance. He recorded his readings as follows.

Diameter of the circular base = (8.6 ± 0.2) cm
Height of the cylinder = (7.4 ± 0.2) cm
Mass of the cylinder = (449.3 ± 0.1) g

(a) Determine a value for the density of the disc with its associated uncertainty.

density = …………… ± ……..…… kg m^{-3} [4]

(b) Explain which variable has the largest impact on the uncertainty of the density.

…………………………………..……………………………………………..……….

……………………………………..………………..………..…………..……………..……… [1]

2 **(a)** State the conditions for a body to move in parabolic motion.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

(b) A ball was launched from a 2.0 m cliff with an initial velocity of 5.0 m s^{-1} and at an angle of 30° from the horizontal as shown in Fig. 2.1. Assume that air resistance can be ignored.

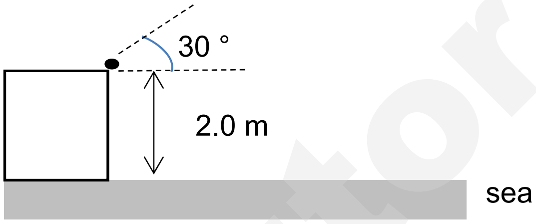


Fig. 2.1

Determine

(i) the maximum height of the ball as measured from sea-level.

maximum height = ………………… m [2]

(ii) the speed and direction of the ball as it enters the sea.

speed = ………………… m s^{-1}

direction = …………………………….. [3]

3 Box **A** rests on a smooth slope and is connected to box **B** with a light inextensible string as shown in Fig. 3.1. Box **A** and box **B** have masses of 10 kg and 3 kg respectively. The setup is initially at rest.

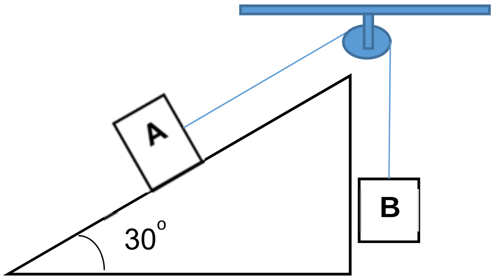


Fig. 3.1

(a) Determine the acceleration of Box **A** when the boxes move.

acceleration = ………………… m s^{-2} [2]

(b) In practice, the acceleration is lower than your answer in part **(a)**. Suggest two reasons to account for this.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [2]

4 **(a)** Define *work*.

…………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

(b) In each of the following situations, describe how work is done on the object and the energy changes.

(i) A small and heavy ball released from rest in the school laboratory.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………… [2]

(ii) A bicycle coming to a stop at the traffic light.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………… [2]

5 **(a)** Define the *ohm*.

………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

(b) A circuit is set up as shown in Fig. 5.1. Two identical bulbs, **A** and **B**, are arranged in parallel with a dry cell **P**. The voltmeter reading is 4.0 V.

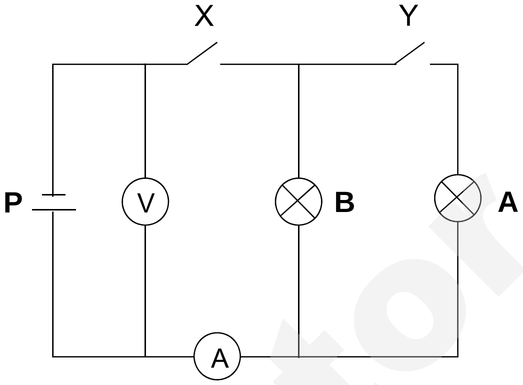


Fig. 5.1

Switch X is now closed. The voltmeter reading dropped to 3.9 V and the ammeter reading is 0.1 A.

(i) Determine the internal resistance of the cell **P**.

internal resistance = ………………… Ω [2]

(ii) Calculate the power supplied by the cell **P**.

power = ………………… W [1]

(iii) Switch Y is now closed.

Without calculation, explain the changes to

the voltmeter reading,
the ammeter reading,
the brightness of bulbs **A** and **B**,
and the power supplied by the cell **P**.

……………………………………………………………………………………………

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……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………………… [4]

6 **(a)** Define the *tesla*.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

(b) Fig. 6.1 shows one section of a long straight wire carrying a steady current to the right.

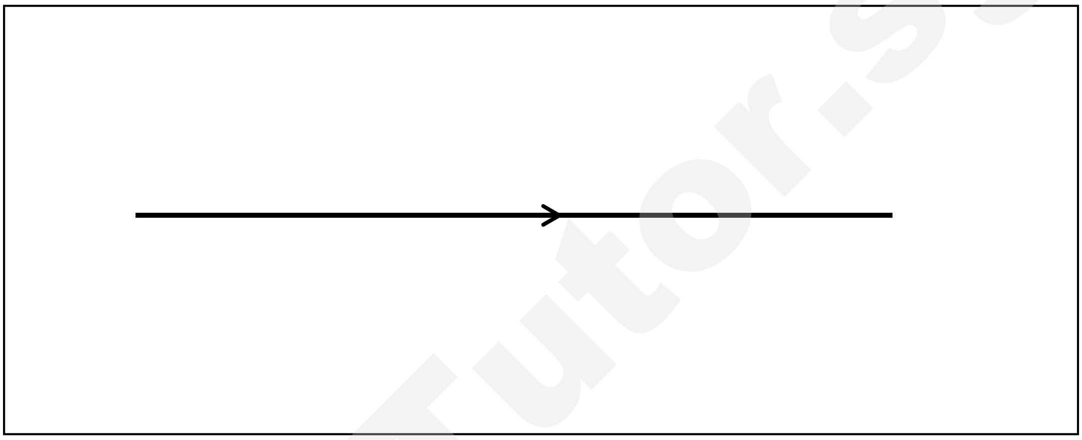


Fig. 6.1

Using crosses (×) and dots (•) to indicate the directions of the magnetic flux density, draw within the box on Fig. 6.1, the magnetic field around the wire. [2]

(c) The wire in part **(b)** is now placed within an external uniform magnetic field as shown in Fig. 6.2.

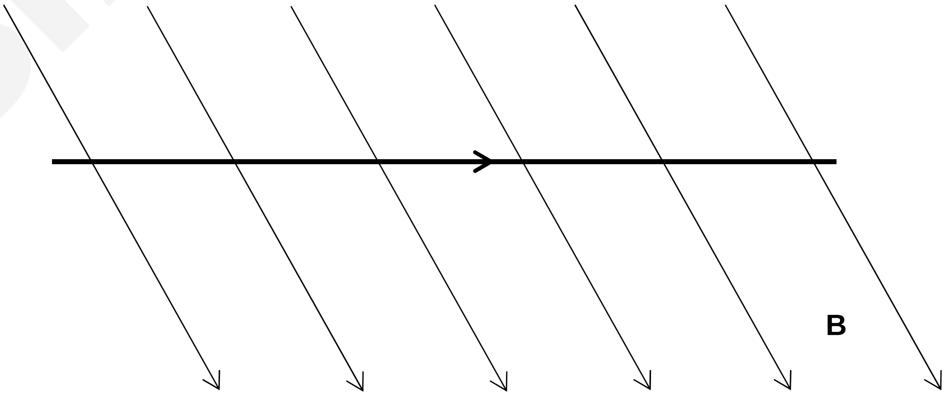


Fig. 6.2

State the direction of the magnetic force acting on the wire.

……………………………………………………………………………………………… [1]

7 A force is applied on an extension spring. The variation with extension of the elastic potential energy of the spring is shown in Fig. 7.1.

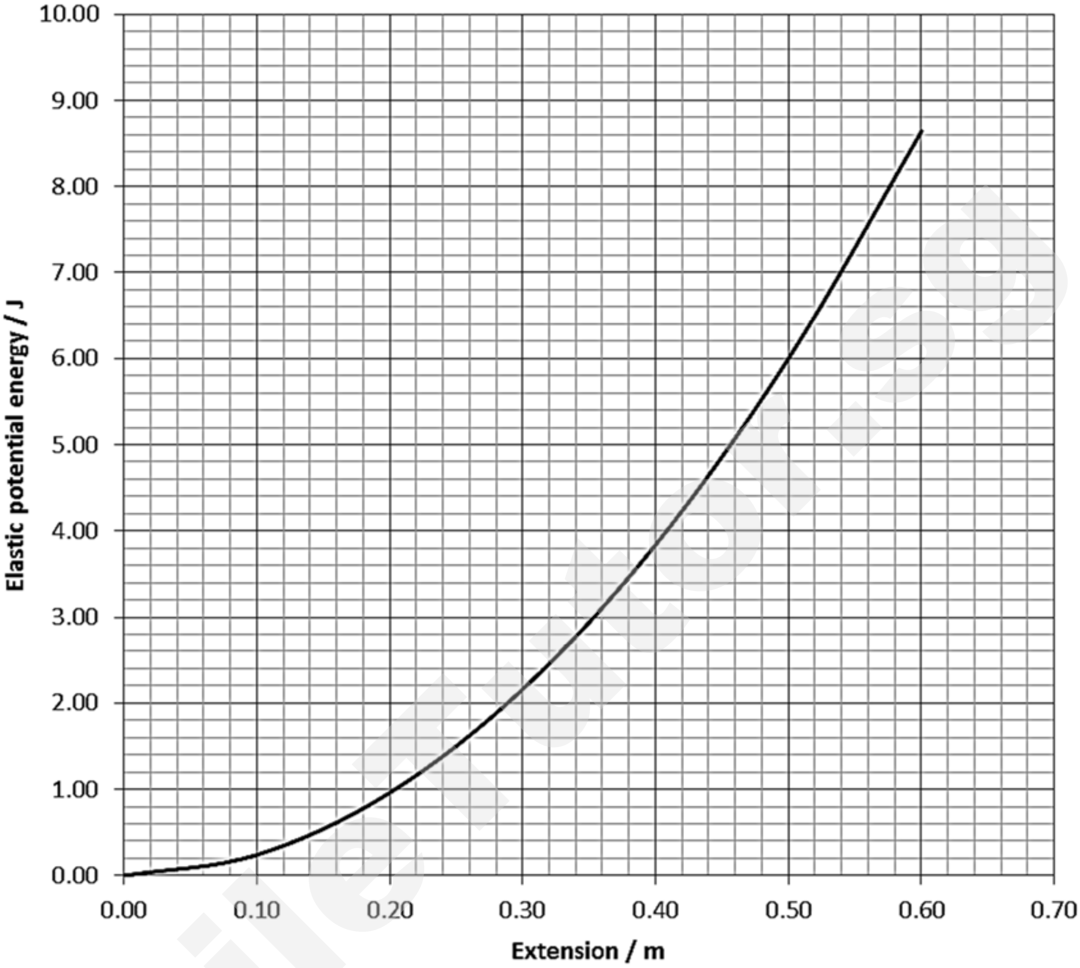


Fig.7.1

(a) Suggest how you would determine the magnitude of the spring force from Fig. 7.1.

……………………………………………………………………………………………………..

…………………………………………………………………………………………………… [1]

(b) The elastic potential energy of the spring is directly proportional to the square of its extension.

Using Fig. 7.1, show that this relationship is valid.

[4]

(c) Using your answer to part **(b)** or otherwise, state the value of the spring constant.

.... [1]

(d) State the condition of the spring for the graph in Fig. 7.1 to be valid.

.... [1]

Section B

Answer **two** of the questions from this section.

8 **(a)** **(i)** Explain what is meant by *impulse*.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) State Newton's second law of motion.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(b) Using your answers in **(a)**, explain,

(i) why it is safer for a driver to wear a seat belt than not wearing a seat belt.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(ii) why it is better for a soccer player to not slow down his leg at the end of a kick.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(c) Fig. 8.1(a) shows a sphere A of mass m_A and velocity $\overrightarrow{u_A}$, and a sphere B of mass m_B and velocity $\overrightarrow{u_B}$.

Fig. 8.1(b) shows the same spheres at velocities $\overrightarrow{v_A}$ and $\overrightarrow{v_B}$ after a head-on collision.

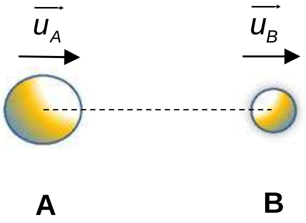


Fig. 8.1(a)

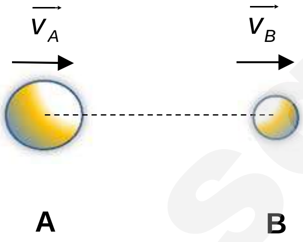


Fig. 8.1(b)

(i) Using Newton's laws of motion, show that

$$m_A\overrightarrow{u_A} + m_B\overrightarrow{u_B} = m_A\overrightarrow{v_A} + m_B\overrightarrow{v_B}$$

[2]

(ii) State the condition for the equation in part **(c)(i)** to be true.

....

.... [1]

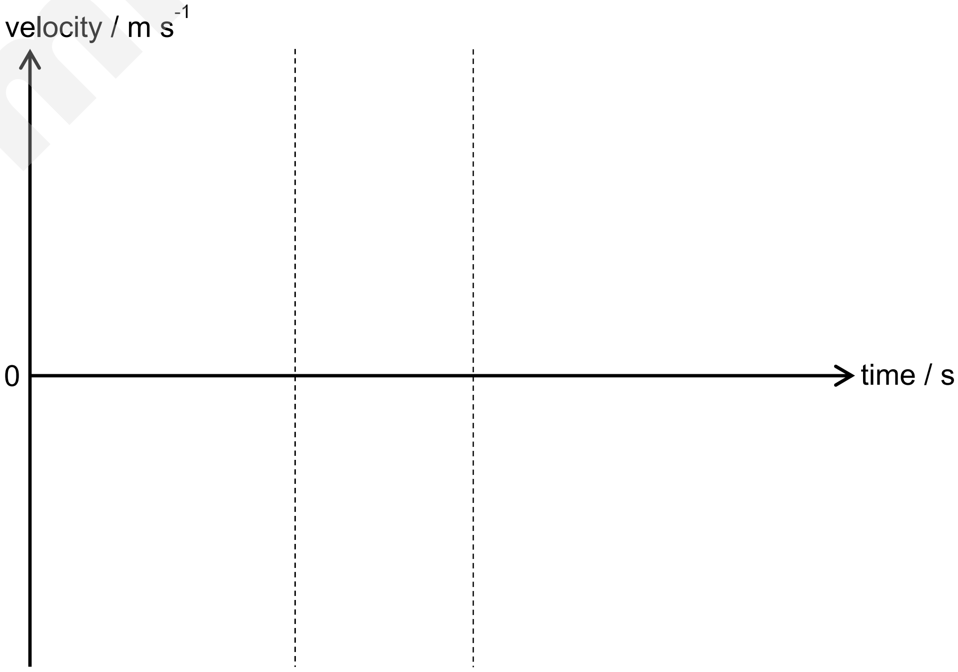
(iii) Given that m_A = 3.0 kg, m_B = 1.0 kg, $\overrightarrow{u_A}$ = +2.0 m s^{-1}, and $\overrightarrow{u_B}$ = - 2.0 m s^{-1}, complete the table. Show all workings clearly.

	before collision		***after*** collision	
	A	**B**	**A**	**B**
kinetic energy / J	**6.0**	**2.0**	**0**	**8.0**
momentum / N s	**6.0**			

Space for working:

[3]

(iv) Hence, sketch the variation with time of the velocities of **A** and **B**, before, during and after the collision. Label the graphs clearly.



[3]

(d) A student stands on a weighing scale in the lift and notices that the reading on the weighing scale fluctuates as the lift ascends from the first to the fifth floor.

By drawing a suitable free-body diagram and applying Newton's second law of motion, explain,

(i) why the reading increases as the lift starts to ascend from the first floor.

....

....

....

....

....

....

.... [2]

(ii) why the reading decreases as the lift is reaching the fifth floor.

....

....

....

....

....

....

.... [2]

9 **(a)** State the Principle of Superposition.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(b) Using a graphical method, explain the formation of stationary waves on a stretched string.

[5]

(c) A contractor tries to measure the depth of a new well shaft so that he can build a ladder to reach the bottom of the shaft. He uses a speaker with adjustable frequency and positions it at the top of the well. Two successive resonances are heard at 77.5 Hz and 98.5 Hz. The speed of sound is 343 m s^{-1}.

Determine the depth of the well.

depth of well = ……………… m [3]

(d) (i) Explain why transverse waves can be polarised but not longitudinal waves.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

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………………………………………………………………………………………… [2]

(ii) A beam of unpolarised light is passing through two Polaroid filters as shown in Fig. 9.1. The transmitting axes of these filters are intially aligned.

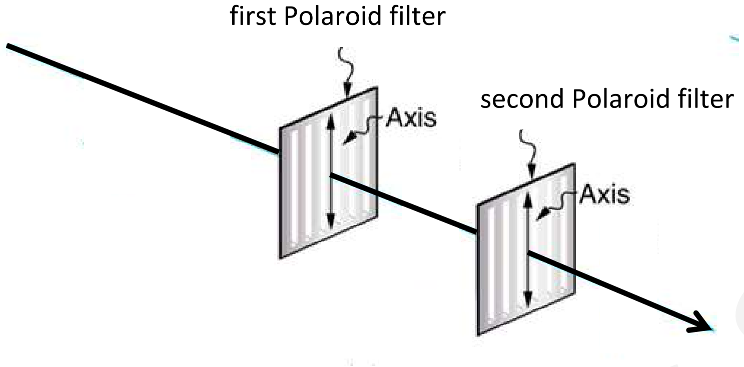

Fig. 9.1.

The intensity of the light emerging from the first filter is I.

1. State the intensity of the light before entering the first filter in terms of I.

……………………………………………………………………………………………… [1]

2. The second filter is now rotated through 360° in its own plane.

State and explain the number of maxima of intensity that occur in the light emerging from the second filter after it starts to rotate.

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……………………………………………………………………………………………… [3]

(e) A point source produces a wave that spreads out in all direction. At a distance of 1.5 m from the source, the amplitude of the wave is 2.3 mm.

(i) State the relationship between the intensity of the wave I and the distance from the point source *d*.

……………………………………………………………………………………… [1]

(ii) Hence, or otherwise, determine the amplitude of the wave at a distance of 2.5 m from the source.

amplitude = ………………… mm [3]

10 (a) The element composition of gas clouds in space can be determined by observing the spectrum of light detected when we point our telescopes at them.

The type of spectrum depends on how the electromagnetic radiation reaches the telescopes as shown in Fig. 10.1.

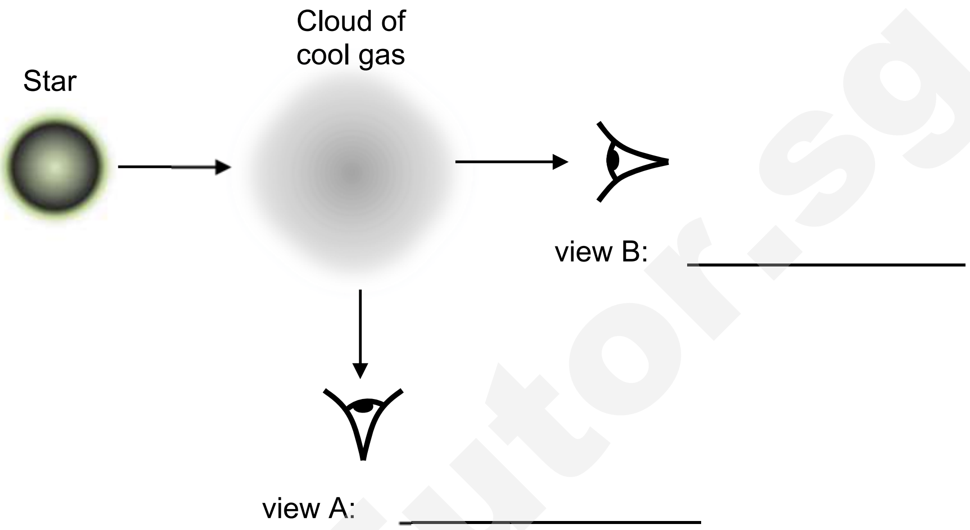

Fig. 10.1

(i) Label, on Fig. 10.1, the two different types of spectrum that can be observed from view A and B. [1]

(ii) Fig. 10.2 shows a spectrum from Orion nebula, a gas cloud in the constellation Orion. The spectrum contains a combination of spectral lines from different elements, which provides evidence that this gas cloud contains many different elements.

The spectral lines are labelled using the atomic symbol for that particular element (e.g. H, He, etc) with their corresponding wavelengths. In particular, hydrogen lines of different wavelengths have notations using the Greek alphabet (e.g. Hα).

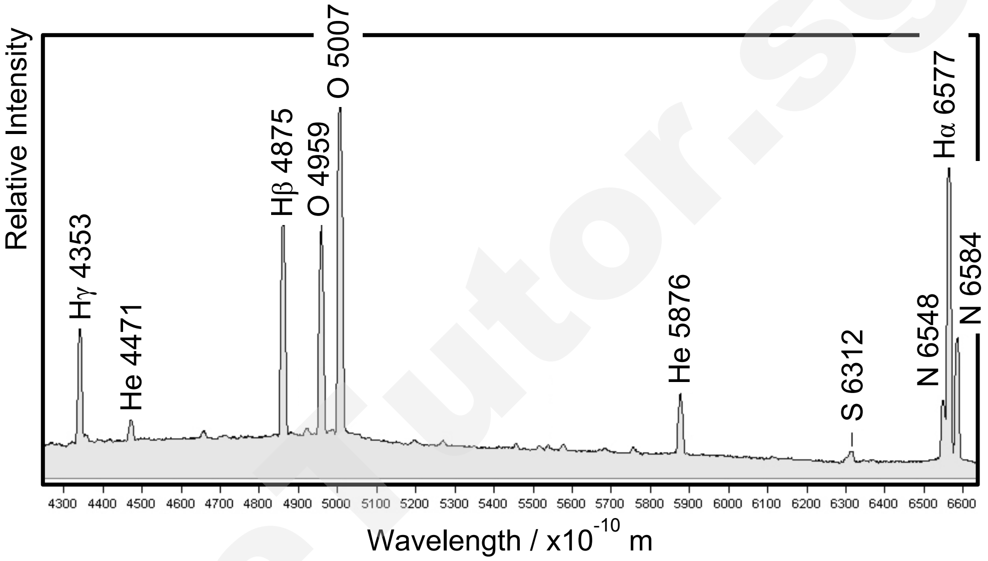

Fig. 10.2

1. State and explain whether this spectrum is recorded from view A or B.

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………………………………………………………………………………………… [2]

2. Suggest why the relative intensity of hydrogen spectra lines are higher than that of helium.

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………………………………………………………………………………………… [1]

3. Fig. 10.3 shows the lowest six energy levels of the hydrogen atom. Each of the hydrogen spectral line in Fig. 10.2 corresponds to a transition between the energy levels of hydrogen. The transition for Hα line is shown in Fig. 10.3.

Draw and label the energy transitions, Hβ and Hγ, which are responsible for producing the spectral lines of hydrogen in Fig. 10.2. Show your working clearly.

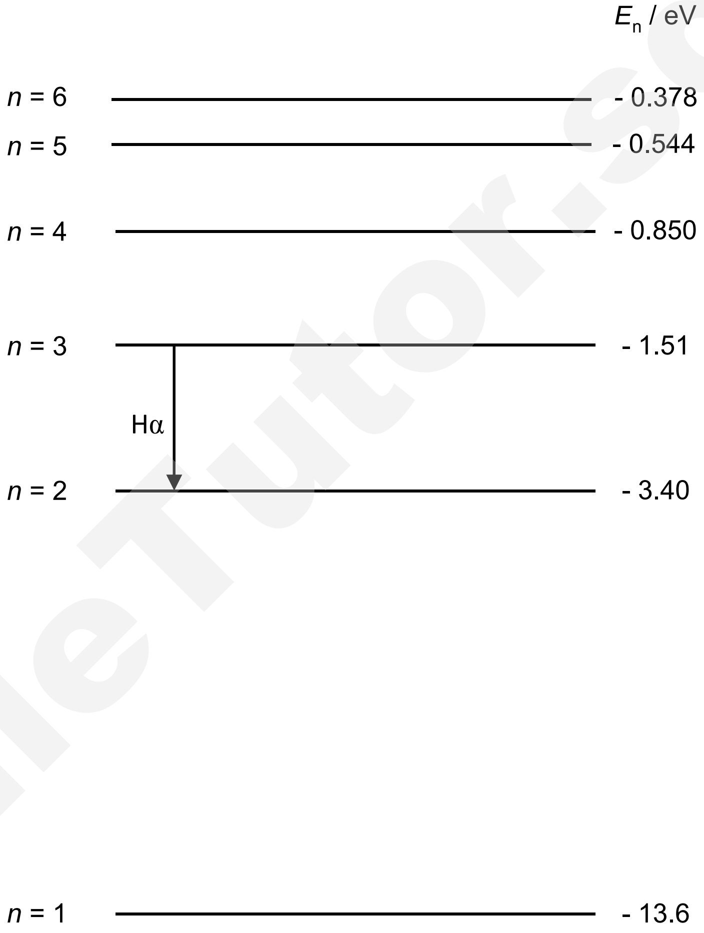

Fig. 10.3

Space for working:

[3]

(b) Electromagnetic radiation can exhibit wave or particle properties in different circumstances.

(i) The photoelectric effect experiment shows that electromagnetic radiation has a particulate nature.

Describe and explain two observations from the photoelectric effect experiment that give evidences for the particulate nature of electromagnetic radiation and not its wave nature.

1.

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…………………………………………………………………………………… [2]

2.

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……………………………………………………………………………………………

…………………………………………………………………………………… [2]

(ii) The wave nature of light can be supported by other experimental evidence.

Describe, with the aid of a diagram, an experiment which provides evidence for the wave nature of electromagnetic radiation.

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…………………………………………………………………………………….... [4]

(c) Protons, similar to electromagnetic radiation, can also exhibit wave or particle properties depending on the situation.

Protons are accelerated from rest across a potential difference of 500 kV.

(i) Determine the de Broglie wavelength of the protons after they have obtained their maximum speed.

wavelength = …………………………….. m [3]

(ii) State and explain whether the accelerated protons in part **(c)(i)** can be used to demonstrate proton diffraction.

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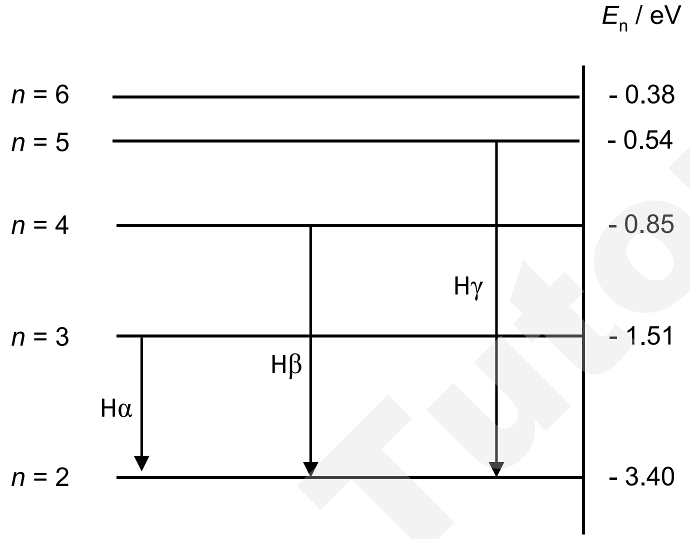
………………………………………………………………………………………….…….... [2]

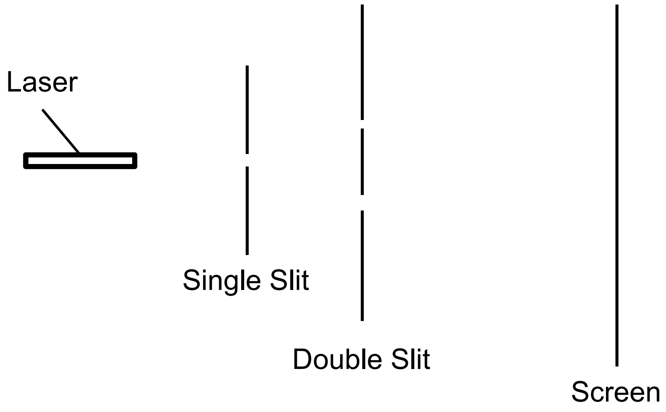
Qn	**MS**
1a	$\rho = \dfrac{\text{mass}}{\text{volume}}$ $= \dfrac{0.4493}{\pi(\frac{0.086}{2})^2(0.074)}$ $= 1.0451 \times 10^3$ kg m^{-3}
	$\rho = \dfrac{\text{m}}{\text{v}}$ $= \dfrac{\text{m}}{\pi(\frac{\text{d}}{2})^2 h}$ $\pm\dfrac{\Delta\rho}{\rho} = \pm(\dfrac{\Delta m}{m} + 2\dfrac{\Delta d}{d} + \dfrac{\Delta h}{h})$
	$= \pm(\dfrac{0.1}{449.3}) + 2(\dfrac{0.2}{8.6}) + (\dfrac{0.2}{7.4})$ $= \pm 0.0738$
	$\pm\Delta\rho = \pm 77$ $\approx \pm 80$ kg m^{-3} $\therefore \rho \pm \Delta\rho = (1.04 \pm 0.08) \times 10^3$ kg m^{-3}
b	Diameter as the term $2\dfrac{\Delta d}{d}$ has the largest contribution to the uncertainty of density.
2a	Constant velocity in horizontal direction
	Constant acceleration in vertical direction
b (i)	$v_y{}^2 = u_y{}^2 + 2a_y s_y$ $0 = (5\sin 30°)^2 + 2(-9.81)(s_y)$ $s_y = 0.319m$
	$Height = 2 + 0.319 = 2.319m$
(ii)	$v_y{}^2 = u_y{}^2 + 2a_y s_y$ $v_y{}^2 = 0 + 2(-9.81)(2.319)$ $v_y = 6.75ms^{-1}$
	$v = \sqrt{(5\cos 30°)^2 + (6.75)^2}$ $v = 8.02ms^{-1}$
	$\tan\theta = \dfrac{6.75}{5\cos 30°}$ $\theta = 57.3°$ below the horizontal

3a	$T - m_B g = m_B a$
	$m_A g \sin 30° - T = m_B a$
	$a = \dfrac{m_A g \sin 30° - m_B g}{m_B + m_A}$ $= 1.51 ms^{-2}$
b	Friction at axle of pulley
	Slope has friction
	Accept air resistance
4a	Work done is the product of force on an object and its displacement in the direction of the force.
b(i)	Work done by gravitational force on object is positive
	Loss in GPE becomes Gain in KE
(ii)	Work done by brakes on wheels is negative
	Loss in KE of wheel becomes thermal energy
5a	The ohm is the resistance of a component when a potential difference of 1 volt drives a current of 1 ampere through it
b (i)	E = V + Ir $emf - Ir = 3.9$ $(0.1)r = 4 - 3.9$ $r = 1.0\Omega$
(ii)	$P = VI$ $= (4)(0.1)$ $= 0.4W$
(iii)	Total resistance of the circuit decreases, ammeter reading increases
	As Ir increase, voltmeter reading decreases
	As the pd drop across the bulbs decreases, brightness of bulbs decrease
	As the current drawn is larger, power supplied by cell increases
6a	Tesla is the magnetic flux density when a wire carrying a current of 1 A placed at right angles to the magnetic field experiences a force of 1 N per metre
b	equally spaced crosses and dots
	spacing of crosses and dots wider at farther distance from wire
c	into the paper
7a	Gradient of the tangent of graph

b	Know that U α x^2
	Calculate first set of Ux^2
	Calculate second set of Ux^2
	Suitable conclusion
c	K = 50 (actual value = 48)
d	Spring must obey Hooke’s Law
8a(i)	Product of force and time
(ii)	Rate of change of momentum of a body is directly proportional to the net external force acting on the body
	Direction of change of momentum is same as direction of net force
b(i)	Change in momentum is the same for both cases
	Seat belt: time is longer hence force on passenger is lower
(ii)	Longer time of kick means larger impulse
	Ball travels faster
c(i)	N2L: F b on a = (mva – mua) / t
	F a on b = (mvb – mub) / t
	N3L: F a on b = - F b on a
	Substitute equation and rearrange
(ii)	No net external force acts on system
(iii)	Pa = 0
	mbub = (1)(-2.0)
	Pb after collision = 4
(iv)	Graph correct before collision
	During collision
	After collision
(d)(i)	FBD correct
	N – W = ma
(ii)	FBD correct
	W – N = ma

9(a)	When two or more progressive waves meet
	The resultant displacement of the wave is the vector sum of the displacement of individual wave
(b)	Two progressive waves with same amplitude and frequency and speed and travelling in opposite direction
	Appropriate graphs
	Node – zero displacement/points of destructive interference
	Antinode – max amplitude/points of constructive interference
(c)	90.8 – 70.6 = 2
	343 = (fundamental freq)(λ)
	L = 2λ
(d)(i)	Transverse waves have vibrations which are perpendicular to direction of energy transfer therefore oscillation can be restricted to a single directin
	Longitudinal waves have vibrations which are parallel to energy transfer
(ii)1.	2I
2.	Maxima when axes are aligned OR explain variation in intensity
	$I = I_o\cos^2\theta$
	2
(e)(i)	Intensity is inversely proportional to square of distance from point source
(ii)	$I \alpha A^2$
	$A \alpha 1/d$
	2.3/A = 2.5/1.5
	A = 1.38 mm
10a (i)	A – Emission spectrum B – Absorption spectrum
(ii) 1.	Higher intensity for spectrum lines while all other wavelengths are fairly constant and low
	A – emission spectrum
	Image from http://www.lafterhall.com/Special_Interest_Spectroscopy.html
(ii) 2.	Hydrogen is in larger concentration in the gas cloud than Helium

(ii) 3.	Energy of $H_{\beta} = \frac{hc}{\lambda_{\beta}} = \frac{6.63\times10^{-34}\times3\times10^{8}}{4862\times10^{-10}}$ $\left(=4.09\times10^{-19}\text{ J}\right)$ $=2.55$ eV
	Energy of $H_{\gamma} = \frac{hc}{\lambda_{\gamma}} = \frac{6.63\times10^{-34}\times3\times10^{8}}{4340\times10^{-10}}$ $\left(=4.58\times10^{-19}\text{ J}\right)$ $=2.864$ eV
	 Correct label. Ignore arrow direction.
(b)(i)	Any of the following 2 pair of answers: When light below (above) a threshold frequency (wavelength) shines on the metal, there is no current flowing through the circuit.
	Since particles of light carry discrete packets of energy, each photon must carry sufficient energy, hf_0, in order to knock out the surface electrons.
	Current flows almost instantaneously after light is shone on the metal.
	Photons are packets of energy and will instantaneously transfer all of its energy to the electron.
	Maximum KE o electrons/Stopping potential is not affected by a change in intensity of light.
	Increasing/Decreasing the intensity on increases the number of photons hitting the metal surface per unit time. Each photon still imparts the same energy to each electron no matter how high the intensity.

(ii)	 Appropriate Diagram drawn: - Coherent source - Double slit and screen
	Describe how two coherent EM source can be set up to observe their interference pattern.
	Explain that in this experiment, light can diffract into its geometric shadow (at the single slit, and) at both of the double slit. This highlights one wave like property.
	Explain that interference patterns of bright and dark bands will be formed at the screen, which is a result of superposition of the EM waves coming from both slits (sources). Superposition is a wave property.
(c)(i)	gain in KE = lost in Electric PE $= eV_s = \left(1.60\times10^{-19}\right)\left(500\times10^{3}\right)$ $\left(=8.0\times10^{-14}\text{ J}\right)$
	$p=\sqrt{2(1.67\times10^{-27})(8.0\times10^{-14})}$ = 1.635x10^{-20} kg m s^{-1}
	$\lambda=\dfrac{h}{p}=\dfrac{6.63\times10^{-34}}{1.635\times10^{-20}}$ = 4.06 x 10^{-14}
(ii)	De Broglie wavelength is too small and not of the order of the spacing between atoms (~10^{-10}m)
	Hence, no diffraction pattern is observable.

DUNMAN HIGH SCHOOL
Preliminary Examinations
Year 6
Higher 1

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS

8866/02

Paper 2 Structured Questions

14 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.

Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**7**
2	**8**
3	**8**
4	**6**
5	**11**
Section B	
6	**20**
7	**20**
8	**20**
Total	**80**

This document consists of **23** printed pages and **1** blank page.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\,\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 A 20 kg monkey has a firm hold on a light rope that passes over a frictionless pulley and is attached to a 20 kg bunch of bananas, as shown in Fig. 1.1. The monkey looks up, sees the bananas, and starts to climb the rope to get them.

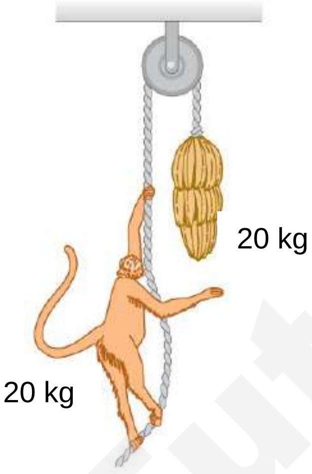


Fig. 1.1

(a) As the monkey climbs,

(i) State the forces acting on the monkey.

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

(ii) Hence or otherwise, state and explain whether the bananas move up, down or remain at rest.

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……………………………………………………………………………………………[3]

(iii) State and explain whether the vertical separation between the monkey and the bananas decrease, increase or remain constant.

…………………………………………………………………………………………………

…………………………………………………………………………………………………[1]

(b) The monkey releases her hold of the rope and both the monkey and bananas fall.

Before reaching the ground, the monkey grabs the rope to stop her fall. State and explain the motion of the bananas while monkey slows down to a complete stop.

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…………………………………………………………………………………………………

…………………………………………………………………………………………………[2]

2 A block of mass 0.40 kg slides in a straight line with a constant speed of 0.30 m s^{-1} along a horizontal surface, as shown in Fig. 2.1.

Fig. 2.1

The block hits a spring and decelerates. The speed of the block becomes zero when the spring is compressed by 8.0 cm.

(a) Calculate the initial kinetic energy of the block.

kinetic energy = …………………….. J [1]

(b) The variation of the compression *x* of the spring with the force *F* applied to the spring is shown in Fig. 2.2.

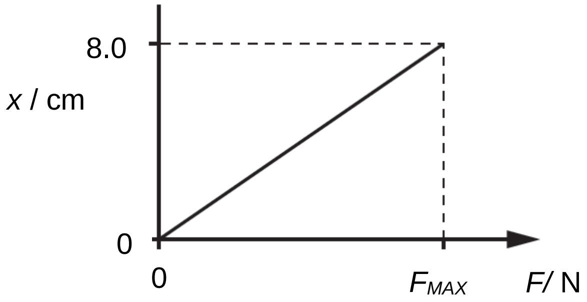


Fig. 2.2

Use your answers in **(a)** to determine the maximum force F_{MAX} exerted on the spring by the block.

F_{MAX} = …………………….. N [1]

(c) Calculate the maximum deceleration of the block.

decceleration = …………………….. m s^{-2} [1]

(d) State and explain whether the block is in equilibrium when its speed becomes zero.

……………………………………………………………………………………………………

……………………………………………………………………………………………………[1]

(e) The length of the spring is then cut in half. The same block travelling at the same speed of 0.30 m s^{-1} hits the spring.

Suggest and explain the change, if any, on the length of compression of the spring when the speed of the block becomes zero.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(f) The mass *m* of the block is now varied. The initial speed of the block remains constant and the spring continues to obey Hooke's law.

On Fig. 2.3, sketch the variation with mass *m* of the maximum compression x_0 of the spring. [2]

Fig. 2.3

3 A resistor of resistance 2.0 Ω is connected to a circuit with a supply of internal resistance 0.80 Ω and another resistor of resistance 5.0 Ω as shown in Fig. 3.1.

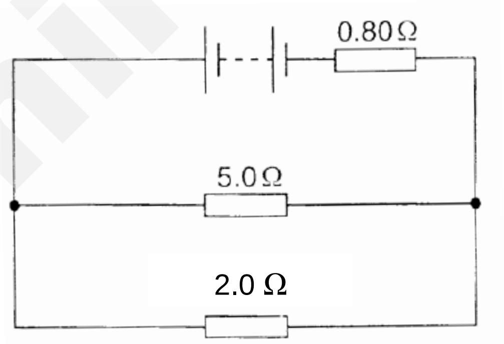


Fig. 3.1

The current through the 5.0 Ω resistor is 0.85 A. Calculate

(a) the p.d. across 2.0 Ω resistor,

p.d. = ... V [2]

(b) the total current from the supply,

current = ... A [2]

(c) the e.m.f. of the supply,

e.m.f. = ...V [2]

(d) the energy supplied to 2.0 Ω resistor in 20 minutes.

energy = ...J [2]

4 **(a)** A uniform magnetic field has constant flux density *B*. A straight wire of fixed length carries a current I at an angle θ to the magnetic field, as shown in Fig. 4.1.

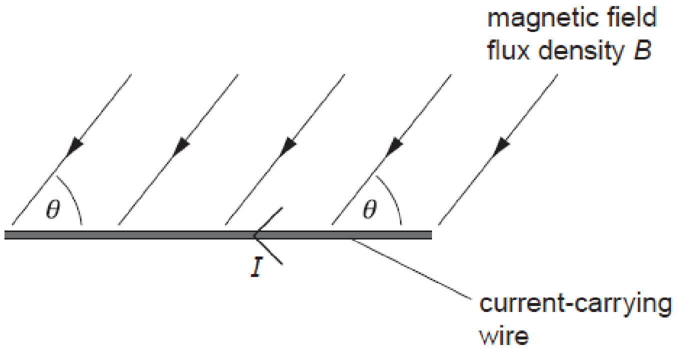
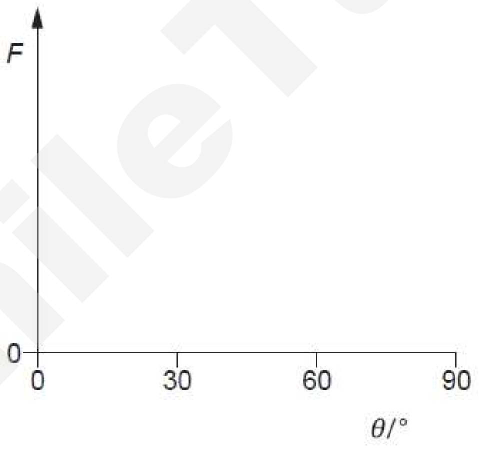


Fig. 4.1

The angle θ between the wire and the magnetic field is now varied. The current I is kept constant.

On Fig. 4.2, sketch a graph to show the variation with angle θ of the force *F* on the wire.



[3]

Fig. 4.2

(b) A small bar magnet is suspended 5.0 cm away from a long straight wire which is orientated in a north-south direction. The magnet is on the right side of the wire. When there is no current in the wire, the north pole of the magnet dips at an angle of 5.0^{o} below the horizontal, as shown in Fig. 4.3.

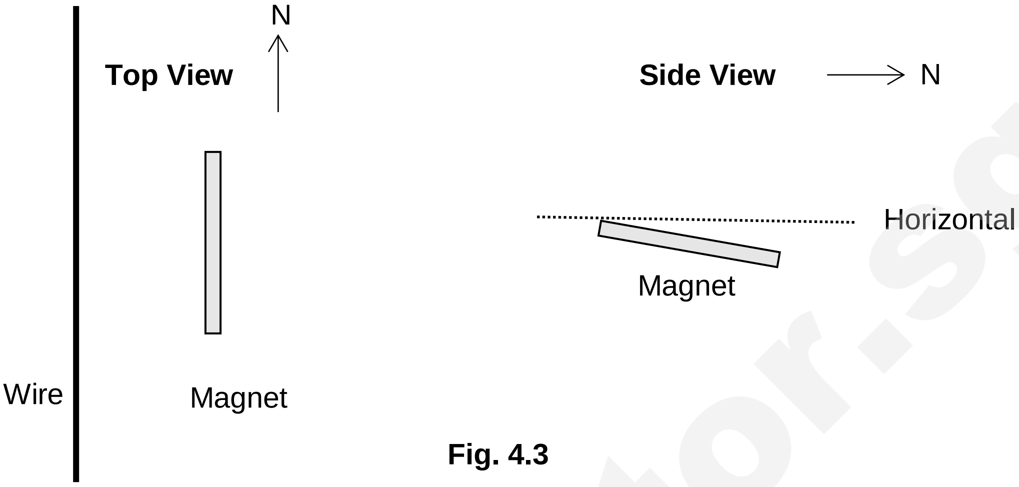


Fig. 4.3

A current is then supplied to the wire to move the magnet back to the horizontal position. Determine the magnitude and the direction of the current required.

The Earth's magnetic field in the region around the magnet is 0.17 mT.

The magnetic flux density, *B* due to a long straight wire carrying a current, I at a distance, *d* from the wire is given by the expression, $B = \frac{\mu_o I}{2\pi d}$ where μ_o is 4π x 10^{-7} H m^{-1}.

direction = …………………………..…………………….

magnitude = ………………….…….. A [3]

5 Resistivity and Temperature

Temperature generally affects current in an electrical circuit by changing the speed at which the charge carriers travel. In metals, this is due to an increase in resistance of the circuit that results from the increase in temperature.

Over a limited temperature range, the resistivity of different materials varies linearly with temperature according to the expression

$$\rho = \rho_0[1 + \alpha(T - T_0)]$$

where ρ is the resistivity at some temperature T (in degrees Celsius), ρ_0 is the resistivity at the reference temperature T_0 = 20°C, and α is a constant called the temperature coefficient of resistivity.

The resistivity at 20°C and the temperature coefficients of resistivity for some materials are shown in the table of Fig. 5.1 below.

Material	ρ_0 / **Ω m**	α / **°C^{-1}**
Gold	2.44×10^{-8}	3.4×10^{-3}
Tungsten	5.60×10^{-8}	4.5×10^{-3}
Silver	1.59×10^{-8}	3.8×10^{-3}
Platinum	11.0×10^{-8}	3.9×10^{-3}
X	1.50×10^{-6}	0.40×10^{-3}
Y	10.0×10^{-8}	5.0×10^{-3}

Fig. 5.1

(a) Distinguish between electrical *resistance* and *resistivity.*

……………………………………………………………………………………………………

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……………………………………………………………………………………………………

…………………………………………………………………………………………………… [3]

(b) Calculate the resistivity, at 120^{o}C, of

(i) gold

resistivity = ………….………… Ω m [1]

(ii) tungsten

resistivity = ………………………. Ω m [1]

(c) A 5.0 cm length of gold wire, of diameter 0.240 mm, is soldered to a 5.0 cm length of tungsten wire, of diameter 0.140 mm, to form a composite wire, in the configuration as shown in Fig. 5.2.

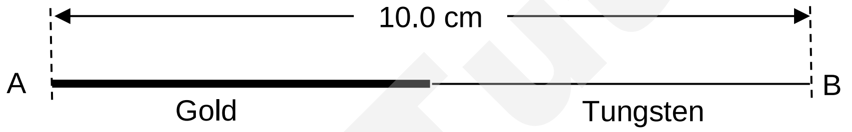

Fig. 5.2

(i) Calculate the resistance across A and B at a temperature of 120^{o}C.

resistance = ………………………. Ω [3]

(ii) The composite wire in Fig 5.2 is now bent into a square loop, as shown in Fig. 5.3.

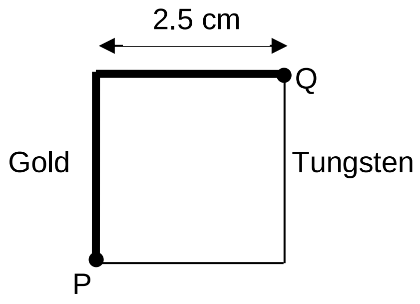

Fig 5.3

Calculate the resistance across P and Q at a temperature of 120ºC.

resistance = ………..……………….. Ω [2]

(d) A student would like to make an electric kettle with a coil of wire made from either material **X** or **Y**. Suggest with a reason which material, **X** or **Y**, is more suitable to be used as a heating element in an electric kettle.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………[1]

Section B

Answer **two** of the questions in this section.

6 Fig. 6.1 shows an object M on a smooth slope.

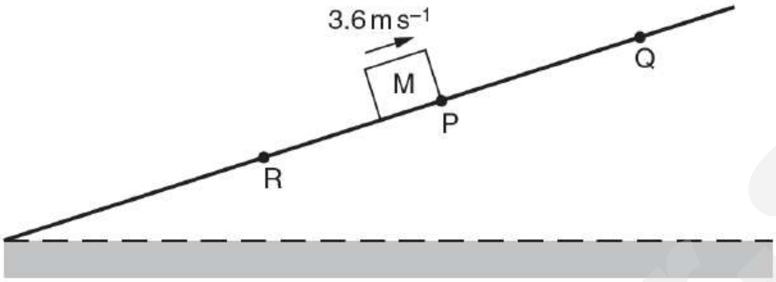

Fig. 6.1

M moves up the slope, comes to rest at point Q and then moves back down the slope to point R. M has a constant acceleration of 3.0 m s^{-2} down the slope at all times.

At time *t* = 0, M is at point P and has a velocity of 3.6 m s^{-1} up the slope.
The total distance from P to Q and then to R is 6.0 m.

(a) Calculate, for the motion of M from P to Q,

(i) the time taken,

time = …………………….. s [2]

(ii) the distance travelled.

distance = …………………….. m [1]

(b) Determine the speed of M at R.

speed of M = …………………….. m s^{-1} [3]

(c) On Fig. 6.2, draw the variation with time *t* of the velocity *v* of M for the motion P to Q to R.

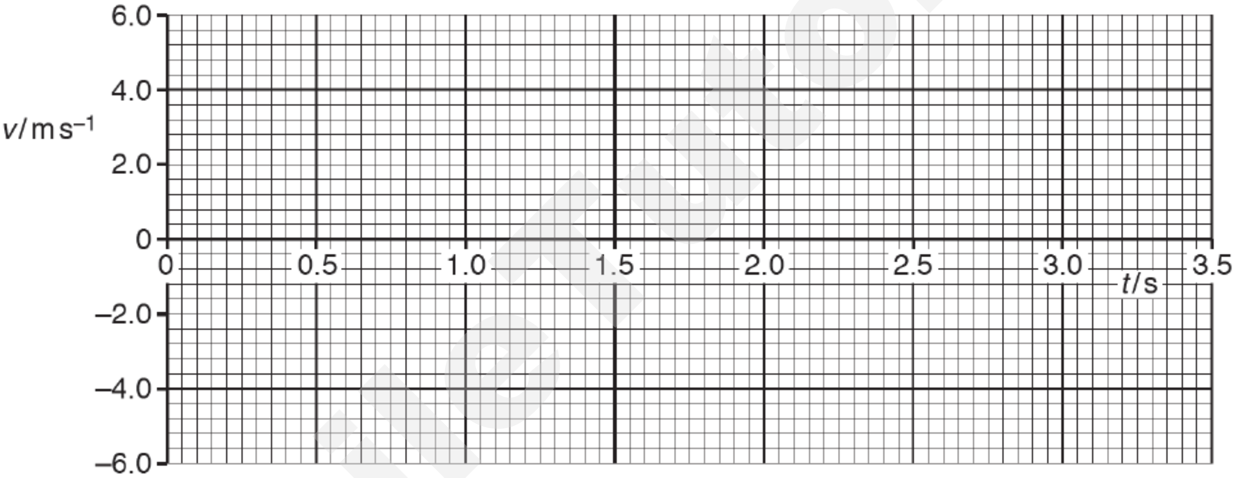

Fig. 6.2

[3]

(d) The mass of M is 450 g.

Calculate the difference in the kinetic energy of M at P and at R.

difference in kinetic energy = …………………….. J [2]

(e) A cart of mass 2.0 kg is moving to the right at a speed of 10 m s^{-1} on a smooth horizontal floor as shown in Fig. 6.3. M continues to slide down the slope that is inclined at an angle θ from the horizontal and leaves the end of the slope with a speed of 6.0 m s^{-1}. M lands in the cart and they roll off together.

The vertical distance between the lower end of the slope and the bottom of the cart is 4.0 m.

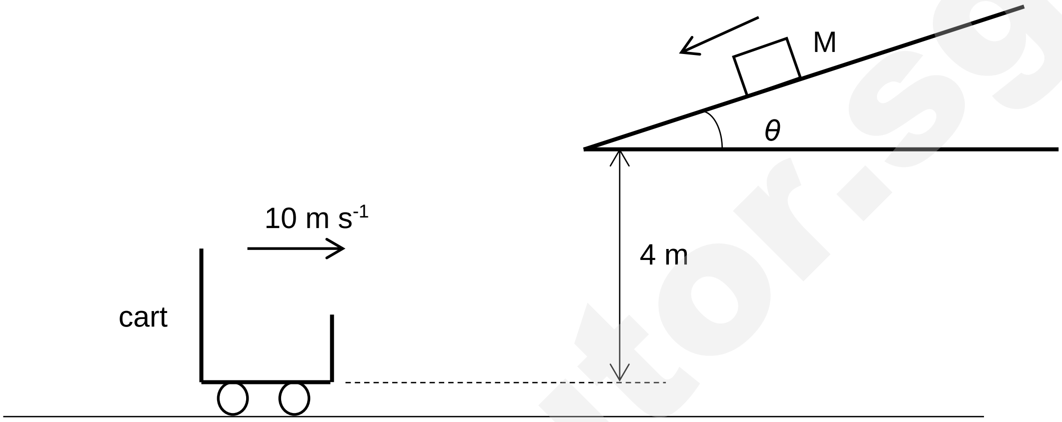

Fig. 6.3 (not to scale)

(i) Given that M has a constant acceleration of 3.0 m s^{-2} down the smooth slope at all times, show that the angle θ is 18°.

[2]

(ii) State the *principle of conservation of linear momentum*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

(iii) Calculate the speed of M just before it lands in the cart.

speed of M = …………………….. m s^{-1} [2]

(iv) Determine the final speed of the cart.

final speed of cart = …………………….. m s^{-1} [3]

7 **(a)** Describe the basic difference between the following terms. You may use diagrams to illustrate your answers.

(i) a *transverse* wave and a *longitudinal* wave,

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………[2]

(ii) a *polarised* wave and a *non-polarised* wave,

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………[2]

(iii) a *stationary* wave and a *progressive* wave.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………[2]

(b) Fig. 7.1 shows the variation with distance x along a wave of its displacement d at a particular time.

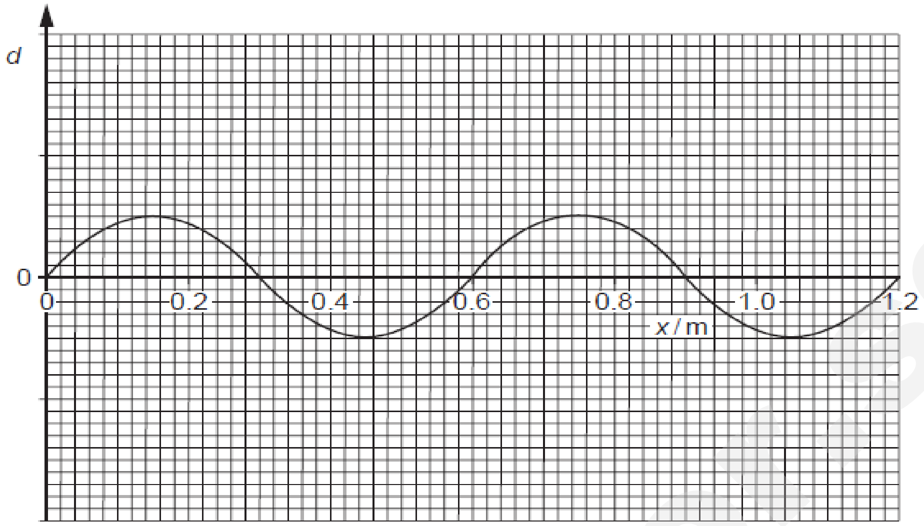

Fig. 7.1

The wave is a progressive wave having a speed of 330 m s^{-1}.

(i) Use Fig. 7.1 to determine the wavelength of the wave.

wavelength = ... m [1]

(ii) Hence calculate the frequency of the wave.

frequency = ... Hz [2]

(iii) A second wave has the same frequency and speed as the wave shown in Fig. 7.1 but has double the intensity.

The phase difference between the two waves is 180°.

On the axes of Fig. 7.1, sketch a graph to show the variation with distance x of the displacement d of this second wave. [2]

(c) Fig. 7.2 shows wavefronts incident on, and emerging from, a double slit arrangement.

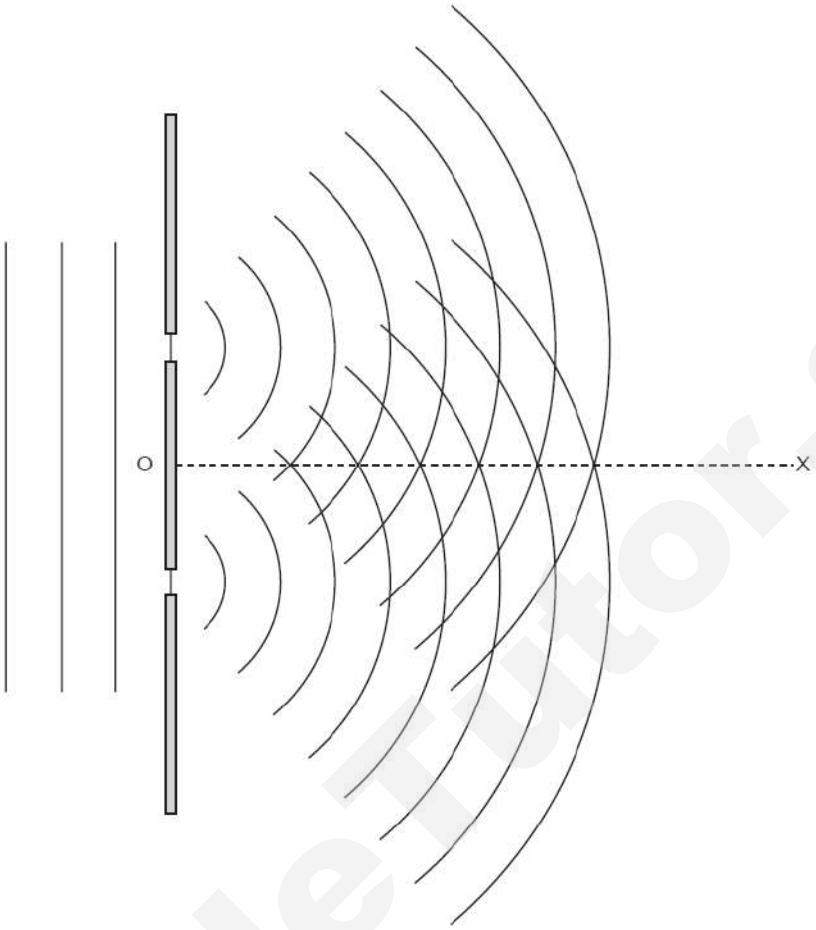

Fig. 7.2

The wavefronts represent successive crests of the wave. The line OX shows one direction along which constructive interference may be observed.

On Fig. 7.2, draw lines to show

(i) a second direction along which constructive interference may be observed (label this line CC),

(ii) a direction along which destructive interference may be observed (label this line DD). [2]

(d) A long tube is open at one end. It is closed at the other end by means of a piston that can be moved along the tube, as shown in Fig. 7.3.

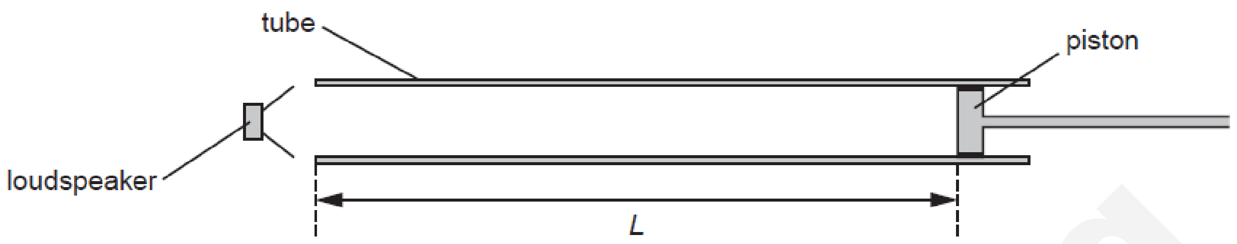

Fig. 7.3

A loudspeaker producing sound of frequency 550 Hz is held near the open end of the tube. The piston is moved along the tube and a loud sound is heard when the distance L between the piston and the open end of the tube is 45 cm.

The speed of sound in the tube is 330 m s^{-1}.

(i) Show that the wavelength of the sound in the tube is 60 cm.

[1]

(ii) On Fig. 7.3, mark all the positions along the tube of

1. the displacement nodes (label these with the letter N),

2. the displacement antinodes (label these with the letter A). [3]

(e) The frequency of the sound produced by the loudspeaker in **(d)** is gradually reduced. Determine the lowest frequency at which a loud sound will be produced in the tube of length L = 45 cm.

frequency = ... Hz [3]

8 **(a)** Experiments are conducted to investigate the photoelectric effect.

(i) It is found that, on exposure of a metal surface to light, either electrons are emitted immediately or they are not emitted at all.

Suggest why this observation does not support a wave theory of light.

....

....

....

.... [3]

(ii) Data for the wavelength λ of the radiation incident on the metal surface and the maximum kinetic energy E_K of the emitted electrons are shown in Fig. 8.1.

λ/nm	$E_K / 10^{-19}$ J
650 240	– 4.44

Fig. 8.1

Without any calculation, suggest why no value is given for E_K for radiation of wavelength 650 nm.

....

.... [1]

(iii) Use data from Fig. 8.1 to determine the work function energy of the surface.

work function energy = ... J [3]

(iv) Radiation of wavelength 240 nm gives rise to a maximum photoelectric current I. The intensity of the incident radiation is maintained constant and the wavelength is now reduced.

State and explain the effect of this change on

1. the maximum kinetic energy of the photoelectrons,

....

....

.... [2]

2. the maximum photoelectric current I.

....

....

.... [2]

(b) State what is meant by *the de Broglie wavelength*.

....

....

.... [2]

(i) An electron is accelerated in a vacuum from rest through a potential difference of 850 V. Calculate

1. the final momentum of the electron.

final momentum = ... N s [3]

2. the de Broglie wavelength of this electron.

wavelength = ... m [2]

(c) A parallel beam of electrons, all travelling at the same speed, is incident normally on a carbon film. The scattering of the electrons by the film is observed on a fluorescent screen, as illustrated in Fig. 8.2.

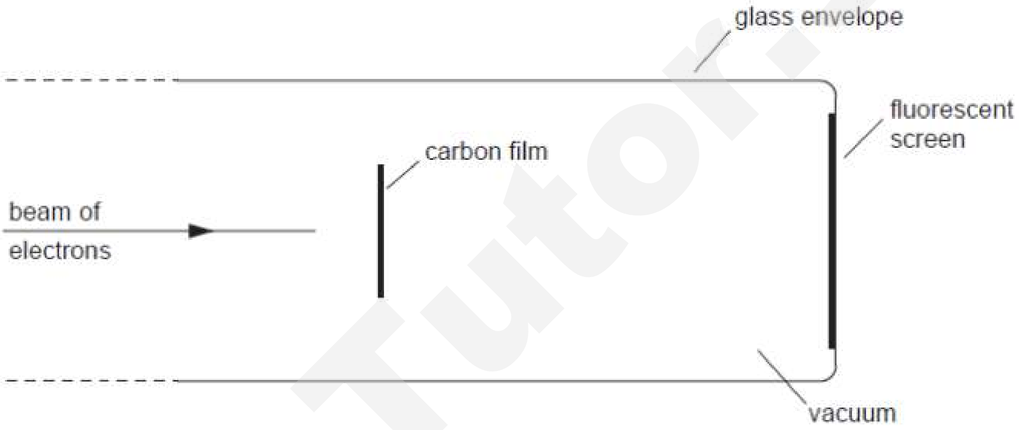

Fig. 8.2

(i) Assuming that the electrons behave as particles, predict what would be seen on the screen.

....

.... [1]

(ii) In this experiment, the electrons do not behave as particles.

Describe briefly the pattern that is actually observed on the screen. You may draw a sketch if you wish.

....

.... [1]

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For Examiner's Use

Dunman High School Year 6 H1 Physics Prelim Exam Answers

Paper 1

1. B	2. B	3. C	4. A	5. C	6. B	7. B	8. C	9. A	10. D
11. C	12. B	13. D	14. D	15. D	16. D	17. D	18. C	19. B	20. D
21. C	22. A	23. A	24. B	25. B	26. A	27. D	28. D	29. B	30. A

Paper 2
Section A

1 **(a)** **(i)** Weight of monkey and (frictional) force by rope on monkey
Or Weight of monkey and tension of rope on monkey A1

(ii) Monkey climbs up so force by monkey on rope > 20g B1
(Frictionless pulley) tension in the rope is the same on the monkey and on the bananas M1
Bananas move up. A1

(iii) Start at rest with same upwards acceleration, distance is a constant. A1

(b) Bananas slow down at the same rate as that of monkey (same magnitude of force on monkey and bananas). M1
Bananas also come to a complete stop at the same time as that of monkey. A1

2 **(a)** $E_k = \frac{1}{2} mv^2 = \frac{1}{2} \times 0.40 \times 0.30^2 = 1.8 \times 10^{-2}$ J A1

(b) loss in KE = gain in EPE
$1.8 \times 10^{-2} = \frac{1}{2} \times F \times 0.080$
$F_{MAX} = 0.45$ N A1

(c) $a = F/m = 0.45 / 0.40 = 1.1$ m s^{-2} A1

(d) Resultant force is not zero (F_{MAX} acting on block), so not in equilibrium. A1

(e) spring constant increases (by 2 times) M1
maximum compression reduces (is now 5.7 cm) A1

(f) Curved line from origin, B1
With decreasing gradient (no plateau) B1

3 **(a)** pd across 2.0 Ω = pd across 5.0 Ω
= 5 × 0.85 C1
= 4.25 = 4.3 V A1

(b) Total current = 0.85 + 4.25/2 C1
= 2.975 = 3.0 A A1

(c) emf = 4.25 + 2.975(0.8) C1
= 6.63 = 6.6 V A1

(d) Energy = *IVt*

= (2.125)(4.25)(20 × 60) C1

= 10838 = 11000 J A1

4 **(a)** Maximum force shown at angle $\theta = 90^0$ M1

Zero force shown at $\theta = 0^0$ M1

Reasonable curve with *F* about ½ max at 30^0 A1

(b) The north pole of the magnet indicates the direction of the Earth's magnetic field which points at an angle of 5^0 below the horizontal.

Vertical component of Earth's magnetic field, *B* downwards

$= 0.17x10^{-3}\sin 5^o$

$= 1.48 \text{ x } 10^{-5}\ T$ C1

To orientate the magnet horizontally, the magnetic field due to the wire must neutralise the downward field due to the Earth.

$$B = \frac{\mu_o I}{2\pi r} = \frac{4\pi x10^{-7} I}{2\pi(5.0x10^{-2})} = 1.48 \text{ x } 10^{-5}\ T \quad = 3.7 \text{ A}$$ M1

in the north-south direction A1

5 **(a)**

The resistance R of a conductor is defined as the **ratio** $\frac{V}{I}$ where V is the potential difference across the conductor and I is the current flowing through it. -----------------[B1]

Resistivity is a relationship between the dimensions of a specimen of a material and its resistance that is constant at constant temperature and determined by ρ = $\frac{RA}{L}$ where *R* is resistance, *A* is cross-sectional area and *L* is length. ----------------------------[B1]

Resistance is a property of the sample (depends on the dimensions of the sample) whereas resistivity relates to the material. --[B1]

(b) (i) $3.27 \text{ x } 10^{-8}$ Ωm -----[A1]

(ii) $8.12 \text{ x } 10^{-8}$ Ωm -----[A1]

(c) The 2 wires are in series, thus effective resistance adds up.

Resistance

$$= R_{gold,120\deg} + R_{tungsten,120\deg}$$

$$= \frac{(3.27\times10^{-8})(0.050)}{\pi(\frac{0.240\times10^{-3}}{2})^2} + \frac{(8.12\times10^{-8})(0.050)}{\pi(\frac{0.140\times10^{-3}}{2})^2}$$ ----[M2, A1]

$$= 0.03614 + 0.26374 = 0.300\Omega$$

(d) The 2 wires are in parallel,

$$R = (1/R_{gold,120\deg} + 1/R_{tungsten,120\deg})^{-1}$$

$$= (\frac{1}{0.03614} + \frac{1}{0.26374})^{-1} = 0.0318\Omega$$ -----[M1,A1]

(e) Material X is more suitable, as it has a larger resistivity. Thus for the same resistance in the heating element, a shorter length of X is required compared to Y.

OR

Material X is a more suitable material. It has a much smaller temperature coefficient of resistivity α than material Y. The resistance of X and hence the power output will be relatively more constant compared to Y during heating. ---[B1]

6 **(a)** **(i)** $v = u + at$

$0 = 3.6 - 3.0t$ C1

$t = 1.2$ s A1

(ii) distance travelled = ½ (3.0)(1.2)^2 = 2.16 = 2.2 m. A1

(b) distance = 6.0 – 2.16 = 3.84 C1

$v^2 = u^2 + 2as$ = 2 x 3.0 x 3.84 = 23.04 C1

v = 4.8 m s^{-1} A1

(c) straight line from v = 3.6 m s^{-1} to v = 0 at t = 1.2 s B1

straight line continues with the same gradient as v changes sign B1

straight line from v = 0 intercept to v = – 4.8 m s-*1* B1

(d) difference in KE = ½ $m(v^2 - u^2)$

= 0.5 x 0.45 x (4.8^2 – 3.6^2) M1

= 2.27 J A1

(e) **(i)** Based on Newton's 2nd Law,

Component of weight down the slope = mass x acceleration B1

$mg\sin\theta = ma$

$\sin\theta = 3/9.81$ M1

θ = 17.8 = 18° A0

(ii) The principle of conservation of linear momentum states that the total momentum of a system remains constant [B1] provided no net external resultant force acts on system [B1].

(iii) Using conservation of energy

½ (0.45)(6.0)^2 + (0.45)(9.81)(4.0) = ½ (0.45)(v^2) C1

v = 10.7 m s^{-1} A1

(iv) horizontal speed of M = 6.0 cos(17.8°) = 5.713 m s^{-1} C1

Apply conservation of momentum in horizontal direction

(2.0)(10) – (0.45)(5.713) = (2.45) v C1

v = 7.11 m s^{-1} A1

7 **(a)** **(i)** transverse wave has vibrations perpendicular/normal to direction of energy travel B1

longitudinal wave has vibrations parallel to the direction of energy travel B1

accept answers in terms of a diagram

(ii) polarised with all vibrations in a single axis / direction (normal to direction of energy travel) B1

non-polarised with vibrations in all directions B1

a diagram here must have at least three doubled headed arrows.

(iii) progressive: all particles have same amplitude

stationary: maximum (antinode) to minimum/zero amplitude (node) B1

progressive: adjacent particles are not in phase

stationary: wave particles are in phase (between adjacent nodes) B1

progressive: transfer energy

stationary: do not transfer energy B1

*(*max 2 marks)

(b) **(i)** $\lambda =$ 0.60 m A1

(ii) $f = \frac{v}{\lambda} = \frac{330}{0.60}$ M1

$= 550$ Hz A1

(iii) Amplitude shown is greater than 5 units but less than 10 units and B1

constant correct phase B1

(waves to be at least 3 half-periods, otherwise 1-overall)

(c) **(i)** Any correct line through points of intersection of crests B1

(ii) Any correct line through intersections of a crest and a trough B1

(d) **(i)** λ = (330 x 10^2)/550 M1

= 60 cm A0

(ii) Node labelled at piston B1

Antinode labelled at open end of tube B1

Additional node and antinode in correct positions along tube B1

(e) At lowest frequency, length = $\frac{\lambda}{4}$ C1

λ = 1.8 m

Frequency = 330/1.8 C1
= 180 Hz A1

8 **(a)** **(i)** For a wave,
electron can ‘collect’ energy continuously B1
electron will always be emitted/will be emitted at all frequencies… M1
after a sufficiently long delay A1

(ii) Either wavelength is longer than threshold wavelength
or frequency is below the threshold frequency
or photon energy is less than work function B1

(iii)

$$\frac{hc}{\lambda} = \phi + E_{\text{max}}$$ C1

$$\frac{(6.63\ x\ 10^{-34})(3.0\ x\ 10^{8})}{(240\ x\ 10^{-9})} = \phi + 4.44\ x\ 10^{-19}$$ C1

$$\phi = 3.8\ x\ 10^{-19}\ \text{J}$$ A1

(iv) **1.** Photon energy larger M1
so (maximum) kinetic energy is larger A1

2. Few photons (per unit time) M1
so (maximum) current is smaller A1

(b) Wavelength of wave associated with a particle M1
that is moving A1

(i) **1.** Energy of electron = 850 x 1.6 x10^{-19} = 1.36 x 10^{-16} J C1

$$Energy = \frac{p^2}{2m}$$

$$1.36\ x\ 10^{-16} = \frac{p^2}{2(9.11\ x\ 10^{-31})}$$ M1

$$p = 1.6\ x\ 10^{-23}\ \text{N s}$$ A1

2.

$$\lambda = \frac{h}{p} = \frac{6.63x10^{-34}}{1.6x10^{-23}}$$ M1

$$= 4.1\ x\ 10^{-11}\ \text{m}$$ A1

(c) **(i)** ‘Uniform’ distribution B1

(ii) Pattern of concentric rings observed B1

HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 1

CANDIDATE NAME		**CT GROUP**	16S
CENTRE NUMBER		**INDEX NUMBER**	

PHYSICS

8866/01

Paper 1 Multiple Choice

21 September 2017

1 hour

Additional Materials: Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the OMS.

Each correct answer will score one mark. A mark will **not** be deducted for a wrong answer.

Any rough working should be done in this booklet.

This document consists of **13** printed pages.

Data

speed of light in free space,

$c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge,

$e = 1.60 \times 10^{-19}$ C

the Planck constant,

$h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant,

$u = 1.66 \times 10^{-27}$ kg

rest mass of electron,

$m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton,

$m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall,

$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/ by a gas,	$W = p\,\Delta V$
hydrostatic pressure	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 Which of the following is equivalent to the quantity, 37.86×10^{-4} MJ cm^{-4}?

A 37.86×10^{-18} J m^{-4}

B 37.86 μJ m^{-4}

C 378.6 TJ m^{-4}

D 378.6 GJ m^{-4}

2 Which of the following is the best estimate of the population density (population per unit area) in Singapore?

A 10^{0} km^{-2} **B** 10^{2} km^{-2} **C** 10^{4} km^{-2} **D** 10^{6} km^{-2}

3 A particle has an initial speed *v* along the 0-*x* direction as shown in Fig. (a).

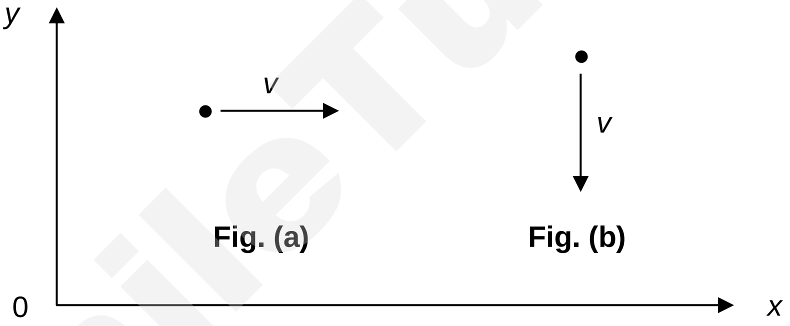
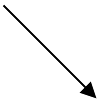


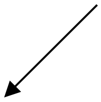
Fig. (a) **Fig. (b)**

After some time, it travels with the same speed *v* in a direction perpendicular to its original direction as shown in Fig. (b). Which of the following shows the direction of the change of velocity that has taken place in this time interval?

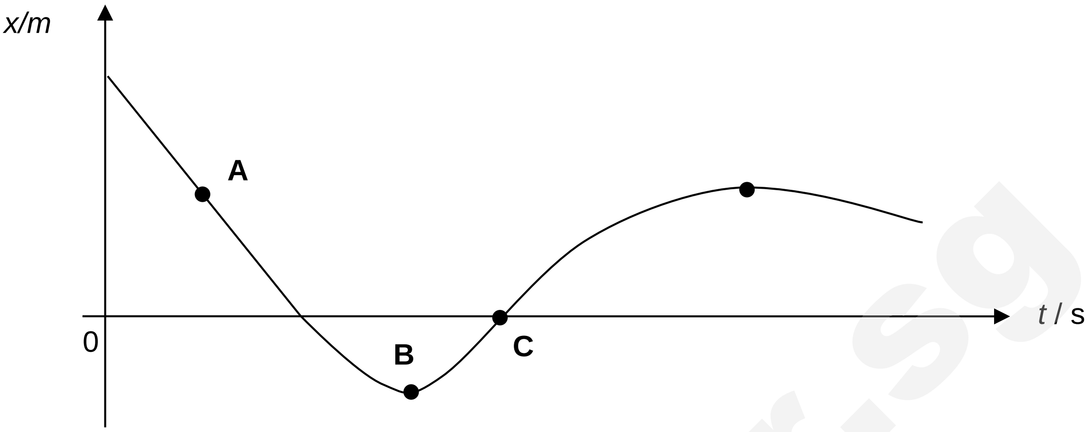
A


B

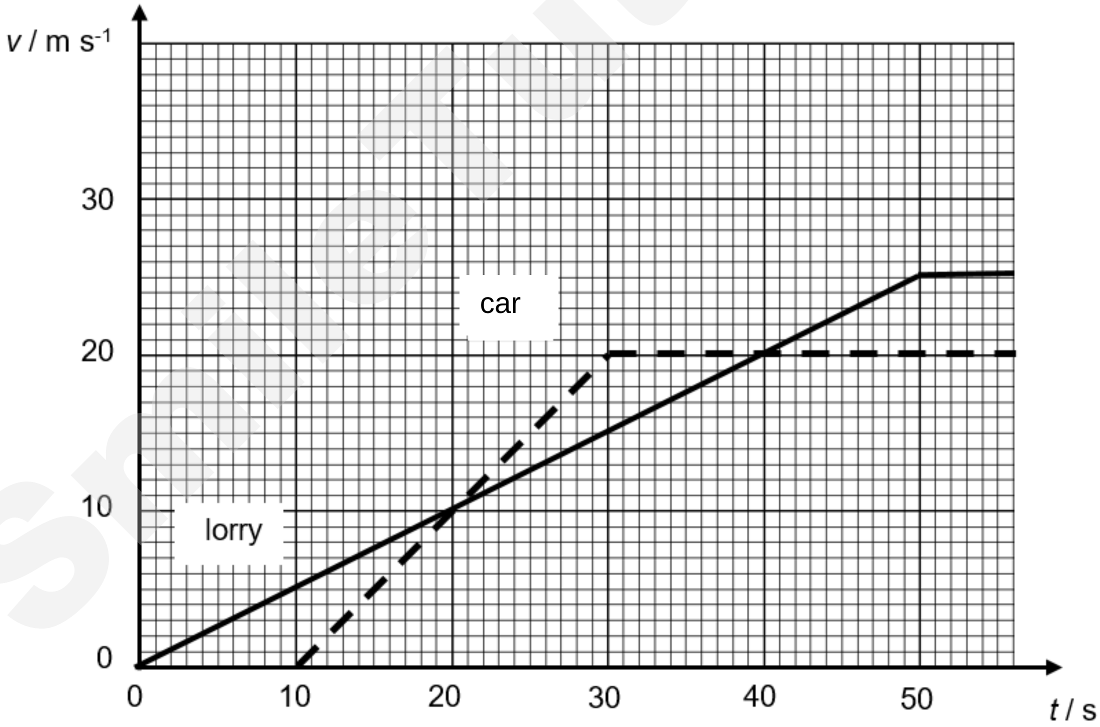

C


D


4 A ball moves along a straight line. The variation of its displacement x with time t is given by the graph. At which point is the acceleration of the ball the greatest?



5 The variation with time t of the speed v of a lorry after leaving a petrol station is shown. A car leaves the petrol station 10.0 s later and its speed-time graph is also shown.



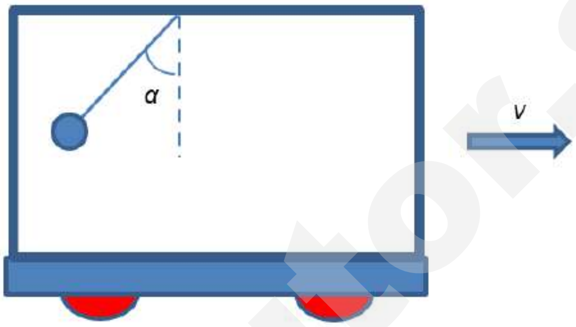
At which of the following times would the distance between the lorry and car be the least?

A 20.0 s **B** 30.0 s **C** 40.0 s **D** 50.0 s

6 A hot air balloon ascends from rest with an acceleration of 2.50 m s^{-2}. When it reaches an altitude of 48.0 m above the initial ground level, its ballast of mass 5.00 kg is suddenly released. Taking *g* as 10 m s^{-2} and ignoring air resistance, what is the speed of the ballast, in m s^{-1}, just before it impacts the ground?

A 35.8 **B** 34.6 **C** 31.1 **D** 28.3

7 A mass *m* hangs at the end of a rope which is attached to a support fixed on a trolley moving to the right with a speed *v* on a horizontal track as shown. The angle, *α*, is the angle the rope makes with the vertical.



Which of the following statements is **false**?

A The angle *α* is zero when the trolley moves with a uniform speed.

B When the trolley moves with a constant acceleration *a*, the magnitude of angle *α* is only determined by *a* and *g*.

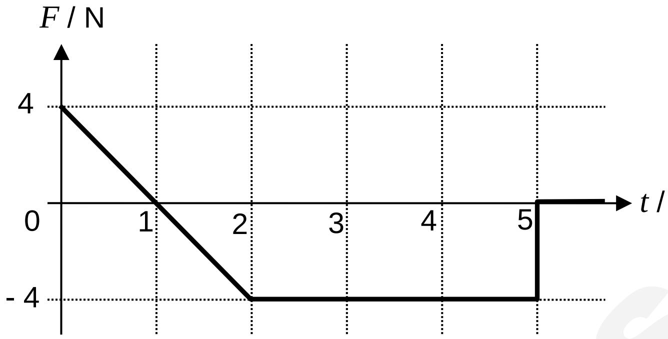
C The tension *T* in the rope is larger when the trolley moves with a uniform speed than when it moves with a constant acceleration.

D The ball swings to the right when the trolley decelerates.

8 A girl, riding in an elevator, weighs herself by standing on a scale that is placed on the floor of the elevator. The scale reads 65.0 kg when the elevator is moving at constant velocity. What is the reading of the scale when the elevator is accelerating downwards at 2.00 m s^{-2}?

A 51.7 kg **B** 60.0 kg **C** 65.0 kg **D** 78.3 kg

9 A force F acts on a 2.0 kg body for 5.0 s. The body moves with an initial velocity of 4.0 m s^{-1} along the positive x direction. A graph of the force on the body against time is shown. What is the velocity of the body at 5.0 s?



A -2.0 m s^{-1} **B** 6.0 m s^{-1} **C** -6.0 m s^{-1} **D** 8.0 m s^{-1}

10 A 70 000 kg railway gun sitting on the railway platform in contact with the Earth is shown below.

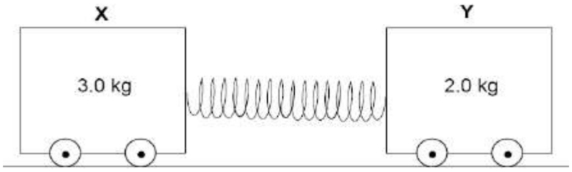
It fires a 500 kg artillery shell at an angle of 45° and with a muzzle velocity of 200 m s^{-1}. What is the magnitude of the recoil velocity of the gun?

A 0.5 m s^{-1} **B** 1.0 m s^{-1} **C** 1.4 m s^{-1} **D** 2.8 m s^{-1}

11 Mass M has the same kinetic energy as mass m. The ratio of their momenta $\frac{p_M}{p_m}$ is

A $\frac{M+m}{M}$ **B** $\frac{M}{M+m}$ **C** $\sqrt{\frac{M}{m}}$ **D** $\sqrt{\frac{m}{M}}$

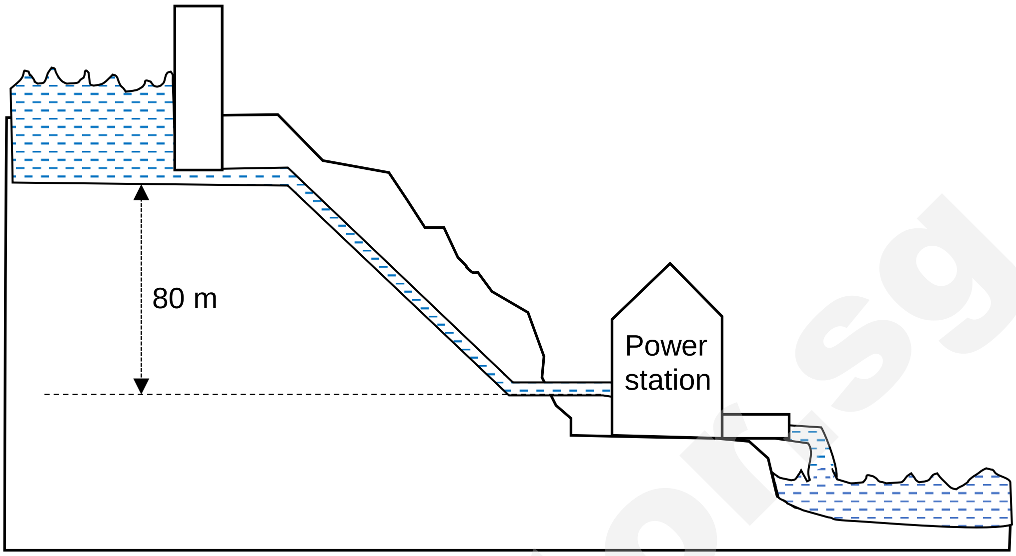
12 Two trucks, X and Y, are held with a light spring between them as shown. The spring is attached to truck X but not to Y.



When the trucks are released, X is found to be moving to the left at 4.0 m s^{-1}. If the ground is smooth, the energy, in J, initially stored in the compressed spring must have been

A 24 **B** 36 **C** 48 **D** 60

13 A hydroelectric power station is shown.



Water is supplied from a reservoir which is 80 m above the power station. The water passes through its turbines at a rate of 6.0 $m^3 s^{-1}$.

Assume that the density of water is 1000 kg m^{-3}.

If the efficiency of the power station is 60%, the electrical power output is

A 0.29 MW **B** 1.9 MW **C** 2.8 MW **D** 4.7 MW

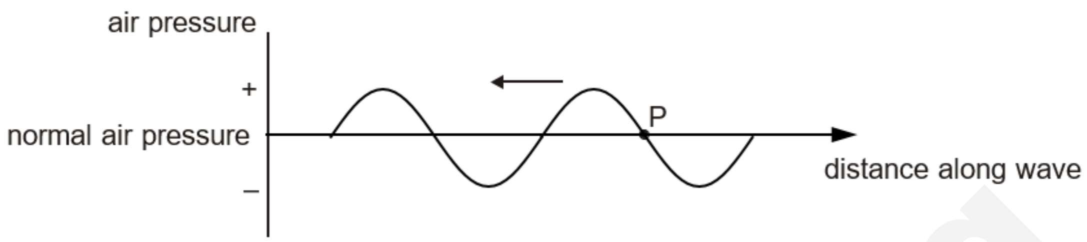
14 The engine of a boat delivers 30.0 kW to the propeller while the boat is moving at a constant speed of 15.0 m s^{-1}. The total drag on the boat is proportional to the square of the speed of the boat. If the boat is being towed at 5.0 m s^{-1} after its engine has broken down, the average tension in the towline will be

A 44.4 N **B** 220 N **C** 2000 N **D** 3330 N

15 The least distance between two points of a progressive transverse wave which have a phase difference of $\frac{\pi}{3}$ rad is 0.050 m. If the frequency of the wave is 500 Hz, what is the speed of the wave, in m s^{-1}?

A 75 **B** 150 **C** 250 **D** 1670

16 The graph shows the variation of air pressure with distance along a wave at one given time. The arrow indicates the direction of travel of the wave.



The air pressure at point P is

A decreasing **B** increasing **C** constant **D** zero

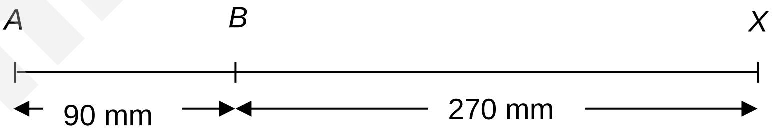
17 A point source of sound emits energy equally in all directions at a constant rate and a detector placed 2.0 m from the source measures an intensity of 4.0 W m^{-2}. The power of the source is then halved. What intensity, in W m^{-2}, would the detector measure if it is now placed at a distance 4.0 m from the source?

A 0.25 **B** 0.50 **C** 1.00 **D** 2.00

18 In Young's double slit experiment, the slit separation is 0.960 mm and the distance between the slits and the screen is 13.7 m. The distance between the two third-order bright fringes is measured to be 5.00 cm. Determine the wavelength of the source.

A 5.26 x 10^{-7} m **B** 5.84 x 10^{-7} m **C** 7.00 x 10^{-7} m **D** 1.17 x 10^{-6} m

19



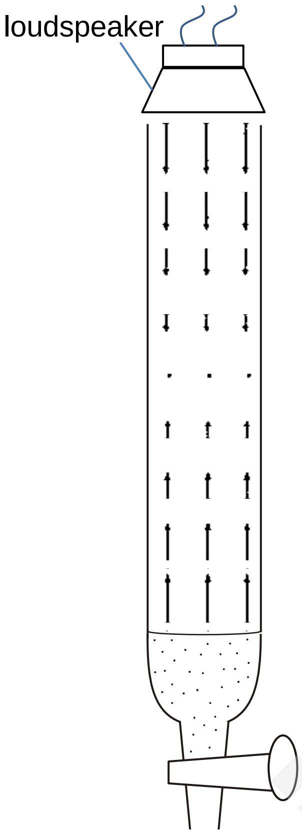
A and *B* are two coherent sound sources which are in phase. Point *X* shows permanent zero displacement. From the options given below, choose the sound wave with the minimum wavelength that can satisfy this condition.

A 180 mm **B** 90 mm **C** 60 mm **D** 45 mm

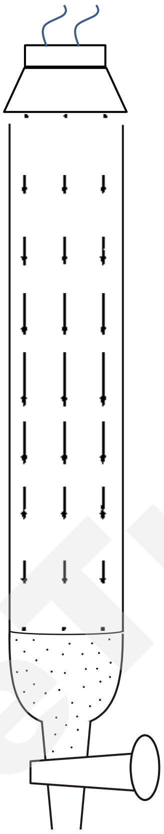
20 A loudspeaker generating a sound of a fixed frequency is held above the top of a burette filled with water. The water gradually runs out of the burette until a maximum loudness of the sound is heard.

Which of the following best shows a possible standing wave pattern set up by air molecules in the burette at this position?

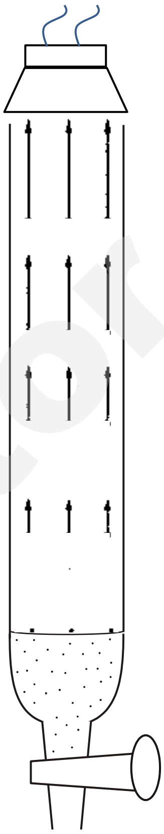
A



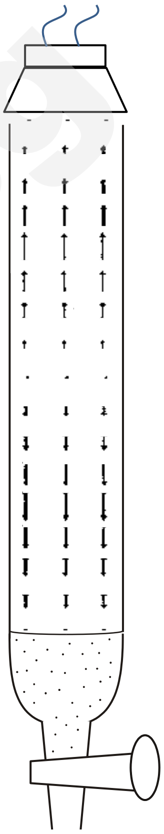
B



C



D



21 A stationary sound wave exists in a horizontal tube which is closed on one end and opened on the other end. The sound wave can be described in terms of the amplitude of oscillation Δx of the air molecules from their mean positions and of the fluctuation of pressure Δp above and below the average pressure. Which of the following correctly describes the situation at each end of the tube when the tube is in resonance?

	at closed end		at open end	
	Δx	Δp	Δx	Δp
A	zero	maximum	zero	maximum
B	zero	maximum	maximum	zero
C	maximum	zero	maximum	zero
D	maximum	zero	zero	maximum

22 A wave is diffracted as it passes through an opening in a barrier. The amount of diffraction that the wave undergoes depends on both the

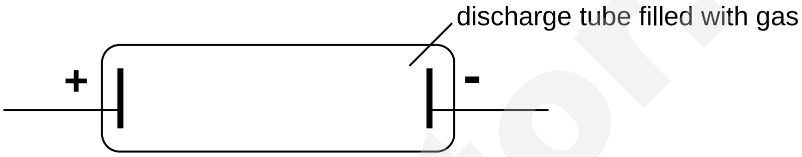
A amplitude and frequency of the incident wave.

B wavelength and speed of the incident wave.

C wavelength of the incident waves and the size of the opening.

D amplitude of the incident wave and the size of the opening.

23 A high potential is applied between the electrodes of a gas discharge tube so that the gas is ionised. The current flowing in the discharge tube is 8.16 mA and the number of electrons passing any point in the gas per unit time is 2.58 x 10^{16} s^{-1}.



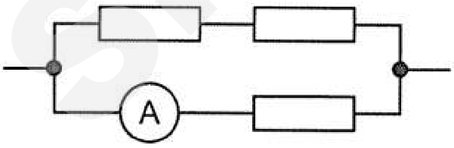
If the charge on each positive ion is 3.2 x 10^{-19} C, what is the number of positive ions passing any point in the gas per unit time?

A 1.26 x 10^{16} s^{-1} **B** 2.58 x 10^{16} s^{-1} **C** 3.84 x 10^{16} s^{-1} **D** 5.10 x 10^{16} s^{-1}

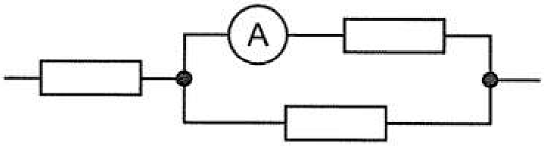
24 Four different arrangements of identical resistors are connected to the same constant voltage power supply. An ammeter of negligible resistance is connected as shown in each arrangement.

In which arrangement will the ammeter show the minimum reading?

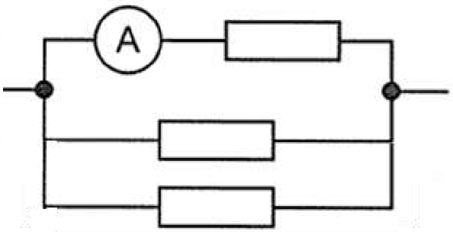
A



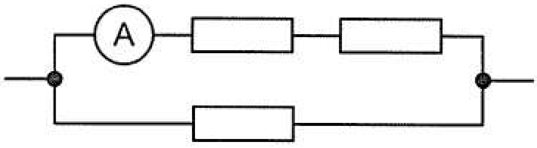
B



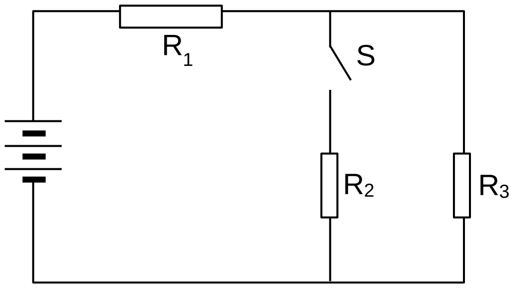
C



D



25 The diagram shows a network of resistors R_1, R_2 and R_3 connected to a battery of negligible internal resistance.

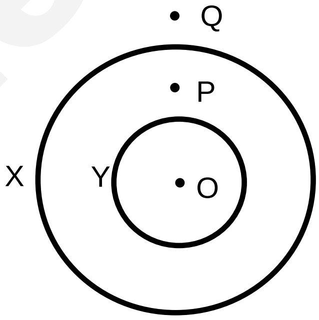


When the switch S is closed, the potential difference (p.d.) across R_2 rapidly increases to a steady value.

What happens to the potential difference (p.d.) across each of the other two resistors, and to the power output of the battery?

	p.d. across R_1	p.d. across R_3	battery power output
A	decreases	decreases	decreases
B	increases	decreases	decreases
C	increases	decreases	increases
D	increases	stays the same	increases

26 X and Y are two coaxial circular coils lying on a table. O, P and Q are three points on the table.



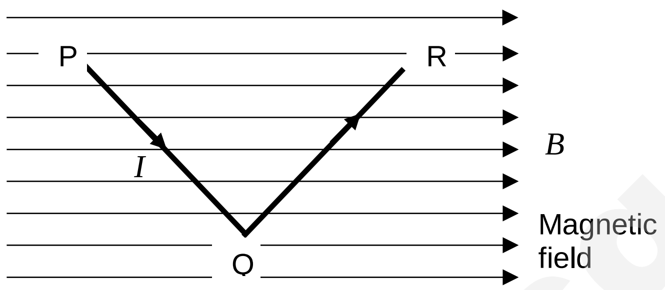
Initially, there is a constant current in coil X and no current in coil Y.

A small current is now passed through coil Y, which increases the magnitude of the magnetic flux density at O.

How does the magnitude of the flux density change at P and Q?

	P	Q
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

27 The figure shows a conductor PQR, carrying a current I and subjected to a uniform magnetic field.



What effect is experienced by the conductor PQR as a result of the magnetic field?

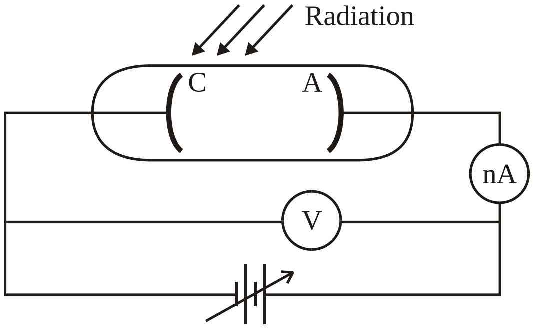
A No resultant force and no resultant torque.

B No resultant force but a couple is produced.

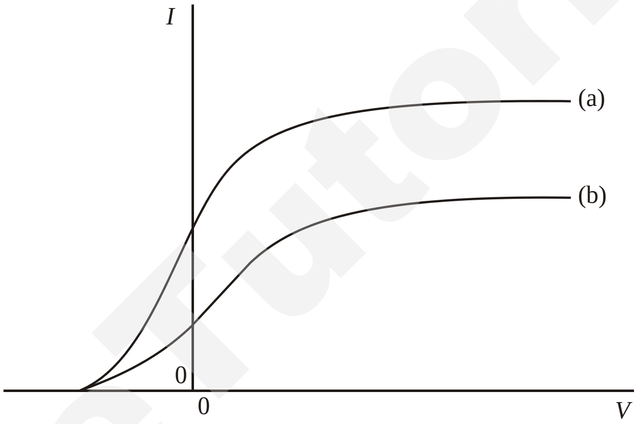
C Net force out of the page and a couple is produced.

D Net force into the page and no resultant torque.

28 The diagram shows the apparatus for an experiment on the photoelectric effect.



Monochromatic radiation strikes the cathode C and photoelectrons are emitted towards the anode A. When a potential difference V is applied, a current I is measured on the very sensitive ammeter. Data can also be obtained with the polarity of the supply reversed. Using this apparatus, graph (a) below was obtained. After a change to the intensity of incident radiation, graph (b) was obtained.



Which of the following cannot be deduced from the graph?

A Intensity does not affect the maximum kinetic energy of the photoelectrons.

B Photoelectrons are being emitted at a slower rate for graph (b).

C The intensity of light is proportional to the current.

D Electrons are ejected with different kinetic energies.

29 The continuous optical spectrum of light from the Sun, observed from the Earth is crossed by dark lines at particular wavelengths. The photosphere is the outer layer of gas around the Sun's core. Which one of the following statements correctly accounts for these dark lines?

A The elements that exist in the photosphere which are hotter than the Sun's inner regions, absorb the photons emitted from the Sun.

B The elements that exist in the solar interior absorb the photons emitted from the Sun.

C The elements found in the Earth's atmosphere absorb the photons emitted from the Sun.

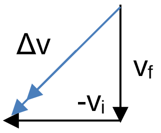
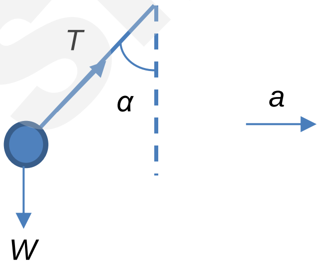
D The elements that exist in the cooler photosphere absorb the photons emitted from the Sun.

30 A beam of light of wavelength λ is totally reflected at normal incidence by a plane mirror. The intensity of the light is such that photons hit the mirror at a rate n. Given that the Planck constant is h, the force exerted on the mirror by the beam is

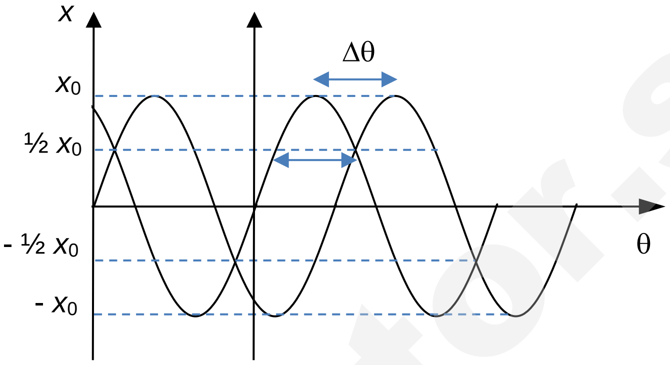
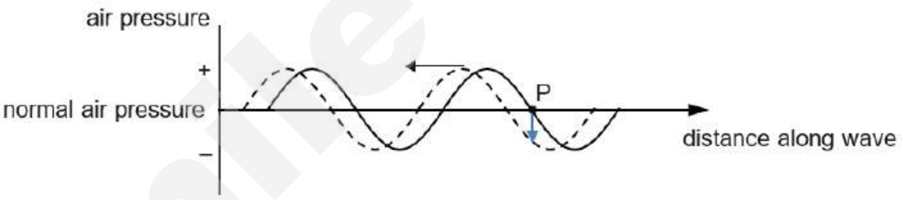
A $nh\lambda$ **B** $2nh/\lambda$ **C** $2nh\lambda$ **D** nh/λ

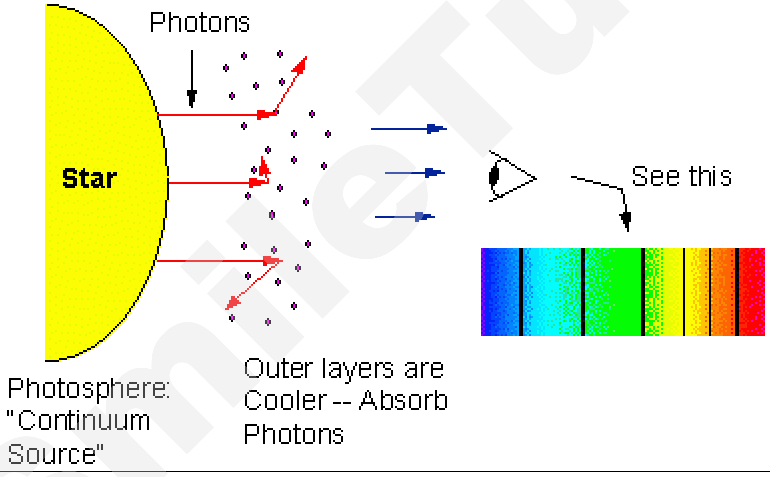
~ End of Paper ~

Solutions to 2017 HCI H1 Physics Paper 1

1	**D**	$37.86\times10^{-4}\ \text{MJ cm}^{-4}\ = 37.86\times10^{-4}\ 10^{6}\,\text{J}\ (10^{-2}\ \text{m})^{-4}$ $= 37.86\times10^{-4}\times10^{8}\times10^{6}\,\text{J m}^{-4}$ $= 3.786\times10^{11}\text{m}^{-4}\text{J} = 378.6\times10^{9}\ \text{J m}^{-4}$ $= 378.6\ \text{GJ m}^{-4}$
2	**C**	Estimate the population as 6 million people and the land as 700 km^2. $\dfrac{6\times10^{6}}{7\times10^{2}\ \text{km}^{2}} \approx 10^{4}\ \text{km}^{-2}$
3	**D**	
4	**B**	Greatest acceleration is where the rate of change of velocity is greatest, i.e. where the gradient of the x-t graph changes most quickly.
5	**C**	The distance travelled by each vehicle is given by the area under their respective graphs. For both car and lorry, the distance travelled between 0 and 40 seconds is the same at 400 m. This means the separation distance is zero at 40 s, which is also the least distance.
6	**B**	Velocity at release: $v^2 = 0 + 2(2.50)(48.0)$ → v = 15.49 m s^{-1} upward Velocity on impact: $v^2 = (-15.49)^2 + 2(10)(48.0)$ → 34.6 m s^{-1} downward
7	**C**	Option A: True. At the uniform speed the rope does not experience any horizontal acceleration. Hence, the angle is zero. Option B: True. See the working below  $T \sin \alpha = ma$ $T \cos \alpha = W = mg$ $\tan \alpha = a / g$ Option C: False. Tension is $W / \sin \alpha$ when it is accelerates. Tension is equal to W when it moves with a uniform speed. $W / \sin \alpha > W$ Option D: True. When the car decelerates, the net horizontal force is leftwards which swings the rope to the right.

8	**A**	Net force downward = W – N 65.0(2.00) = 65.0(9.81) – N N = 507.65 N Reading = 507.65/9.81 = 51.7 kg
9	**A**	Impulse = change in momentum = area under graph = -12 Ns -12 = 2.0v – 2.0(4.0) v = -2.0 m s^{-1}
10	**B**	Since the railway platform is in contact with the Earth, the Earth absorbs the vertical momentum. Therefore, by PCOLM, $P_{1x} = P_{2x}$ 1: bullet 2: gun $M_1v_1\cos45° = m_2v_2$ v_2 = (500)(200)cos 45°/70000 = -1.01 ms^{-1}
11	**C**	KE = $p^2/2m$ p^2 = 2m×KE $\frac{p_M}{p_m} = \sqrt{\frac{M}{m}}$
12	**D**	By the principle of conservation of momentum, Magnitude of momentum of Y = magnitude of momentum of X = 12 N s Hence speed of Y = 6 m s^{-1} EPE transformed to KE, which is ½ $(3.0)(4.0)^2$ + ½ $(2.0)(6.0)^2$ = 60 J
13	**C**	Raw Power input = Rate of GPE converted to Electrical Energy $= \frac{mgh}{t}$ $= \frac{\rho Vgh}{t}$ $= \frac{1000(6.0)(9.81)(80)}{1\ \text{sec}}$ = 4.7088 MW Since Efficiency $= \frac{P_{out}}{P_{in}} = 0.60$ Then P_{out} = 0.60 x 4.7088 = 2.8 MW
14	**B**	The driving force by the propeller equals the drag force on the boat when the boat is at constant speed. $P_{engine} = F_{engine}v = F_{drag}v$ 30000 = F_{drag}(15.0) F_{drag}= 2000 N Since $F_{drag} = kv^2$ 2000 = k $(15.0)^2$ So drag constant k = 8.889 When v = 5.0 m s^{-1}, $F_{drag} = kv^2 = 8.889 \times 5.0^2$ = 222 N When the boat is being towed at constant speed at 5.0 m s^{-1}, the drag force equals the towline tension.

15	**B**	Wavelength = 0.050/(π/3) × 2 π = 0.30 m Speed = 0.30 × 500 = 150 m s^{-1}
15	**B**	Since we are determining phase difference, it is easier to work directly in x- θ equation instead of x-t equation. Determine the phase angle such at $x = x_0/2$: $x_0/2 = x_0 \sin \theta \Rightarrow \theta = \sin^{-1}(½) = 30°, 150°$  Δθ = 150° - 30° = 120°
16	**A**	The pressure variation "moves" along with the energy, compression and rarefaction will move to the left. 
17	**B**	Original: $4.0 = P/4\pi(2.0)^2$ New: Intensity = $0.5P/4\pi(4.0)^2$ Intensity = 0.50 W m^{-2}
18	**B**	$6\Delta y = 0.0500$ m $= 6\lambda(13.7)/(0.960\times 10^{-3})$ λ = 584 nm
19	**C**	Path difference = AX – BX = 90 mm = (n + ½)λ, where n is an integer >= 1
20	**C**	The longitudinal stationary wave will form a displacement node at the closed (water) end and a displacement antinode at the open end (loudspeaker, with vibrating diaphragm)
21	**B**	Concept.
22	**C**	Concept.
23	**B**	I = Q/t $0.00816 = (1.6 \times 10^{-19})(2.58 \times 10^{16}) + (3.2 \times 10^{-19})(n/t)$ $n/t = 1.26 \times 10^{16}$ s^{-1}

24	**B**	Taking V to be the voltage applied, In both A and C the current is V/R. In D the current is V/2R In B the current is ½ × (V/1.5R) = V/3R
25	**C**	Effective resistance of entire circuit decreases, hence current drawn from battery increases → larger power output and larger PD across R_1. By potential divider principle, the PD across the parallel branches of R_2 and R_3 will be smaller than the PD across R_3 along before the switch was closed.
26	**B**	Since the current in Y increases the magnetic flux density at O, the current in Y is flowing in the same direction as that in X. Hence at Q the flux density should also be reinforced, and the flux density between the coils oppose each other.
27	**B**	By Fleming's left-hand rule, force on PQ is out of the page while force on QR is into the page.
28	**C**	A can be deduced because the saturation current changed with intensity. B can be deduced from th fact that graph (b) has lower saturation current. D can be deduced from the slope of the graphs down to stopping potential. C cannot be deduced because we do not know by how much the intensity as changed.
29	**D**	In the solar absorption line spectra, the dark lines are caused by photons being absorbed by elements in the cooler photosphere, to excite to higher energy states. 
30	**B**	p = h/λ Totally reflected, so change in momentum = 2p = 2h/λ Force is rate of change of momentum = n × 2h/λ

HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 1

CANDIDATE NAME		**CT GROUP**	16S
TUTOR NAME			

PHYSICS

8866/02

Paper 2 Structured Questions

13 September 2017

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your **name, CT class and tutor's name** clearly on all work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paperclips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Section B

Answer any **two** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use		
1		9
2		10
3		10
4		11
5		20
6		20
7		20
Deductions		
Total		80

This document consists of **21** printed pages.

Data

speed of light in free space,

$c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge,

$e = 1.60 \times 10^{-19}$ C

the Planck constant,

$h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant,

$u = 1.66 \times 10^{-27}$ kg

rest mass of electron,

$m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton,

$m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall,

$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/ by a gas,	$W = p\,\Delta V$
hydrostatic pressure	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 **(a)** Define the ohm.

………………………………………………………………………………………………………

……………………………………………………………………………………………………… [1]

(b) An experiment is performed to determine the resistivity ρ of the material used to manufacture a wire. The average of the measurements, with their actual uncertainties, are shown in Fig. 1.1.

potential difference / V	current / A	diameter of wire / mm	length of wire / cm
1.20 ± 0.01	0.29 ± 0.01	0.23 ± 0.01	42.0 ± 0.1

Fig. 1.1

(i) Calculate the value of *ρ*.

ρ = ……………………………… Ω m [3]

(ii) Calculate the actual uncertainty in *ρ*.

actual uncertainty = …………………….. Ω m [2]

(iii) State the value of ρ and its actual uncertainty to the appropriate number of significant figures.

ρ = …………………… ± …………………… Ω m [1]

(c) The accepted value for ρ is 4.5×10^{-7} Ω m.

Use your answer in **(b)(iii)** to distinguish between *accuracy* and *precision*.

Accuracy ……………………………………………………………………………………………

……………………………………………………………………………………………………

Precision ……………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

2 **(a)** State the two conditions for equilibrium.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(b) A uniform rigid rod of mass 30 kg is attached to a vertical wall by a hinge as shown in Fig. 2.1. The other end of the rod is held to the ceiling by a cable.

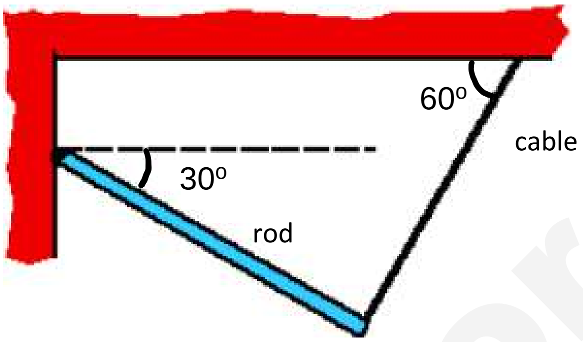


Fig. 2.1

(i) On Fig. 2.1, draw and label clearly all the forces acting on the rod. [2]

(ii) Show that the tension in the cable is 127 N. [2]

(iii) Determine the force acting on the rod by the hinge.

magnitude of force = ……………….. N

direction = …………………………… [4]

3 In order to investigate the photoelectric effect, a student varied the wavelength of the radiation incident on the metal surface. For each value of wavelength λ, the stopping voltage V_s required just to prevent electrons from reaching the collector was measured. Two such data are shown in Fig. 3.1.

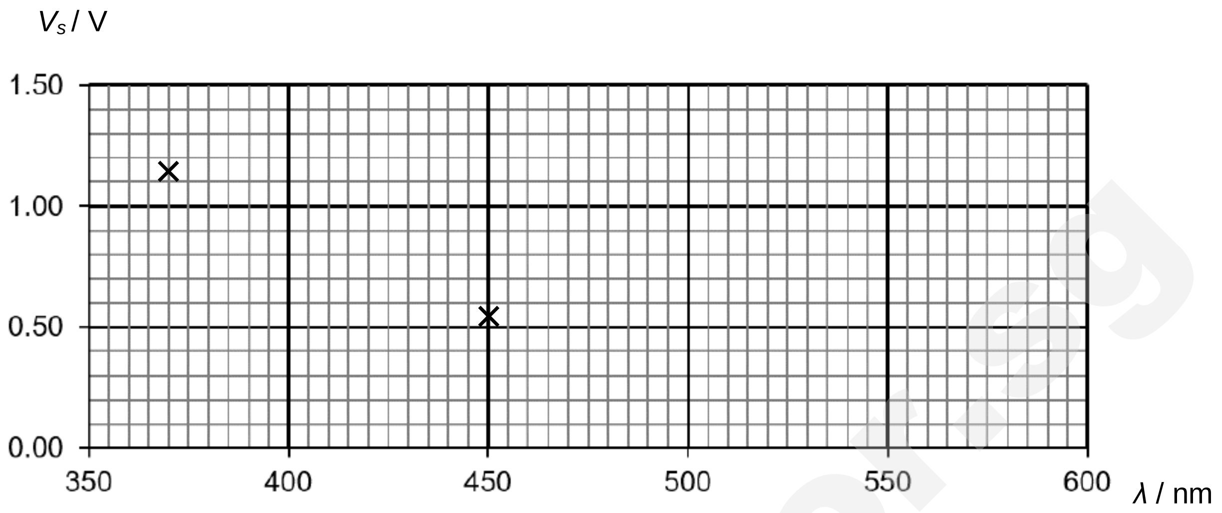


Fig. 3.1

(a) What is the maximum kinetic energy of a photoelectron emitted from the metal surface by radiation of wavelength 370 nm?

maximum kinetic energy = …………..………..…….. J [2]

(b) Calculate the energy of a photon of wavelength 370 nm.

energy of photon = …………..………..…….. J [2]

(c) Using your answers to **(a)** and **(b)**, show that the threshold wavelength is 560 nm. [2]

(d) Without further calculations, sketch in Fig. 3.1 the graph that the student should obtain at the end of the experiment.

[2]

(e) The student decided to repeat the experiment by doubling the intensity of the radiation incident on the metal surface. State and explain whether this change would affect the results obtained in Fig. 3.1.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………[2]

4 A wire-wound resistor is manufactured by winding resistance wire on an insulating former. A commonly used material for the wire is an alloy of nickel and chromium called nichrome. The wire is produced by pulling the nichrome through a suitably sized hole. Nichrome is sufficiently ductile to be drawn into a wire without danger of it cracking or breaking after winding. It resists corrosion and has a fairly high resistivity. The wire itself must be uniform and thin, and is covered with an insulating material.

A manufacturer of resistors of this type supplies information concerning them in the form of a family of lines shown in the graph in Fig. 4.1. Resistors of different resistance R_1, R_2 ... R_5 are shown by the separate lines.

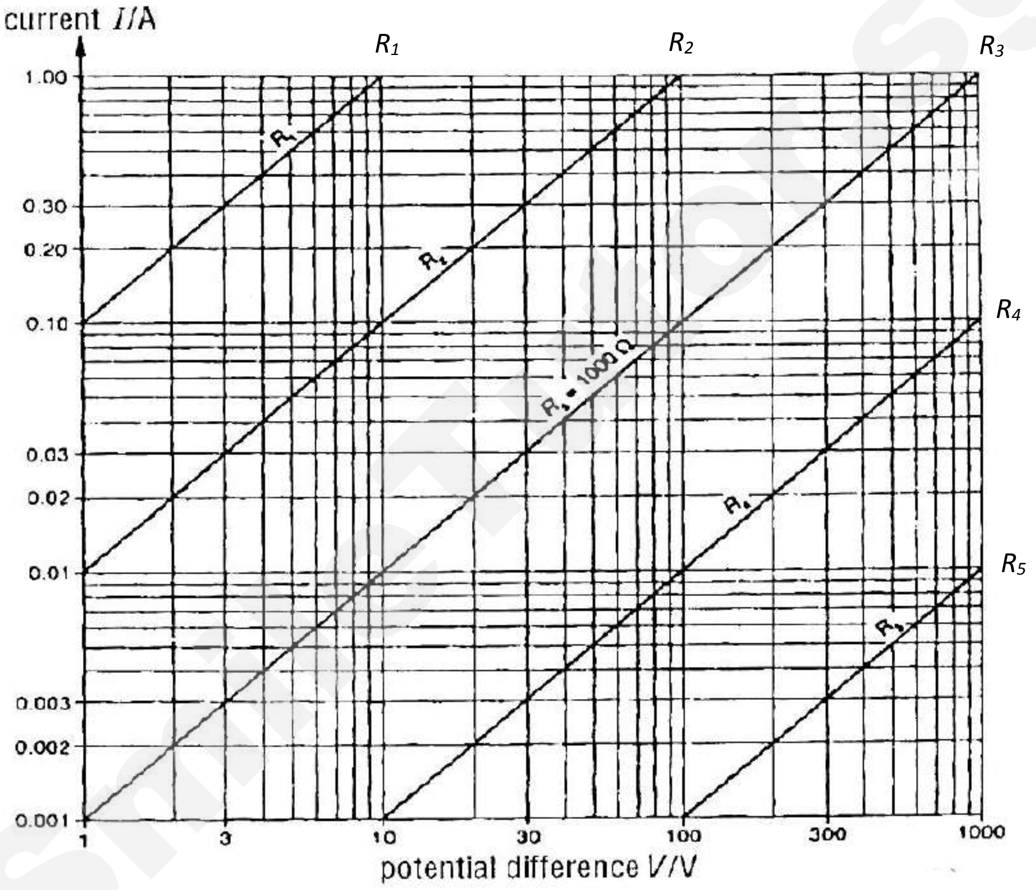


Fig. 4.1

(a) By choosing some values of potential difference and current from Fig 4.1, complete the table below showing the resistances R_1, R_2 ... R_5. [2]

R_1 =	
R_2 =	
R_3 =	1000 Ω
R_4 =	
R_5 =	

(b) Draw two additional lines on Fig. 4.1,

(i) one line for a resistance of 2000 Ω,

(ii) one line for a resistance of 47 Ω. [2]

(c) This particular set of resistors is manufactured so that the resistors can safely be used with power dissipation up to 1 W. Complete the following table to show the maximum safe current in the resistors for the potential differences given. [2]

potential difference / V	**maximum current / A**
1 000	
100	
10	
1	

(d) Plot the points in **(c)** on the graph of Fig. 4.1. On the graph shade the region of safe use for all these resistors. [3]

(e) The lines in Fig. 4.1 represent ideal behaviour. Suggest, with a reason, how the line for a real resistor might differ from the ideal.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

Section B

Answer **two** of the questions from this section.

5 **(a)** Three blocks of masses 4.0 g, 10.0 g and 3.0 g move on a frictionless horizontal track with speeds of 5.0 m s^{-1}, 3.0 m s^{-1}, and 4.0 m s^{-1} respectively as shown in Fig. 5.1. Velcro couplers make the blocks stick together after colliding.

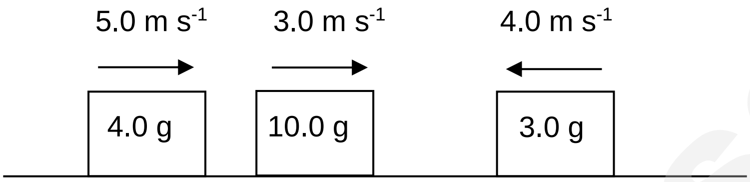


Fig. 5.1

(i) State the principle of conservation of momentum.

....

.... [2]

(ii) Show that the final speed *v* of the train of three blocks after colliding is 2.24 m s^{-1}. [1]

(iii) Fig. 5.2 shows the train of three blocks making a head-on collision with a sphere of mass 9.0 g which is initially at rest and suspended by a stiff light rod pivoted at C. After the collision, the train of three blocks moves off at 1.12 m s^{-1} and the sphere swings upwards.

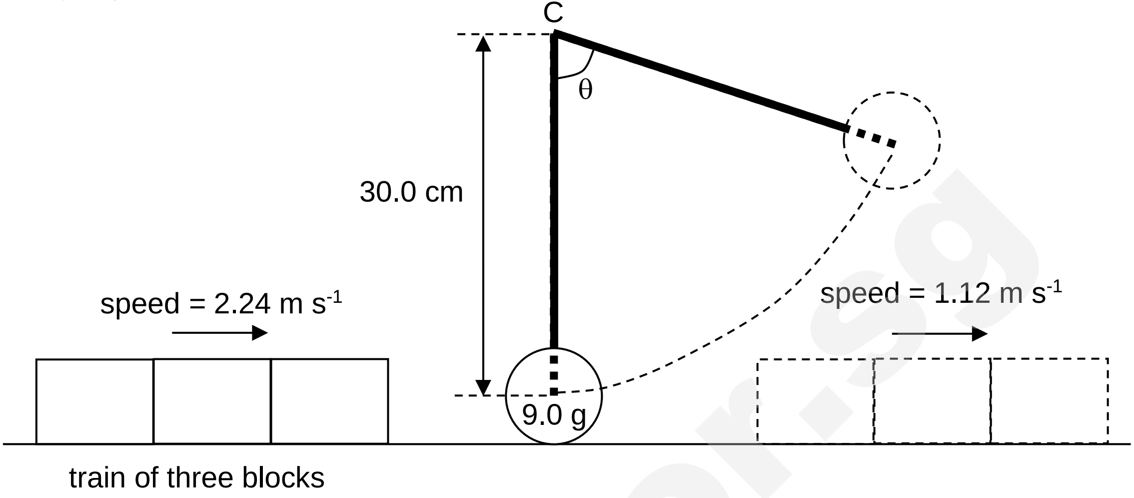


Fig. 5.2

1. Calculate the speed of the sphere immediately after the train of three blocks collide with it.

speed = ……………….. m s^{-1} [2]

2. The distance from the centre of the ball to point C is 30.0 cm. Calculate the angle θ subtended by the rod at the maximum height reached by the sphere after the collision.

θ = …………………….. ° [3]

(b) A car starts from rest and travels upwards along a straight road inclined at an angle of 5.0° to the horizontal, as illustrated in Fig. 5.3.

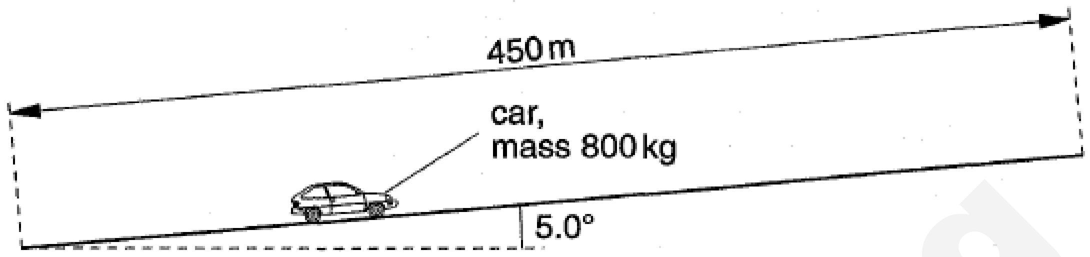


Fig. 5.3

The length of the road is 450 m and the car has mass 800 kg. The speed of the car increases at a constant rate and is 28 m s^{-1} at the top of the slope.

(i) Determine, for this car travelling up the slope,

1. its acceleration,

acceleration = …………………….. m s^{-2} [2]

2. the time taken to travel the length of the slope.

time = ……………………… s [1]

3. the gain in kinetic energy,

gain in kinetic energy = ……………………… J [2]

4. the gain in gravitational potential energy.

gain in gravitational potential energy = ………………….. J [2]

(ii) Use your answers in **(b)(i)** to determine the useful output power of the car.

power = ………………….. W [2]

(iii) At the top of the slope, the driver loses control of his car, and veers off the cliff as shown in Fig. 5.4.

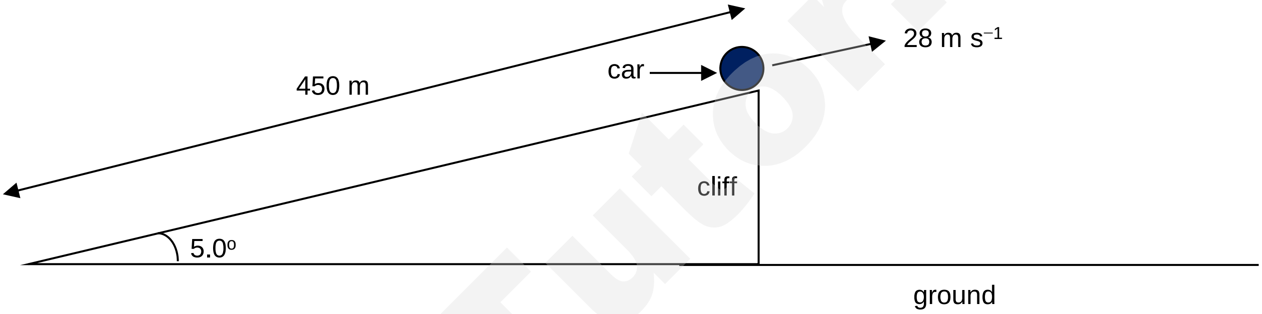


Fig. 5.4

Calculate the height *above the ground* the car reaches.

height = …………………………….. m [3]

6 **(a)** A tuning fork is struck near one end of a glass tube open at both ends. The air molecules in the tube then vibrate at the fundamental frequency.

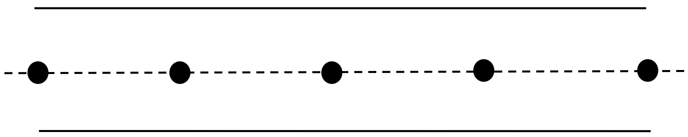


Fig. 6.1

(i) Draw on Fig. 6.1, arrows on the five dots to represent the amplitude and the direction of motion of the air molecules *at* a particular instant when a stationary wave has been set up along the tube. [2]

(ii) State the phase difference between the vibrations of air molecules along the tube situated at adjacent antinodes.

phase difference = ………………. rad [1]

(b) A two-source interference pattern is set up using monochromatic light of a certain wavelength. The light passes through two slits a distance *d* = 0.75 mm apart. A pattern of light is formed on a screen at a distance *D* = 2.8 m from the slits. The arrangement and the pattern seen on the screen are shown in Fig. 6.2. The positions of the dark fringes are shown.

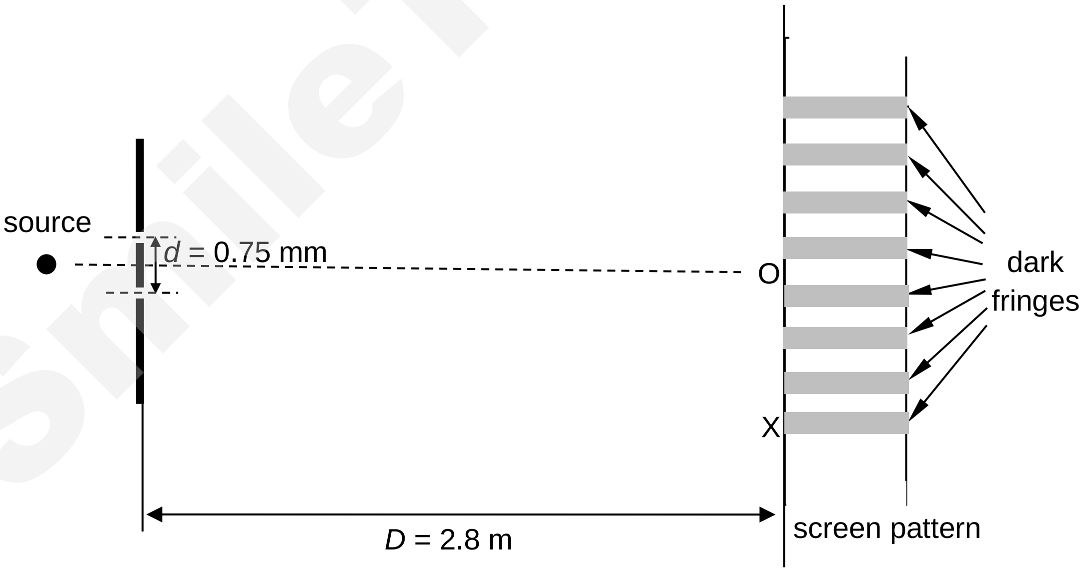


Fig. 6.2 (not to scale)

The central bright fringe is located at O and the dark fringe at X is 5.88 mm from O.

(i) Calculate the wavelength of the light.

wavelength = ………………………… nm [3]

(ii) Describe what happens to the fringes if both slits are covered with sheets of polaroid and that in front of one of the slits is slowly rotated.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(c) Fig. 6.3 shows two dippers, D and E, mounted on the same vibrating beam. The dippers touch the surface of the shallow water in a ripple tank. When the beam vibrates, waves travel outwards in all directions on the surface of the water from each dipper.

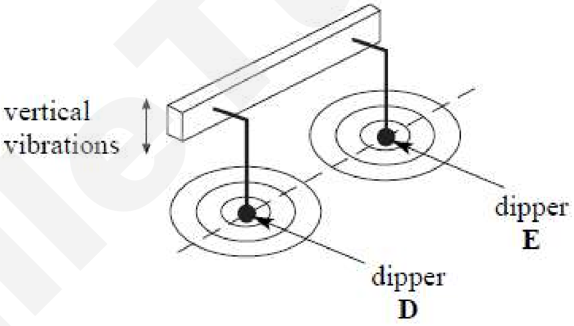


Fig. 6.3

(i) State the principle of superposition as applied to waves.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) Explain why dippers D and E are *coherent*.

…………………………………………………………………………………………… [1]

(iii) Explain why a stationary wave will be formed on the surface of the water along the line joining D and E.

....

....

....

....

.... [2]

(iv) Wavefronts produced by the two sources are illustrated in Fig. 6.4.

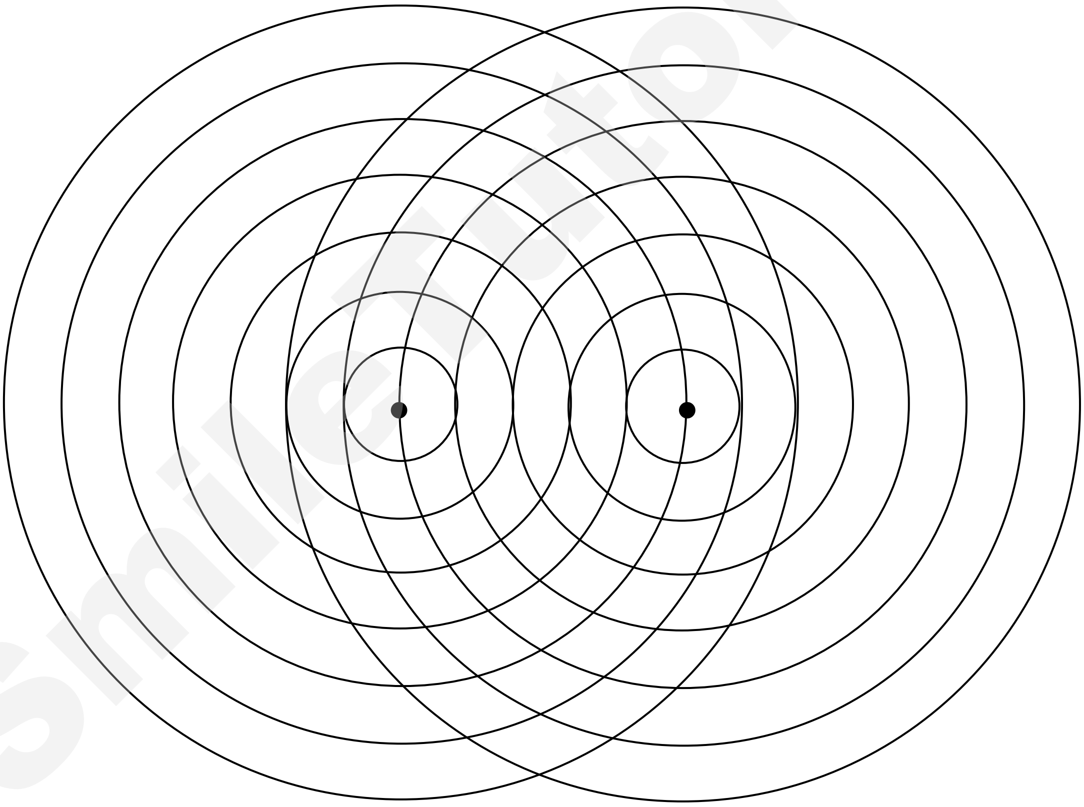


Fig. 6.4

On Fig. 6.4,

1. draw **all** the antinodal lines between the two sources,
2. draw **one** nodal line and label it **N**.

[3]

(v) When the beam vibrates at a certain frequency, the distance between two adjacent nodes along the line between dippers D and E is 12 mm. When the frequency of vibration is increased by 2.0 Hz, the distance between two adjacent nodes is decreased to 10 mm.

1. Calculate the original frequency of vibration of the beam.

frequency = ……………………….. Hz

2. Calculate the speed of wave travel on the water surface.

speed = ………………… m s^{-1} [4]

7 **(a)** A student conducts an experiment to investigate the electromotive force (e.m.f.) *E* and internal resistance *r* of a dry cell using the circuit shown in Fig. 7.1.

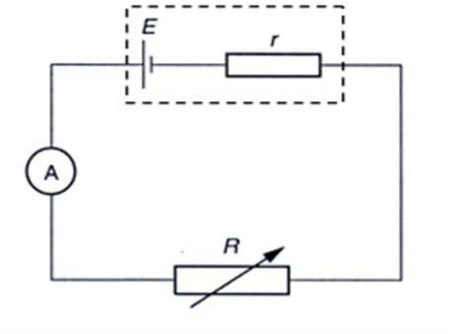


Fig. 7.1

Fig. 7.2 shows the variation with current I through *R* of the product IR.

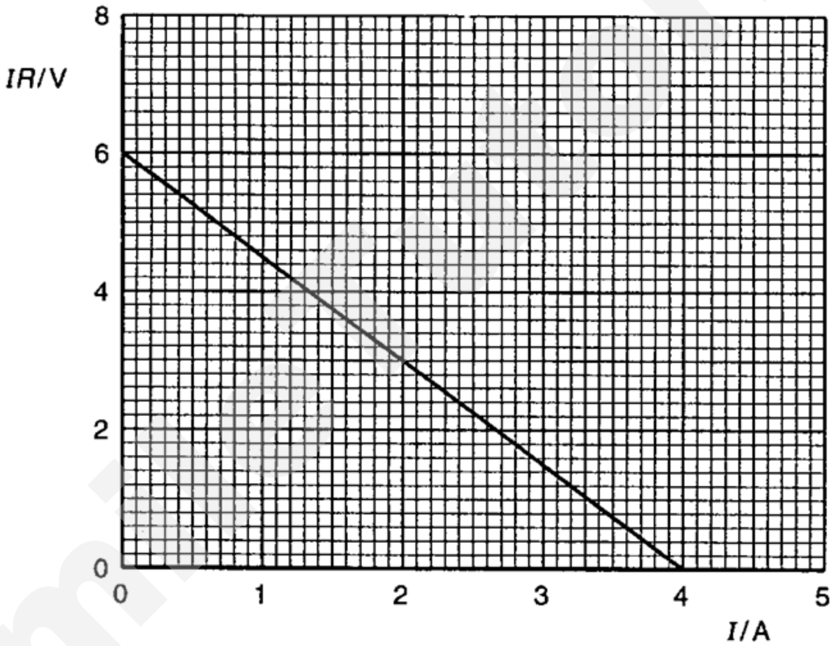


Fig. 7.2

(i) State the relationship between *E*, *r*, *R*, and I. [1]

(ii) Use Fig. 7.2 to determine

1. the e.m.f. of the dry cell,

e.m.f. = ……………………. V [1]

2. the power dissipated in the variable resistor when the current in the circuit is 1.2 A.

power = ………………… W [2]

3. the internal resistance of the dry cell.

internal resistance = ……………….. Ω [2]

(iii) To verify his results above, the student decides to connect a voltmeter and switch to the circuit. Include on Fig. 7.1 a switch and a voltmeter so as to allow him to determine either the e.m.f. of the dry cell or the terminal potential difference across the dry cell. [1]

(iv) State whether the switch should be open or closed when measuring

1. the e.m.f.

2. the terminal p.d. [1]

(v) The student decides to repeat his experiment by replacing the dry cell with another of e.m.f. 0.5*E* and internal resistance 2*r*. This new dry cell is connected in series to the original variable resistor *R*.

On the axes of Fig. 7.2, draw the variation with current *I* of the product *IR* for this circuit. [2]

(b) A *light* single-turn square-shaped coil PQRS of sides 25 cm is suspended from a well-insulated spring. The coil is placed half-way in a region of uniform magnetic field of flux density 2.0 T, as shown in Fig. 7.3.

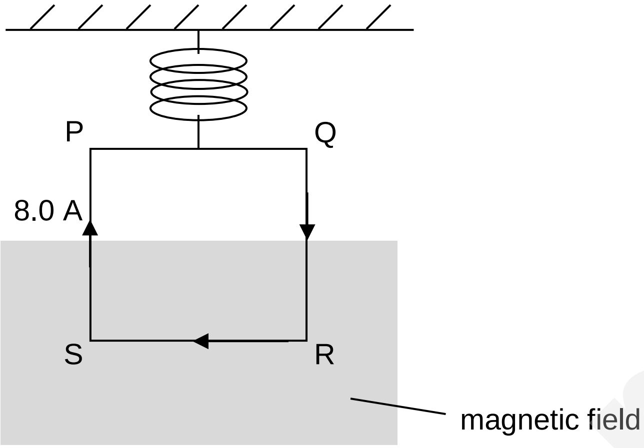


Fig. 7.3

A current of 8.0 A flows through the coil and the spring extends by 10 mm.

(i) Define the *tesla*.

....

....

.... [2]

(ii) State the direction of the magnetic field.

.... [1]

(iii) Calculate the spring constant.

spring constant = ... N m^{-1} [2]

(iv) The Earth's magnetic field is in the same direction as the applied magnetic field of 2.0 T. Suggest a reason why the Earth's field does not affect your answer in **(b)(iii)**.

....

.... [1]

(v) The same magnetic field is now applied towards the right, with coil PQRS fully in the region of the uniform field and the plane of the coil parallel to the field, as shown in Fig. 7.4.

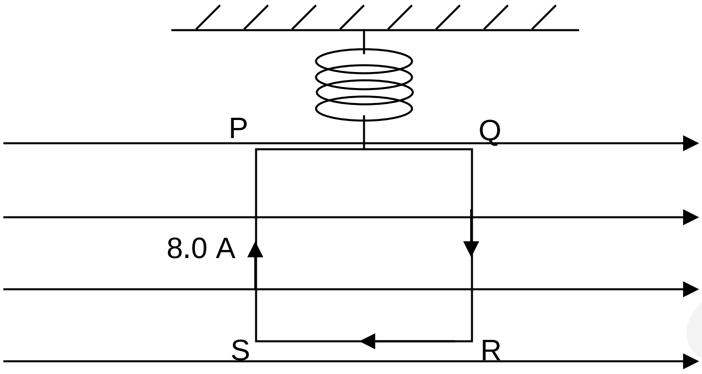


Fig. 7.4

1. Calculate the torque experienced by the coil.

torque = ………………….. N m [2]

2. The coil is then tilted about the vertical axis and makes an angle θ to the horizontal magnetic field lines as shown in Fig. 7.5.

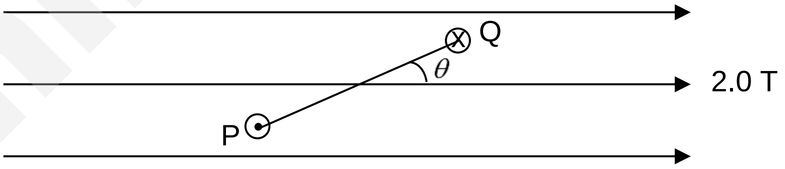


Fig. 7.5

Discuss qualitatively how your answer to **(b)(v)1.** changes.

………………………………………………………………………………………

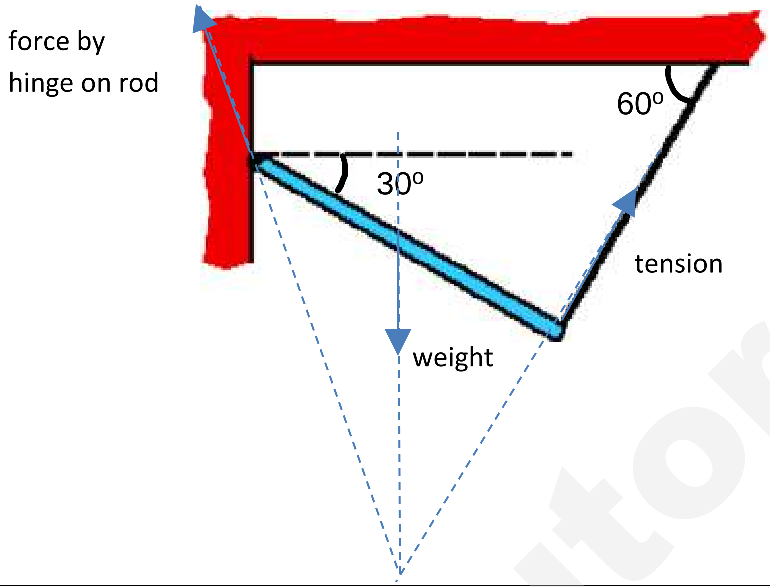
………………………………………………………………………………………

……………………………………………………………………………………… [2]

~ End of Paper ~

Solutions to 2017 HCI H1 Physics Paper 2

1	**(a)**	One ohm is the resistance of a device when a current of 1 A flows through it when the potential difference across it is 1 V.		[1]
	(b)	**(i)**	$R = \frac{\rho L}{A} = \frac{4\rho L}{\pi d^2}$ $\rho = \frac{\pi d^2 R}{4L} = \frac{\pi(0.00023)^2\frac{1.20}{0.29}}{4(0.420)} = 4.09 \times 10^{-7}\ \Omega\ \text{m}$	[1] [2]
		(ii)	$\Delta\rho = \left(\frac{\Delta V}{V} + \frac{\Delta I}{I} + \frac{\Delta L}{L} + 2\frac{\Delta d}{d}\right)\rho = \left(\frac{0.01}{1.20} + \frac{0.01}{0.29} + \frac{0.1}{42.0} + 2\frac{0.01}{0.23}\right) 4.09 \times 10^{-7}$ $\Delta\rho = 5.4 \times 10^{-8}\ \ \Omega\ \text{m}$	[1] [1]
		(iii)	ρ = (41 ± 5) × 10^{-8} Ω m	[1]
	(c)	Accuracy: Compared to the accepted value, the percentage difference is (4.5-4.1)/4.5 × 100% = 8.9 %. Precision: The spread about the calculate value represents a percentage difference of 5/41 × 100% = 12 %		[1] [1]

2	**(a)**	Net force on a body is zero. Net torque on the body about any point is zero.		[1] [1]
	(b)	**(i)**		[2]
		(ii)	Taking moments about hinge, Sum of clockwise moments = sum of anticlockwise m0˚oments $Mg\,(L/2\cos 30^\circ) = T \times L$ $T = 30(9.81)(\cos 30^\circ)/2 = 127$ N	 [1] [1]
		(iii)	$F_y = Mg - T\sin 60^\circ = 30(9.81) - 127\sin 60^\circ = 184$ N upward $F_x = T\cos 60^\circ = 127\cos 60^\circ = 63.5$ N leftward $F = \sqrt{184^2 + 63.5^2} = 195$ N $\theta = \tan^{-1}\frac{184}{63.5} = 71.0^\circ$ The force is 195 N and at 71.0˚ clockwise from the leftward direction.	[1] [1] [1] [1]

3	**(a)**	Max KE = 1.1 eV = $1.15 \times 1.6 \times 10^{-19}$ = 1.84×10^{-19} J	[1] [1]
	(b)	Energy = hc/λ = hc/(370×10^{-9}) = 5.38×10^{-19} J	[1] [1]
	(c)	By Einstein's photoelectric equation, hc/λ_0 = energy of photon – max KE of electron = (5.38 – 1.84) × 10^{-19} J λ_0 = 560 nm	 [1] [1]
	(d)	Sketch a curve through the two points given, and end at 560 nm.	[1] [1]
	(e)	No change, because higher intensity just means more photons per unit time and does not change the energy of each photon. Since the photon-electron interaction is one-on-one, the maximum ke and hence stopping potential at each photon energy or wavelength will not change.	[1] [1]

4 **(a)** [2]

For R_1 : Choose (3, 0.30) $R_1 = \dfrac{V}{I} = \dfrac{3}{0.3} =$ 10 Ω

For R_2 : Choose (30, 0.30) $R_2 = \dfrac{V}{I} = \dfrac{30}{0.3} =$ 100 Ω

For R_4 : Choose (200, 0.02) $R_4 = \dfrac{V}{I} = \dfrac{200}{0.02} = 10000\Omega$

For R_5 : Choose (400, 0.004) $R_5 = \dfrac{V}{I} = \dfrac{400}{0.004} = 10^5\,\Omega$

(b) [2]

For R = 2000 Ω, When V = 10 V, $I = \dfrac{V}{R} = \dfrac{10}{2000} = 0.005A$

When V = 1000 V, $\dfrac{V}{R} = \dfrac{1000}{2000} = 0.5A$

For R = 47 Ω, When V = 1, $I = \dfrac{V}{R} = \dfrac{1}{47} = 0.021A$

When V = 40, $I = \dfrac{V}{R} = \dfrac{40}{47} = 0.85A$

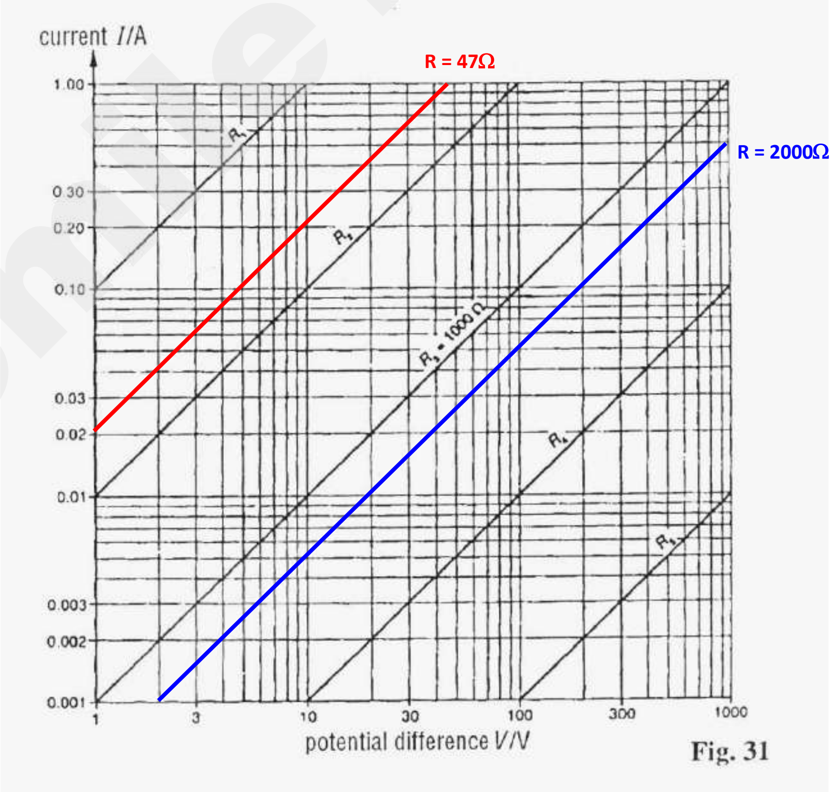
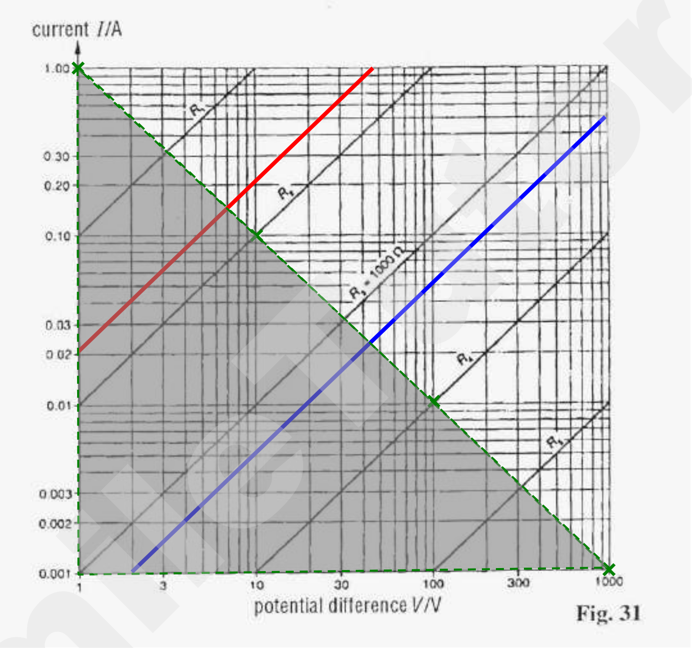
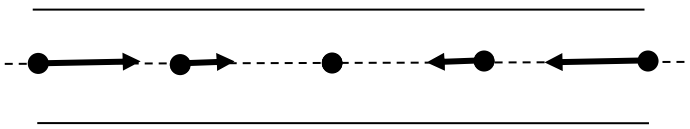
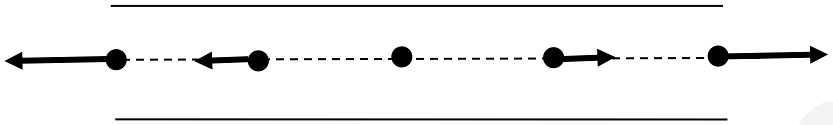
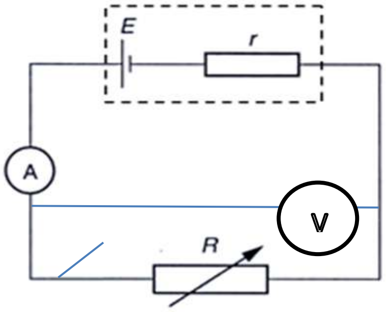
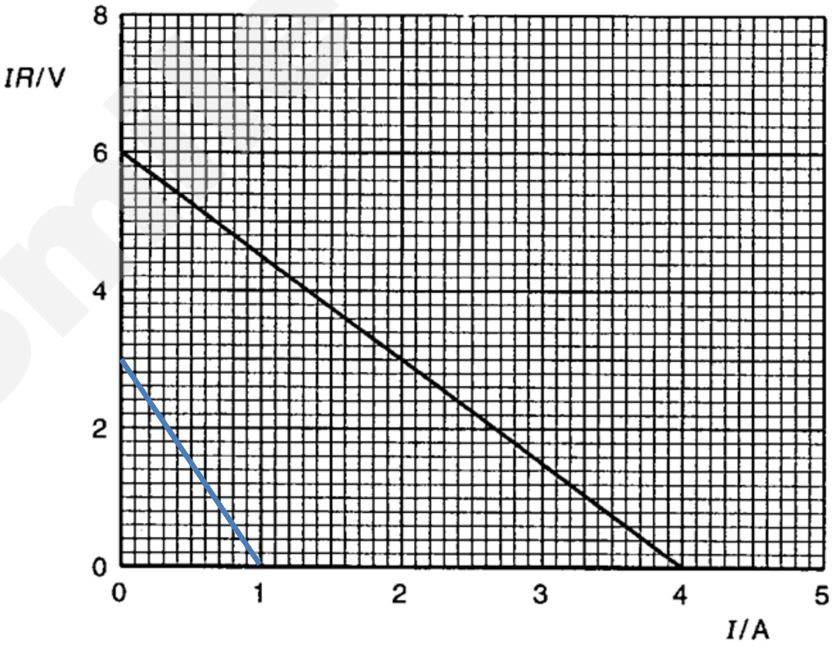


Fig. 31

	(c)	P = 1 W. Maximum safe current, $I = \frac{P}{V}$ For V = 1000 V, $I = \frac{P}{V} = \frac{1}{1000} = 0.001A$ For V = 100 V, $I = \frac{1}{100}$ = 0.01 A For V = 10 V, $I = \frac{1}{10}$ = 0.1 A For V = 1 V, I = 1 A	[2]
	(d)	 Fig. 31	[3]
	(e)	For a real resistor, the resistivity of the material may actually vary with temperature; the resistance will tend to increase when the current is large as the temperature may increase. Therefore, the graph for low currents may be approximately a straight line but that for high currents a curve of a lower gradient may result.	[2]

5	**(a)**	**(i)**	The total momentum of a system is conserved, If no net external force acts on the system.	[1] [1]
		(ii)	Taking rightward as positive, 4.0(5.0) + 10.0(3.0) + 3.0(-4.0) = 17.0v v = 2.24 m s^{-1} (rightward)	[1]
		(iii)	**1.** By the principle of conservation of momentum, 17.0(2.24) = 9.0(v) + 17.0(1.12) v = 2.12 m s^{-1}	[1] [1]
			2. By the principle of energy conservation, Gain in GPE = loss in KE m g Δh = ½ m v^2 – ½ m (0)^2 $\Delta h = \frac{\frac{1}{2}(2.12)^2}{9.81} = 0.229$ m Δh = 22.9 = 30.0 – 30.0 cos θ θ = 76.3°	[1] [1] [1]
	(b)	**(i)**	**1.** $v^2 = u^2 + 2as$ $28^2 = 2a(450)$ a = 0.87 m s^{-2}	[1] [1]
			2. $s = ut + \frac{1}{2}at^2$ $450 = \frac{1}{2}(0.87111)t^2$ t = 32 s	[1]
			3. Gain in kinetic energy = ½ m v^2 = ½ (800)(28)^2 = 3.1 × 10^5 J	[1] [1]
			4. Gain in gravitational potential energy = m g Δh = 800 (9.81) (450 sin 5°) = 3.1 × 10^5 J	[1] [1]
		(ii)	Useful output power = 6.2 × 10^5/32 = 1.9 × 10^4 W	[1] [1]
		(iii)	Consider launch point to top and taking upward as positive, $v^2 = u^2 + 2as$ $0 = (28\sin 5°)^2 + 2(-9.81)s$, hence s = 0.30 m Height above ground = 450 sin5° + 0.30 = 39.5 m	[1] [1] [1]

6	**(a)**	**(i)**	 Or 	[2]
		(ii)	π rad	[1]
	(b)	**(i)**	Fringe separation = OX/3.5 = $5.88 \times 10^{-3} / 3.5 = 1.68 \times 10^{-3}$ m Using $x = \lambda D/d$, $\lambda = xd/D$ $= 1.68 \times 10^{-3} \times 0.75 \times 10^{-3} / 2.8$ = 450 nm	[1] [1] [1]
		(ii)	The intensity of the fringes is maximum when the axes of the polaroids are aligned but the intensity decreases as one of the polaroid is rotated till the axes of the polaroids are perpendicular When the axes of the polaroids are perpendicular, the fringes disappear.	[1] [1]
	(c)	**(i)**	When two or waves of the same type overlap, the resultant displacement at any point at any time is the vector sum of the individual displacements at that point at that time.	[2]
		(ii)	They are mounted on the same vibration beam (same source), hence they always maintain a constant phase difference (in this case zero) between them.	[1]
		(iii)	D and E radiate in all directions. Along the line that joins them, they send waves that are of the same sped, amplitude and frequency towards each other.	[2]
		(iv)	Nine antinodal line (constructive interference). A nodal line between any two antinodal lines (destructive interference).	[2] [1]
		(v)	**1.** At f, wavelength = 24 mm Speed of waves = 24f At (f+2.0) Hz, the wavelength = 20 mm Speed of wave = (f + 2.0)(20) 24f = (f + 2.0)(20) Hence, f = 10 Hz	[1] [1] [1]
			2. Speed = 0.024 × 10 = 0.24 m s^{-1}	[1]

7	**(a)**	**(i)**	E = IR + Ir	[1]
		(ii)	**1.** e.m.f. = 6.0 V (from y-intercept)	[1]
			2. power = VI = 4.2 × 1.2 = 5.0 W	[2]
			3. V = E – Ir r = gradient = (6.0 – 0)/(4.0 – 0) = 1.5 Ω	 [1] [1]
		(iii)		[1]
		(iv)	**1.** Open	
			2. Closed	[1]
		(v)		[2]

	(b)	**(i)**	The magnetic flux density of a magnetic field is said to be 1 tesla, if the force per unit length per unit current which acts on a straight current-carrying conductor placed perpendicular to the magnetic field is 1 newton per metre per ampere.	[2]
		(ii)	Into the page.	[1]
		(iii)	$BIl = ke$ $\left(2\times 8.0\times 0.25\right) = k\times 10\times 10^{-3}$ k = 400 N m^{-1}	[1] [1]
		(iv)	The Earth's magnetic flux density is of the order of 10^{-5} T, and is negligible compared to 2 T.	[1]
		(v)	**1.** The torque on the coil is due to the magnetic force F_B acting on the sides PS and QR only. $\tau = F_B \times l$ $\tau = 2\times 8.0\times 0.25\times 0.25$ $\tau = 1.0\ \text{N m}$	[1] [1]
			2. When the magnetic field is applied at an angle θ to the plane area of the coil, the magnitude of the magnetic force on sides PS and QR of the coil remains the same. However, the perpendicular distance to the magnetic force is smaller than before. Hence, the torque experienced by the coil will decrease.	[1] [1]

~ End of Paper ~

H

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	
CLASS	
INDEX NUMBER	

PHYSICS

8866/01

Paper 1 Multiple Choice

15 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **14** printed pages.

Data

speed of light in free space, $c = 3.00 \text{ x } 10^{8}$ m s^{-1}

elementary charge, $e = 1.60 \text{ x } 10^{-19}$ C

the Planck constant, $h = 6.63 \text{ x } 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \text{ x } 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \text{ x } 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \text{ x } 10^{-27}$ kg

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + ½at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

1 The following physical quantities can be either positive or negative.

s : displacement of a particle along a straight line

θ : temperature on the Celsius scale

q : electric charge

V : readings on a digital voltmeter

Which of these quantities are vectors?

A s, θ, q, V **B** s, q, V only **C** θ, V only **D** s only

2 The resistance R of a resistor is determined by measuring the potential difference V across it and the current I in it. The value of R is then calculated using the equation

$$R = \frac{V}{I}$$

The values measured are $V = 1.00 \pm 0.05$ V and $I = 0.50 \pm 0.01$ A.

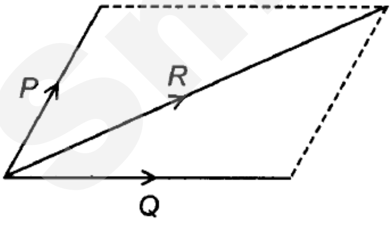
What is the percentage uncertainty in the value of R?

A 2.5 % **B** 3.0 % **C** 7.0 % **D** 10.0 %

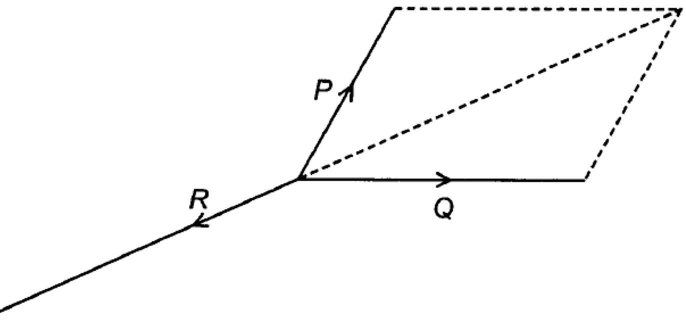
3 Vectors P and Q represent two forces.

In which vector diagram does the vector R represent the difference between P and Q, such that $R = P - Q$?

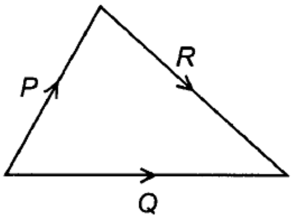
A



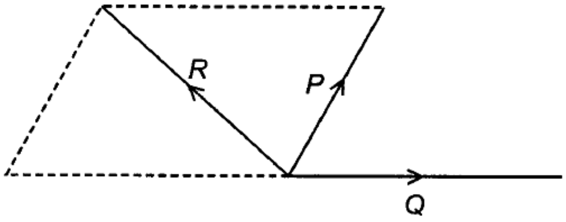
B



C



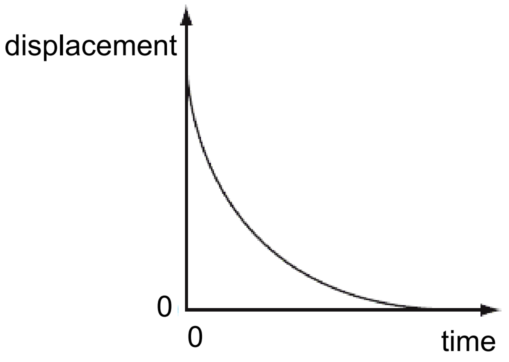
D



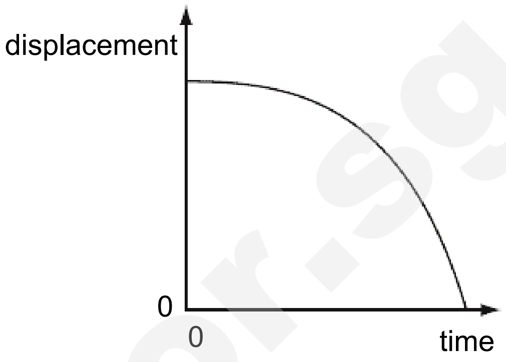
4 A sphere is released and falls. Its initial acceleration reduces until it eventually begins to travel at constant terminal velocity.

Which displacement-time graph best represents the motion of the sphere?

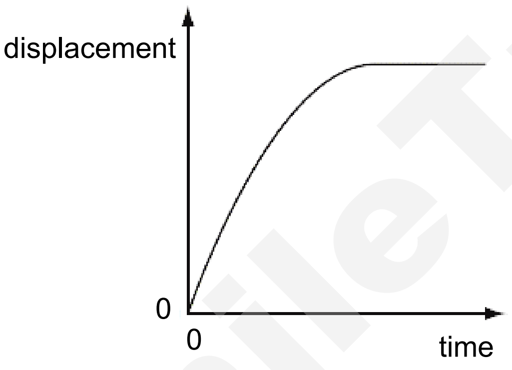
A



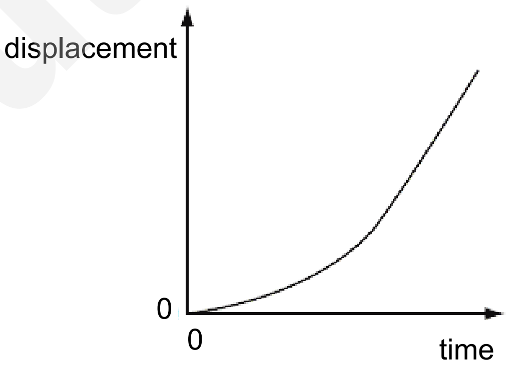
B



C



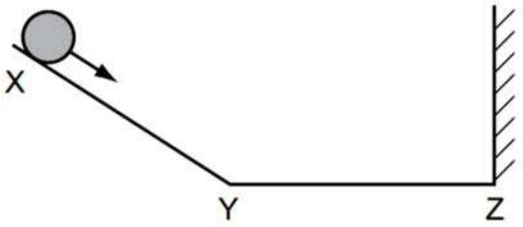
D



5 A ball is released from rest on a smooth slope XY.

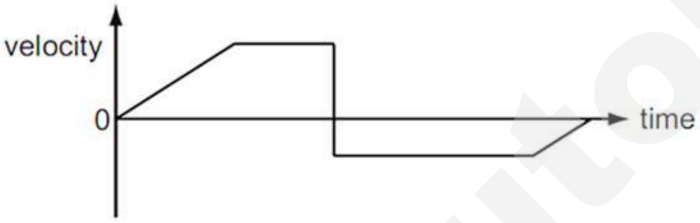
It moves down the slope, along a smooth horizontal surface YZ and rebounds at Z. The collision is in-elastic.

Then it moves back to Y and comes to rest momentarily somewhere on XY.

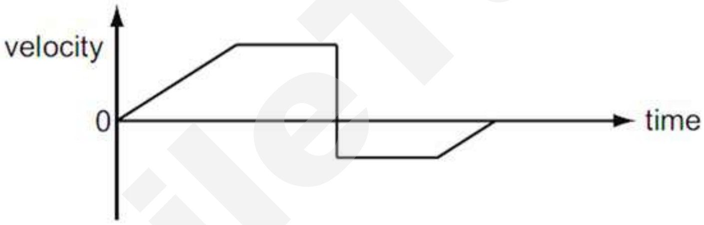


Which velocity-time graph represents the motion of the ball?

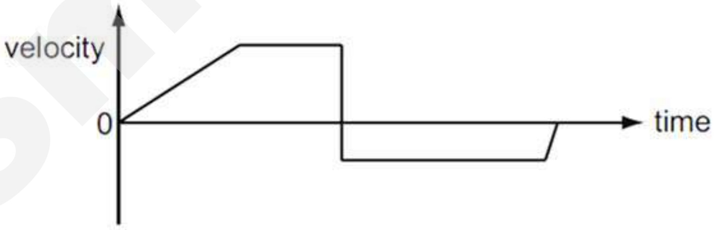
A



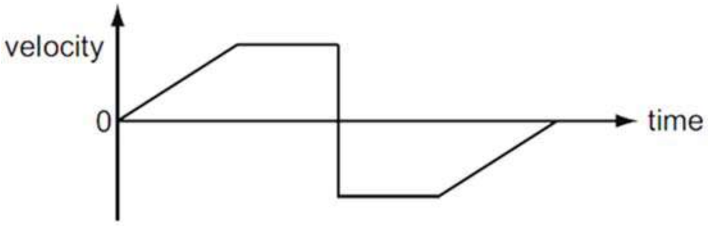
B



C



D



6 A football on a level playing field is kicked so that it leaves the ground at an angle 45° to the horizontal. It then travels a horizontal distance of 95 m before it hits the ground again.

How far will the ball travel when launched at the same speed on the same field if launched at an angle of 35° to the horizontal?

Neglect the effect of air resistance.

A 89 m **B** 78 m **C** 54 m **D** 32 m

7 A car has mass *m*. A person needs to push the car with force *F* in order to give the car acceleration *a*. The person needs to push the car with force 2*F* in order to give the car acceleration 3*a*.

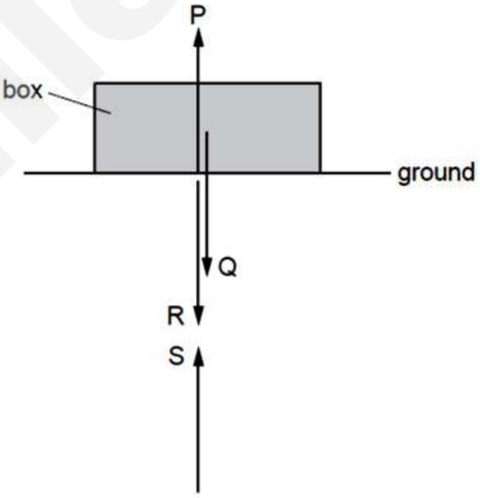
Which expression gives the constant resistive force opposing the motion of the car?

A *ma* **B** 2*ma* **C** 3*ma* **D** 4*ma*

8 A box is shown resting on the ground. Newton's third law implies that four forces of equal magnitude are involved. These forces are labelled P, Q, R and S.

Forces P and Q act on the box. Forces R and S act on the Earth.

For clarity, the forces are shown slightly separated.



Which statement about the forces is correct?

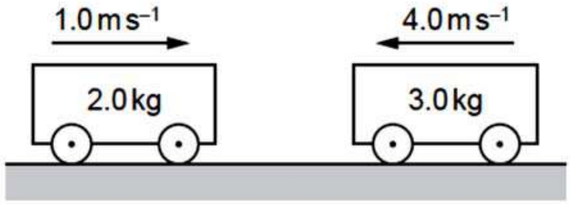
A P is the equal and opposite force to Q and both are forces of contact.

B Q is the equal and opposite force to P and both are gravitational forces.

C R is the equal and opposite force to S and both are forces of contact.

D S is the equal and opposite force to Q and both are gravitational forces.

9 Two frictionless trolleys are moving towards each other along the same horizontal straight line. Their masses and velocities are shown.



The trolleys collide and stick together.

What is the velocity of the trolleys after the collision?

A 2.0 m s^{-1} to the left

B 2.0 m s^{-1} to the right

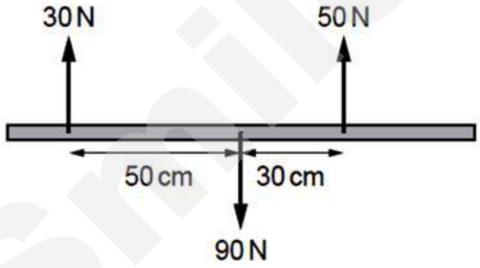
C 2.8 m s^{-1} to the left

D 2.8 m s^{-1} to the right

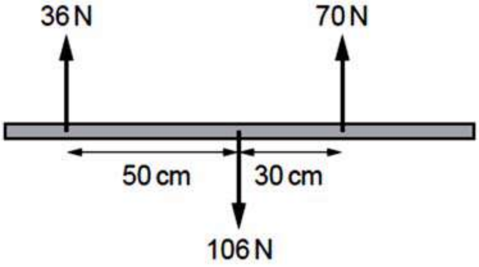
10 Four beams of the same length each have three forces acting on them.

Which beam is in static equilibrium?

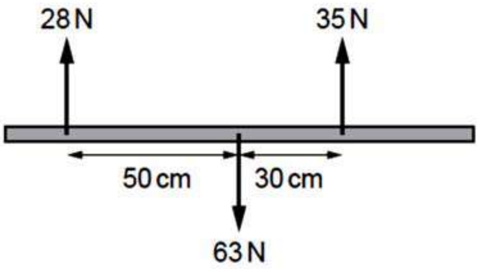
A



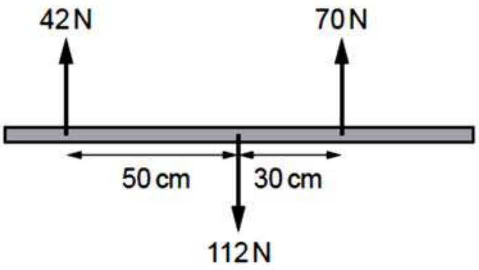
B



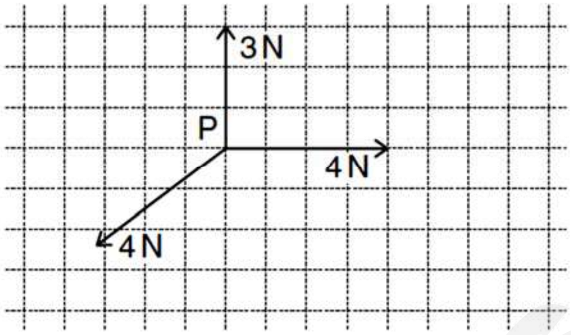
C



D



11 The vector diagram shows three coplanar forces acting on an object at P.

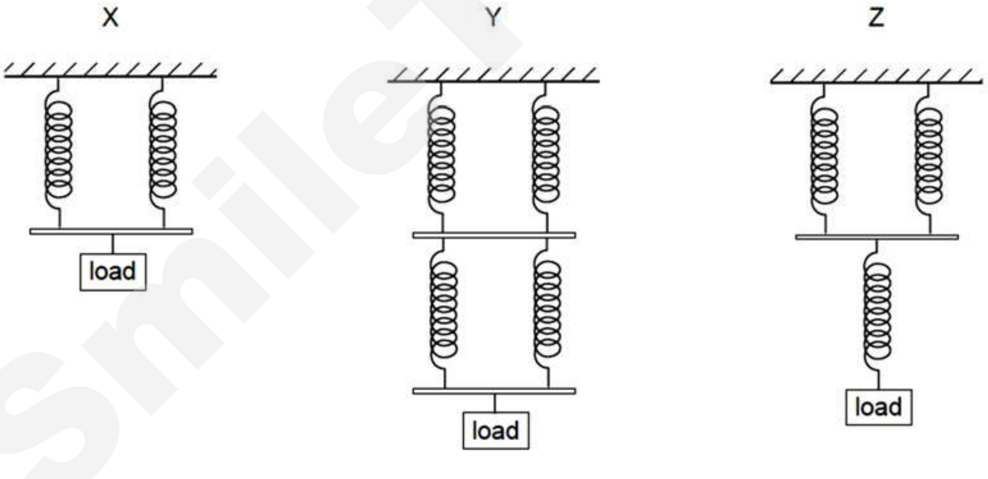


The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant?

A ↑ **B** ↘ **C** ↙ **D** ↗

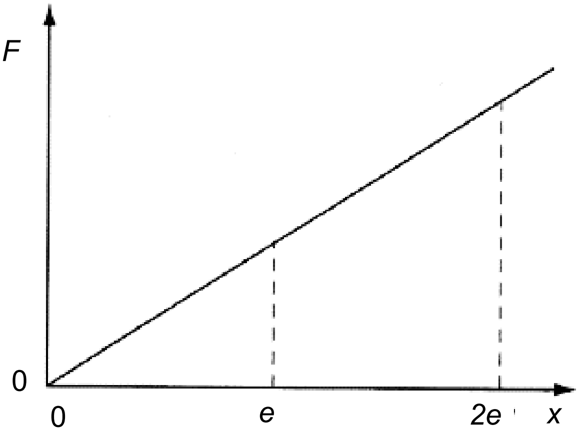
12 A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.



Which is the order of increasing extension for these arrangements?

	smallest	→	largest
A	X	Y	Z
B	Z	X	Y
C	Z	Y	X
D	Y	X	Z

13 The extension x of a particular spring is related to the stretching force as shown in the graph.



When the extension of the spring is e, the elastic potential energy stored in the spring is E. What is the increase in the elastic potential energy when the extension is increased from e to $2e$?

A E **B** $2E$ **C** $3E$ **D** $4E$

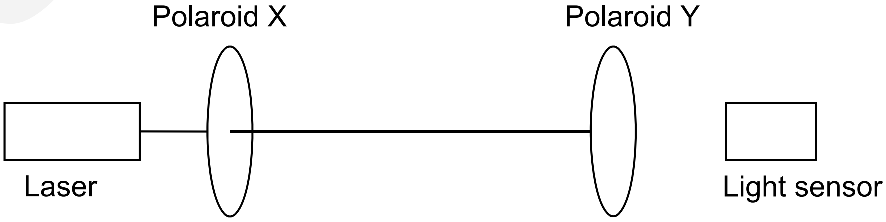
14 An airplane has two jet engines. If each of the jet engines has an efficiency of 80%, what is the power input of each engine required to allow the plane to fly with a thrust of 200 kN at a speed of 250 m s^{-1}?

A 20.0 MW **B** 31.3 MW **C** 40.0 MW **D** 62.5 MW

15 The figure below shows a setup where a laser beam is directed towards two polaroids.

The polaroids are adjusted such that zero intensity is detected by the light sensor.

Without changing the orientation of either Polaroid X or Polaroid Y, how may we adjust the setup such that the light sensor detects a non-zero intensity?



A Place another Polaroid between Polaroid X and Polaroid Y.

B Place another Polaroid between the laser and Polaroid X.

C Place another Polaroid between Polaroid Y and the light sensor.

D Rotate both Polaroid X and Y by 90° but in different direction.

16 A tube which is open at both ends is held vertically and partially submerged in a beaker of water.

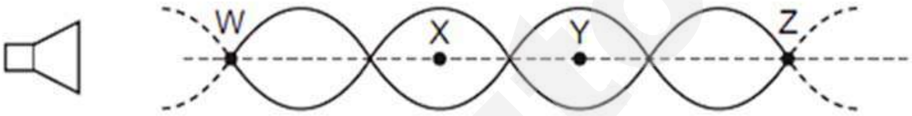
A speaker producing waves of wavelength 24.0 cm is placed near the top end of the tube.

The tube is slowly raised from the water until a loud sound is heard from the tube.

What is the shortest possible length of tube above the water that produces this loud sound?

A 6.0 cm **B** 12.0 cm **C** 16.0 cm **D** 24.0 cm

17 The diagram represents a stationary wave formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet (not shown).



W, X, Y and Z are four points on the line through the centre of this wave.

Which statement about this stationary wave is correct?

A A displacement antinode is formed at the surface of the metal sheet.

B A node is a quarter of a wavelength from an adjacent antinode.

C The oscillations at X are in phase with those at Y.

D The particles of the waves oscillate at right angles to the line WZ.

18 If one of the slits of a standard Young's double slit demonstration of interference in light is painted over so that it transmits only half the light intensity of the other, which of the following is correct?

A Only the bright lines will become brighter.

B Only the bright lines will become dimmer.

C The dark lines will remain dark and the bright lines will become brighter.

D The dark lines will become brighter and the bright lines will become dimmer.

19 A power cable has length 2000 m. The cable is made of twelve parallel strands of copper wire, each with diameter 0.51 mm.

Given that the resistivity of copper is 1.7×10^{-8} Ω m, what is the resistance of the cable?

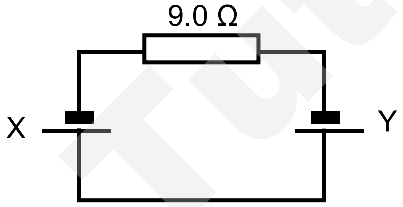
A 0.014 Ω **B** 3.5 Ω **C** 14 Ω **D** 166 Ω

20 Two heating coils X and Y, of resistance R_X and R_Y respectively, deliver the same power when 12 V is applied across X and 6 V is applied across Y.

What is the ratio of R_X / R_Y?

A ¼ **B** ½ **C** 2 **D** 4

21 Two cells X and Y are connected in series with a resistor of resistance 9.0 Ω, as shown.

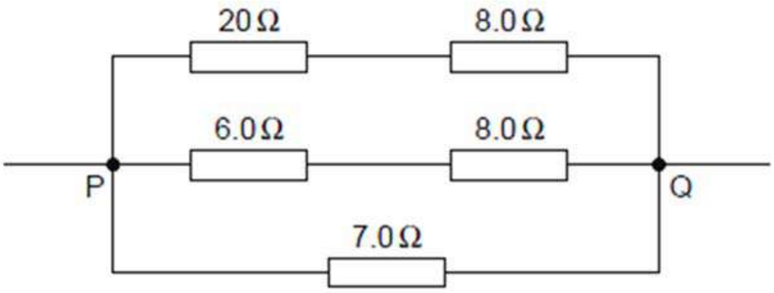


Cell X has an e.m.f. of 1.0 V and an internal resistance of 1.0 Ω. Cell Y has an e.m.f. of 2.0 V and an internal resistance of 2.0 Ω.

What is the current in the circuit?

A 0.083 A **B** 0.10 A **C** 0.17 A **D** 0.25 A

22 Five resistors are connected as shown.



What is the total resistance between P and Q?

A 0.25 Ω **B** 0.61 Ω **C** 4.0 Ω **D** 16 Ω

23 When four identical resistors are connected as shown in diagram 1, the ammeter reads 1.0 A and the voltmeter reads zero.

diagram 1

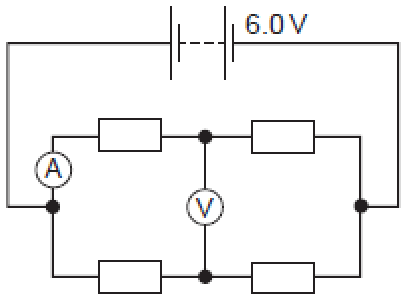
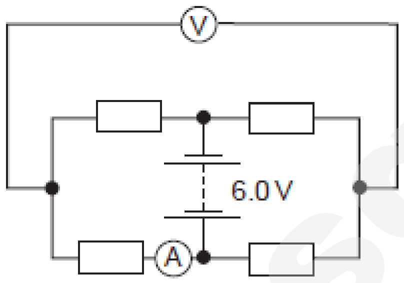


diagram 2

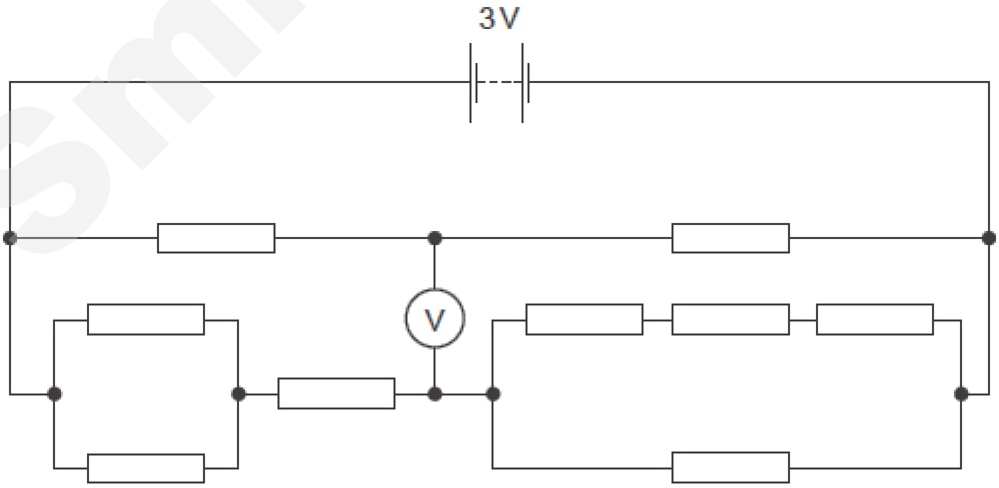


The resistors and meters are reconnected to the supply as shown in diagram 2.

What are the meter readings in diagram 2?

	voltmeter reading / V	ammeter reading / A
A	0	1.0
B	3.0	0.5
C	3.0	1.0
D	6.0	0

24 A circuit is set up as shown, supplied by a 3 V battery. All resistances are 1 kΩ.

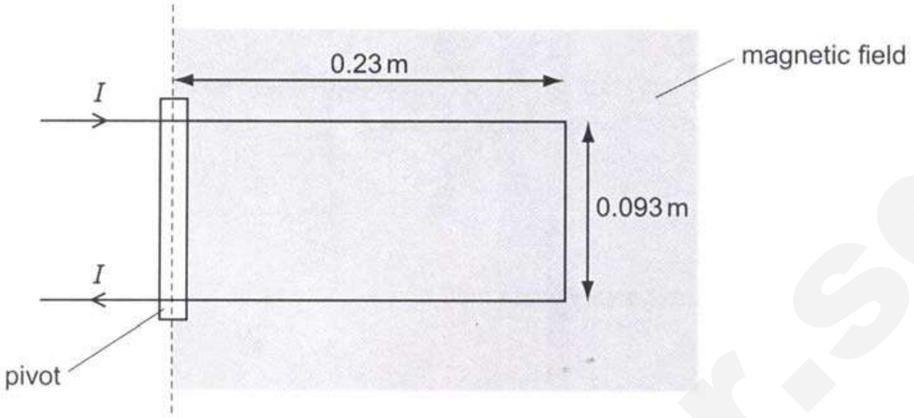


What will be the reading on the voltmeter?

A 0 **B** 0.5 V **C** 1.0 V **D** 1.5 V

25 In order to determine the value of a current I, a current balance is used. This consists of a U-shaped wire placed in a constant magnetic field of flux density 3.6×10^{-2} T.

This U-shaped wire has length 0.23 m and the arms are 0.093 m apart, as shown.

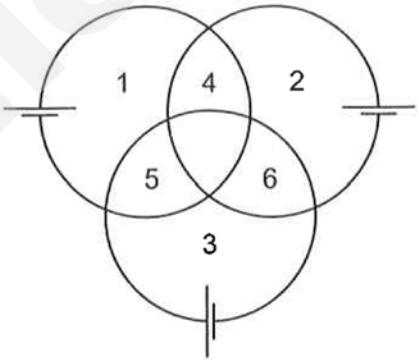


This U-shaped wire experiences a turning moment about the pivot of value 7.4×10^{-3} N m.

What is the value of I?

A 0.044 A **B** 1.6 A **C** 2.8 A **D** 9.6 A

26 Three separate coils of insulated wire are connected to cells as shown. They are placed on a table on top of each other, partially overlapping.



Six of the seven areas formed within the coils are numbered.

In which areas of the magnetic fields of all the coils reinforce each other?

A 1 and 6 **B** 2 and 5 **C** 3 and 4 **D** 4 and 6

27 The work function of platinum is twice that of calcium. If the *minimum* photon energy required to emit photoelectrons from the surface of platinum is *E*, then that for the surface of calcium would be

A 2*E* **B** 3*E*/2 **C** *E*/2 **D** *E*/4

28 In order that an electron has a de Broglie wavelength equal to that of a proton,

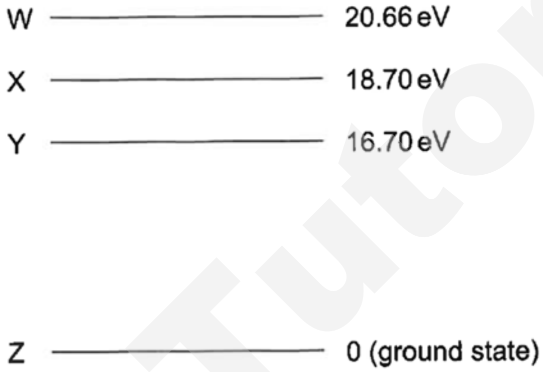
A their momenta must be equal.

B their kinetic energies must be equal.

C their velocities must be equal.

D the ratio of their energies must be equal to the ratio of their masses.

29 Some of the electron energy levels for neon in a helium-neon laser are shown in the diagram.



Which energy change for electrons results in laser light of wavelength 633 nm?

A W → X **B** X → Y **C** W → Y **D** W → Z

30 White light from a tungsten filament lamp is passed through sodium vapour and viewed through a diffraction grating.

Which of the following best describes the spectrum that is seen?

A coloured lines on a black background

B coloured lines on a white background

C dark lines on a coloured background

D dark lines on a white background

END OF PAPER

JC2 H1 Physics Prelim Exam Solution (Paper 1)

Answer Key

Qn	Ans		Qn	Ans		Qn	Ans
1	**D**		11	**D**		21	**A**
2	**C**		12	**A**		22	**C**
3	**D**		13	**C**		23	**A**
4	**D**		14	**B**		24	**B**
5	**A**		15	**A**		25	**D**
6	**A**		16	**A**		26	**B**
7	**A**		17	**B**		27	**C**
8	**D**		18	**D**		28	**A**
9	**A**		19	**C**		29	**A**
10	**D**		20	**D**		30	**C**

1. *Ans: **D***
Only *s* is a vector quantity

Comments

2. *Ans: **C***

$$\frac{\Delta R}{R}\text{x}100\% = \frac{\Delta V}{V}\text{x}100\% + \frac{\Delta I}{I}\text{x}100\%$$

$$\frac{\Delta R}{R}\text{x}100\% = \frac{0.05}{1.00}\text{x}100\% + \frac{0.01}{0.50}\text{x}100\%$$

$$= 5.0\ \% + 2.0\ \%$$

$$= 7.0\ \%$$

Comments

3. *Ans: **D***
By drawing an appropriate vector subtraction diagram or consider that R + Q = P.

Comments

4 *Ans: **D***
At the point of release, its displacement is zero. Hence, only option C and D are possible.

When the sphere is accelerating (though reducing), its velocity increases at a reducing rate. Hence, the gradient of the displacement-time graph should be increasing. When the sphere has achieved terminal velocity, its velocity remains constant, hence, the gradient of the displacement-time graph should be constant. Only option D fits this description of its motion.

Comments

5 *Ans: **A***
XY: Velocity increases at a constant rate.
YZ: Velocity remains constant (smooth surface)

Comments

Z: Rebound velocity (decreases as rebound is in-elastic)
Magnitude of negative velocity decreases.
ZY: Constant velocity. Since rebound velocity is smaller, it takes a longer time to travel from Z to Y.
YX: Velocity decreases at the same constant rate as V_{XY}

Hence, option A best describes the motion.

6 *Ans: **A***

Let the launch speed be u
Using,
$s_y = u_y t + ½ a_y t^2$
$0 = u\sin45^\circ t – ½ (9.81)t^2$
$t = (u\sin45^\circ) / 4.905$
Therefore,
$s = ut$
$95 = u\cos45^\circ t = (u\cos45^\circ)(u\sin45^\circ) / 4.905$
$u^2 = 95(9.81)$
$u = 30.53 \text{ m s}^{-1}$

Similarly,
New horizontal distance $= (u\cos35^\circ)(u\sin35^\circ) /4.905$
$= 95(9.81)(\sin35^\circ)(\cos35^\circ) / 4.905$
$= 89 \text{ m}$

Comments

7 *Ans: **A***
Let *f* be the constant resistive force
$F – f = ma$
$2F – f = 3ma$
Solving, $f = ma$

Comments

8 *Ans: **D***
P: Normal contact force on box by Earth
Q: Gravitational force on box by Earth
R: Normal contact force on Earth by box
S: Gravitational force on Earth by box
Therefore, Q and S are equal and opposite force due to Newton's third law and both are gravitational forces

Comments

9 *Ans: **A***
By conservation of linear momentum,
Total initial linear momentum = Total final linear momentum
2.0(1.0) + 3.0(-4.0) = (2.0 + 3.0)v (Taking right as positive)
$v = -2.0 \text{ m s}^{-1}$

Comments

(negative sign means that the trolleys are moving to the left.

10 *Ans:* ***D*** Comments
(A): net force = 10 N
(B): net moment about mid-point = 3 N m
(C): net moment about mid-point = 3.5 N m
(D): sum of forces and torque = 0

11 *Ans:* ***D*** Comments
Sum of forces 3 N and 4 N (vertical) forces = 5 N
Since the resultant of the three forces = 1 N, the other force of 4 N must be opposite of the force of 5 N (pointing diagonally up).

Hence the direction of the resultant force points in the direction of the 5 N.

12 *Ans:* ***A*** Comments
X: force in each spring = W/2
extension = 0.5x
Y: total extension = x
Z: total extension = x + 0.5x = 1.5x
Order : X, Y, Z

13 *Ans:* ***C*** Comments

Increase in EPE = Area under the graph.
Area under the graph would be multiplied by 3

14 *Ans:* ***B*** Comments
Power needed = $(2 \times 10^5)(250) = 5 \times 10^7$
Therefor the power input by both engines
= $(5 \times 10^7) \times 100/80 = 6.25 \times 10^7$ W

Therefor the power input by each engine
= $6.25 \times 10^7 /2 = 3.13 \times 10^7$= 31.3 MW

15 *Ans:* ***A*** Comments

Place another polaroid between X and Y so that the vibration plane of the light is no more at right angle to the polaroid Y. Hence some light will pass through Y

16 *Ans:* ***A*** Comments

When the length of the tube is 6.0 cm, it will fullfill the boundary condition of Node and Antinode at the both ends, producing a loud sound

17 *Ans:* ***B***

Node to Antinode = ¼ wavelength

Comments

18 *Ans:* ***D***

The bright lines would become dimmer as the amplitude of the CI would decrease and dark lines become brighter as the waves will not destruct completely

Comments
.

19 *Ans:* ***C***

$$R=\frac{\rho l}{A}$$

$$R=\frac{1.7\times10^{-8}\times2000}{12\times\frac{\pi}{4}\times\left(0.51\times10^{-3}\right)^2}$$

= 13.9 ≈ 14 Ω

Comments

20 *Ans:* ***D***

$$P=\frac{V^2}{R}$$

Since both resistors deliver the same power,

$$\frac{{V_X}^2}{R_X}=\frac{{V_Y}^2}{R_Y}$$

$$\frac{12^2}{R_X}=\frac{6^2}{R_Y}$$

$$\frac{R_X}{R_Y}=4$$

Comments

21 *Ans:* ***A***

$$E_{net}=I\left(R+r_X+r_Y\right)$$

2.0 – 1.0 = I (9.0 + 1.0 + 2.0)

I = 0.083 A

Comments

22 *Ans:* ***C***

$$\frac{1}{R_{PQ}}=\frac{1}{20+8.0}+\frac{1}{6.0+8.0}+\frac{1}{7.0}$$

R_{PQ} = 4.0 Ω

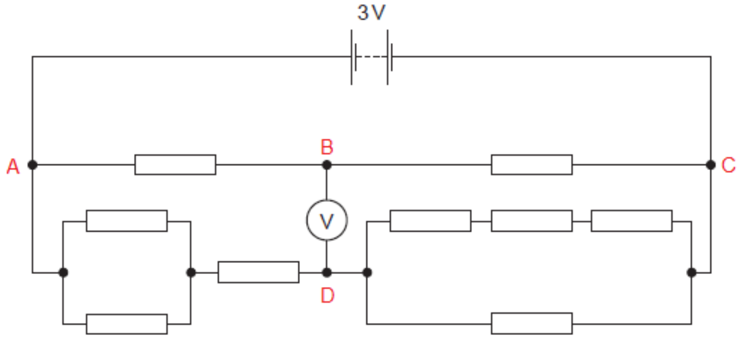
Comments

23 *Ans:* ***A***

The four identical resistors are connected in the same arrangement in both diagram 1 and 2. As such the voltmeter and ammeter which are also placed in similar position would register the same voltage and current.

Comments

24 Ans: **B**



$$R_{AD} = \left(\frac{1}{1000} + \frac{1}{1000}\right)^{-1} + 1000$$

$= 1500\ \Omega$

$$R_{DC} = \left(\frac{1}{1000+1000+1000} + \frac{1}{1000}\right)^{-1}$$

$= 750\ \Omega$

$$V_{BC} = \frac{R_{BC}}{R_{AB} + R_{BC}} \times E$$

$$V_{BC} = \frac{1000}{1000+1000} \times 3 = 1.5\text{ V}$$

$$V_{DC} = \frac{R_{DC}}{R_{AD} + R_{DC}} \times E$$

$$V_{BC} = \frac{750}{1500+750} \times 3 = 1.0\text{ V}$$

Voltage across the voltmeter

$V_{BD} = V_{BC} - V_{DC}$

$= 1.5 – 1.0 = 0.5\ V$

Comments

25 Ans: **D**

Resultant moment = F x d

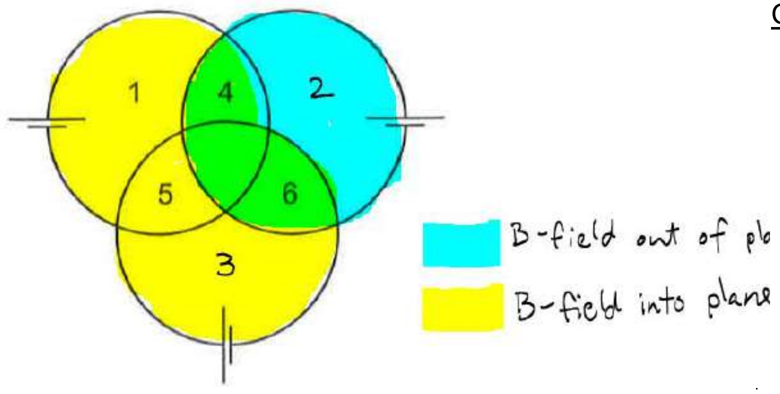
$7.4 \times 10^{-3} = B\ I\ L \times d$

$7.4 \times 10^{-3} = (3.6 \times 10^{-2})(I)(0.093) \times (0.23)$

$I = 9.6$ A

Comments

26 Ans: **B**



Comments

Referring to the shaded diagram above, the areas where the B-fields of all 3 coils reinforce each other will be:

Region 5 – inward B field inside left and bottom coil, inward B field outside right coil

Region 2 – outward B field inside right coil, outward B field outside left and bottom coil.

27 *Ans:* ***C***

The work function of a metal corresponds to the minimum photon energy required to eject photoelectrons from the metal surface. Hence since the work function of calcium is half that for platinum, the minimum photon energy to emit photoelectrons for calcium will be half that for platinum.

Comments

28 *Ans:* ***A***

Comments

Since λ=h/p, for their wavelength to be the same, momenta must be the same.

29 *Ans:* ***A***

Comments

$$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34})(3.0 \times 10^{8})}{633 \times 10^{-9}}$$

= 3.142×10^{-19} J

= 1.964 eV

30 *Ans:* ***C***

Comments

White light from tungsten filament lamp (a hot solid) will be a **continuous spectrum**.

Sodium vapour is a **cool** gas (atoms at ground state).

Passing white light through a cool gas is similar to the **absorption spectrum** experiment.

So the observation will be dark lines on a coloured background.

H

INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME			
CLASS		INDEX NUMBER	

PHYSICS 8866/02

Paper 2 Structured Questions **25 August 2017**

2 hours

Candidates answer on the Question Paper

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in the brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	10
2	10
3	8
4	6
5	6
Section B	
6	20
7	20
8	20
Penalty	
Total	80
Percentage	

This document consists of **24** printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots$

Section A

Answer **all** questions in this section.

1 **(a)** A boat travels across a river in which the water is moving at a speed of 1.8 m s^{-1}. The velocity vectors for the boat and the river water are shown in Fig. 1.1.

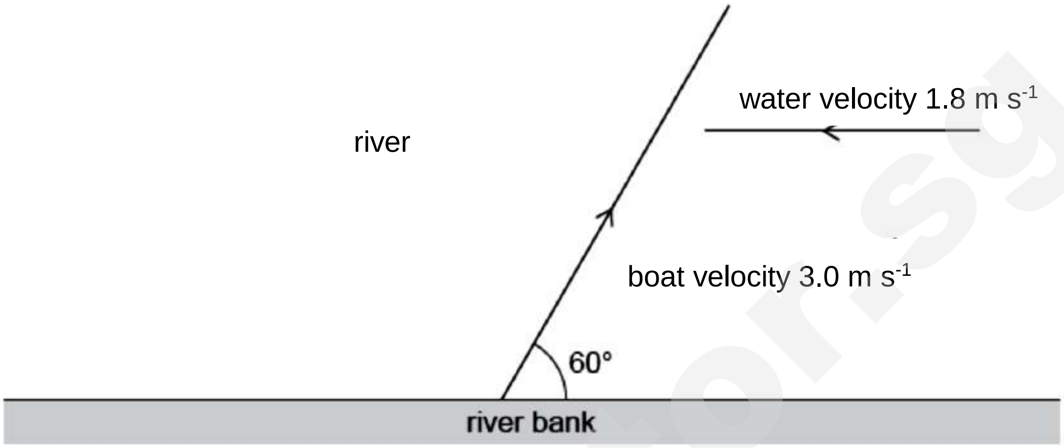


Fig. 1.1 (not to scale)

In still water the speed of the boat is 3.0 m s^{-1}. The boat is directed at an angle of 60° to the river bank.

(i) Sketch a labelled vector triangle to show the resultant velocity of the boat. [1]

(ii) Determine the resultant velocity of the boat.

resultant velocity = ………………………………… m s^{-1} [2]

direction = ………………………………………. [2]

(b) The volume *V* of liquid flowing in time *t* through a pipe of radius *r* is given by the equation

$$\frac{V}{t} = \frac{\pi P r^4}{8Bl}$$

where *P* is the pressure difference between the ends of the pipe of length *l*, and *B* depends on the frictional effects of the liquid.

An experiment is performed to determine *B*. The measurements made are shown in Fig. 1.2.

$\frac{V}{t}$ / 10^{-6} m^3 s^{-1}	P / 10^3 N m^{-2}	r / mm	l / m
1.20 ± 0.01	2.50 ± 0.05	0.75 ± 0.01	0.250 ± 0.001

Fig. 1.2

(i) Show that the value of *B* is 1.04 x 10^{-3} N s m^{-2}. [1]

(ii) Calculate the absolute uncertainty in *B*.

absolute uncertainty = ………………………… N s m^{-2} [3]

(iii) State the value of *B* and its uncertainty to the appropriate number of significant figures.

B = ………………………… ± ………………………… N s m^{-2} [1]

2 The variation with time *t* of the velocity *v* of a ball is shown in Fig. 2.1.

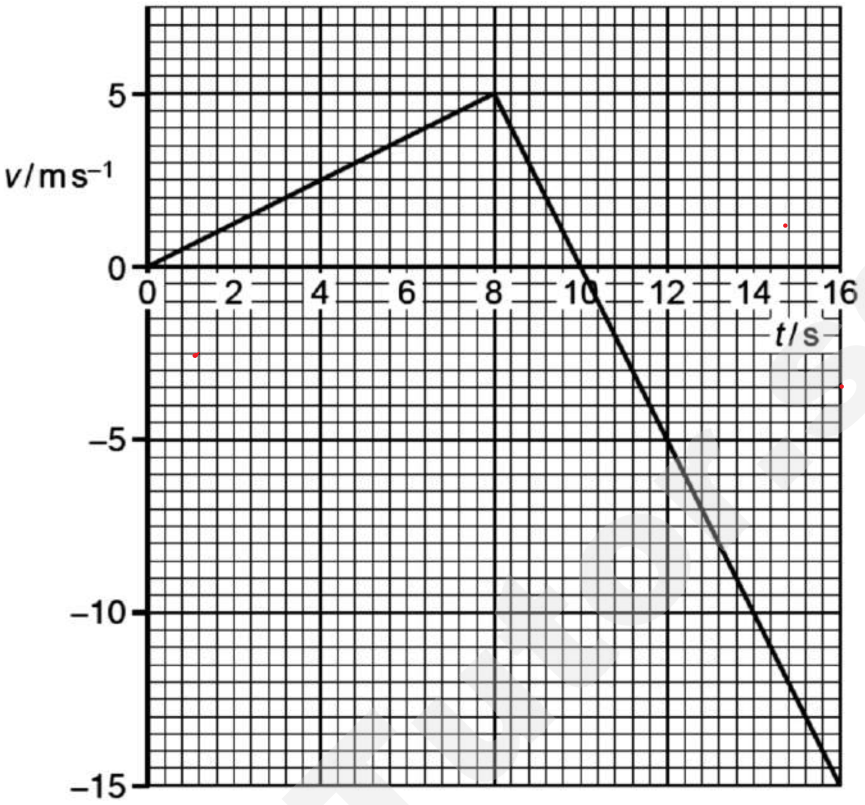


Fig. 2.1

The ball moves in a straight line from a point P at *t* = 0. The mass of the ball is 400 g.

(a) Use Fig. 2.1 to describe, without calculation, the velocity of the ball from *t* = 0 to *t* = 16 s.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [2]

(b) Use Fig. 2.1 to calculate, for the ball,

(i) the displacement from P at *t* = 10 s,

displacement = ……………………….. m [2]

(ii) the acceleration at *t* = 10 s,

acceleration = …………………….... m s^{-2} [2]

(iii) the maximum kinetic energy.

kinetic energy = …………………….... J [2]

(c) Use your answers in **(b)(i)** and **(b)(ii)** to determine the time from *t* = 0 for the ball to return to P.

time = …………………….... s [2]

3 **(a)** State two conditions for an object to be in equilibrium.

1. ……………………………………………………………………………………………..

……………………………………………………………………………………………………

2. ……………………………………………………………………………………………..

…………………………………………………………………………………………… [2]

(b) A uniform beam AC is attached to a vertical wall at end A. The beam is held horizontal by a rigid bar BD, as shown in Fig. 3.1.

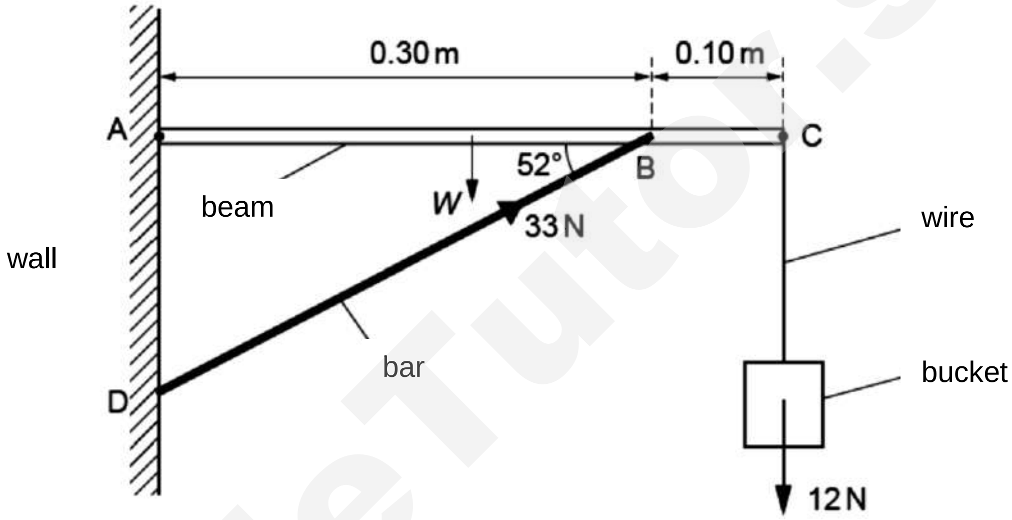


Fig. 3.1 (not to scale)

The beam is of length 0.40 m and weight *W*. An empty bucket of weight 12 N is suspended by a light metal wire from end C. The bar exerts a force of 33 N at 52° to the horizontal on the beam. The beam is in equilibrium.

(i) Calculate the vertical component of the force exerted by the bar on the beam.

component of the force = ………………………………… N [1]

(ii) By taking moments about A, calculate the weight *W* of the beam.

W = ………………………………… N [2]

(iii) State and explain how the force in the bar will change when the bucket is filled with water.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [3]

4 A long straight copper wire is placed at an angle of 90° to a uniform magnetic field of flux density 5.2×10^{-2} T, as shown in Fig. 4.1.

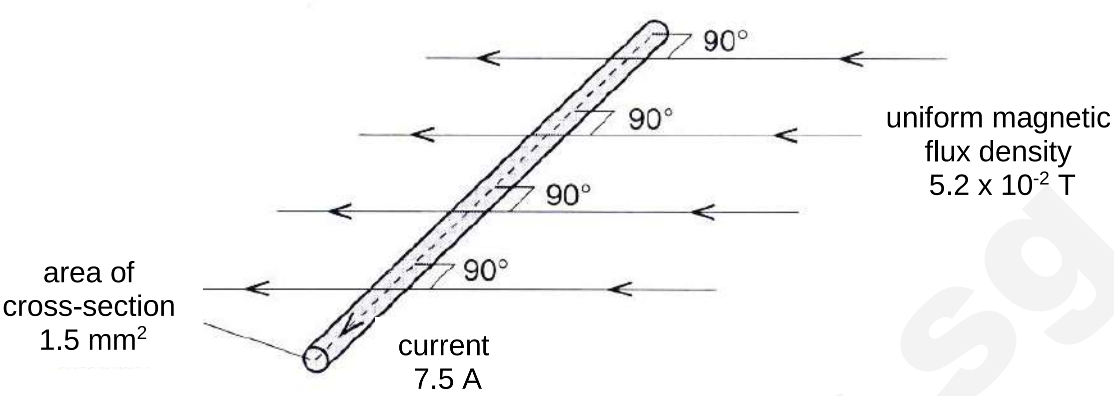


Fig. 4.1

The current in the wire is 7.5A.
There is a force on the current-carrying wire due to the magnetic field.

(a) Determine the magnitude and direction of the force per unit length on the wire.

force per unit length = …………………………………. N m^{-1} [2]

direction = ……………………………………….... [1]

(b) The current in the wire is a movement of free electrons along the wire. The electrons may be assumed to be moving with speed *v* along the wire.

The number of free electrons per unit volume of the wire is 7.8×10^{28} m^{-3}.
The cross-sectional area of the wire is 1.5 mm^2.

The force on the wire is equal to the total force on the free electrons as they move along the wire.

Use your answer in **(a)** to determine the magnitude of the force on each free electron as it moves along the wire in the magnetic field.

force on each free electron = ………………………………… N [3]

5 Light of frequency *f* and wavelength λ is incident on a metal surface having work function energy ϕ. Electrons are emitted from the surface with maximum kinetic energy E_{MAX}.

Conservation of energy for this effect may be expressed as,

$$E_{MAX} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

where, *h* is the Planck constant, *c* is the speed of light and λ_0 is the corresponding wavelength of light at threshold frequency.

The variation with $\frac{1}{\lambda}$ of E_{MAX} is shown in Fig. 5.1.

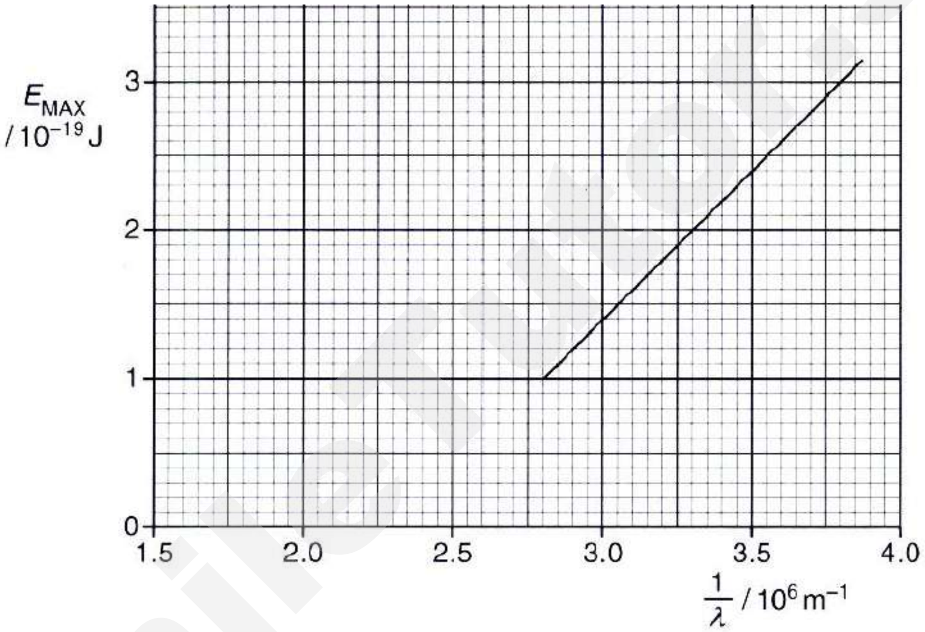


Fig. 5.1

(a) Use Fig. 5.1 to

(i) determine, without using a value for *h*, the maximum wavelength λ_0 at which emission of electron occurs, and

λ_0 = ……………………………… m [3]

(ii) show that the Planck constant is approximately 6.7 × 10^{-34} J s. [2]

(b) The metal surface becomes oxidised but photoelectric emission is still observed. The work function energy of this new surface has been increased.

On Fig. 5.1, draw a line to show the variation with $\frac{1}{\lambda}$ of E_{MAX} for this oxidised surface.

[1]

Section B

Answer **two** of the questions in this section.

6 **(a)** State the principle of conservation of linear momentum.

....

....

.... [2]

(b) A sphere of mass m travelling in a straight line with speed u collides head-on with another sphere of the same mass that has a speed u_2. The speed u of the incoming sphere is greater than u_2, as shown in Fig. 6.1. The collision is perfectly elastic.

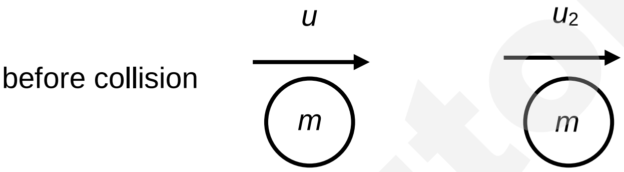


Fig. 6.1 (not to scale)

The incoming sphere of kinetic energy E may lose an amount of kinetic energy W.

The fractional energy lost by the incoming sphere, F is given to be

$$F = \frac{\text{energy lost by incoming sphere}}{\text{kinetic energy of incoming sphere}} = \frac{W}{E}$$

Fig. 6.2 shows how F, the fractional energy lost by the incoming sphere, depends on the ratio u_2 / u.

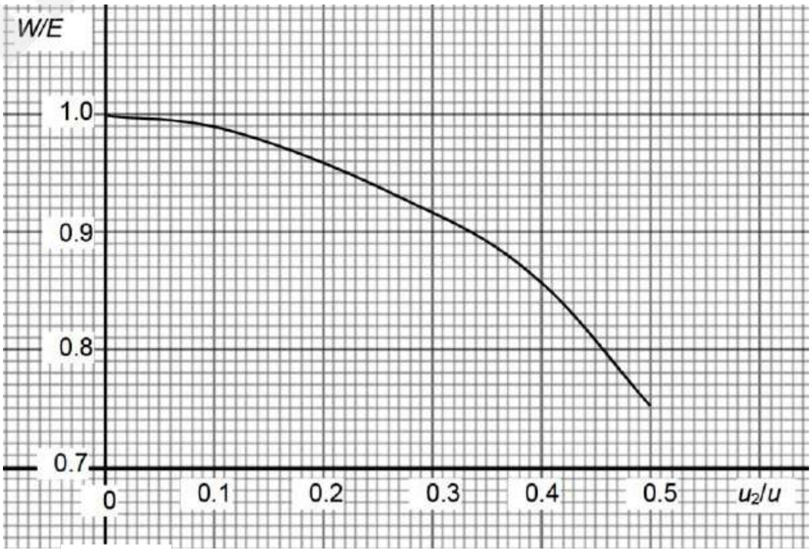


Fig. 6.2

(i) Explain what is meant by a *head-on* collision.

....

....

.... [1]

(ii) Explain what happens to the kinetic energy lost by the incoming sphere.

....

....

....[2]

(iii) Given that the mass of the sphere is 1.67×10^{-27} kg and the speed of the incoming sphere is 1.40×10^{7} m s^{-1}, calculate the energy lost by this incoming sphere in a perfectly elastic collision when $u_2 / u = 0.400$.

energy loss = ... J [3]

(iv) In another collision, the incoming sphere, moving with speed *u* collided with the second sphere that is initially at rest.

1. Determine the fraction of energy lost.

fraction = ... [1]

2. Describe the motion of the two particles after the collision.

....

....

....

.... [2]

(v) Use the graph of Fig. 6.2 to suggest why paraffin wax, which has a high number density of protons, is a good absorber of high speed neutrons. (mass of neutrons = 1.67 x 10^{-27} kg)

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………….... [3]

(c) The collision of particles is often not a head-on collision. In most cases, two particles A and B collide elastically, as illustrated in Fig. 6.3.

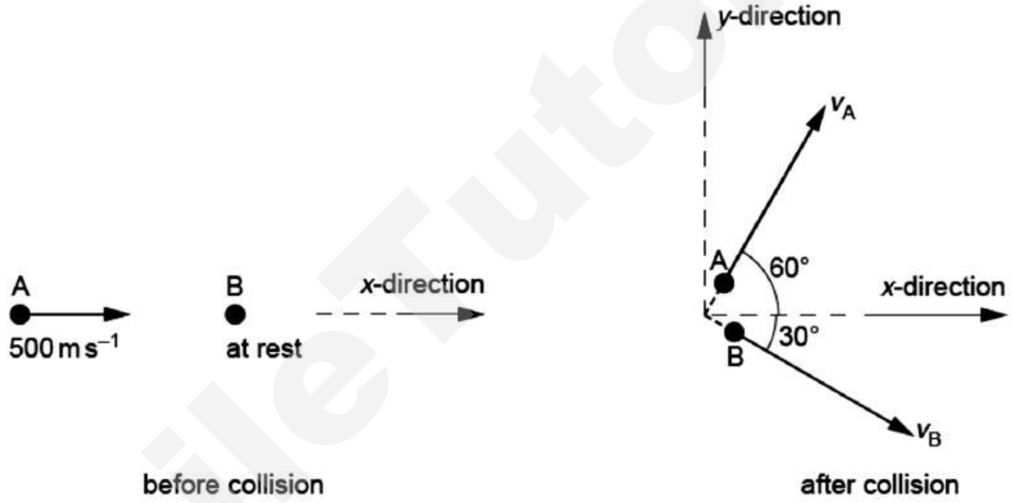


Fig. 6.3

The initial velocity of A is 500 m s^{-1} in the x-direction and B is at rest.

The velocity of A after collision is v_A at 60° to the x-direction. The velocity of B after the collision is v_B at 30° to the x-direction.

The mass *m* of each particle is 1.67 × 10^{-27} kg.

(i) Calculate the total initial momentum of A and B.

momentum = …………………………………. N s [1]

(ii) State an expression in terms of *m*, v_A and v_B for the total momentum of A and B after the collision

1. in the x-direction,

………………………………………………………………………………………...........

2. in the y-direction.

………………………………………………………………………………………........[2]

(iii) Calculate the magnitudes of the velocities of v_A and v_B after the collision.

v_A = ………………………………….. m s^{-1}

v_B = ………………………………….. m s^{-1} [3]

7 **(a)** A tuning fork is knocked against a hard object such that it causes the neighbouring air molecules to vibrate with a frequency of 128 Hz. Fig. 7.1 shows the positions of the air molecules around the tuning fork at a particular instant.

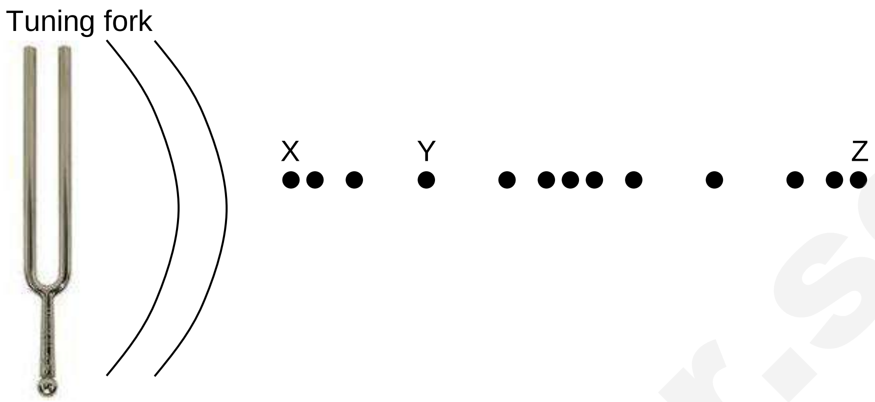


Fig. 7.1

(i) Explain why the wave produced by the tuning fork cannot be polarised.

………………………………………………………………………………………...

………………………………………………………………………………………...

……………………………………………………………………………………….. [1]

(ii) Given that the distance between X and Z is 5.2 m, calculate the speed of the longitudinal wave between X and Z.

speed = ……………………… m s^{-1} [1]

(iii) Determine the phase difference between X and Y.

phase difference = ………………………… rad [1]

(iv) The longitudinal waves created by tuning fork A can be assumed to have a power of 0.72 W and is equally generated in all directions. A microphone whose circular cross-section of radius 2.0 cm is placed 5.0 m away from the tuning fork as shown in Fig. 7.2.

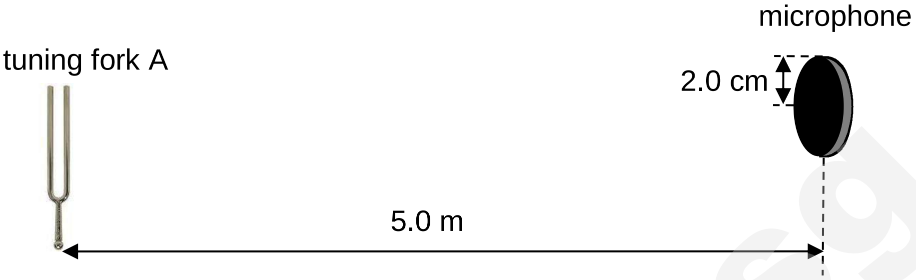


Fig. 7.2 (not to scale)

Determine the power received by the microphone.

power received = ………………………….. W [3]

(b) In Fig. 7.3, S_1 and S_2 are two small loudspeakers, initially placed at position Y and Z, that emit sound waves of the same intensity and wavelength. A microphone for detecting sound intensity is placed at point P such that YP = ZP.

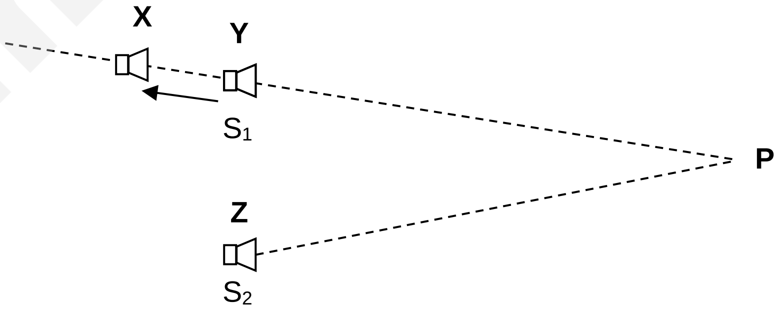


Fig. 7.3

(i) Describe a method in which the period of the sound wave can be recorded.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………. [2]

(ii) One of the conditions required for the formation of a well-defined interference pattern is that the two sources are coherent.

State what is meant by coherent sources and suggest how *coherence* of S_1 and S_2 can be achieved.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………….. [2]

(iii) Given that S_1 and S_2 are in phase, the speaker S_1 is moved slowly from Y to X along the line between these two points. As S_1 is moved, the sound detected at P fluctuates in intensity.

Explain this observation.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………….. [3]

(iv) In moving S_1 from point Y to point X as shown in Fig. 7.3, the intensity of the sound at P changes from a maximum to a minimum. The distance YX = 0.082 m.

Calculate the wavelength of the sound emitted by the sources.

wavelength = ………………………….. m [1]

(v) S_1 remains at the point X and the frequency f of the sound emitted from both S_1 and S_2 is gradually increased until a maximum sound intensity is first detected at P. This occurs when f = 4100 Hz.

1. Estimate a value for the speed of sound.

speed = ……………………….. m s^{-1} [2]

2. Explain why the maximum sound intensity detected at P when S_1 is at point X differs from that detected at P if S_1 is at Y.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………….. [2]

(vi) Explain why for the maxima and minima to be observable, the amplitude of the two sound sources have to be approximately the same.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………….. [2]

8 **(a)** A battery of e.m.f. *E* and internal resistance *r* is connected to a variable resistor, as shown in Fig. 8.1.

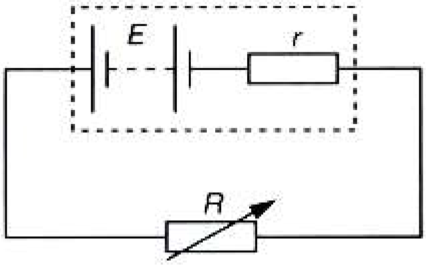


Fig. 8.1

The total power produced in the battery is P_T. The power dissipated in the variable resistor is P_R. The variation of P_T and P_R with resistance *R* of the variable resistor are shown in Fig. 8.2.

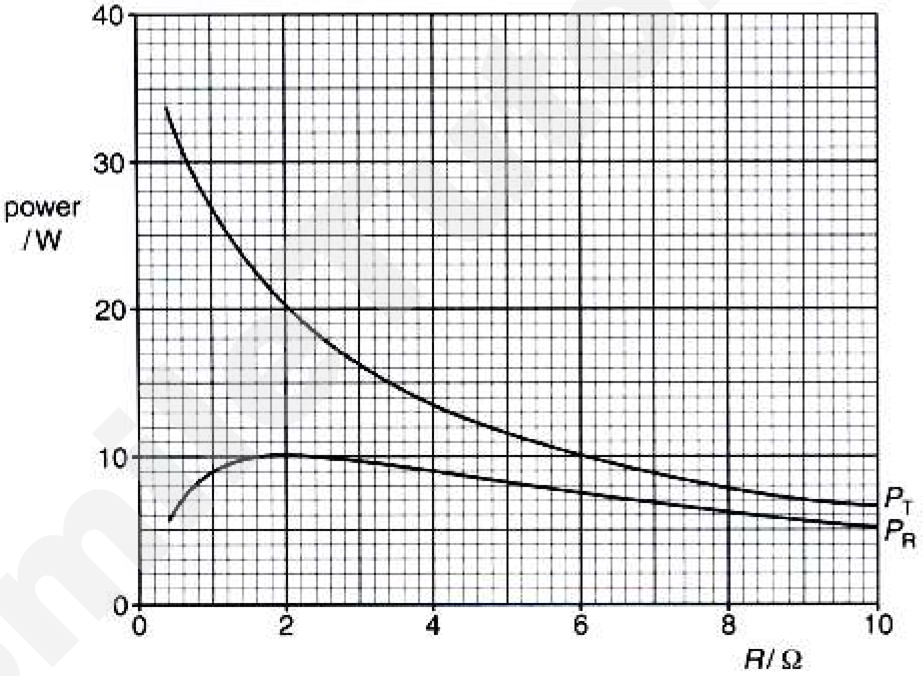


Fig. 8.2

(i) For resistance *R* = 1.0 Ω, use Fig. 8.2,

1. to show that the current in the circuit is 3.0 A. Explain your working.

[2]

2. to determine the e.m.f. E of the battery.

E = ………………………… V [2]

(ii) For any value of R, the value of P_T is greater than that of P_R.

1. Suggest what is represented by the quantity (P_T – P_R).

………………………………………………………………………………………

………………………………………………………………………………………[1]

2. Use the values of P_T and P_R at R = 1.0 Ω and your answer to **(a)(i)1.** to determine the internal resistance r of the battery.

r = ………………………… Ω [2]

(iii) **1.** Use Fig. 8.2 to state the value of R at which P_R is maximum.

R = ………………………… Ω [1]

2. For the value of R stated in **(a)(iii)1.**, determine the efficiency of power transfer from the battery to the variable resistor.

efficiency = ………………………… % [1]

3. State how the efficiency of power transfer changes for values of *R* between 4 Ω to 10 Ω.

………………………………………………………………………………………

……………………………………………………………………………………... [1]

(b) Fig 8.3 shows the variation with applied potential difference *V* of the current *I* in an electrical component C.

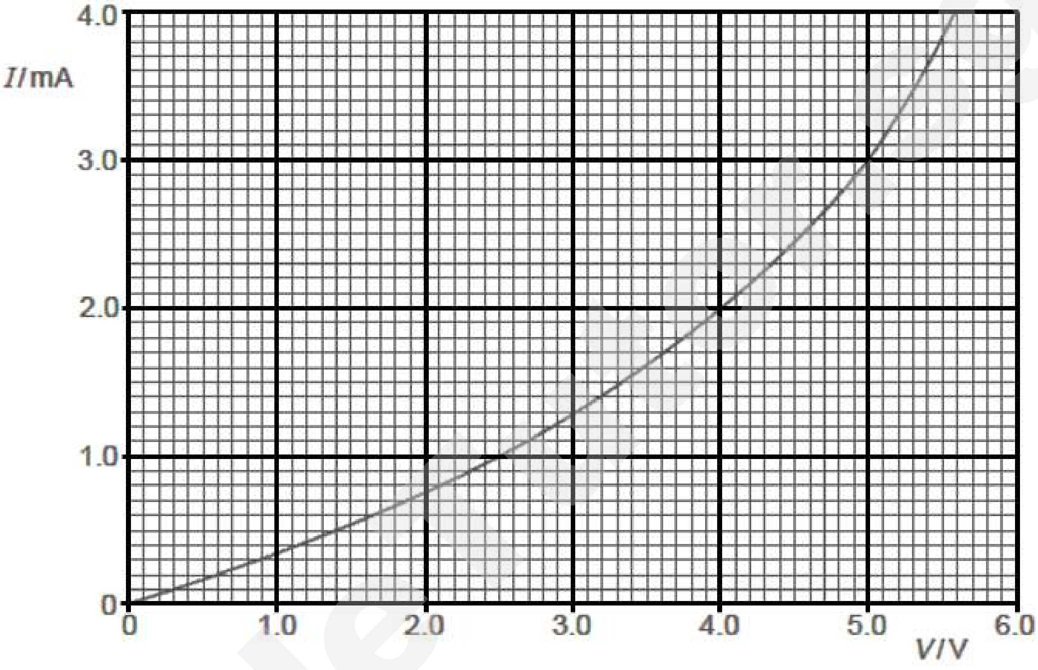


Fig. 8.3

(i) **1.** Using Fig 8.3, explain why the resistance of component C decreases with increasing potential difference.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………... [1]

2. Determine the resistance of component C at a potential difference of 4.0 V.

resistance = ………………………… Ω [2]

(ii) Component C is connected in parallel with a resistor X of resistance 1500 Ω and a battery of e.m.f. *F* and negligible internal resistance, as shown in Fig. 8.4.

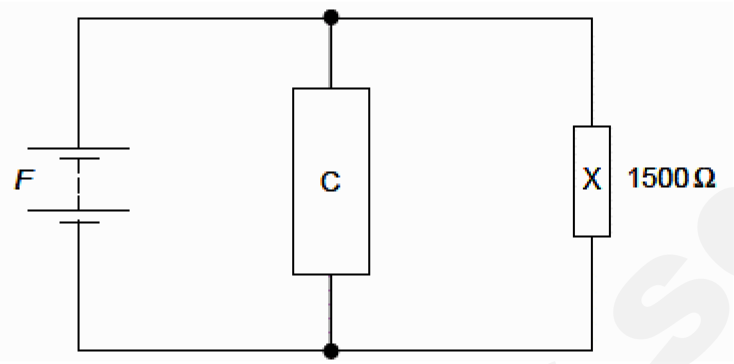


Fig. 8.4

1. On Fig. 8.3, draw a line to show the variation with potential difference *V* of the current *I* in resistor X. [2]

2. Hence, or otherwise, use Fig. 8.3 to determine the current in the battery for an e.m.f. of 2.0 V.

current = ………………………… A [2]

(iii) The resistor X of resistance 1500 Ω and the component C are now connected in series across a supply of e.m.f. 7.0 V and negligible internal resistance.

Using information from Fig. 8.3, state and explain which component, X or C will dissipate thermal energy at a greater rate.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

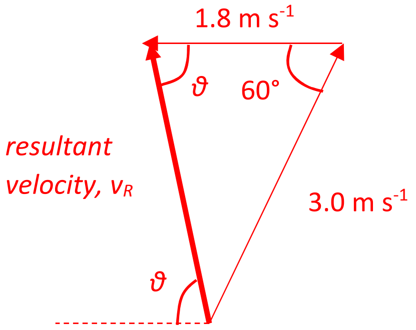
……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

END OF PAPER

SECTION A

1 (a)(i)



[B1] – Correct vector triangle (direction and magnitude)

Comments

Students need to be careful to label the vector diagram with BOTH the correct direction (arrow direction) and magnitude (value of velocity). Otherwise, it is not considered a vector diagram.

1 (a)(ii)

Using cosine rule,

$$(v_R)^2 = (1.8)^2 + (3.0)^2 - 2(1.8)(3.0)\cos 60^0 \qquad [M1]$$

$$v_R = 2.6 \text{ m s}^{-1} \qquad [A1]$$

$$(\sin \vartheta) / 3.0 = \sin 60^\circ / v_R \qquad [M1]$$

$$\vartheta = 88^\circ$$

Direction is 88° anticlockwise from the river bank *[A1]*

Alternative marking: For students who use a scale diagram, workings need to be shown and accuracy mark to be awarded.

Marking points: - correct direction and vector length drawn to chosen scale for boat and water velocity. *[B2]*

accuracy for v_R ($\pm$0.2 m s^{-1}) *[B1]*

accuracy for ϑ ($\pm$2.0°) *[B1]*

Comments

Those who chose the calculation method could obtain the magnitude of the resultant velocity correctly. However, most failed to calculate the direction correctly. Note, that calculating and angle is not considered having described the direction correctly. The angle must be described with reference to a reference direction which should not be respect to NSEW direction as no where in the question was stated where the N is! Reference should easily be made with respect to the river bank.

Those who chose to use the scale diagram option must draw angles accurately with a protractor.

1 (b)(i)

$$\frac{V}{t} = \frac{\pi P r^4}{8 B l}$$

$$B = \frac{\pi P r^4}{8\left(\frac{V}{t}\right) l}$$

$$B = \frac{\pi \left(2.50 \text{ x } 10^3\right)\left(0.75 \text{ x } 10^{-3}\right)^4}{8\left(1.20 \text{ x } 10^{-6}\right)\left(0.250\right)} \qquad [M1]$$

$$B = 1.04 \text{ x } 10^{-3} \text{ N s m}^{-2} \qquad [A0]$$

Comments

1 (b)(ii)

$$\frac{\Delta B}{B} = \frac{\Delta P}{P} + 4\left(\frac{\Delta r}{r}\right) + \left(\frac{\Delta (V/t)}{(V/t)}\right) + \frac{\Delta l}{l}$$

[C1] – Correct application of multiplication law

Comments

Many students failed to make B the subject BEFORE applying the multiplication law. In fractional uncertainty, it is not necessary to convert the numerator and denominator to SI base units. Many

$$\frac{\Delta B}{B}=\frac{0.05}{2.50}+4\left(\frac{0.01}{0.75}\right)+\left(\frac{0.01}{1.20}\right)+\frac{0.001}{0.250}$$

[M1] – Correct substitution

$$\frac{\Delta B}{(1.04 \times 10^{-3})}=0.085667$$

$$\Delta B = 8.91 \times 10^{-5} \quad OR$$
$$= 0.09 \times 10^{-3} \text{ N s m}^{-2}$$

[A1] – Correct answer (rounded to 1 sf)

who chose to do so, made conversion errors.

Absolute uncertainty of B must already be stated to 1 sf here.

1 (b)(iii)

$B = (1.04 \pm 0.09) \times 10^{-3}$ N s m^{-2} *[A1]*

Comments

Many could not write the value to B to the correct format. 1sf for uncertainty and B to the correct dp as the uncertainty.

2 (a)

- *The velocity increases from rest at a constant rate from t = 0 to t = 8 s.*
- *The velocity decreases to 0 m s^{-1} at a constant rate from t = 8 to t = 10 s.*
- *The velocity increases from 0 m s^{-1} at a constant rate in the opposite direction from t = 10 to t = 16 s.*

[B1] – First 2 bullet points
[B1] - Last bullet point

Comments

Many students could not describe the third point correctly, failing to recognize that the object is now travelling in the opposite direction with increasing velocity at a constant rate.

2 (b)(i)

Displacement is given by the area under the graph

displacement = ½ (10)(5) *[M1]*
= 25 m *[A1]*

Comments

Quite well done.

2 (b)(ii)

Acceleration is given by the gradient of the graph at t = 10 s

acceleration = - 5/2 *[M1]*
$= -2.5$ m s^{-2} *[A1]*

If no negative sign, minus 1 mark

Comments

Quite a handful did not state acceleration here as negative value. (Object is decelerating here)

2 (b)(iii)

Maximum speed of the ball occurs at t = 16 s

Maximum speed = 15 m s^{-1} *[M1]*

Maximum kinetic energy $= \frac{1}{2} m v_{max}^2$
$= \frac{1}{2}(0.4)(15)^2$
$= 45$ J *[A1]*

Comments

Quite well done.

2 (c)

The maximum displacement of the ball from P = 25 m

The ball starts to return to P from t = 10 s travelling in the opposite direction.

Let t be the time for the ball to travel a distance of 25 m from then.

Using, $s = ut + \frac{1}{2}at^2$

$25 = 0 + \frac{1}{2}(2.5)(t)^2$ [M1]

$t = 4.5$ s

Hence time from t = 0 for the ball to return to P = 10 + 4.5 = 14.5 s [A1]

Comments

Many student was caught unaware by the requirement of calculating the elapsed time from *t* = 0 s!

3 (a)

Resultant force in any direction is zero [B1]

Resultant moment/ torque about any point is zero [B1]

Comments

Students need to explicitly state the term "in any direction" and "about any point" for the conditions to hold. Most students lose a mark because of this reason.

3 (b)(i)

Force = 33 sin52° = 26 N [A1]

Comments

Generally well done. Students are able to resolve the force into two components.

3 (b)(ii)

$26 \times 0.30 = (W \times 0.20) + (12 \times 0.40)$ [C1]

W = 15 N [A1]

Comments

Some students were careless with finding the moment and did not determine the perpendicular distance.

3 (b)(iii)

When bucket is filled with water, there is larger downward force that leads to an increase in the clockwise moment of the weight of the bucket about the pivot A. (no change in perpendicular distance) [B1]

Since the moment due to the weight of the beam at point A remains the same. [B1]

Force in the bar has to increase to provide a greater counter-clockwise moment to balance the increased clockwise moment for the same perpendicular distance of the force about the pivot. [A1]

Comments

Students need to explain that the moment of weight of beam remains the same. Also, students should state clearly that the perpendicular distance of the force in the bar remains the same too. Students who explained the increase in the force using summation of force is not accepted. This explanation does not take into account the force acting at the pivot.

4 (a)

Magnetic force on wire F = BIL

Force per unit length $F/L = BI = (5.2 \times 10^{-2})(7.5)$ [M1]

$= 0.39$ N m^{-1} [A1]

Using FLHR, direction of magnetic force on wire is downwards.

Comments

Well done.

[B1]

4 (b)

force on wire is equal to the total force on the free electrons,

BIL = N (Force on 1 electron)

(Number of electrons = number per unit volume × cross sectional area × length)

BIL = (N/V)(AL)(Force on 1 electron)

BI = (7.8 × 10^{28})(1.5 × 10^{-9})(force on 1 electron)

= 1.17 × 10^{23}(force on 1 electron) *[M1]*

Force on 1 electron = 0.39/1.17 × 10^{23} *[M1]*

= 3.3 × 10^{-24} N *[A1]*

Comments

Poorly done with a lot of students not careful with the units conversion or not aware that unit conversion is required.

5 (a)(i)

When E_{max} = 0,

$$hc\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)=0$$ *[M1]*

$\lambda = \lambda_0$

From Fig 5.1, when E_{max} = 0,

$$\frac{1}{\lambda}=2.30\times10^6$$ *[M1]*

λ = 4.34 × 10^{-7} m *[A1]*

i.e. λ_0 = 4.34 × 10^{-7} m

Comments

Poorly attempted. Only a handful was able to use the correct approach for this question. However many read off the corresponding x-intercept for E_{max} = 0 wrongly as they did not realise that the graph did not intersect the x-axis.

5 (a)(ii)

Using points (3.80 × 10^6, 3.0 × 10^{-19}) and (2.30 × 10^6, 0) to find gradient of graph

Gradient of graph = hc *[M1]*

$$\frac{(3.0\times10^{-19}-0)}{(3.8\times10^6-2.3\times10^6)}=hc$$

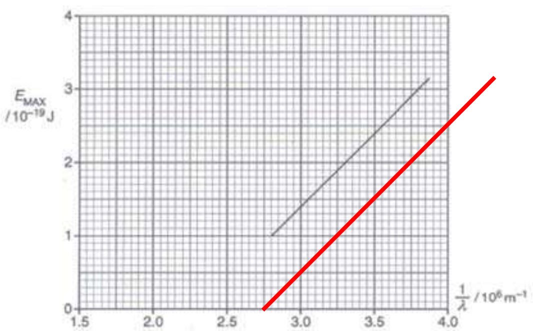
$$3.0\times10^{-19}=h\times3.0\times10^8\left(3.80\times10^6-2.30\times10^6\right)$$ *[M1]*

h = 6.7 × 10^{-34} J s *[A0]*

Comments

Fairly well done by those who attempted this question. Most could recognise that the gradient of the graph gives *hc*.

5 (b)



The new line should be a straight line having the ***same gradient but a larger x-intercept****.* *[A1]*

Comments

Fairly well done. Only a handful did not realise that the new graph will have the same gradient since gradient gives *hc*, which is a constant.

SECTION B

6 (a)

The total momentum of a system (of colliding particles) remains constant *[M1]*

Provided there is no resultant external force acting on the system/ isolated or closed system *[A1]*

Comments

Students should note that the conservation law does not only apply to collisions. The law can be applied when a system undergoes decay or explosion. Students should spend time to memorise the law.

6 (b)(i)

A head-on collision is when the particles move along the same linear direction after the collision. *[B1]*

Comments

Most students were not aware of the meaning of "head-on".

6 (b)(ii)

As the collision is elastic, the total kinetic energy of the spheres must be conserved. *[B1]*

Hence, the loss of kinetic energy of the incoming sphere goes to the gain of kinetic energy of the bombarded sphere. *[B1]*

Comments

Several students did not realise that since the collision is elastic, there is no loss of energy to other forms of energy. The total KE remains constant and the loss of KE of the incident sphere is transferred to the other sphere.

6 (b)(iii)

Kinetic energy of sphere = ½ mv^2 = 1.64 $\times 10^{-13}$ J *[M1]*

From graph, for $\frac{u_2}{u} = 0.400$,

$\frac{W}{E} = 0.855$ [M1]

$\frac{W}{1.64 \times 10^{-13}} = 0.855$

energy loss, $W = 1.40 \times 10^{-13}$ J (to 3 s.f) [A1]

Comments

Students need to read the graph to half a small square. One mark is penalised for reading the value to be 0.85 or 0.86.

Generally poorly done.

6 (b)(iv)1.

Since the second sphere is at rest $u_2 = 0$,

$u_2/u = 0$,

From graph, W/E = 1 *[A1]*

Comments

This part is poorly done. Students need to understand the question and how to use the graph to help them solve a problem.

6 (b)(iv)2.

The first sphere will come to rest [B1] and the second sphere will move off speed u. [B1]

Comments

This part is poorly done, primarily because students faced difficulties in (iv)2.

6 (b)(v)

The graph can be used on the ground that the proton and neutron have the same mass.

The protons in the paraffin wax have very low initial velocities compared to the fast-moving neutrons, hence the ratio $\frac{u_2}{u}$ is small. *[B1]*

From the graph, the $\frac{W}{E}$ ratio will be high, meaning the neutrons would lose most or all of its kinetic energy during collision. [B1]

Comments

Students do not understand the meaning of "high number density" which simply means that there is a large number of protons per unit volume in paraffin wax. Also, student failed to recognise that given the masses of protons and neutrons to be the same, they could use the graphs

The incoming neutrons will be absorbed or stopped at its tracks by the paraffin wax. [B1]

and part (iv) to respond to this question.

6 (c)(i)

Total momentum = $p_A + p_B$

$= 1.67 \times 10^{-27} \times 500 + 0$

$= 8.35 \times 10^{-25}$ N s [A1]

Comments

Mostly well done. Several students showed clearly that the momentum of particle B is zero.

6 (c)(ii)

1. $mv_A\cos60^\circ + mv_B\cos30^\circ$ [A1]
2. $mv_A\sin60^\circ + mv_B\sin30^\circ$ [A1]

Comments

Students showed understanding that they need to resolve the momentum into two components.

6 (c)(iii)

$500m = mv_A\cos60^\circ + mv_B\cos30^\circ$ [C1]

And

$0 = mv_A\sin60^\circ + mv_B\sin30^\circ$ [C1]

Or using a vector triangle

$v_A = 250$ m s^{-1}

$v_B = 430$ m s^{-1} [A1]

Comments

Not well done. Only a few students could make sense of the conservation of linear momentum in the x and y-directions.

7 (a)(i)

Given that it is a sound wave, its particle vibrates in the direction as the wave propagation, thus it cannot be polarised [B1]

Comments

Well done.

7 (a)(ii)

2 full cycles are found between X and Z

This means that the wavelength $\lambda = 5.2 / 2 = 2.6$ m

Since $v = f\lambda = 128 \times 2.6 = 333$ m s^{-1} [A1]

Comments

Some students were not mindful about when determining the wavelength.

7 (a)(iii)

Between a rarefaction and compression, half a wave is found.

Hence, phase difference = $\phi = 2\pi \dfrac{0.5\lambda}{\lambda} = \pi$ rad [A1]

Comments

Well done.

7 (a)(iv)

Intensity of wave at position of microphone

$= P / 4\pi x^2$

$= 0.72/[4\pi(5.0)^2]$

$= 2.29 \times 10^{-3}$ W m^{-2} [M1]

Power picked up by microphone

$= I \times A = (2.29 \times 10^{-3}) \times [\pi(0.02)^2]$ [M1]

$= 2.9 \times 10^{-6}$ W [A1]

Comments

Poorly done with several students not knowing how to link the quantities involved.

7 (b)(i)

Connect the microphone to a C.R.O [B1]

Comments

Poorly done. For those student who noticed the use of C.R.O, the description of how to capture the period was not elaborated.

Set the time base of the C.R.O such that a full wave can be registered and the period will be the time taken for one full wave form. [B1]

7 (b)(ii)

The waves generated by the sources have a phase difference that remains constant with time. [B1]

This can be achieved by connecting the two loudspeakers to the same sound source/ signal generator, producing waves that are in phase.
OR
two constant sound sources of the same frequencies. [B1]

Comments

Students were able to state correctly what is coherent. But not many were able to obtain the second mark.

7 (b)(iii)

The sound waves from the two sources undergo interference. The path difference ($S_1P - S_2P$) and the phase difference at P is altering as S_1 moves. [B1]

Since the two sources are in phase, the waves meet in phase at P when the path difference between the sources is an integral multiple of wavelengths; constructive interference at P results in maximum intensity. [B1]

The waves meet in anti-phase at P when the path difference is an odd integral multiple of half wavelengths; destructive interference at P results in minimum intensity. [B1]

Comments

Most students can bring in the idea of path difference but not able to further explain using the concept.

7 (b)(iv)

path difference = $S_1X = \lambda/2$

$\lambda = 0.164$ m; [A1]

Comments

well done.

7 (b)(v)1.

S_1X = one wavelength = 0.082 m;

$v = f\lambda = 4100 \times 0.082$ [M1]

$= 336 \text{ m s}^{-1}$ OR 340 m s^{-1}; [A1]

Comments

Many students were not able to identify the magnitude of wavelength.

7 (b)(v)2.

As S_1 is moved further away, the intensity at P due to S_1 decreases as intensity is inversely proportional to the square of the distance from the source. The wave amplitude at P due to S_1 also decreases since intensity is proportional to $(\text{amplitude})^2$. [B1]

During constructive interference at P, the resultant amplitude, and thus the resultant maximum intensity when S_1 is at point X is smaller than that when S_1 is at its original position. [B1]

Comments

Many students argue that the one is CI while the other is a DI, without understanding the question.

7 (b)(vi)

During maxima, the resultant amplitude will the maximum vector sum of the amplitude of the 2 waves, while during

Comments

Some students were able to identify the change in the amplitude but not

minima, the resultant amplitude will be the minimum vector sum of the two amplitude. [B1]
Thus in order to have the biggest contrast between these two vector sums, their amplitude have to be approximately the same. [B1]

the significant and the contrast between the two amplitudes.

8 (a)(i)1.
When R = 1.0 Ω, P_R = 9.0 W.
$P_R = I_R^2 R$
$9.0 = I_R^2 \times 1.0$ [C1]
$I_R = 3.0$ A
Since R is connected in series with battery, the current I_E in the circuit is the same as that in the resistor [M1]
i.e. $I_{circuit} = 3.0$ A [A0]

Comments
Most did not realise the question is asking for current in the circuit, rather than current in the resistor. An explicit relationship between the two variables is expected to be stated.

8 (a)(i)2.
When R = 1.0 Ω, P_T = 27.0 W
$P_T = I_E E$
$27.0 = 3.0 \times E$ [C1]
$E = 9.00$ V [A1]

Comments
Some wrongly use 1.0 Ω as the total resistance of the circuit while others have no idea how (a)(i)1. is linked to 2. Those who manage to solve it may have forgotten about the s.f rule.

8 (a)(ii)1.
$(P_T - P_R)$ represents the power dissipated in the internal resistance of the battery. [B1]

Comments
About half got it correct. But students should be explicit in stating both the object (internal resistance of battery).

8 (a)(ii)2.
Since the internal resistance is connected in series with the battery, the current flowing through it is the same as that of the battery.
$(P_T - P_R) = I_r^2 r$
$27.0 - 9.0 = 3.0^2 \times r$ [C1]
$r = 2.00$ Ω [A1]

Comments
For those who did not know the significance of (P_T - P_R), they usually do not know how to solve the next part. Those who manage to solve it may have forgotten about the s.f rule.

8 (a)(iii)1.
When P_R is maximum, R = 2.00 Ω. [B1]

Comments
Generally well done.

8 (a)(iii)2.

$$\text{Efficiency} = \frac{\text{Power Output}}{\text{Power Input}} \times 100\%$$

$$\text{Efficiency} = \frac{10.0}{20.0} \times 100\% = 50\%$$ [B1]

Comments
Generally well done.

8 (a)(iii)3.
The increase in resistance from 4 Ω to 10 Ω increases the efficiency of the power transfer. [B1]

Comments
There are some amount of guessing in this question.

8 (b)(i)1.

Comments

Resistance is the ratio of voltage to current. Since the increase in current is proportionally greater than the increase in voltage [M1], the resistance of component C decreases with increasing potential difference [A0].

Student needs to understand that resistance is not related to the gradient of the I-V graph. Explanation needs to be highlighted the extent of increase in both current and voltage.

8 (b)(i)2.

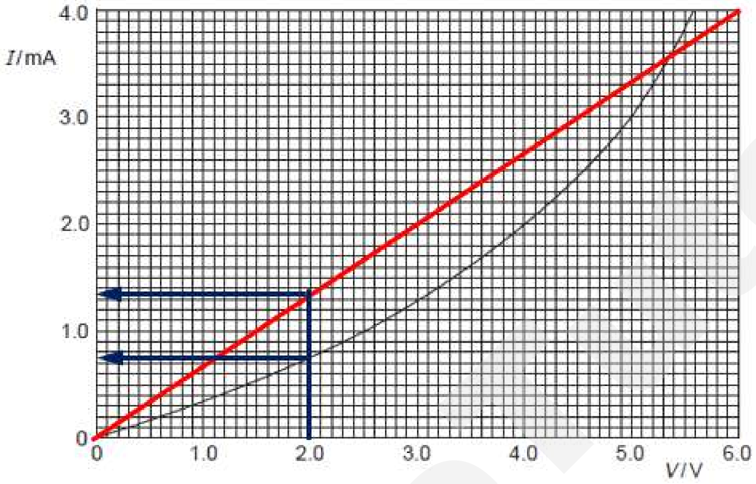
$R = \frac{V}{I} = \frac{4.0}{2.00\times10^{-3}}$ [C1]

$= 2000\ \Omega$ [A1]

Comments

Most common error is that the unit of current is mA not A.

8 (b)(ii)1.



Straight line from origin [M1]

and passing through (6.0 V, 4.0 mA) [A1]

Comments

Surprisingly, a significant majority did not draw the I-V graph of a fixed resistor. For those who draw a straight line through origin needs to be more careful how to depict a resistance of 1500 Ω.

8 (b)(ii)2.

From Fig. 8.3, when e.m.f. F = 2.0 V,

$I_c = 0.75$ mA and $I_X = 1.35$ mA [C1]

Since component C and resistor X is connected in parallel to battery,

$I_{battery} = I_C + I_X$

$I_{battery} = 0.75 + 1.35 = 2.1$ mA [A1]

(Allow argument in terms of $P = I^2R$ or IV)

Comments

Many did not fully understand that the current of the circuit consists of both the current in C and X in a parallel circuit. Potential divider should not be used in this solution. Students need to be careful in the reading of coordinates.

8 (b)(iii)

Since resistor X and component C are connected in series, the current in X and C is the same. [B1]

From Fig. 8.4, the p.d. across C is larger than that across X when the e.m.f. is 7.0 V. [M1]

Since P = IV, component C dissipate thermal energy at a greater rate. [A1]

Comments

Comparison of the rate of thermal dissipation requires comparison of the voltage, current and resistance of the component. Such information should be obtained from the graph, especially understanding that X and C are connected in series.

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2017

Name		Class	17S

PHYSICS **8866/01**

Higher 1

Multiple Choice **15 Sep 2017**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your **name** and **class** in the spaces provided at the top of this page.

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

(This question paper consists of 16 printed pages)

Data

speed of light in free space, $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$

elementary charge, $e = 1.60 \times 10^{-19}\ \text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\ \text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\ \text{kg}$

rest mass of electron, $m_{\text{e}} = 9.11 \times 10^{-31}\ \text{kg}$

rest mass of proton, $m_{\text{p}} = 1.67 \times 10^{-27}\ \text{kg}$

acceleration of free fall, $g = 9.81\ \text{m s}^{-2}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^{2}$

$v^{2} = u^{2} + 2as$

work done on/by a gas, $W = p\,\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

1 What is a realistic estimate of the magnitude of the average momentum of an Olympic 100 m sprinter?

A 10 N s

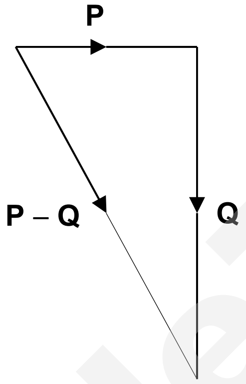
B 70 N s

C 700 N s

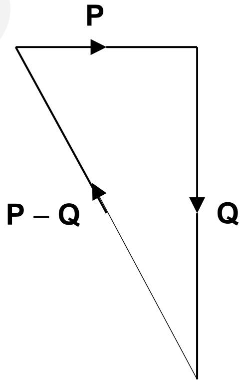
D 3000 N s

2 Which vector triangle shows the resultant of the vector subtraction **P** – **Q**?

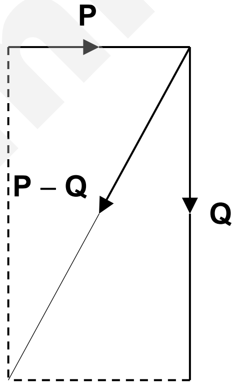
A



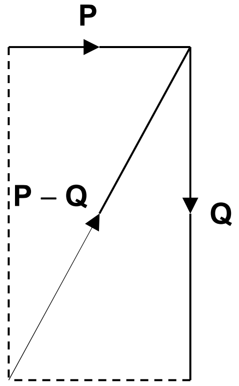
B



C



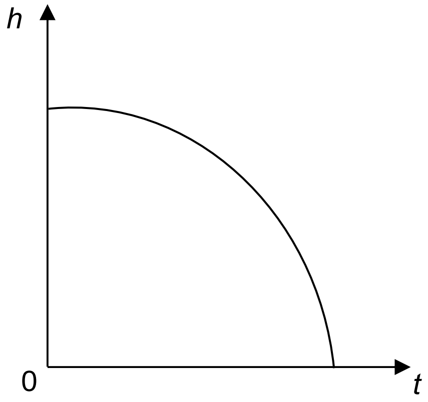
D



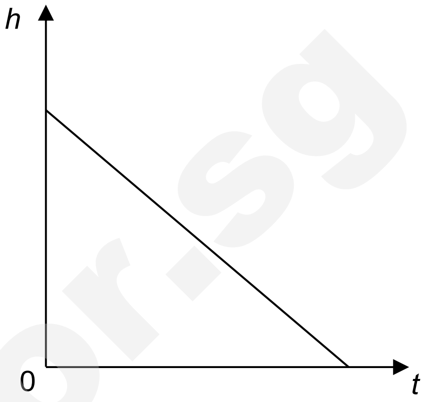
3 A small steel ball falls towards the ground after being released from rest.

Which graph best represents the variation with time *t* of the height *h* of the ball measured from the ground?

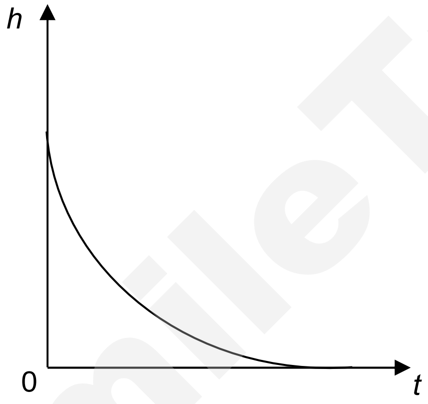
A



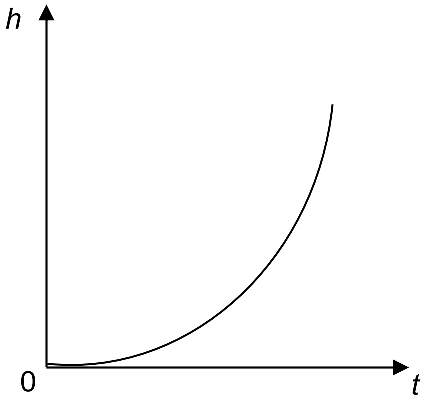
B



C



D



4 A crew of an oil tanker spotted an iceberg in its path and immediately sounded the alarm. At the time when the engine of the oil tanker was driven to slow it down, the oil tanker was moving at 10 m s^{-1}, the iceberg was 800 m away and moving at 0.5 m s^{-1} in the same direction as the oil tanker. The oil tanker managed to stop just 20 m from the iceberg.

Determine the average deceleration of the oil tanker.

A 0.055 m s^{-2}

B 0.058 m s^{-2}

C 0.067 m s^{-2}

D 0.071 m s^{-2}

5 A golfer hits a golf ball on a flat golf course. The golf ball reaches a maximum height of 23 m.

Determine the time of flight of the golf ball.

A 2.2 s

B 4.3 s

C 4.7 s

D 9.4 s

6 A 4.0 kg food parcel attached to a parachute descends at a constant velocity of 2.0 m s^{-1}. You may take the acceleration of free fall as 10 m s^{-2}.

What is the resultant force acting on the parcel?

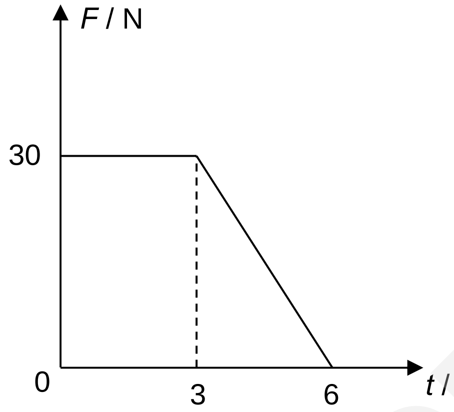
A 0 N

B 8 N

C 20 N

D 40 N

7 An object of mass 20 kg moves along a straight line on a smooth horizontal surface. A force F acts on the object in its direction of motion. The variation with time t of force F is shown below.



What is the velocity of the object at t = 6 s if its velocity at t = 4 s is 4.5 m s^{-1}?

A 3.5 m s^{-1}

B 5.5 m s^{-1}

C 6.8 m s^{-1}

D 11 m s^{-1}

8 Rubber bullets, each of mass m, are fired at the rate of n bullets per second on a vertical wall. The speed of each bullet is u and they rebound from the wall with the same speed.

Determine the average force exerted on the wall.

A mnu

B $2mnu$

C $mnug$

D $2mnug$

9 An object of mass *m* is hanging on a string from the roof of a lift. The lift is moving upwards, but slowing down.

The tension in the string is

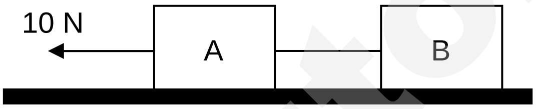
A zero.

B less than *mg*.

C equal to *mg*.

D more than *mg*.

10 Blocks A and B have the same mass but different roughness. When block A is pulled with a force of 10 N, blocks A and B experience frictional forces of 4 N and 2 N respectively.



What is the tension in the rope joining blocks A and B?

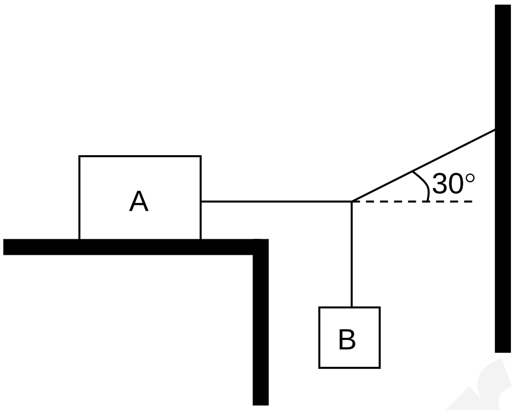
A 2 N

B 4 N

C 6 N

D 8 N

11 Inextensible strings hold blocks A and B in equilibrium as shown in the diagram. The friction between block A and the rough horizontal surface is 1.8 N.



Determine the weight of block B.

A 0.90 N

B 1.0 N

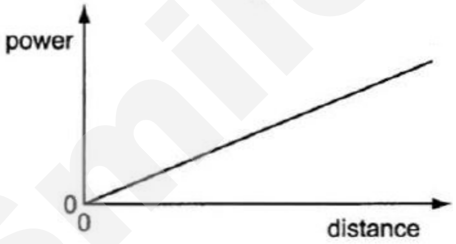
C 1.6 N

D 3.1 N

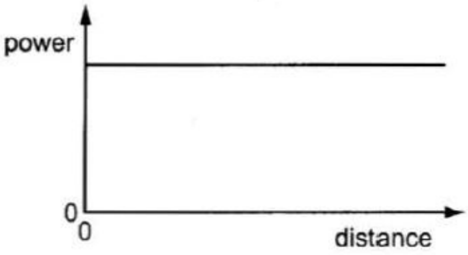
12 A vehicle starts from rest and accelerates uniformly.

Which graph shows how the power output of the vehicle varies with distance travelled?

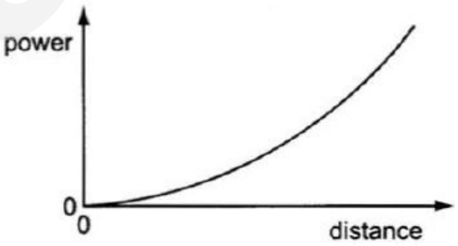
A



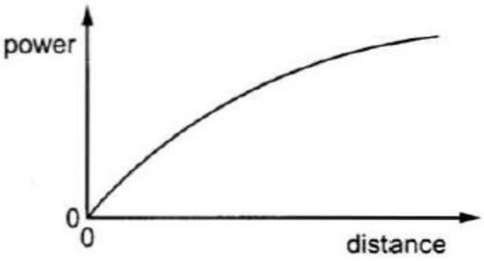
B



C



D



13 A small metal sphere of mass *m* moves through a viscous liquid.

When it reaches a constant downward velocity *v*, which of the following describes the changes with time in the kinetic energy and gravitational potential energy of the sphere?

	change in kinetic energy	gravitational potential energy
A	$\frac{1}{2}mv^2$	decreases at a rate of mgv
B	$\frac{1}{2}mv^2$	decreases at a rate of $(mgv - \frac{1}{2}mv^2)$
C	zero	decreases at a rate of $(\frac{1}{2}mv^2 - mgv)$
D	zero	decreases at a rate of mgv

14 Which does not involve work being done by a force?

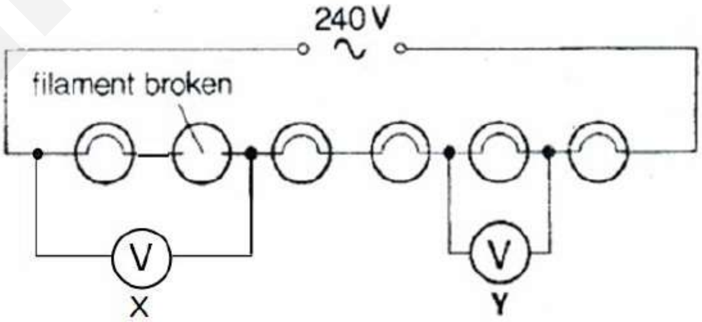
A the release of compressed air from a cylinder into the atmosphere

B the charging of a car battery

C the motion of a spacecraft in deep space

D a bicycle free-wheeling downhill at constant speed

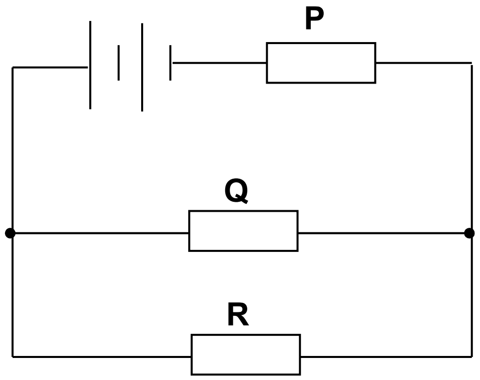
15 A mains circuit contains six similar bulbs connected in series. One of the bulbs has a broken filament. Voltmeters X and Y of infinite resistance are placed in the circuit shown below.



Which of the following voltmeter readings is correct?

	X	Y
A	0 V	0 V
B	0 V	240 V
C	240 V	240 V
D	240 V	0 V

16 The resistors **P**, **Q** and **R** in the circuit shown below have equal resistance.



The battery, of negligible internal resistance, supplies a total power of 12 W.

What is the power dissipated in resistor **R**?

A 2.0 W **B** 3.0 W **C** 4.0 W **D** 6.0 W

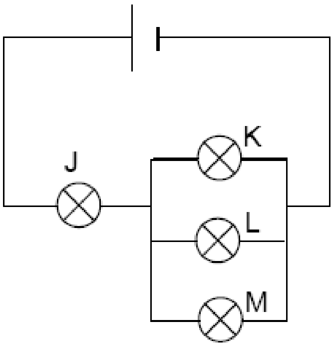
17 In an electrostatic machine, a belt of width *w*, having surface charge density ρ, travels with velocity *v*. As the belt passes a certain point, all the charge is removed and is carried away as an electric current.

What is the magnitude of this current?

A ρwv **B** ρwv^2 **C** $\frac{\rho w}{v}$ **D** $\frac{\rho v}{w}$

18 The diagram below shows four identical lamps J, K, L and M which are all lit.

Lamp K is then removed from the circuit.



Which of the following statements is correct?

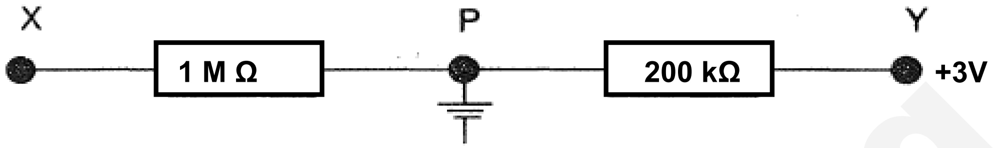
A J, L and M are equally bright.

B J is brighter than before but not as bright as L and M.

C J is less bright than before and not as bright as L and M.

D J is less bright than before but brighter than L and M.

19 Two electrical conductors, of 1 MΩ and 200 kΩ respectively, form a potential divider. Junction Y is maintained at +3 V and junction P is earthed as shown.

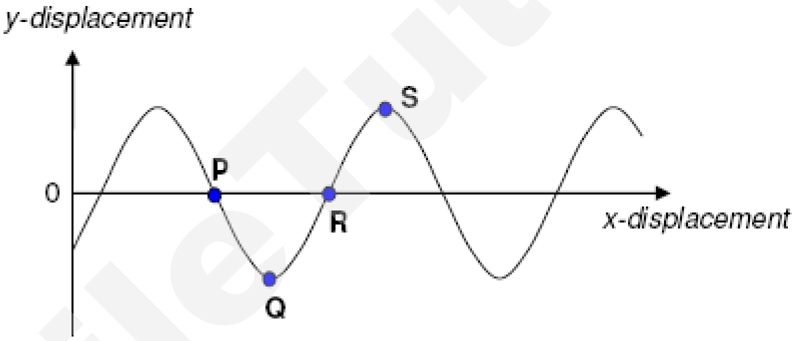


What is the potential at the other junction X?

A +15 V **B** +12 V **C** -12 V **D** -15 V

20 The graph below shows the profile of a progressive transverse wave at a particular instant of time. The waveform progress from left to right.

The particles **P**, **Q**, **R** and **S** all oscillate with uniform amplitude.



Which one of the following statements is correct?

A Particles P and R have zero kinetic energy.

B Particle P will move to the right after a while.

C Particles P and R are in anti-phase to each other.

D Particle S has the highest total energy.

21 A warning siren on top of a tall pole is taken to be a point source and radiates sound waves uniformly in all directions. At a distance 4*d*, the amplitude of the wave is *A*.

What is the distance from the siren at the point where the amplitude of the wave is 2*A*?

A 8*d* **B** 4*d* **C** 2*d* **D** *d*

22 A stationary sound wave has a series of nodes. The distance between the first and fourth node is 15.0 cm.

What is the wavelength of the sound wave?

A 4.0 cm

B 5.0 cm

C 10.0 cm

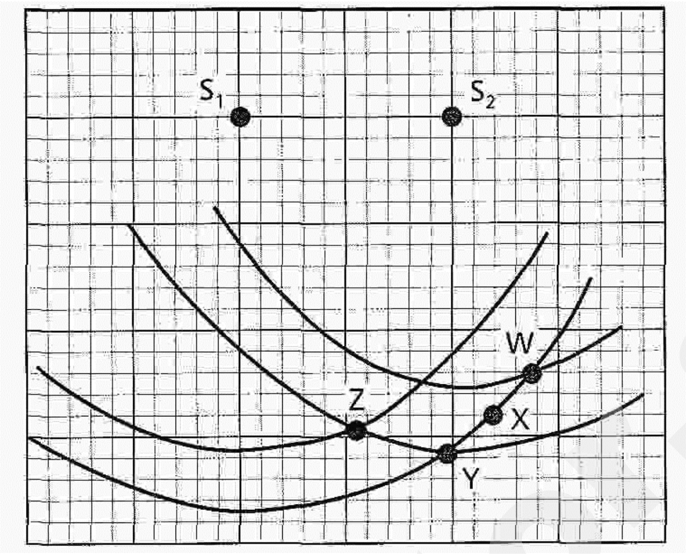
D 13.3 cm

23 A stationary sound wave was set up in a closed pipe, one end closed, but the other end open.

Which of the following row correctly describes the physical changes for the displacements of the air particles and the air pressure at the open and closed end of the pipe?

	Open end	**Closed end**
A	Displacement antinode, Pressure node	Displacement node, Pressure antinode
B	Displacement node, Pressure antinode	Displacement antinode, Pressure node
C	Displacement antinode, Pressure antinode	Displacement node, Pressure node
D	Displacement node, Pressure node	Displacement antinode, Pressure antinode

24 S_1 and S_2 are two identical sources of waves that are in phase. The instantaneous positions of two wave crests from each source are shown below.



Which of the following is true?

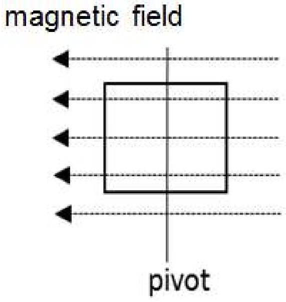
A X is a point of constructive interference.

B W is a point of destructive interference.

C $S_1Y - S_2Y = n\lambda$ where n is an integer.

D $S_1Z - S_2Z = (2n - 1)\dfrac{\lambda}{2}$ where n is an integer.

25 A 20-turns square coil of side 8.0 mm is pivoted at its centre and placed in a magnetic field of flux density 0.010 T. The two sides of the coil are parallel to the field and two sides of the coil are perpendicular to the field as shown below. A current of 5.0 mA is passed through the coil.



What is the magnitude of the torque acting on the square coil?

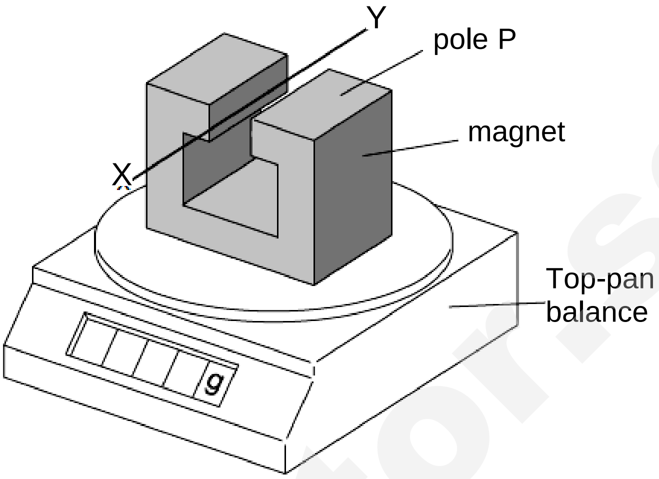
A 1.6×10^{-9} N m

B 3.2×10^{-8} N m

C 6.4×10^{-8} N m

D 3.2×10^{-5} N m

26 A large horseshoe magnet produces a uniform magnetic field of flux density *B* between its poles. The magnet is placed on a top-pan balance and a wire XY is situated between its poles, as shown in the figure below.

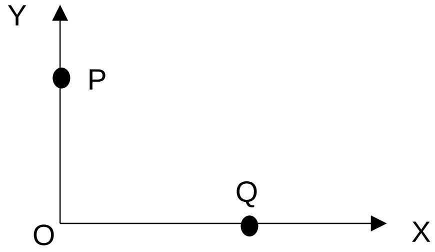


The wire XY is placed perpendicular to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y. The reading on the top-pan balance increases by 2.3 g.

What is the polarity of pole P of the magnet and the magnitude of the flux density between the poles?

	polarity of P	flux density / T
A	north	0.020
B	north	0.20
C	south	0.20
D	south	200

27 The diagram shows a flat surface with lines OX and OY at right angles to each other.
``



Which current in a straight conductor will produce a magnetic field at O in the direction of OY?

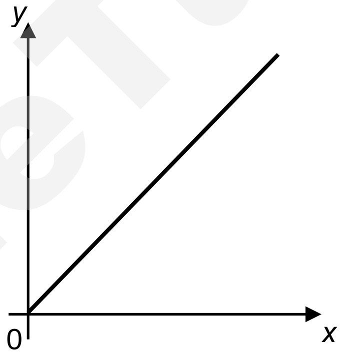
A at P into the plane of the diagram

B at P out of the plane of the diagram

C at Q out of the plane of the diagram

D at Q into the plane of the diagram

28 In a photoelectric emission experiment on a certain metal surface, two quantities, when plotted as a graph of *y* against *x*, give a straight line passing through the origin.



Which of the following correctly identifies *x* and *y* with the photoelectric quantities?

	x	*y*
A	photocurrent	threshold frequency
B	light intensity	maximum kinetic energy of photoelectrons
C	light intensity	photocurrent
D	frequency of incident light	maximum kinetic energy of photoelectrons

29 If the de Broglie waves associated with each of the following particles are to have the same wavelength, which particle must have the smallest velocity?

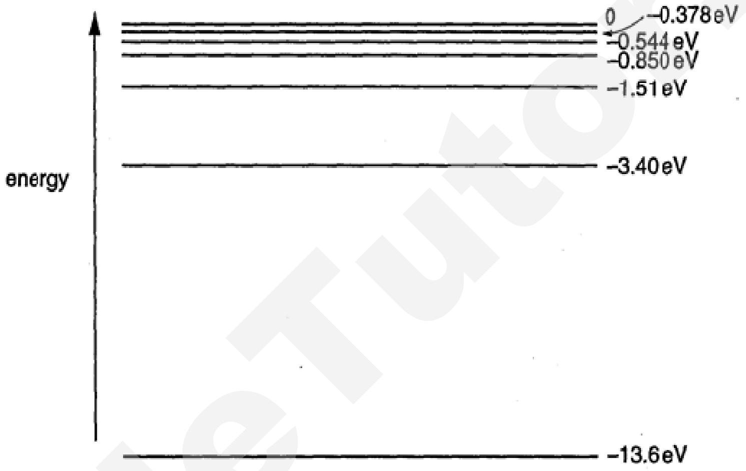
A proton

B electron

C neutron

D alpha particle (helium nucleus containing 2 neutrons and 2 protons)

30 Some of the energy levels in atomic hydrogen are shown in the figure below.



Electrons having kinetic energy of 13.00 eV are incident on a sample of cold hydrogen gas.

Assume that the photon energies corresponding to wavelengths within the visible light spectrum are between 1.78 eV and 3.11 eV.

What is the maximum number of visible spectral lines that can be observed from the emission spectrum of the gas?

A zero **B** 2 **C** 3 **D** 6

End of paper

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2017 JC2 Preliminary Examination
8866 H1 Physics Paper 1 Solutions

Qn	Ans	Suggested solution
1	**C**	The speed of Olympic sprinter is estimated to be 10 m s^{-1}. The mass of Olympic sprinter is estimated to be 70 kg. Therefore the magnitude of the momentum of Olympic sprinter is estimated to be (70)(10) = 700 N s.
2	**D**	**A** shows **P + Q**, **B** shows – **P** – **Q**, **C** shows **Q** – **P**.
3	**A**	Initial speed is zero, meaning zero gradient at $t = 0$ (**A** or **D**) The ball gains speed as it falls so value of gradient increases with time (**A** or **D**). The height measured from the ground decreases with time (**A**).
4	**B**	Let the time taken for the oil tanker to stop be t. $800 + 0.5t - 0.5(10)t = 10 \Rightarrow t = 173.333$ s Deceleration = $\dfrac{10}{173.333} = 0.058 \text{ m s}^{-2}$
5	**B**	Consider only the vertical components for motion of the golf ball from the ground to the maximum height. $\left[v^2 = u^2 + 2as\right] 0 = u^2 + 2(-9.81)(23) \Rightarrow u = 21.24 \text{ m s}^{-1}$ $\left[v = u + at\right] 0 = 21.24 + (-9.81)(t) \Rightarrow t = 2.165 \text{ s}$ Time of flight = (2)(2.165) = 4.33 s.
6	**A**	Constant velocity motion means zero acceleration therefore zero resultant force.
7	**B**	At $t = 4$ s, $F = 20$ N. Impulse Δp = area under the graph from $t = 4$ s to $t = 6$ s = $\frac{1}{2}(2)(20) = 20$ N s [$\Delta p = m\Delta v$] 20 = 20(Δv) ⇒ $\Delta v = 1.0$ m s^{-1} Final velocity $v_f = v_i + \Delta v = 4.5 + 1.0 = 5.5$ m s^{-1}
8	**B**	In one second, mass of bullets hitting the wall = mn momentum of bullets hitting the wall = mnu change in momentum of bullets = $2mnu$ = momentum imparted to wall = force on wall
9	**B**	The lift is moving upwards, but slowing down, so the acceleration is downwards. $mg - T = ma \Rightarrow T = mg - ma \Rightarrow T < mg$
10	**B**	Both objects have the same mass and experience the same acceleration. Object A: $10 - 4 - T = ma \Rightarrow 6 - T = ma$ Object B: $T - 2 = ma$ Solving simultaneously, $T = 4$ N
11	**B**	Horizontal component of tension in string balances static friction: $T\cos 30° = 1.8$ Vertical component of tension in string balances weight of block B: $T\sin 30° = W_B$ $\tan 30° = \dfrac{W_B}{1.8} \Rightarrow W_B = (1.8)(\tan 30°) = 1.04$ N
12	**D**	Power output = Fv where F is constant since a is uniform. Using $v^2 = u^2 + 2as$ and since $u = 0$, $v = \sqrt{2as}$ Therefore $P \propto \sqrt{s}$

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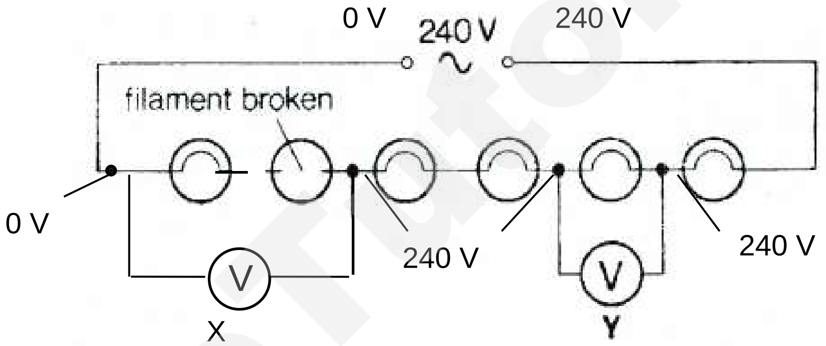
Qn	Ans	Suggested solution
13	**D**	Since the sphere reaches a constant velocity, the kinetic energy must be constant. Hence the change in kinetic energy is zero. The gravitational potential energy is given by $E_P = mgh$ where *h* is the vertical height. Since the sphere is falling at velocity *v*, $h = h_0 - vt$ where h_0 is the initial height and is a constant. $E_P = mg(h_0 - vt) \quad \Rightarrow \quad \frac{dE_P}{dt} = -mgv$ Hence the gravitational potential energy decreases (as indicated by the negative sign) at a rate of *mgv*.
14	**C**	A - work done in expanding gas against atmospheric pressure B - work done results in change of energy from electrical to chemical C - no force involved, so no work done D - work done by component of weight leads to increase in kinetic energy.
15	**D**	 Using the potential method, assuming arbituary potential.
16	**A**	The current passing through Q and R is half of the current passing through P. Using *P*= I^2R, the power of Q and R should ¼ of P, thus the power of Q and R should be 2 W.
17	**A**	$I = \frac{Q}{t} = \frac{\rho ws}{t} = \rho wv$
		DC
18	**D**	When K is removed, the effective resistance of the lamps in parallel is higher, thus the p.d. across J will be lower, but the p.d. across J will be higher than the p.d across L and M.
19	**D**	p.d across XY= $\frac{3}{200 \times 10^3} \times 1.2 \times 10^6 = 18V$ Since potential of X is lower, thus the potential at X should be 3-18 = -15 V
20	**C**	A: Both particles have the highest KE at the equilibrium position. B: The particles moves up and down, not left or right. D: All the particles have the same total energy at all times.
21	**C**	$I \alpha \frac{1}{r^2}$ $I \alpha A^2$ Therefore $A \alpha \frac{1}{r}$ When the amplitude is doubled, the distance will be halved of the original.
22	**C**	Between 1st to 4th nodes is 1.5 wavelengths = 15 cm. Thus the wavelength is 10 cm.
23	**A**	A displacement node is a pressure anti-node and vice-versa.

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8866 H1 Physics Paper 1 Solutions

Qn	Ans	Suggested solution
24	**C**	Since S_1Y and S_2Y are $n_1\lambda$ and $n_2\lambda$, thus $S_1Y - S_2Y = n\lambda$ where n is an integer
25	**C**	$\tau = Fd$ $= 2F_B \frac{L}{2}$ $= NBIL \times L$ $= 20 \times 0.01 \times 5 \times 10^{-3} \times (8 \times 10^{-3})^2$ $= 6.4 \times 10^{-8}$ N m
26	**B**	Since balance reading increases, force on magnet/balance is downwards. By Newton's 3rd law, force on wire is upwards. Using Fleming's Left Hand Rule, pole P is a north pole. $F = BIL = mg$ $B \times 2.6 \times 4.4 \times 10^{-2} = 2.3 \times 10^{-3} \times 9.81$ $B = 0.20$ T
27	**D**	Using the Right Hand Grip Rule, only a current at Q into the plane of the diagram would produce a magnetic field at O in the direction of OY.
28	**C**	As light intensity increases, the rate of incidence of photons increases. As rate of incidence of photons is proportional to the rate of emission of photoelectrons, the photocurrent increases proportionally as well.
29	**D**	$p = mv = \frac{h}{\lambda} \Rightarrow v = \frac{h}{mv}$ Hence, the most massive particle would have the smallest velocity.
30	**B**	Assuming range of wavelength for visible light to be 400 – 700 nm, the range of photon energies that would lead to visible spectral lines is about 1.8 – 3.1 eV. Since the gas is cold, the atom is at the ground state i.e. –13.6 eV level. Electrons of KE 13.00 eV would be able to excite it up to only the –0.850 eV level. From the –0.850 eV level, only the following transitions would lead to emission of photons with energies in the range of 1.8 – 3.1 eV. • from –0.850 eV to –3.40 eV level • from –1.51 eV to –3.40 eV level

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2017

Name		Class	17S

PHYSICS
8866/02

Higher 1

Structured Questions

25 August 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your **name** and **class** in the spaces provided at the top of this page.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

(This question paper consists of 23 printed pages)

Data

speed of light in free space, $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$

elementary charge, $e = 1.60 \times 10^{-19}\ \text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\ \text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\ \text{kg}$

rest mass of electron, $m_{\text{e}} = 9.11 \times 10^{-31}\ \text{kg}$

rest mass of proton, $m_{\text{p}} = 1.67 \times 10^{-27}\ \text{kg}$

acceleration of free fall, $g = 9.81\ \text{m s}^{-2}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\,\Delta V$

hydrostatic pressure, $p = \rho g h$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** questions in this section.

1 Fig. 1 shows an experimental setup used to measure the acceleration of free fall.

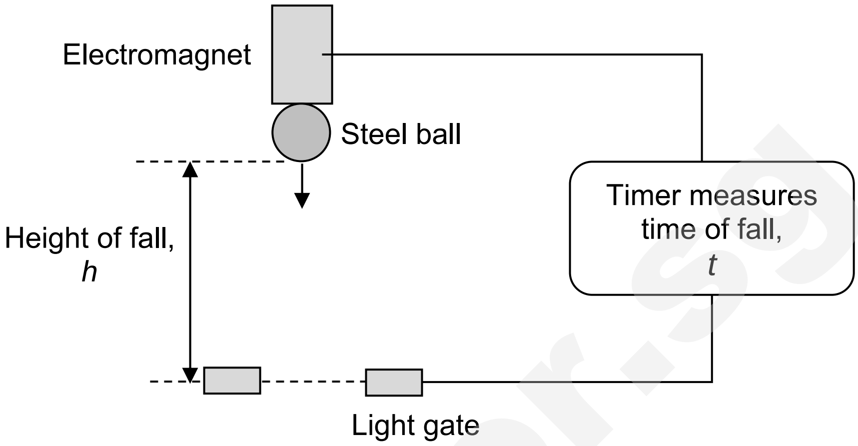


Fig. 1

The steel ball is suspended at the top by an electromagnet. The electronic timer starts when the electromagnet is turned off. As the steel ball falls by height h and goes through the light gate, the timer stops and displays the time of fall, t.

Only one set of data was collected:

$$h = (0.600 \pm 0.001) \text{ m}$$

$$t = (354 \pm 1) \text{ ms}$$

The acceleration of free fall is calculated to be 9.5758 m s^{-2}.

(a) Express the acceleration of free fall with its associated uncertainty.

acceleration of free fall = (±) m s^{-2} [2]

(b) It was later found out that when the electromagnet was turned off, there is some constant delay before the steel ball starts falling.

(i) Suggest a cause for this delay.

[1]

(ii) State and explain the type of error caused by this delay.

[2]

(iii) Suggest how this delay can be determined.

[2]

2 **(a)** Two objects, P and Q, of masses 1.5 kg and 0.30 kg respectively, are connected by a string that passes over a pulley as shown in Fig. 2.1. The pulley is frictionless and the string is inelastic. Object P rests on a horizontal hard surface.

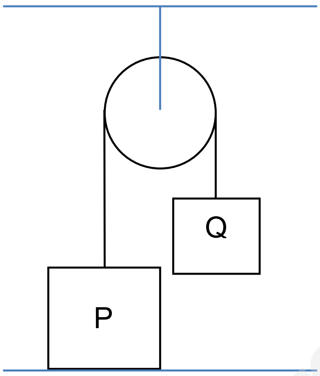
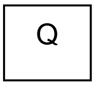


Fig. 2.1

(i) Draw the forces acting on objects P and Q. [3]



(ii) Show that the contact force between the horizontal hard surface and object P is 12 N. [2]

(b) The setup in **(a)** was modified such that object P rests horizontally on a spring as shown in Fig. 2.2. The spring is compressed by 2.0 cm.

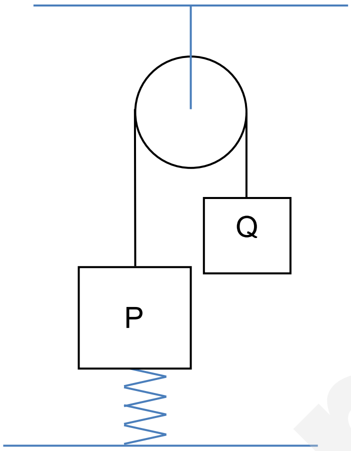


Fig. 2.2

(i) State *Hooke's law.*

....

....

.... [1]

(ii) Determine the force constant of the spring.

force constant of spring = ... N m^{-1} [1]

(iii) Determine the elastic potential energy stored in the spring.

elastic potential energy = ... J [2]

3 A drunk tourist at a ski resort drives his 1800 kg car up a snow-covered ski-jump at a constant speed of 60 km h^{-1} between points A and B as shown in Fig. 3.1. The ski-jump is inclined at an angle of 37.5° and points A and B are 77.2 m apart.

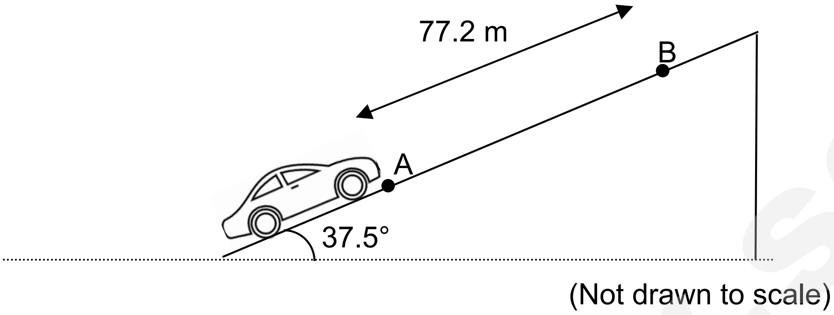


Fig. 3.1

(a) Define *power*.

[1]

(b) Determine the minimum power required for the car to perform the feat.

minimum power = ______________ kW [3]

(c) At point B, a braking mechanism enables the car to be held at that position when it is stationary. If the braking mechanism suddenly fails and the car slides down the ski jump, calculate its speed when it reaches point A.

speed = ______________ m s^{-1} [2]

4 Fig. 4.1 shows a wire frame ABCD supported on two knife-edges P and Q so that the section PBCQ of the frame lies within a solenoid. Side BC has a length of 5.0 cm and QC has a length of 12.0 cm.

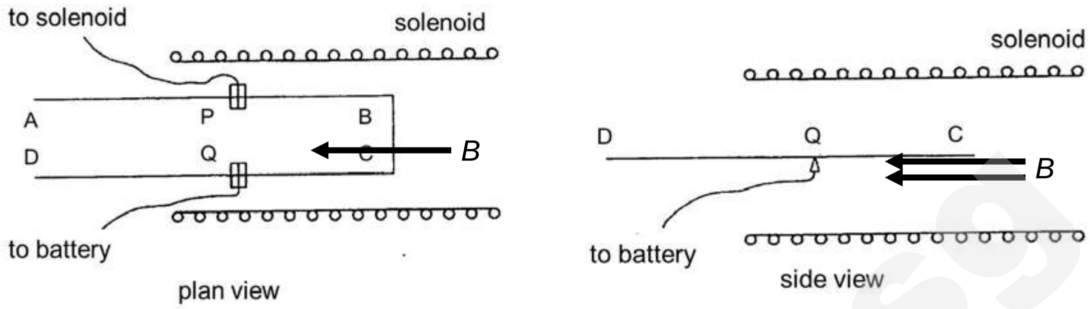


Fig. 4.1

Electrical connections are made to the frame through the knife-edges so that the part PBCQ of the frame and the solenoid can be connected in series with a battery. When there is no current in the circuit, the frame is horizontal.

(a) When the frame is horizontal and a current passes through both the frame and solenoid, the magnetic flux density *B* of the solenoid in the region of side BC of the frame is towards the left and the current flows from B to C.

State and explain the direction of the force, if any, due to the magnetic field of the solenoid acting on

(i) side BC, and

....

....

.... [2]

(i) side AB.

....

.... [1]

(b) **(i)** The solenoid has 700 turns m^{-1} and carries a current of 3.5 A.

The magnetic flux density B on the axis of a long solenoid is $B = \mu_0 n I$, where n is the number of turns of the coil per unit length.

Calculate the magnetic flux density in the region of side BC of the frame.

magnetic flux density = ... T [1]

(ii) Determine the force acting on BC due to the magnetic field in the solenoid.

force acting on BC = ………………… N [2]

(iii) A small piece of paper of mass 0.100 g is placed on the side DQ and positioned so as to keep the frame horizontal.

Determine the distance *d* from the knife-edge the paper must be positioned.

distance *d* = ………………… m [2]

(iv) The current through both the solenoid and frame is doubled.

State and explain the changes, if any, that must be made to the mass of the piece of paper in order to keep the frame horizontal.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

5 **(a)** With reference to the photoelectric effect, state what is meant by *work function* of a metal.

[1]

(b) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface and the maximum kinetic energy E_{max} of the emitted electrons. The variation with E_{max} of λ is shown in Fig. 5.1.

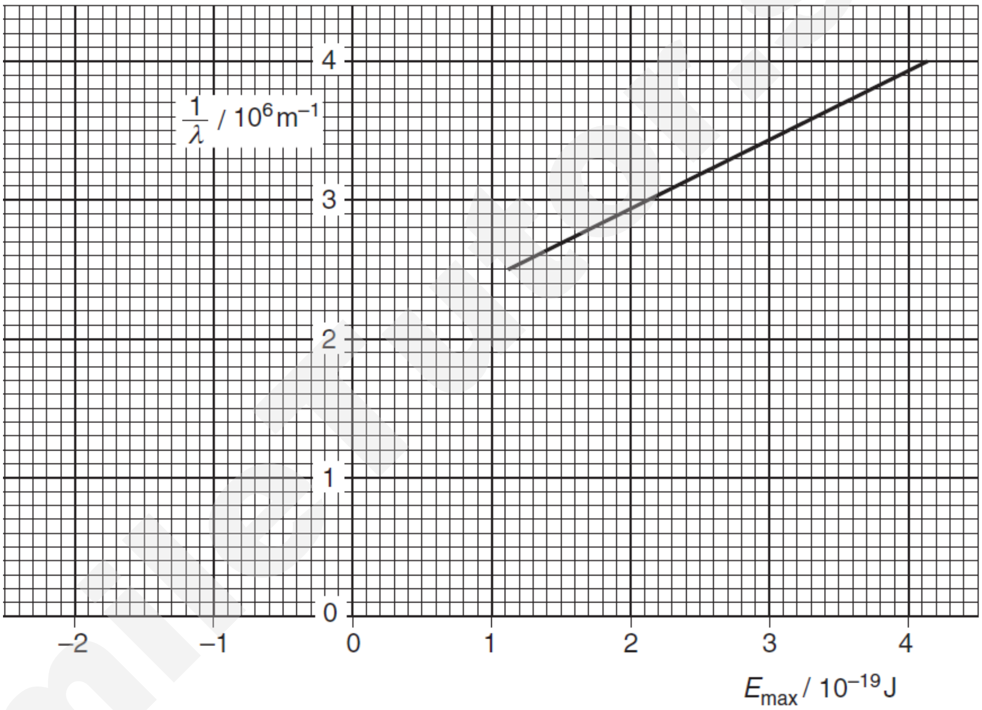


Fig. 5.1

(i) Einstein's photoelectric equation may be expressed as

$$\frac{hc}{\lambda} = E_{\text{max}} + \phi$$

where ϕ is the work function of the metal, h is the Planck constant and c is the speed of light.

Show that the threshold frequency f_0 of the metal is approximately 5.9×10^{14} Hz. [2]

(ii) On Fig. 5.1, sketch a second graph to represent the results for an experiment using a metal plate of higher work function. Label this graph **W**. [1]

(c) If the intensity of the light is increased while keeping the frequency constant, state and explain the effect, if any, on the

1. number of electrons emitted per unit time; and

[1]

2. the maximum kinetic energy of these emitted electrons.

[3]

Section B

Answer **two** questions from this section.

6 Fig. 6.1 shows a smooth table on which there are two objects A and B of masses 1.0 kg and 2.5 kg respectively. Object B is initially stationary. Object A is moving to the right towards object B and hits it at a speed of 5.0 m s^{-1}. The collision is elastic.

Fig. 6.1

(a) **(i)** State two characteristics unique to elastic collisions. [2]

1. ....

....

2. ....

....

(ii) Determine the final velocity of object A and show that the final velocity of object B is 2.9 m s^{-1} after the collision. [4]

final velocity of object A = ... m s^{-1}

(b) **(i)** Define *displacement*.

....

.... [1]

(ii) Define *acceleration*.

....

.... [1]

(c) After the collision, object B slides on the horizontal smooth table surface before falling off the edge of the table with a horizontal velocity of 2.9 m s^{-1}. Object B lands in the middle of a sand bath whose top surface is 0.70 m below the top surface of the table as shown in Fig. 6.2. Assume air resistance is negligible.

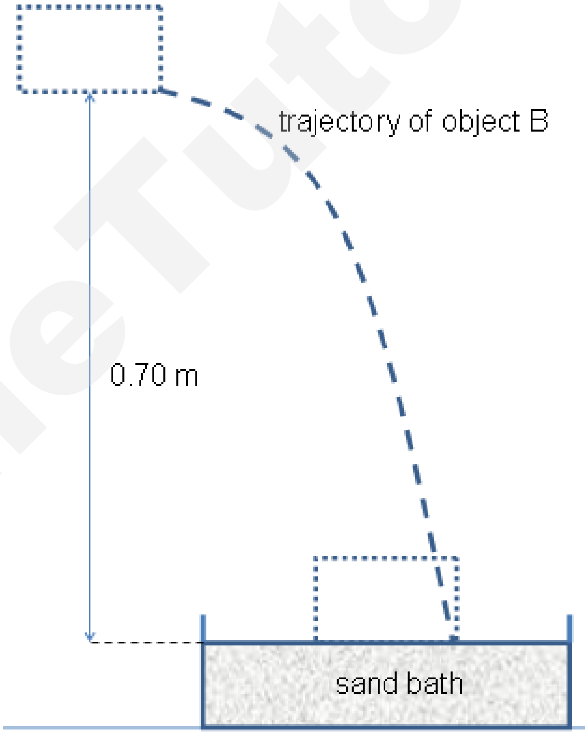
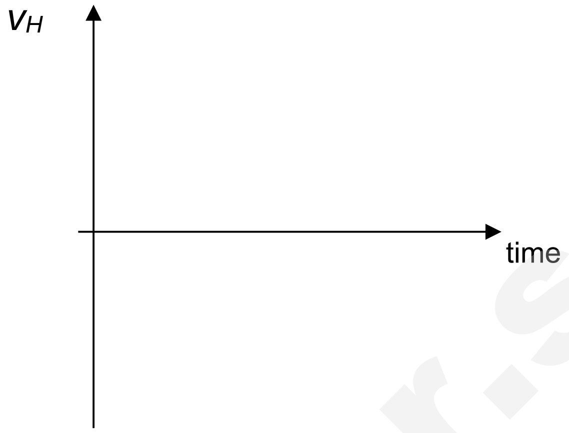


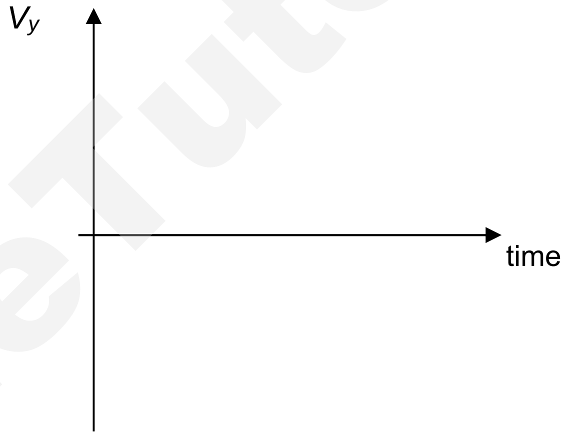
Fig 6.2

Sketch graphs of the following quantities for object B from the time it falls off the edge of the table to the time it lands on the sand bath.

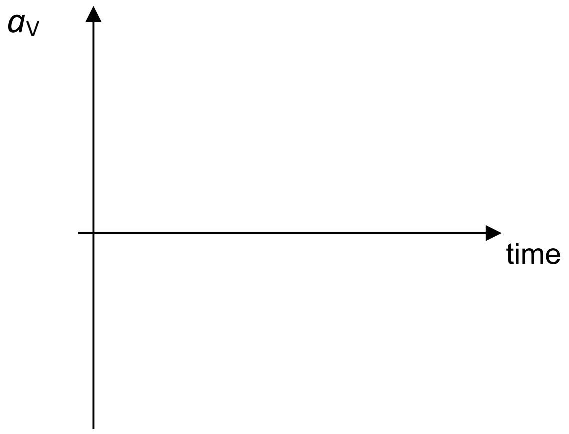
(i) The variation with time of its horizontal component of velocity v_H. [1]



(ii) The variation with time of its vertical component of velocity v_y. [1]



(iii) The variation with time of its vertical acceleration a_y. [2]



(iv) Determine the horizontal distance from the edge of the table moved by object B when it just hits the sand bath.

horizontal distance = ... m [4]

(v) Determine the vertical speed of object B when it just hits the surface of the sand.

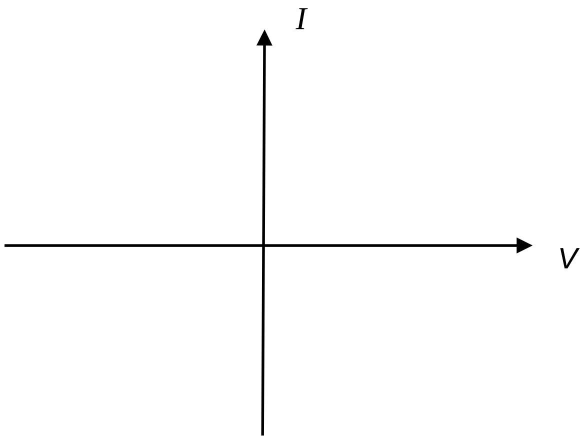
vertical speed of object B = ... m s^{-1} [2]

(d) Object B is eventually embedded in the sand bath, entering vertically by 12 cm. Assuming the vertical retarding force on object B is constant as it enters the sand, determine the average deceleration of object B as it enters the sand.

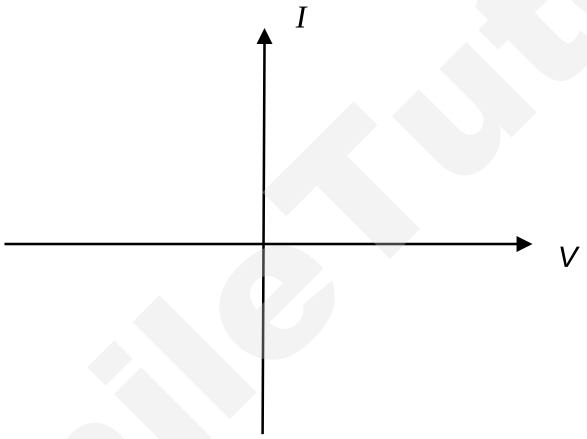
average deceleration of object B = ... m s^{-2} [2]

7 **(a)** Sketch the current-voltage (I-V) characteristics of

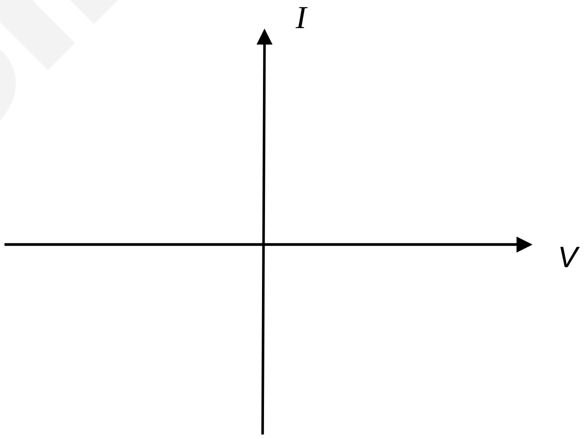
(i) a metallic conductor at constant temperature, [1]



(ii) An ideal semiconductor diode, [1]



(iii) and a non-ideal semiconductor diode. [1]



(b) The I-V characteristic of a 12 V car headlamp is drawn in Fig. 7.1. Only positive values of V and I are shown.

Fig. 7.1

(i) State why the graph stops at V = 15.4 V.

....

....

....

.... [1]

(ii) Deduce the resistance of the headlamp at 2 V and 10 V.

resistance at 2 V = ... Ω

resistance at 10 V = ... Ω [3]

(iii) Explain in terms of the movement of charged particles why the resistance increases with potential difference as shown in Fig. 7.1.

[2]

(c) The filament of a headlamp could be manufactured from a straight piece of tungsten wire of diameter 0.084 mm.

(i) Calculate the length of wire required for a resistance of 0.50 Ω when the wire is at room temperature. The resistivity of tungsten at room temperature is 5.5 x 10^{-8} Ω m.

length = ______ m [4]

(ii) Explain why this straight length of wire is not practical.

[1]

(iii) Suggest two ways of making a filament wire more practical. [2]

1.

2.

(d) Sketch a graph to show the variation with voltage *V* of the power *P* supplied to the headlamp. [2]

(e) When the headlamp is operating at 4.0 V, the heat loss is 4.0 W.

Determine the efficiency of the headlamp.

efficiency = ______________ % [2]

8 **(a)** A student sets up the apparatus illustrated in Fig. 8.1 in order to observe two-source interference fringes. The double slit with slit separation 0.800 mm, situated 2.50 m from the screen, is illuminated with coherent light of wavelength 690 nm. Fringes are observed on the screen.

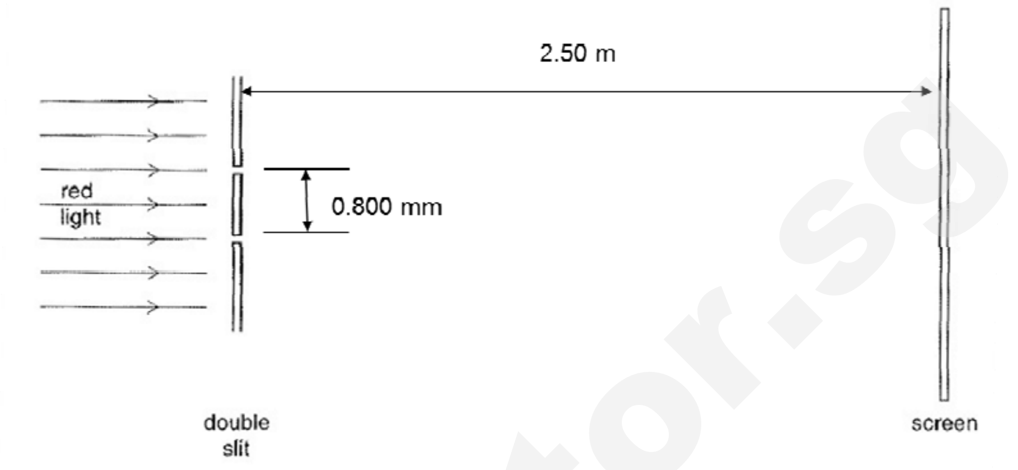


Fig. 8.1

(i) Explain the meaning of *coherent* light.

....

.... [1]

(ii) Calculate the separation of the fringes.

separation = ... m [3]

(iii) State and explain what change, if any, occurs in the separation of the fringes and in the contrast between bright and dark fringes observed on the screen, when each of the following changes is made separately.

1. increasing the intensity of the red light incident on the double slit

[2]

2. increasing the distance between the double slit and the screen

[3]

3. changing the red light into green light

[2]

(b) (i) What conditions must be satisfied in order that two source interference fringes may be observed? [2]

1.

2.

(b) **(ii)** Two sound sources which are 2.00 m apart are set up at **A** and **B** as shown in Fig. 8.2. The perpendicular distance between **AB** and **XY** is 12.0 m. A student attempts to determine the wavelength of the sound from the sources at **A** and **B** using the practical method. He walks along **XY** and detects sound of *minimum* intensity at **P** using a microphone connected to a cathode ray oscilloscope. The next position where he detects sound of *minimum* intensity is at **Q**. The distance **PQ** is 6.00 m.

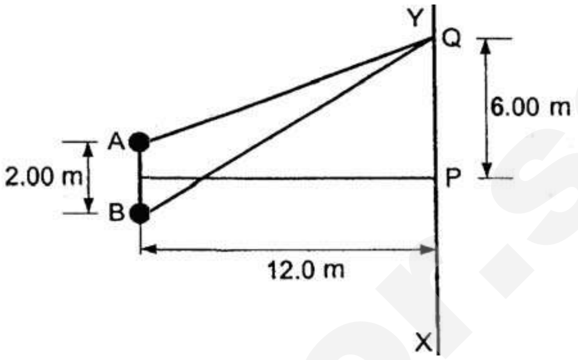


Fig. 8.2

1. Determine the phase difference of the waves at sources A and B.

phase difference = ______________ rad [1]

2. Write down the phase difference between the waves arriving at **Q**.

phase difference = ______________ rad [1]

3. Determine the path difference between the waves arriving at **Q** in 3 decimal places.

path difference = ______________ m [2]

4. Hence deduce the wavelength of the sound from the sources **A** and **B** using this practical method.

wavelength = ______________ m [1]

5. Another student chooses to determine the wavelength of the sound from the sources **A** and **B** theoretically, by using the formula for the double-slit interference pattern.

Which wavelength value, obtained in **(b)(ii)4.** using the practical method or obtained using the theoretical method, is less accurate? Explain.

[2]

The End

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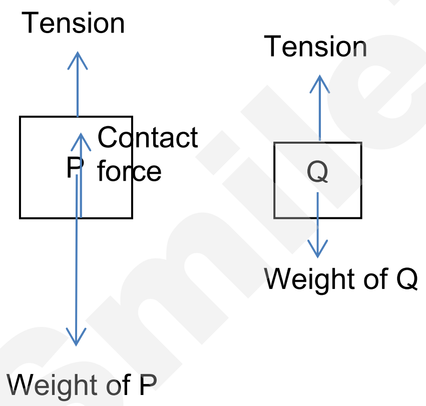
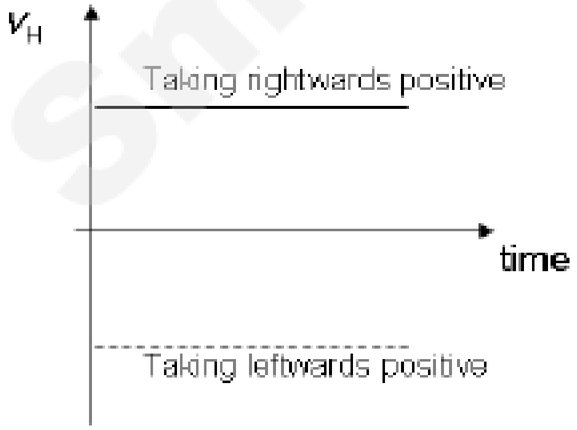
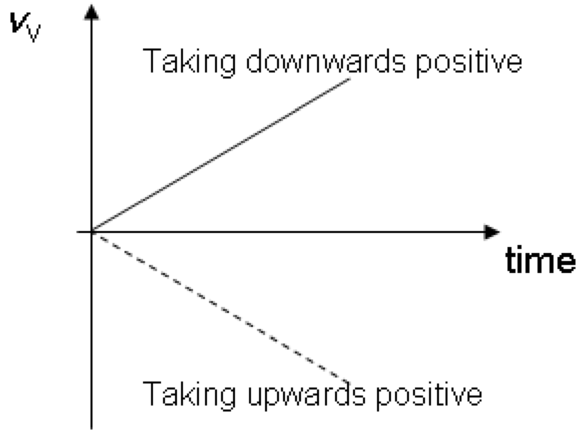
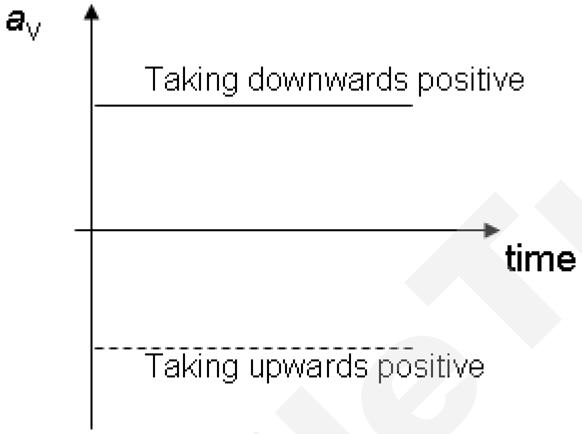
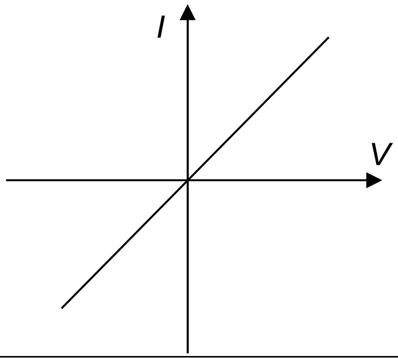
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

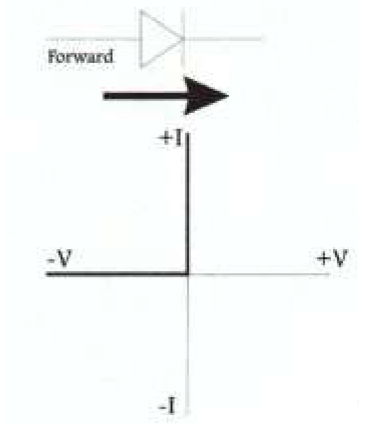
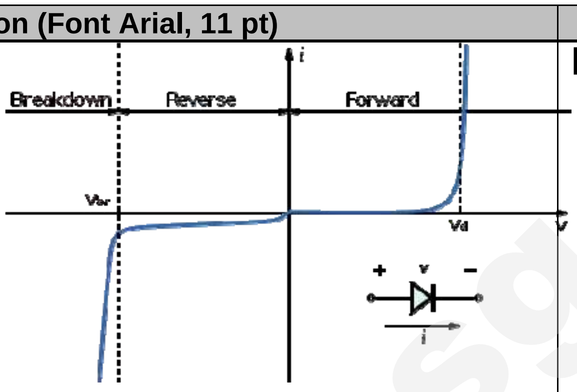
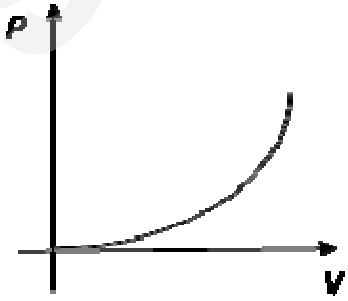
Qn	Suggested solution (Font Arial, 11 pt)	Remarks
1(a)	Using $s = ut + \frac{1}{2}at^2 \rightarrow h = \frac{1}{2}at^2$ $\frac{\Delta a}{a} = \frac{\Delta h}{h} + \frac{2\Delta t}{t}$ $\frac{\Delta a}{9.5758} = \frac{0.001}{0.600} + \frac{2(1)}{354}$ $\Delta a = 0.07 \text{ m s}^{-2}$ $a = (9.58 \pm 0.07) \text{ m s}^{-2}$	**[1] ans: uncertainty** **[1] e.c.f. final expression (correct s.f. for uncertainty, correct d.p. for acceleration of free fall)**
(b)(i)	The delay is due to the time taken for the electromagnet and steel ball to lose their magnetism.	**[1]**
(ii)	Systematic error. The constant delay causes the timing measured to be consistently too long.	**[1]** **[1]**
(iii)	Graphical methiod: Measure the timings for different heights of fall and plot a graph of *h* against t^2. Details: The constant delay is the square root of the x-intercept. <u>OR</u> Experimental method: Use of light gates / high speed camera / etc. Details: Positioning of light gates / view video in slow motion / etc.	**[1] accept graphical or experimental method** **[1] relevant details**
2(a)(i)		**[2] for 3 forces on P, [1] for 2 forces on Q. Minus 1 mark if no label and/or wrong point(s) of application and/or wrong relative magnitudes showing non-equilibrium.**
(ii)	Object Q: tension balances the weight of object Q Object P: tension + contact force balances the weight of object P (0.3)(9.81) + contact force = (1.5)(9.81) Contact force = (1.2)(9.81) = 11.8 = 12 N (shown)	**[1] equate tension to weight of object Q** **[1] sub**
(b)(i)	Hooke's Law states that the <u>extension</u> (or compression) of a spring is <u>proportional</u> to the <u>force required to extend</u> (or compress) it, <u>provided the limit of proportionality is not exceeded</u>.	**[1]**
(ii)	12 = (*k*)(0.020) *k* = 600 N m^{-1}	**[1] ans**
(iii)	EPE = $\frac{1}{2}kx^2$ = $\frac{1}{2}(600)(0.020)^2$ = 0.12 J	**[1] sub** **[1] ans**
3(a)	Power is defined as the <u>rate of work done/ work done per unit time/ rate of energy conversion</u>.	**[1]**

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(b)	For car to move at constant velocity, the minimum engine force required must be equal in magnitude to component of car's weight along slope. Hence, $F = mg\sin\theta$ $= (1800)(9.81)\sin(37.5°)$ $=1.07 \times 10^4$ N Minimum power $P = Fv = (1.07 \times 10^4)(60 \times 10^3/3600)$ $= 179$ kW	**[1]-sub** **[1]-sub** **[1]-ans**
(c)	Gain in KE = Loss in GPE $½ mv^2 = mgh$ $½ v^2 = (9.81)(77.2 \sin 37.5°)$ $v = 30.4$ ms^{-1}	**[1]-sub** **[1]-ans**
4(a)(i)	Magnetic force is acting **downward**. Since **side BC is perpendicular to the magnetic field** *B* of the solenoid, it would **experience a magnetic force whose direction is given by Fleming's Left Hand Rule**.	**[1]** **[1]**
(a)(ii)	Since side AB is **parallel with the magnetic field** *B* of the solenoid, **no magnetic force** acts on it.	**[1]**
(b)(i)	$B = \mu_0 nI$ $= 4\pi \times 10^{-7} \times 700 \times 3.5$ $= 3.08 \times 10^{-3}$ T	**[1] ans**
(b)(ii)	Force acting on BC $F = BIL$ $= 3.08 \times 10^{-3} \times 3.5 \times 5.0 \times 10^{-2}$ $= 5.39 \times 10^{-4}$ N	**[1] sub** **[1] ans**
(b)(iii)	Since frame is horizontal, applying Principle of Moments, Sum of anti-clockwise moments = Sum of clockwise moment $mgd = Fd_{QC}$ $(0.100 \times 10^{-3})(9.81)(d) = (5.39 \times 10^{-4})(12 \times 10^{-2})$ $d = 0.0659$ m	**[1] sub** **[1] ans**
(b)(iv)	The **clockwise moment will increase by 4 times** as the magnetic flux density of the solenoid and current are doubled. The mass of the paper must be **increased by 4 times** so that the anticlockwise moment will be increased by 4 times.	**[1]** **[1]**
5(a)	Work function is the <u>minimum energy required to liberate/emit an electron</u> from the surface.	**[1]**
(b)(i)	From (b)(i), $hc/\lambda = hf_0 + E_{MAX}$ when $E_{MAX} = 0$, $1/\lambda_0 = 1.95 \times 10^6$ m^{-1} (allow $\pm 0.05 \times 10^6$ m^{-1}) (<u>evidence</u> of use of y-intercept from graph) $f_0 = c(1/\lambda_0) = (3.00 \times 10^8)(1.95 \times 10^6)$ $= 5.85 \times 10^{14}$ Hz **OR:** chooses point on the line and substitutes values of $1/\lambda$ and E_{MAX} into $hc/\lambda = \Phi + E_{MAX}$	**[1] method** **[1] sub**
(b)(ii)	Same gradient, towards left of original graph (implying larger y-intercept)	**[1]**

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(c)	($I = \frac{Nhf}{tA} \Rightarrow$ when I increases, it can mean $\frac{N}{t}$ increases or f increases.) (1) Number of electrons emitted per unit time increases because there are now more photons striking the metal surface per unit time. (2) E_{MAX} of emitted photoelectron is the same as photon-electron interaction is 1 to 1, and since f is fixed, energy of photon absorbed by electron is constant and for same surface with same work function.	[1] [1] [1] [1]
6(a)(i)	1. Total kinetic energy is conserved. 2. Relative speed of separation = relative speed of approach	[1] [1]
(ii)	Total final momentum = total initial momentum $v_A + 2.5\, v_B = 5$ Relative speed of separation = relative speed of approach $v_B - v_A = 5$ Solving simultaneously, $v_A = -2.143 = -2.1$ m s^{-1} $v_B = 2.857 = 2.9$ m s^{-1} (shown)	[1] eqn [1] eqn (also accept eqn of KE conservation) [1] working [1] v_A ans (must be –ve)
(b)(i)	Displacement is defined as the linear distance in a specified direction from a reference point.	[1] defn
(ii)	Acceleration is defined as the rate of change of velocity.	[1] defn
(c)(i)		[1]

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(ii)		**[1]**
(iii)		**[1]** **[1] this fourth mark is awarded for consistent convention used in (ii) and (iii)**
(iv)	Consider the vertical motion to determine time of flight: $s = ut + \frac{1}{2}at^2$ $0.7 = \frac{1}{2}(9.81)t^2$ $t = 0.378$ s Consider the horizontal motion to determine horizontal distance traveled: $s = (2.9)(0.378)$ $= 1.1$ m	**[1] sub** **[1] ans** **[1] sub** **[1] ans**
(v)	Consider the vertical motion: $v = u + at = 0 + (9.81)(0.378) = 3.71$ m s^{-1}	**[1] sub** **[1] ans**
(d)	Consider the vertical motion: $v^2 = u^2 + 2as$ $0 = (3.71)^2 + 2a(0.12)$ $a = -57.3$ m s^{-2} deceleration = 57.3 m s^{-2}	**[1] sub** **[1] ans (must be +ve)**
7(a)(i)		**[1]**

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(a)(ii) (iii)	 Ideal Diode  Practical Diode	[2]
(b)i)	The maximum potential difference that the car battery can be applied across the headlamp cannot be more than 15.4 V, beyond which the filament breaks.	[1]
(b)ii)	From the graph, at 2.0 V, I = 2.0 A → R = 1.00 Ω From the graph, at 10.0 V, I = 5.1 A → R = 1.96 Ω	[1] [1] Correct reading [1] Ans
(b)iii)	• Lattice ions in the metal to vibrate more vigorously, causing an increased rate of collision with the moving electrons. • The increased rate of collision reduces the rate of flow of electrons, hence, lowering the current flow.	[1] [1]
c)i)	$R = \frac{\rho \ell}{A} = \frac{4\rho\ell}{\pi d^2}$ $0.50 = \frac{4(5.5\times10^{-8})\ell}{\pi(0.084\times10^{-3})^2} \Rightarrow \ell = 0.0504$ m	[1] Value of A [1] Eqn [1] Subs [1] Ans
c)ii)	The length of the filament wire is **too long** to be placed inside the filament lamp.	[1]
c)iii)	The wire should be **coiled** instead of using a straight wire. A **thinner wire** could be used instead, so that a shorter wire can be used. Metal of higher resistivity could be used, so that a shorter wire can be used.	[2] Any 2
d)	 	[1] correct shape [1] pass through origin
e)	At V = 4 V, I = 3 A Total power= 12 W Efficiency= $\frac{12-4}{12}\times100\% = 67\%$	[1] Method [1] Ans
8(a)(i)	The waves have a constant phase difference.	[1]
(a)(ii)	Using $x = \frac{\lambda D}{a} = \frac{690\times10^{-9}\times2.5}{0.800\times10^{-3}} = 2.16\times10^{-3} m$	[1] Formula [1] Subst [1] Ans

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2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(a)(iii)1.	There is no change in the spacing. The maxima is the brighter and thus the contrast is higher.	**[1]** **[1]**
2.	Since D is larger, x will be larger. The separation will increase. The maxima is dimmer due to the longer distance, thus the contrast is lower.	**[1]** **[2]**
3.	Since wavelength of green light is shorter, x will be smaller. The separation will decrease.	**[1]** **[1]**
(b)i)	1. The waves from the two sources are coherent. 2. The waves from the two sources have approximately the same amplitude. 3. The waves from the two sources must meet. 4. The waves must be unpolarized or polarized in the same plane.	**[2] Any two**
(b)(ii)1.	π rad	**[1]**
(b)(ii)2.	π rad	**[1]**
(b)(ii)3.	Path length AQ $= \sqrt{(12)^2 + (5)^2} = 13.000\text{ m}$ Path length BQ $= \sqrt{(12)^2 + (7)^2} = 13.892\text{ m}$ Path difference $= 13.892 - 13.000 = 0.892\text{ m}$	**[1]** **[1]**
(b)(ii)4.	Wavelength = path difference in (b)(ii)3**.** = 0.892 m	**[1]**
(b)(ii)5.	The wavelength value in (d) is less accurate because *D* must be much larger than *x* in the double-slit interference pattern formula.	**[2] or zero**

MERIDIAN JUNIOR COLLEGE
JC2 Preliminary Examination
Higher 1

H1 Physics 8866/1

Paper 1 Multiple Choice **21 September 2017**

1 hour

	Class	Reg Number
Candidate Name ______________________________		

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

There are **thirty** questions in this section. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the Optical Mark Sheet (OMS).

Read very carefully the instructions on the OMS.

Write your name and class in the spaces provided on the OMS.

Shade your Index Number column using the following format:

1) first 2 digits is your index number in class
(e.g. 5th student is shaded as "05");

2) ignore the last row of alphabets.

DATA AND FORMULAE

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
the Planck constant	h	=	6.63×10^{-34} J s
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p\Delta V$
hydrostatic pressure	p	=	ρgh
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Answer all 30 questions in this paper and shade your answers on the answer sheet provided.

1 Which estimate is realistic?

A The kinetic energy of a bus traveling on an expressway is 30 000 J.
B The power of a domestic light is 300 W.
C The temperature of a hot oven is 300 K.
D The volume of air in a car tyre is 0.03 m^3.

2 The equation relating current I through a semiconductor diode to the applied potential difference V at temperature T is

$$I = I_o \exp\left(-\frac{qV}{kT}\right)$$

where q is the electron charge, and k is a constant.

If I_o is a characteristic constant of the diode with the same units as current I, what is the unit of k?

A kg m^2 s^{-2} K^{-1} A^{-1} **B** kg m s^{-2} K^{-1} A^{-1} **C** kg m^2 s^{-2} K^{-1} **D** kg m s^{-2} K^{-1}

3 The relation between the velocity v of waves in the sea with its wavelength λ, the surface tension γ and density ρ of sea water is given by :

$$v = k\sqrt{\frac{\gamma}{\lambda\rho}}$$

where k = constant of proportionality.

If γ = (4.30 ± 0.05) N m^{-1}, ρ = (1450 ± 20) kg m^{-3} and the uncertainty in λ is 5 %, what is the percentage uncertainty in the velocity of the waves?

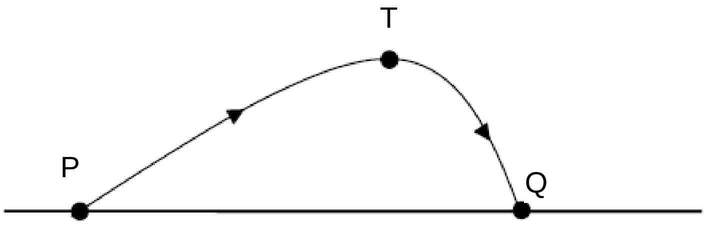
A 2 % **B** 3 % **C** 4 % **D** 8 %

4 A ball is dropped from a window located at the tenth storey of a building. 1 second after it is released, the ball is observed to have fallen by exactly 2 storeys.

At which storey will the ball be at 2 seconds after it is released?

A 2 **B** 4 **C** 6 **D** 8

5 In the presence of air resistance, a stone is thrown from P and follows a path in which the highest point reached is T as shown in the diagram below.



Given that the drag force acting on the stone is directly proportional to the magnitude of its instantaneous velocity, the vertical component of the acceleration of the stone is

A highest at point P.

B highest at point T.

C highest at point Q.

D constant through the travelled path.

6 A car at rest at a traffic junction starts to accelerate at 2.0 m s^{-2} when the traffic light turns green. At this moment, a truck travelling at a constant velocity of 14 m s^{-1} passes the car.

If the car is accelerating uniformly, how long will it take for the car to just overtake the truck?

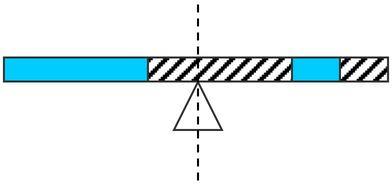
A 7.0 s **B** 14 s **C** 28 s **D** 56 s

7 Four different composite rods of uniform thickness are to be balanced horizontally on a knife-edge. Each rod is made up of 50% material A and 50% material B, where B is denser than A. The mid-point of each composite rod is indicated by a dotted vertical line.

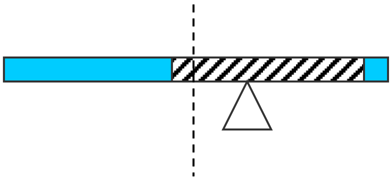
Legend: 🟦 Material A ▨ Material B

Which scenario is unlikely to occur?

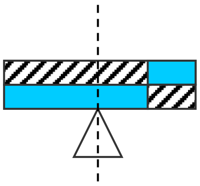
A



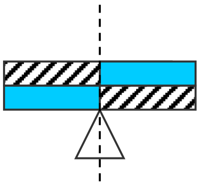
B



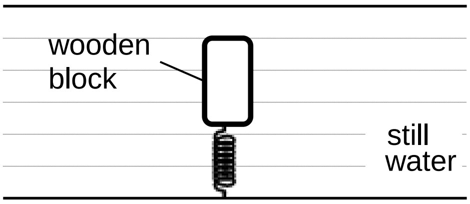
C



D



8 A large wooden block of density 800 kg m^{-3} and volume 1.0 m^3 is fastened to the bottom of a freshwater pond via a spring of force constant 65 kN m^{-1}. The wooden block experiences gravitational force, force from spring and an upward buoyant force. The upward buoyant force is 9810 N.



What is the compression or extension of the spring when the wooden block remains in equilibrium?

A 3.1 cm compression of spring.

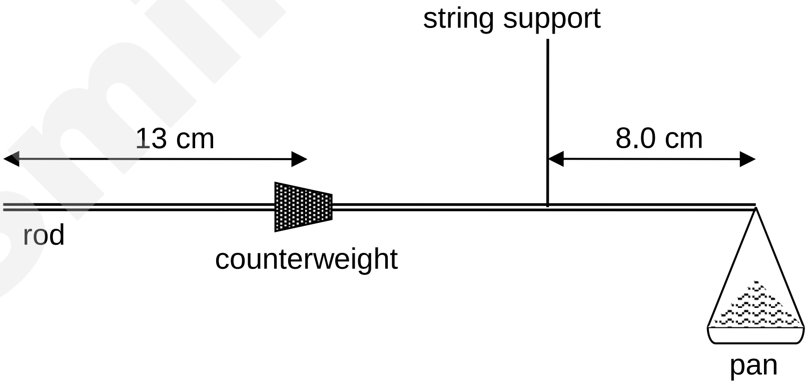
B 3.1 cm extension of spring.

C 3.0 cm compression of spring.

D 3.0 cm extension of spring.

9 A traditional Chinese physician is measuring the mass of herbs with his weighing scale. The scale consists of a uniform 40 g rod, a 100 g counterweight and an 80 g pan.

The rod is 30 cm long, the pan is placed at one end of the rod and the whole system is supported by a string 8.0 cm away from the pan as shown below.

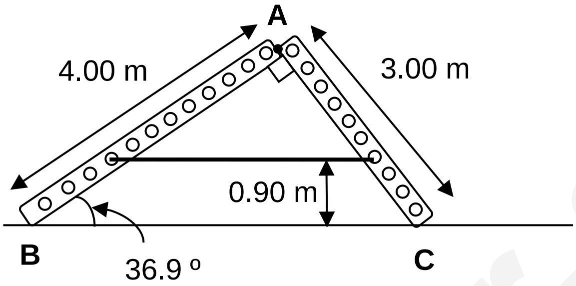


The counterweight is located at 13 cm from the other end of the rod when the system is in equilibrium. What is the mass of the herbs resting on the pan?

A 68 g **B** 108 g **C** 319 g **D** 662 g

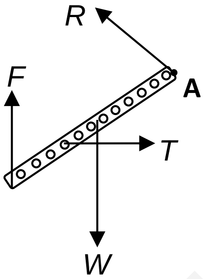
10 Two uniform ladders, 4.00 m and 3.00 m long, weighing 390 N and 290 N respectively are hinged at point **A** (90º apart) and tied together by a horizontal rope 0.90 m above the floor, as shown below. Assume the floor is freshly waxed and frictionless.

The contact force *F* at point **B** is 317 N.

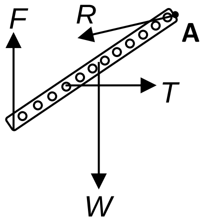


Which of the following diagram shows the correct forces *F*, weight *W* and tension of rope *T* and reaction force *R* acting at point **A** of the 4.00 m ladder?

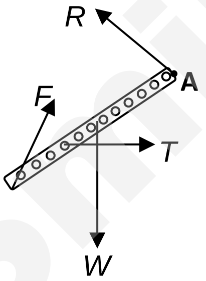
A



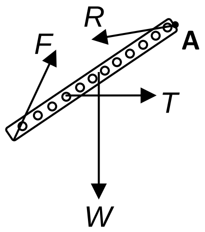
B



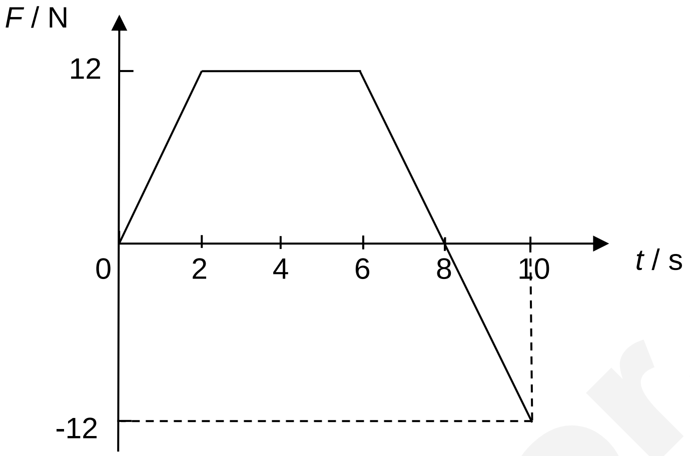
C



D



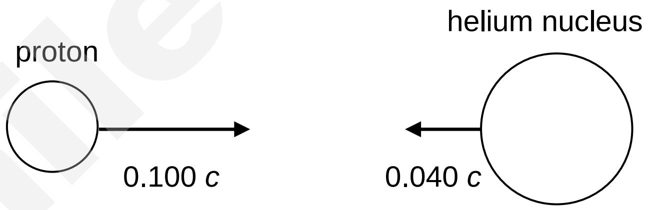
11 A body of mass 300 g initially at rest is acted on by a force *F* which varies with time *t* as shown in the diagram below.



What is the speed of the body at the 10th second?

A 200 m s^{-1} **B** 240 m s^{-1} **C** 260 m s^{-1} **D** 280 m s^{-1}

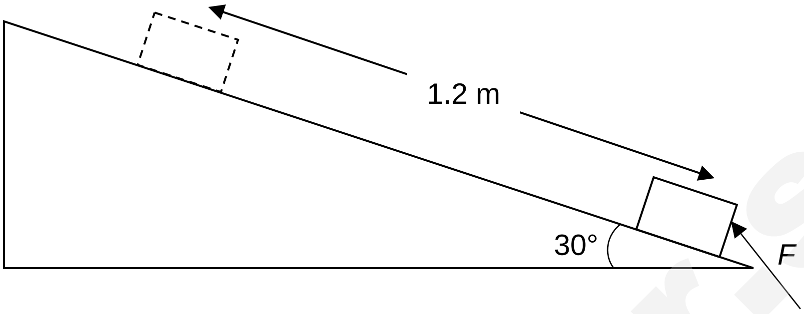
12 A proton (mass 1 *u*) travelling with velocity +0.100 *c* collides elastically head-on with a helium nucleus (mass 4 *u*) travelling with velocity −0.040 *c*.



What are the velocities of each particle after the collision?

	proton	helium nucleus
A	+0.124 *c*	+0.016 *c*
B	-0.124 *c*	+0.016 *c*
C	+0.004 *c*	+0.064 *c*
D	-0.004 *c*	+0.064 *c*

13 A force *F* is applied on a box of weight 200 N to push it up a rough ramp at constant speed through a distance of 1.2 m. The ramp makes an angle of 30° with the horizontal, as shown in the diagram below. The frictional force between the box and the ramp is 80 N.

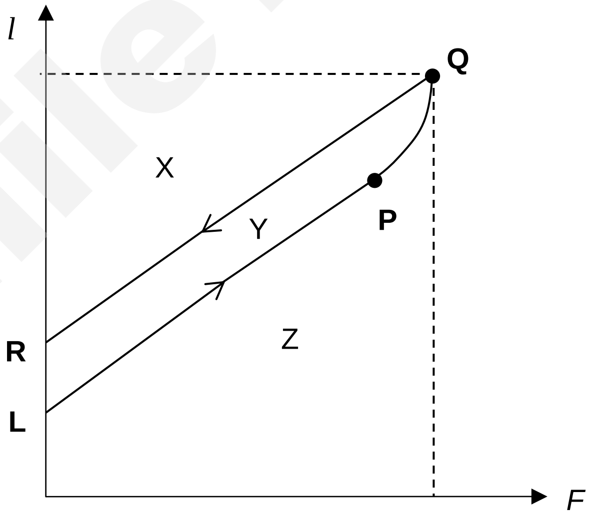


What is the work done by force *F*?

A 300 J **B** 220 J **C** 120 J **D** 24 J

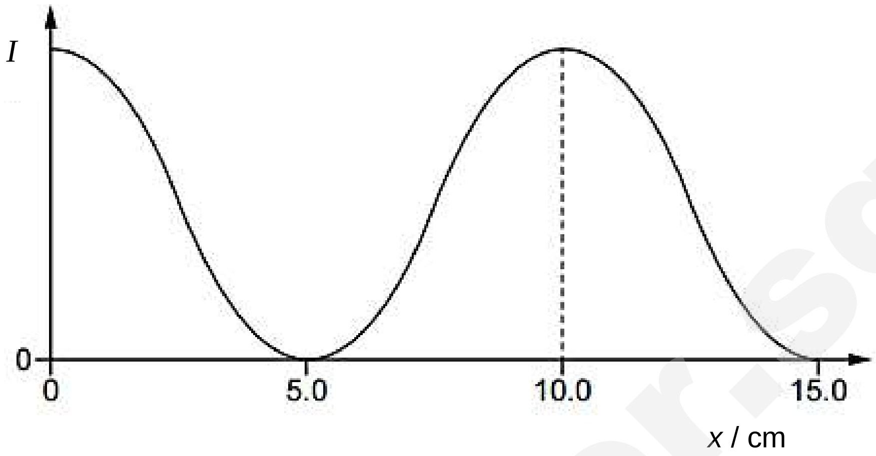
14 A spring is stretched by a varying force *F*, causing its length *l* to increase as shown by the line **LPQ** on the graph. The force is then gradually reduced to zero and the relationship between force and length is indicated by the line **QR**.

Which area represents the elastic potential energy stored in the spring at **Q**?



A X **B** X + Y **C** Y + Z **D** Z

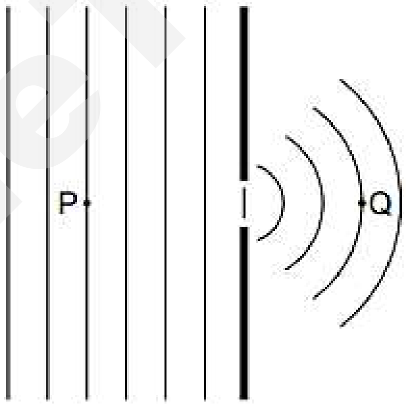
15 The variation with the distance x of intensity I along a stationary sound wave in the air is shown by the following graph.



The speed of sound in air is 320 m s^{-1}. What is the frequency of the sound wave?

A 1600 Hz **B** 2130 Hz **C** 3200 Hz **D** 6400 Hz

16 Plane wavefronts in a ripple tank pass through a gap as shown.



What property of the wave will be different at **Q** compared with **P**?

A velocity

B frequency

C amplitude

D wavelength

17 A musical organ produces notes by blowing air into a set of pipes that are open at one end and closed at the other.

What is the lowest frequency of sound produced by a pipe of length 2 m?
(The speed of sound in the pipe is 320 m s^{-1}.)

A 20 Hz **B** 40 Hz **C** 80 Hz **D** 160 Hz

18 Diffraction can be observed when a wave passes an obstruction. The diffraction effect is greatest when the wavelength and the obstruction are similar in size.

For waves travelling through air, what is the combination of wave and obstruction that could best demonstrate diffraction?

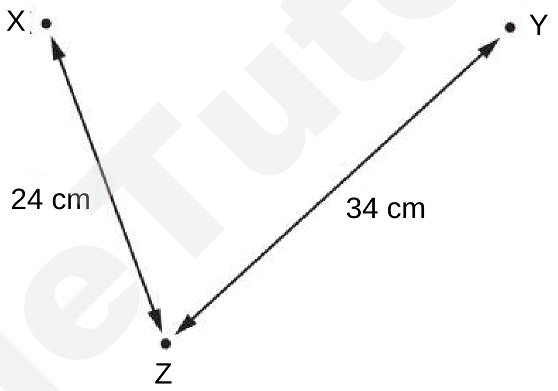
A visible light waves passing through an entrance of a classroom door

B sound waves passing a human hair

C radio waves passing a copper wire

D microwaves passing a steel post

19 Wave generators at points X and Y produce waves of the same wavelength. At point Z, the waves from X have the same amplitude as the waves from Y. Distances XZ and YZ are as shown.

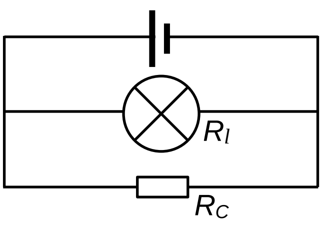


When the wave generators operate in phase, the amplitude of oscillation at Z is zero.

What could be the wavelength of the waves?

A 2 cm **B** 3 cm **C** 4 cm **D** 6 cm

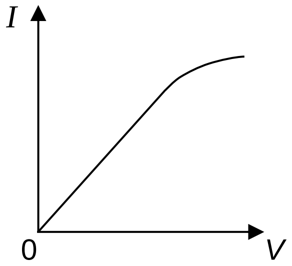
20 The figure below shows a lamp of resistance R_l and a device of resistance R_C being powered by an electrical source, ε.



Which expression gives the fraction of the total power delivered to the lamp?

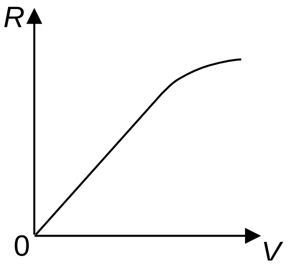
A $\frac{R_C}{R_l}$ **B** $\frac{R_l}{R_C}$ **C** $\frac{R_l}{R_l + R_C}$ **D** $\frac{R_C}{R_l + R_C}$

21 The current I flowing through a component varies with the potential difference V across it as shown.

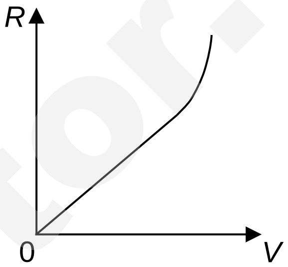


Which graph best represents how the resistance R varies with V?

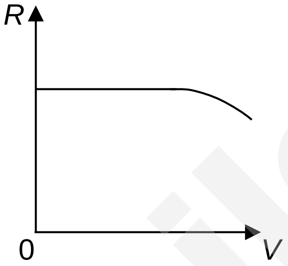
A



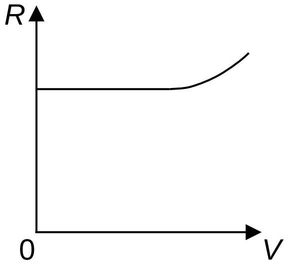
B



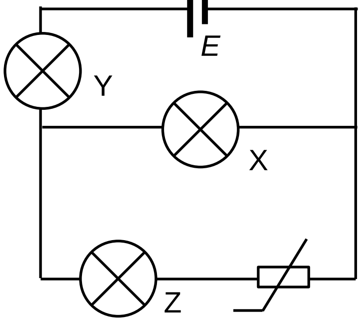
C



D



22 A cell of e.m.f. E is connected to three identical lamps X, Y, and Z, and a negative temperature coefficient thermistor as shown in the figure below.



If the thermistor is heated up, which statement about the change in brightness of bulbs X and Y is true?

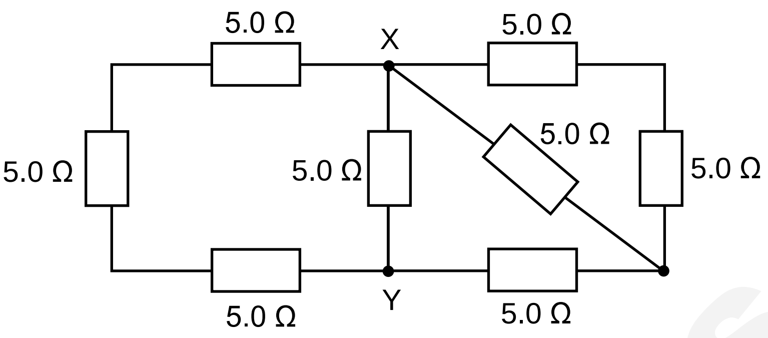
A Both X and Y become brighter.

B Both X and Y become dimmer.

C Y becomes brighter, but X dims.

D X becomes brighter, but Y dims.

23 Eight resistors are connected as shown in the figure below.



What is the equivalent resistance between X and Y?

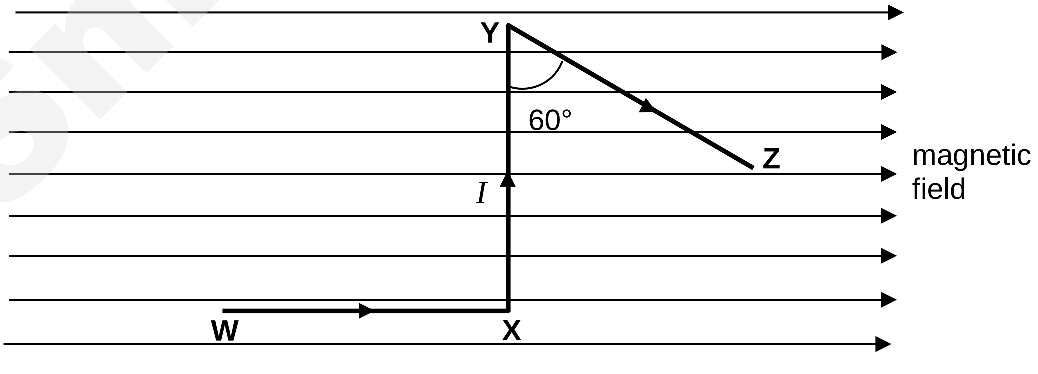
A 2.3 Ω **B** 2.6 Ω **C** 2.9 Ω **D** 3.2 Ω

24 A cell has an internal resistance *r*. A variable resistor is connected across its terminals. When the resistance of the variable resistor is 3.6 Ω, the potential difference across it is 7.2 V. When the resistance of the variable resistor is 7.2 Ω the current through it is 1.1 A.

What is the value of *r* ?

A 0.61 Ω **B** 0.80 Ω **C** 3.5 Ω **D** 4.3 Ω

25 The figure below shows a wire **WXYZ** placed in a uniform magnetic field of flux density 0.40 T. The current, I, flowing through the wire is 5.0 A. The length of **WX**, **XY** and **YZ** are 10 cm each.



What is the net force on the wire **WXYZ**?

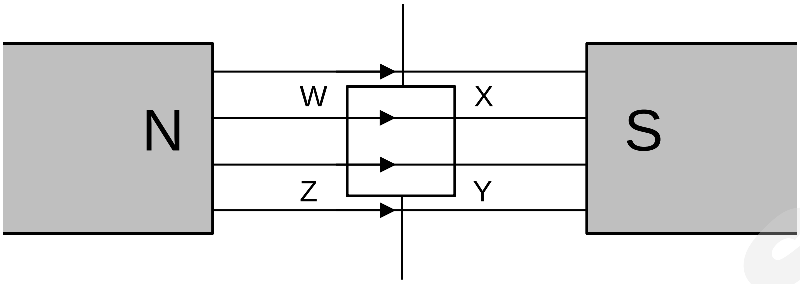
A 0.10 N out of the plane of the paper

B 0.10 N into the plane of the paper

C 0.20 N out of the plane of the paper

D 0.20 N into the plane of the paper

26 In an electric motor, a rectangular coil WXYZ carrying current, I, has 20 turns and is in a uniform magnetic field of flux density 0.80 T.

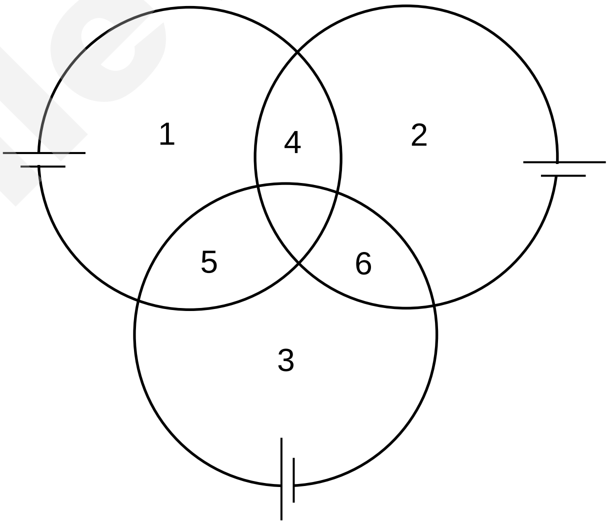


The lengths of sides XY and ZW are 0.17 m and of sides WX and YZ are 0.11 m. The maximum torque provided by the motor is 1.35 N m.

What is the current, I, in the rectangular coil?

A 4.5 A **B** 9.0 A **C** 45 A **D** 90 A

27 Three separate coils of insulated wire are connected to cells as shown. They are placed on a table on top of each other partially overlapping.



Six of the seven areas formed within the coils are numbered.

In which areas do the magnetic fields of all the coils reinforce each other?

A 1 and 6 **B** 2 and 5 **C** 3 and 4 **D** 4 and 6

28 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photoelectrons which are collected at an adjacent electrode.

If the experiment is repeated with light of half the intensity but the same wavelength, how will the photocurrent I and stopping potential V be affected?

A I unchanged, V unchanged

B I unchanged, V halved

C I halved, V unchanged

D I halved, V halved

29 Which type of electromagnetic radiation is emitted when an electron in an atom makes a transition from an energy level at −1.5 eV to an energy level at −3.5 eV?

A microwaves

B infra-red

C orange light

D violet light

30 An electron and a proton have the same de-Broglie wavelength.

Which of the following statements is correct?

A The momentum of the proton is greater than that of the electron.

B The momentum of the proton is smaller than that of the electron.

C The kinetic energy of the proton is greater than that of the electron.

D The kinetic energy of the proton is smaller than that of the electron.

End of Paper

2017 JC2 Preliminary Examination
H1 Physics Paper 1 Suggested Solutions:

1	**D**	6	**B**	11	**A**	16	**C**	21	**D**	26	**A**
2	**C**	7	**A**	12	**B**	17	**B**	22	**C**	27	**B**
3	**C**	8	**D**	13	**B**	18	**D**	23	**B**	28	**C**
4	**A**	9	**A**	14	**A**	19	**C**	24	**B**	29	**C**
5	**A**	10	**A**	15	**A**	20	**A**	25	**B**	30	**D**

MCQ 1: D

A: Typical bus mass = 3000 kg, speed = 60 km/h ≈ 17 m s^{-1}, so KE ≈ 400 000 J
B: Typical power of domestic light = 10 to 90 W
C: 300 K is 27 °C, too low for hot oven
D: Typical tyre is 60 cm radius, 20 cm width, 4 cm breadth ⇒ volume ≈ 0.03 m^3

MCQ 2: C

Since $\frac{qV}{kT}$ is a power, it is dimensionless.

Units of k $= \frac{\text{units of energy}}{\text{units of temp}} = \frac{kgm^2s^{-2}}{K} = kgm^2s^{-2}K^{-1}$

MCQ 3: C

Percentage uncertainty in *v* = $\frac{1}{2}\left[5+\left(\frac{0.05}{4.3}\times100\right)+\left(\frac{20}{1450}\times100\right)\right] \approx 4\%$

MCQ 4: A

Use $s = ut + 0.5at^2$

$$2 = 0 + 0.5a(1)^2$$

$$a = 4 \text{ storeys s}^{-2}$$

$$s = 0 + (0.5)(4)(2)^2$$

$$= 8 \text{ storeys}$$

$$10 - 8 = 2^{nd} \text{ storey}$$

MCQ 5: A

At point P, it experiences weight and drag force in the same direction
At point T, it experiences weight only as it is stationary, hence no drag force
At point Q, it experiences weight and drag force but in opposite direction

MCQ 6: B

$s_{car} = 0 + 0.5(2)t^2$

$s_{truck} = (14)t$

$s_{car} = s_{truck}$

$t = 14 \text{ s}$

MCQ 7: A

To create rotational equilibrium, the sum of moments exerted by the weight of each material about the knife-edge must be equal. Another way is to use visual inspection to estimate the location of the centre of gravity (CG) for the composite rod. The knife-edge must be below the CG for rotational equilibrium.

For C and D, the CG lies in the middle of the rod so knife-edge is placed correctly below the CG.

For B, the CG is off-centre to the right as material B is concentrated to the right. The knife-edge is also positioned more to the right (from centre) There is a chance that rotational equilibrium can be established.

For A, the CG is also off-centre to the right since material B is concentrated to the right, but the knife-edge is at the centre. Hence, rotational equilibrium cannot be established.

MCQ 8: D

Given, upward buoyant force = 9810 N

Weight of block =$\rho_{block}V_{block}g$ = 800 x 1.0 x 9.81 = 7848 N

Therefore force acting on block by spring = 9810 – 7848 = 1962 N (pointing downwards)

Hence force acting on spring by block = 1962 N (pointing upwards)--- leading to an extension of spring.

F = ke

1962 = 65 x 10^3 e

e = 3.0 cm

MCQ 9: A

Let mass of herbs be m

Taking moments about the string support

Clockwise moments = anticlockwise moments

mg (8.0) + 80g (8.0) = 100g (30-8-13) + 40g (15-8)

m = 68 g

MCQ 10: A

Since the floor is frictionless, contact force at point B is only the normal contact force.

At equilibrium,

At point A, there is an upward vertical force (magnitude of 390-317=73 N) to ensure net vertical forces is zero.

At point A, there is a leftward force to counter the rightward tension force.

Hence, reaction force at A is pointing as shown in diagram A.

MCQ 11: A
Change in momentum = area under F-t graph

Area under F-t graph from 0 to 10 seconds = 0.5 x (8+4) x 12 + [(-0.5) x (2) x (12)] = 60 N s

Change in momentum = final momentum – initial momentum

60 = mv – 0

v = 200 m s^{-1}

MCQ 12: B

Using relative speed of approach = relative speed of separation

$$u_1 - u_2 = v_2 - v_1$$
$$0.100c - (-0.040c) = v_2 - v_1$$
$$v_2 = 0.140c + v_1 \quad \text{---------(1)}$$

Using conservation of momentum

$$1u \times 0.100c - 4u \times 0.040c = 1u \times v_1 + 4u \times v_2$$
$$0.100c - 0.160c = v_1 + 4v_2 \quad \text{---------- (2)}$$

Substitute eqn (1) into (2)

$$-0.060c = v_1 + 4 \times (0.140c + v_1)$$
$$v_1 = -0.124c$$
$$v_2 = +0.016c$$

MCQ 13: B
Work done by *F* = gain in GPE + work done against friction
= 200 (1.2 sin 30°) + 80 x 1.2 = 220 J

MCQ 14: A
EPE is equal to the area under the force-extension graph. In this case, a stretched length vs force graph is plotted, hence we consider the area that **Q** makes with the vertical axis.

Note that at point Q, the spring has undergone plastic deformation, hence some energy has been released as heat (represented by area Y)

MCQ 15: A
Graph given is intensity of a stationary wave. Hence peak to peak distance indicates distance between 2 antinodes which is half a wavelength

f = speed / wavelength = 320 / 0.20 = 1600 Hz

MCQ 16: C
Only amplitude changes as distance from source increases. The other factors are affected only if the source changes.

MCQ 17: B
For a closed pipe, the fundamental frequency occurs at 0.25λ
Length of pipe = 2 m = 0.25 λ,
Hence,
$f = v/\lambda$ = 320 / 8 = 40 Hz

MCQ 18: D

Wave	Approx Size	Obstacle	Obstacle Size	Conclusion
visible light wave	400-700nm	Opening of classroom	2 m	
sound waves	1.7 cm – 17 m	Human hair	10^{-5} m	
radiowaves	1 m – 10 m	Copper wire	10^{-3} m	
microwaves	0.1 cm – 10 cm	Steel post	10^{-1} m	Most similar in order of magnitude

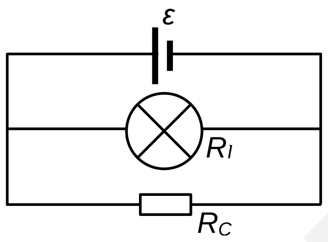
MCQ 19: C

Path difference is 10 cm
For point Z to be at destructive interference, it needs to be in multiples of (n+1/2) λ

Trial and error for all 4 options

If λ = 2cm, PD = 5 λ (CI)
If λ = 3cm, PD = 3.33 λ (no complete cancellation)
If λ = 4cm, PD = 2.5 λ (DI)
If λ = 6cm, PD = 1.67 λ (no complete cancellation)

MCQ 20: D



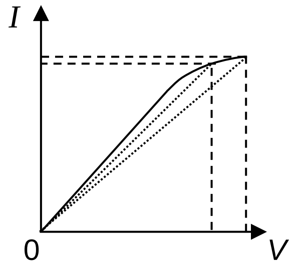
The potential difference across both the lamp and the resistor is the same

$$P_{lamp} = \frac{\varepsilon^2}{R_l} \qquad P_{resistor} = \frac{\varepsilon^2}{R_C}$$

Fraction of power delivered to lamp

$$= \frac{P_{out}}{P_{in}} = \frac{\frac{\varepsilon^2}{R_l}}{\frac{\varepsilon^2}{R_l} + \frac{\varepsilon^2}{R_C}} = \frac{R_C}{R_l + R_C}$$

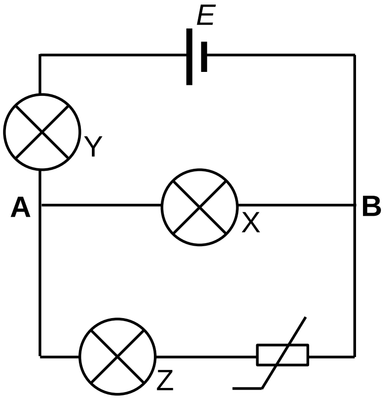
MCQ 21: D
Initially the V to I ratio is constant, hence the resistance is constant.



At large voltage, the V to I ratio increases. Hence the resistance increases.

MCQ 22: C

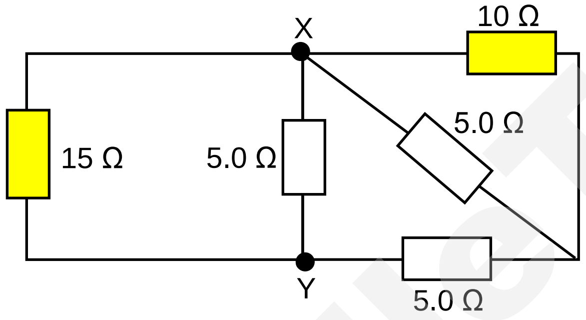
When heated up, resistance of an NTC thermistor decreases.



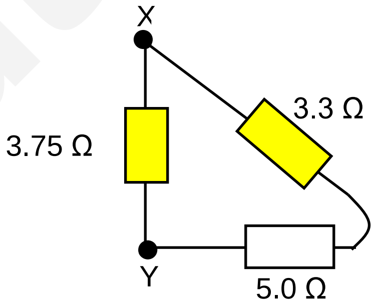
Effective resistance across points **AB** decreases. Hence V_{AB} decreases and p.d. across Y increases. Y will become brighter and X dims.

MCQ 23: B

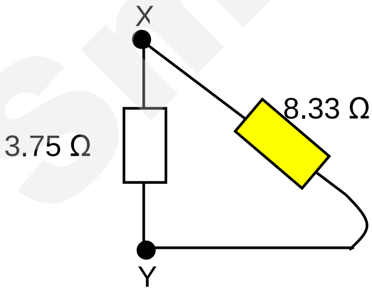
1. Combine those in series



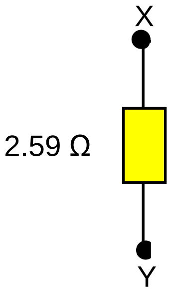
2. Combine those in parallel



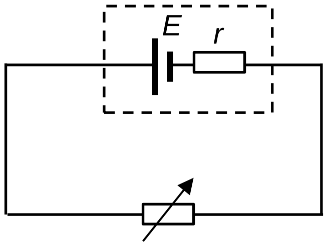
3. Combine those in series



4. Combine those in parallel



MCQ 24: B



$V_T = E - Ir$

$7.2 = E - \frac{7.2}{3.6}r \qquad E = 7.2 + 2.0r$ -------(1)

$7.2(1.1) = E - 1.1r \qquad E = 7.92 + 1.1r$ -------(2)

Eqn (1)=(2)

$7.2 + 2.0r = 7.92 + 1.1r$

$r = 0.80\ \Omega$

MCQ 25: B

Resultant force on wire = $BIL - BIL\sin 30^0 = 0.10$N
By Fleming's LHR, the resultant force is into the page of the paper.

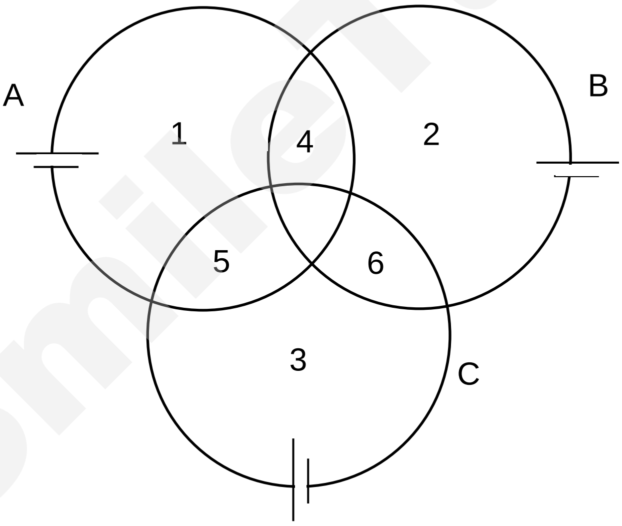
MCQ 26: A

The forces acting on XY and ZW have the same magnitude in opposite directions.
These two forces form a couple with a torque as follow:

$\tau = NBIL \times d = (20)(0.80)(I)(0.17)\times(0.11) = 1.35$

I = 4.5 A

MCQ 27: B



By applying right hand grip rule,
Coil A produces magnetic field into the paper within the coil and magnetic field out of the paper at region outside of coil
Coil B produces magnetic field out of the paper within the coil and magnetic field into the paper at region outside of coil
Coil C produces magnetic field into the paper within the coil and magnetic field out of the paper at region outside of coil
Hence, in areas 2 and 5, the magnetic fields of all the coils reinforce one another.

MCQ 28: C

Half the intensity, i.e. rate of arrival of photon on surface is halved. Hence current I is halved.

Same wavelength means energy of the photon is the same, hence no change in V for the same surface.

MCQ 29: C

$E = (-1.5 - (-3.5)) \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$

$E = hf = hc / \lambda \Rightarrow \lambda = hc / E = 6.63 \times 10^{-34} \times 3 \times 10^{8} / 3.2 \times 10^{-19} = 6 \times 10^{-7}$ m ➔ orange light

MCQ 30: D

de-Broglie wavelength $\lambda = h/p$
Same $\lambda \Rightarrow$ same p
$p = m\,v$
$KE = ½\, m\, v^2 = ½\, p^2/m$
$m_p >> m_e \Rightarrow KE_p << KE_e$

MERIDIAN JUNIOR COLLEGE
JC2 Preliminary Examination
Higher 1

H1 Physics 8866/2

Paper 2 Structured Questions **18 September 2017**

2 hours

Class	Reg Number

Candidate Name: ______________________________

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a 2B pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

Examiner's Use	
Section A	
Q1	**/6**
Q2	**/6**
Q3	**/8**
Q4	**/8**
Q5	**/12**
Section B	
Q6	**/20**
Q7	**/20**
Q8	**/20**
Deductions	
Subtotal for Paper 2	**/80**
Subtotal for Paper 1	**/30**
Grand total	**/110**

This booklet consists of 23 printed pages.

DATA AND FORMULAE

Data

speed of light in free space	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows a basketball player taking a free throw. The ball is thrown with an initial velocity of *u* at an angle of 52.0° to the horizontal. The ball leaves the player's hands at a point which is at a horizontal distance of 4.6 m from the basket and at a height of 1.6 m above the floor. The basket is 3.1 m above the floor.

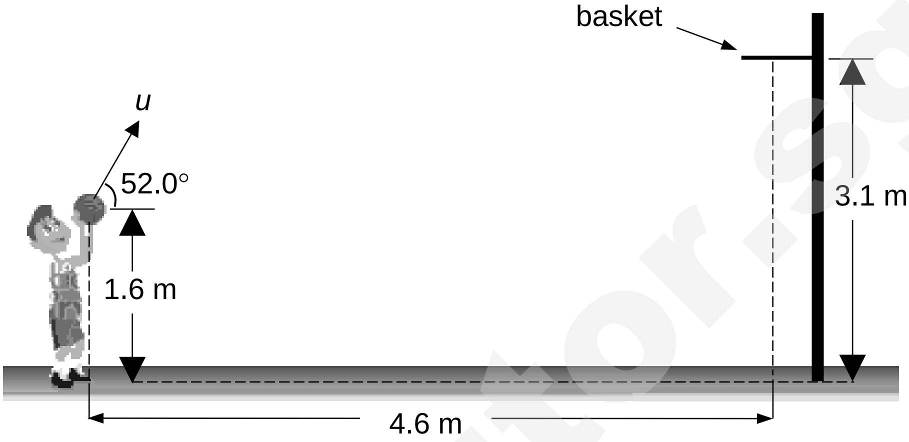


Fig. 1.1

(a) Calculate the initial velocity *u* of the ball required for it to pass through the basket.

u = ………………….. m s^{-1} [3]

(b) Fig. 1.2 shows the side view of the ball passing through the basket. The ball will be able to pass through the basket if its angle of travel with respect to the horizontal, θ, is larger or equal to 34°.

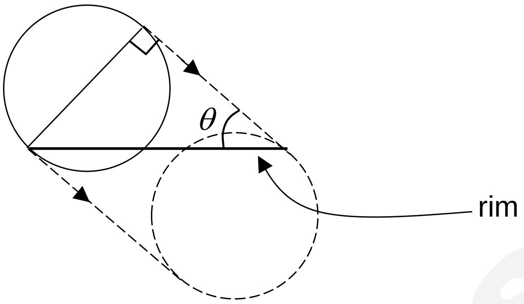


Fig. 1.2 (side view)

By calculating the angle, θ, determine if the ball thrown by the player will pass through the basket.

θ = ………………….. ° [2]

……………………………………………………………………………………………………

…………………………………………………………………………………………… [1]

2 **(a)** Distinguish between transverse waves and longitudinal waves.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) The variation with distance x of the displacement y of a transverse wave is shown in Fig. 2.1.

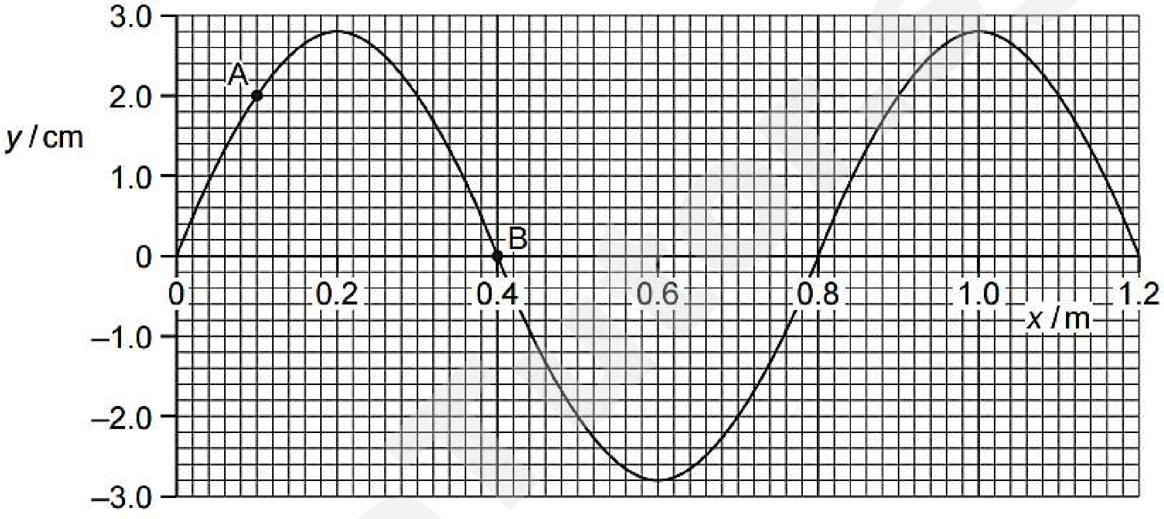


Fig. 2.1

(i) Use Fig. 2.1 to determine the phase difference between the points labelled A and B.

phase difference = ………………….. [2]

(ii) Determine the amplitude of a wave with half the intensity of that shown in Fig. 2.1.

amplitude = ………………….. cm [2]

3 **(a)** State the Principle of Superposition.

………

………

…………………………………………………………………………………………………… [1]

(b) A laser is placed in front of two slits as shown in Fig. 3.1.

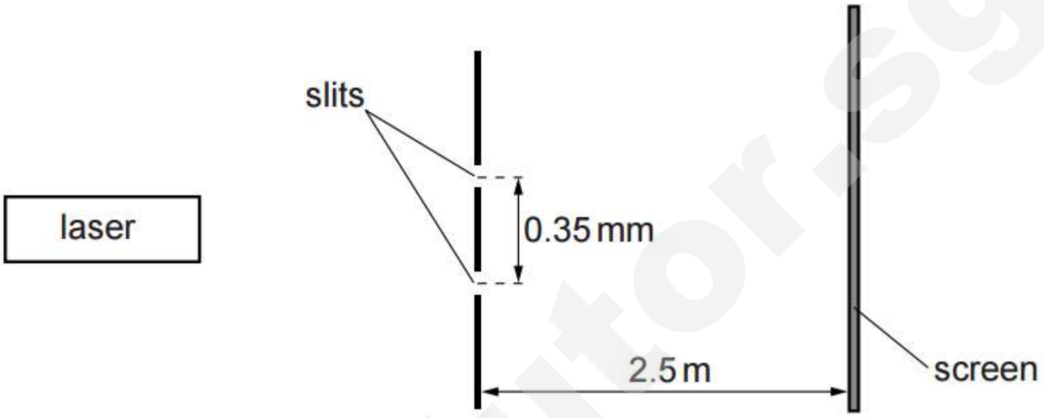


Fig. 3.1 (not to scale)

The laser emits light of wavelength 4.5×10^{-7} m. The distance from the slits to the screen is 2.5 m. The separation of the slits is 0.35 mm. The width of each slit is 2.0×10^{-6} m.

An interference pattern of maxima and minima is observed on the screen.

(i) Explain why an interference pattern is observed on the screen.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) Calculate the distance between adjacent maxima.

distance = ………………….. m [2]

(iii) State and explain the effect, if any, on the appearance of the fringes when each of the following changes is made separately.

1. The laser is replaced by another laser emitting red light.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

……………………………………………………………………………………… [1]

2. The screen is rotated slightly so that it is no longer parallel to the plane of the two slits.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

……………………………………………………………………………………… [2]

4 Two conductors, **A** and **B**, each of length 0.20 m and carrying current I of 5.0 A are placed at right angles to the plane of the magnetic field of magnitude 3.2 mT created by a pair of magnets as shown in Fig. 4.1. Conductor **A** carries current out of the plane of the paper while conductor **B** carries current into the plane of the paper.

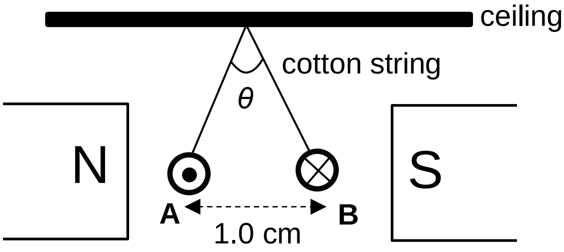


Fig. 4.1

The conductors are hung to the ceiling by cotton strings of equal tensions. At equilibrium, the two conductors make an angle of θ with each other and are separated by 1.0 cm.

The magnetic flux density B due to a long straight current carrying conductor is given by the expression

$$B = \frac{\mu_0 I}{2\pi d}$$

where d is the distance from the conductor. The permeability of free space is μ_0 and it has a value of 4π x 10^{-7} H m^{-1}.

You may assume that the entire length of conductors **A** and **B** lie in the magnetic field of the pair of magnets.

(a) Fig 4.2 shows two forces that are acting on conductor **A**. Draw on the same diagram, two other forces that are acting on conductor **A**. Label all forces drawn. [2]

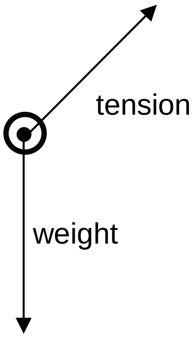


Fig. 4.2

(b) Calculate the magnetic force experienced by conductor **A** due to the pair of magnets.

force = ……………………..N [2]

(c) The mass of conductor **A** is 0.35 g. Determine the tension in the cotton string and the angle, *θ*.

tension = ……………….. N

θ = ………………… ° [4]

5 **(a)** Light is incident on a clean metal surface in a vacuum. The maximum kinetic energy KE_{max} of the electrons ejected from the surface is measured for different frequencies f of the incident light. The measurements are shown plotted below in Fig. 5.1.

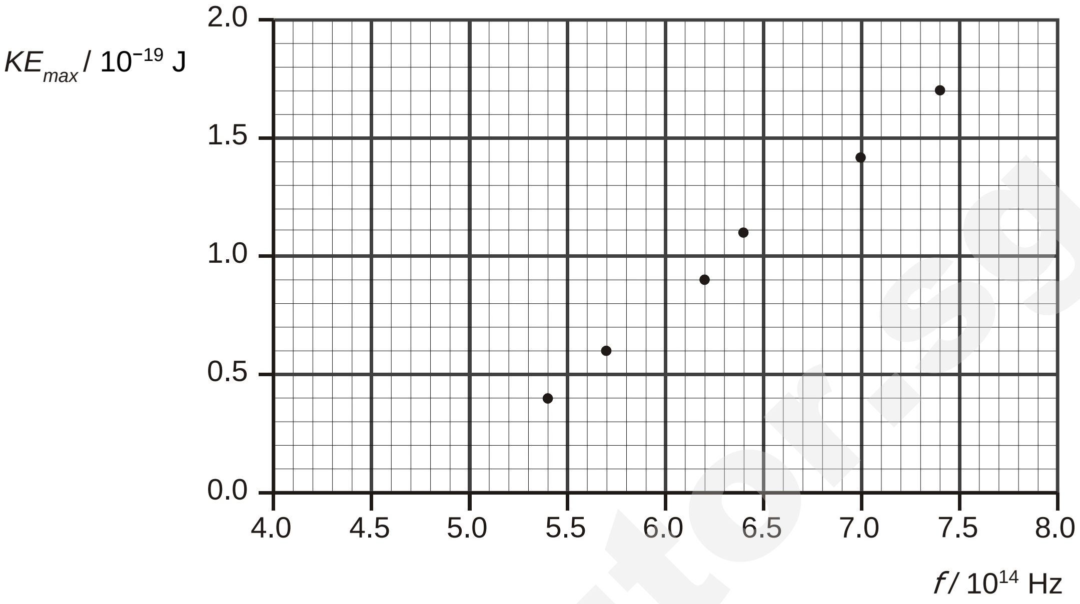


Fig. 5.1

(i) By drawing a suitable straight line on Fig. 5.1, use the graph to determine the Planck constant, h.

h = ………….…………….. J s [2]

(ii) Hence, calculate the work function of the metal.

work function = …………..……… J [2]

(b) Explain how a line emission spectrum leads to an understanding of the existence of discrete energy levels in atoms.

……

……

……

……

……………………………………………………………………………………………………… [3]

(c) Fig. 5.2 represents some of the allowed electron energy levels within a cool gas atom. The energy for each level is given in the diagram, with level 1 being the lowest energy state.

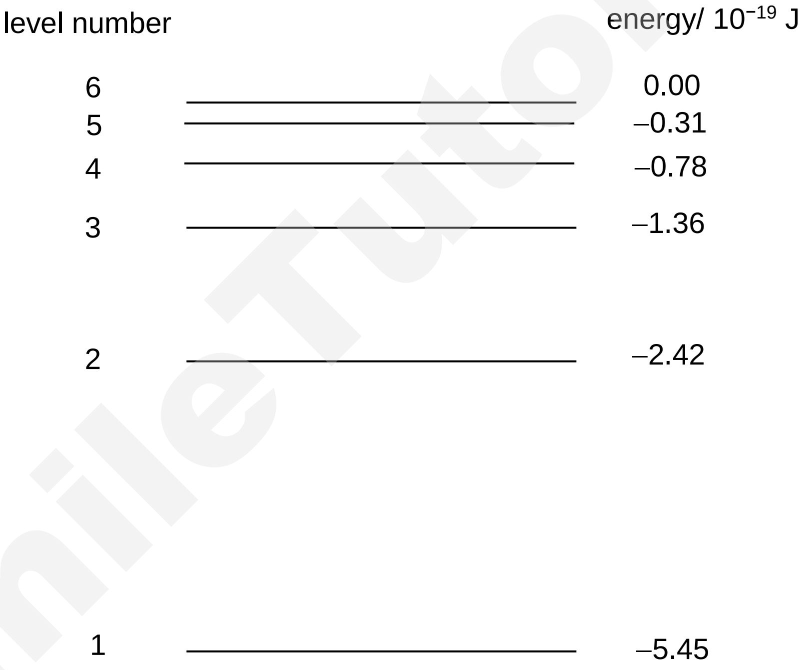


Fig. 5.2

(i) An electron of kinetic energy 5.00×10^{-19} J collides with this atom. Show that the minimum kinetic energy for a scattered electron is 0.33×10^{-19} J. [2]

(ii) Hence determine the the de-Broglie wavelength of the scattered electron.

de-Broglie wavelength = ………………… m [3]

End of Section A

Section B

Answer **two** of the questions from this section.

6 **(a)** State the property of a body that resists change in motion.

…………………………………………………………………………………………………… [1]

(b) Define *impulse*.

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [1]

(c) A soldier, together with his machine gun and bullets, has a combined mass of 90 kg. He stands at rest on a pair of ice skating blades and fires 10 bullets horizontally within 2.0 s in the forward direction. Each bullet has a mass of 10 g and leaves the gun with a speed of 750 m s^{-1}.

Assume there is no friction between the blades and the ground.

(i) Explain the motion of the man after firing by using Newton's laws.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) Calculate the soldier's speed just after he fired the 10th bullet.

speed = ………………… m s^{-1} [3]

(iii) Calculate the average force exerted on the soldier and his machine gun.

average force = ………………… N [2]

(iv) One of the bullet hits a block of uniform mass 500 g which is resting on a horizontal platform. The impact causes the block to slide along the platform. The bullet remains embedded in the block after impact and the block experiences a constant frictional force of 30 N throughout its motion.

1. State the type of collision between the bullet and the block.

………………………………………………………………………………………. [1]

2. Calculate the distance the block travels before it comes to a complete stop.

distance = ………………… m [4]

3. State and explain how the distance in **(c)(iv)2** changes if the platform is inclined upwards.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

………………………………………………………………………………………. [2]

(d) The solider in **(c)** glided towards the edge of a downward slope of 30° to the horizontal. Just as he slides down the frictionless slope, he fired another 10 bullets along the direction of slope in 1.0 s as shown in Fig. 6.1.

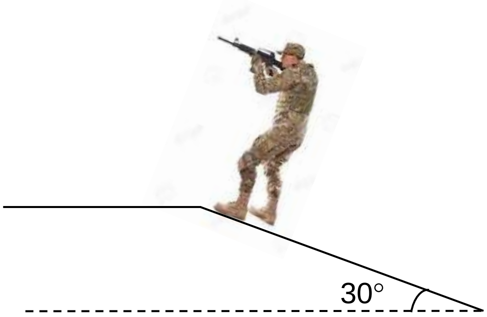


Fig. 6.1

Calculate the average acceleration of the man while firing.

average acceleration = ………………… m s^{-2} [4]

7 **(a)** Explain what is meant by the potential energy of a body.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) From the defining equation of work, show that the change in gravitational potential energy of a mass *m,* near the Earth's surface, when moved a distance *h* upwards is given by the equation

$$E_P = mgh,$$

where *g* is the acceleration due to gravity. [2]

(c) A car of mass 820 kg is travelling on a flat road at **P**. It then travels down a slope to **Q**, descending 5.0 m, as shown in Fig. 7.1

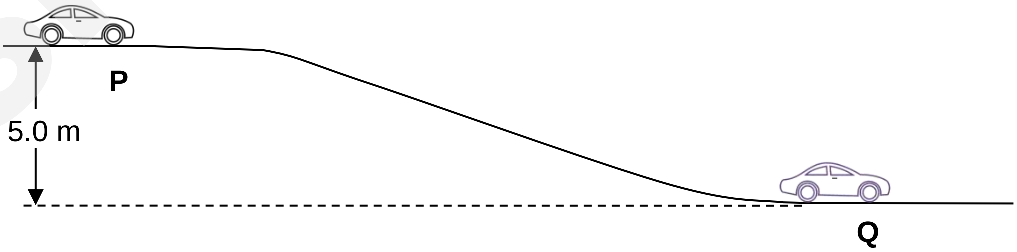


Fig. 7.1

(i) Calculate loss in gravitational potential energy of the car.

loss in gravitational potential energy = ………………… J [2]

(ii) The car is moving at a speed of (10 ± 1) m s^{-1} at point **P** and at (25 ± 3) m s^{-1} at point **Q**.

Determine the gain in kinetic energy of the car with its associated uncertainty.

gain in kinetic energy = ……………±………… J [4]

(iii) The fuel used during the journey has an energy rating of 42 MJ per kilogram. The mass of the fuel used was 35 g.

Calculate the efficiency in converting the stored energy in the fuel to the energy possessed by the car at its final speed at the bottom of the slope.

efficiency = ………………… % [3]

(iv) From point **Q,** the car then travels horizontally off the top of a cliff and enters the sea, as illustrated in Fig. 7.2.

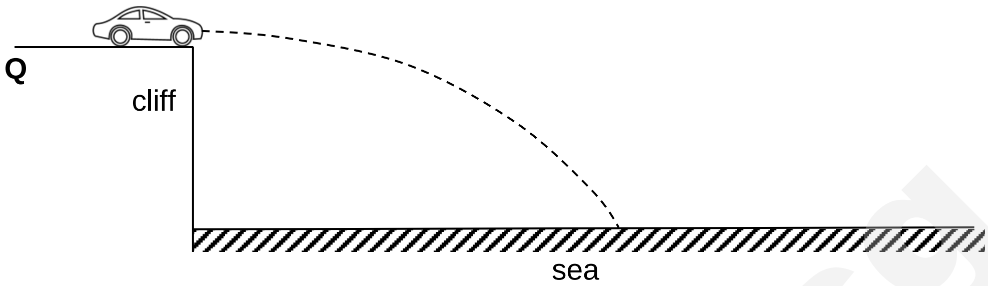


Fig. 7.2

Use energy considerations to suggest why, if the car causes a large splash on hitting the sea, it will be slowed down in a shorter distance than when no splash is produced.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………………… [3]

(d) The variation with speed v of the total resistive force F_R acting on a car at speed v to oppose its motion is shown in Fig. 7.3.

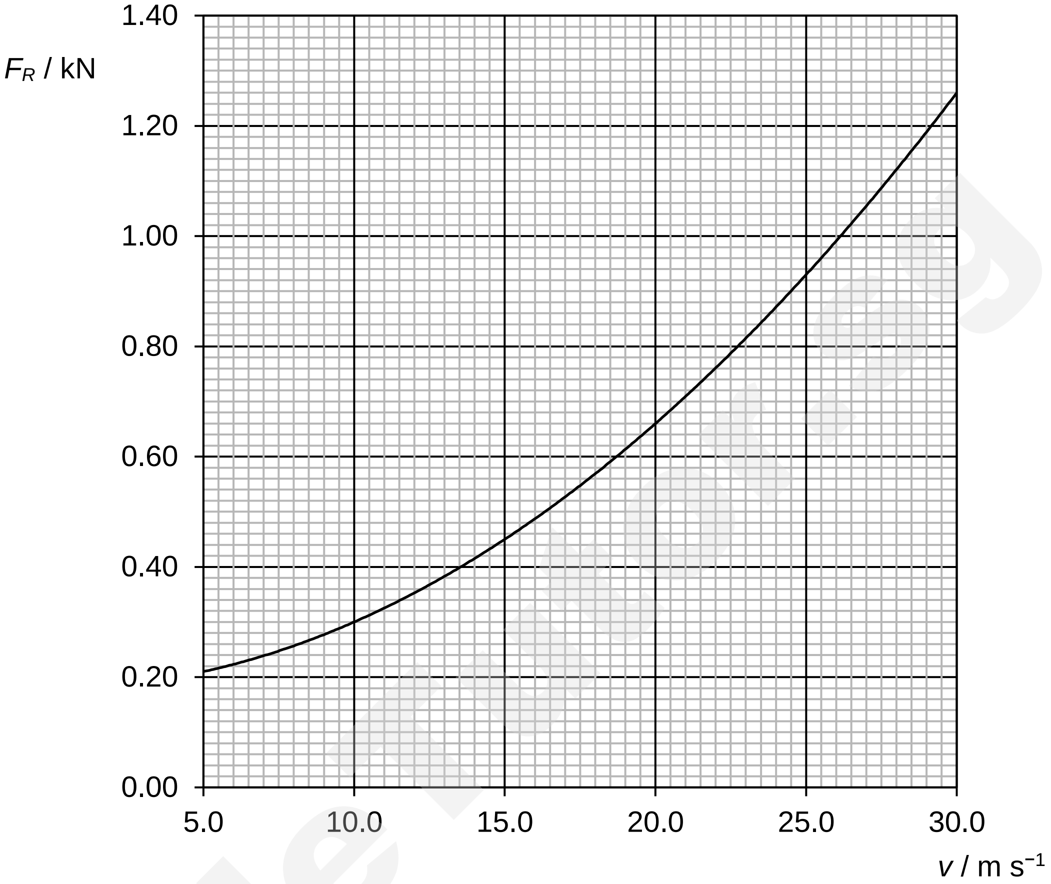


Fig. 7.3

Using the graph, show that the engine of the car needs to provide a greater power when the car is travelling at a constant speed of 30 m s^{-1} on a level road as compared to when it is travelling at a constant speed of 10 m s^{-1} on the same road.

Explain your workings. [4]

8 **(a)** Fig. 8.1 shows a set up for the electrolysis of sodium chloride solution using a 12 V cell. When dissolved in water, each sodium chloride yields a pair of oppositely charged ions; a positively charged sodium ion (Na^+) and a negatively charged chloride ion (Cl^-), both with a charge of *e*.

Fig. 8.2 shows the portion of the electrodes immersed in the solution. The electrodes are 7.5 cm apart and the immersed area parallel to each other is 23 cm^2. The resistivity of the given sodium chloride solution is 9.0 Ω cm.

You can assume that Na^+ and Cl^- are the only charge carriers.

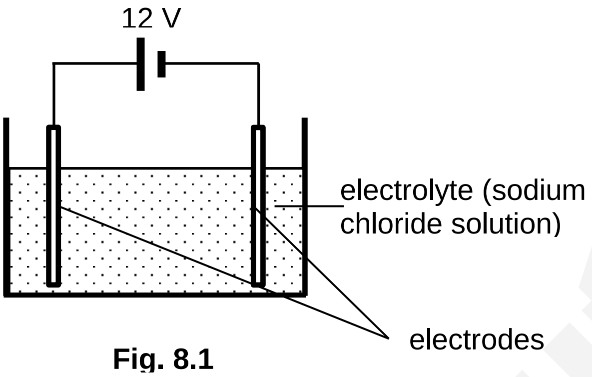


Fig. 8.1

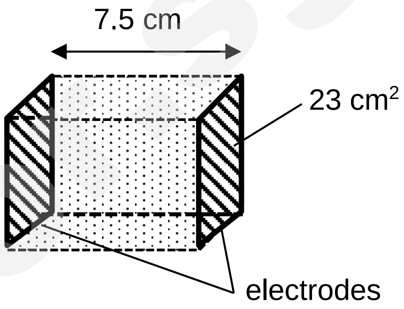


Fig. 8.2

(i) State what is meant by *resistance of a conductor*.

....

.... [1]

(ii) Calculate the resistance *R* of the sodium chloride solution.

R = ………………… Ω [2]

(iii) Hence calculate the current *I* passing through the sodium chloride solution.

I = ………………… A [2]

(iv) With reference to Fig. 8.1, state the direction of the net motion of sodium and chloride ions.

sodium ion = …………………

chloride ion = ………………… [1]

(v) Calculate the number of chloride ions that reaches the electrode in 2.0 s.

number of chloride ions = ………………… [3]

(vi) Calculate the energy supplied by the cell in 2.0 s.

energy supplied = …………………J [1]

(vii) Chloride ions forms chlorine gas as the electrolysis process progresses.

State and explain how the current would change.

....

....

.... [2]

(b) Fig. 8.3 shows a light-dependent resistor (LDR), a resistor R, and a relay in a circuit. The resistance of the LDR varies with the ambient light. In a bright environment, the LDR has a low resistance; as the environment darkens, its resistance increases.

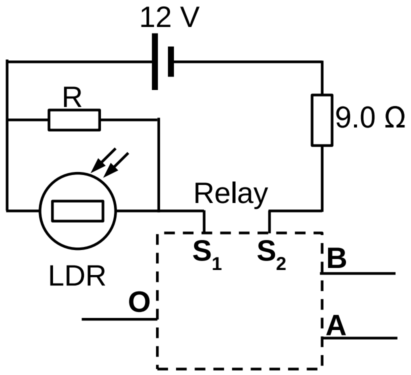


Fig. 8.3

Fig. 8.4 shows an electromagnetic switch setup within the relay. When the potential difference (p.d.) across **S_1S_2** is below 5.0 V, the metal lever, held in position by a spring, forms a conducting path between **O** and **A** (as shown).

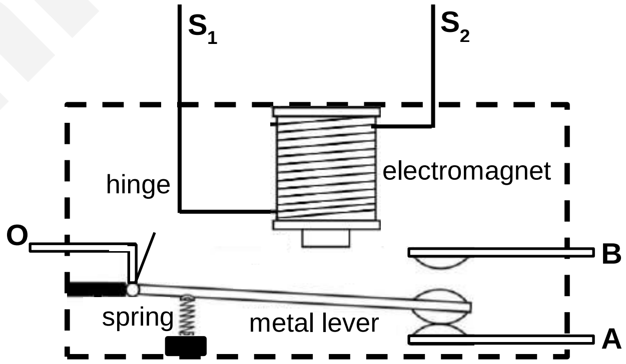


Fig. 8.4

When p.d. across **S_1S_2** is at the rated voltage of 5.0 V, 80 mA of current flows through the electromagnet. The electromagnet produces a sufficiently strong magnetic field to attract the metal lever, forming a conducting path between **O** and **B**. The relay is said to be triggered.

(i) A simple lighting circuit, using a battery and a lamp, can be connected to the relay in Fig. 8.3 such that the lamp lights up when the ambient light is below a certain threshold brightness.

On Fig. 8.3 sketch a possible circuit using appropriate circuit symbols. [2]

(ii) At the threshold brightness, the resistance of the LDR is 3.5 kΩ. Calculate a suitable resistance for the resistor R.

resistance = ………………… Ω [3]

(iii) An electrician found that when she replaces the 12 V cell in Fig. 8.3 with another cell of the same e.m.f., the threshold brightness that triggers the relay changes. Suggest a reason to why this happens.

....

....

.... [2]

(iv) The electrician wants to maintain the same threshold brightness without having to replace any component every time she changes the 12 V cell. Suggest how she can modify the circuit in Fig. 8.3.

....

.... [1]

End of Section B

H1 P2 solutions

1(a)

$$u(\cos 52)t = 4.6 ------1$$

$$u(\sin 52)t + 0.5(-9.81)t^2 = 1.5 -------2$$

Solve,

$t = 0.946$ s

$u = 7.90$ m s^{-1}

(b)

$$v_x = 7.8998\cos 52 = 4.8636$$

$$v_y = 7.8998\sin 52 + (-9.81)(0.9458) = -3.0532$$

$$\theta = \tan^{-1}\left(\frac{3.0532}{4.8636}\right) = 32.1°$$

Less than 34°, therefore the ball will not pass through the basket.

2 **(a)** transverse waves have vibrations that are perpendicular / normal to the direction of energy travel [B1]

longitudinal waves have vibrations that are parallel to the direction of energy travel [B1]

(b) **(i)** phase difference
=(0.4-0.1)/0.8 x 2π

Acceptable answers:
135° or 0.75π rad or ¾π rad or 2.36 radians

(three sf) numerical value [M1]
unit [A1]

(ii)

$$I \propto A^2$$

Using $$\frac{I_1}{I_2} = (\frac{A_1}{A_2})^2$$

$$\frac{I_1}{0.5I_1} = (\frac{2.8}{A_2})^2 \quad [M1]$$

$$A_2 = 1.98cm \quad [A1]$$

3 **(a)** The Principle of Superposition states that when two or more waves of the same kind overlap, the resultant displacement at any point at any instant is the vector sum of the displacements that the individual waves would have separately produced at that point and at that instant. (from notes) [B1]

(b) **(i)** When coherent waves emerging from slits meet at a point on the screen with a phase/path difference, [B1]

When waves meet in phase with phase difference is n(2π rad)/ path difference is integer ×λ, constructive interference occurs. And at the points where the waves meet exactly out of phase (any equivalent explanation of minima e.g. (n+½)×360°), destructive interference occurs. [B1]

(ii) $x = \frac{\lambda D}{a}$

x = $(4.5 \times 10^{-7})(2.5)/(0.35 \times 10^{-3})$ [M1]

= 3.21×10^{-3} m [A1]

(iii) 1. Red light has <u>longer wavelength</u>, hence <u>larger separation/distance between maximas [B1]</u>

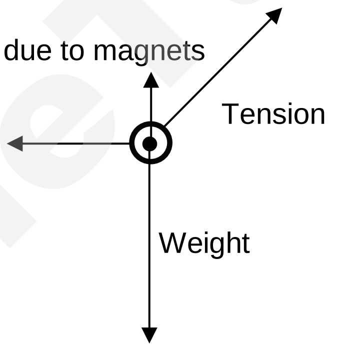
$x = \frac{\lambda D}{a}$

Since D and a remains constant, when wavelength increases, slit separation increases

2. <u>The fringe separation close to the screen will be closer to one another and the fringe separation further from the screen will be further apart</u> as screen separation is directly proportional to screen-to-slit distance. [B1]

<u>The nearer fringes will be brighter and have greater contrast and those futher away will be dimmer and less contrast. [B1]</u>

4 (a) (i)



For each force drawn, it must be labelled and of the correct length [B2]

(ii) $F = BIL = (3.2\times10^{-3})(5.0)(0.20) = 3.2\times10^{-3}$N [B1]

(iii) Magnitude of T_x = Magnitude of force due to conductor B [B1]

$$|T_x| = |BIL| = \frac{\mu_o I}{2\pi d}(I)(L) = \frac{4\pi\times10^{-7}}{2\pi(0.010)}(5.0)(5.0)(0.20)$$

$= 1.0\times10^{-4}$N

$T_y + F_{magnets} = mg$

$$T_y = mg - F_{magnets} = (\frac{0.35}{1000}\times9.81) - 3.2\times10^{-3}$$ [B1]

$= 2.3\times10^{-4}$N

[B1]

Tension = $\sqrt{(1.0\times10^{-4})^2 + (2.3\times10^{-4})^2} = 2.54\times10^{-4}$

$$\tan\left(\frac{\theta}{2}\right) = \frac{T_x}{T_y} = \frac{1.0\times10^{-4}}{2.3\times10^{-4}}$$ [B1]

$\theta = 47^0$

5 a **(i)** Using the points (4.90, 0.10), (7.70. 1.90)

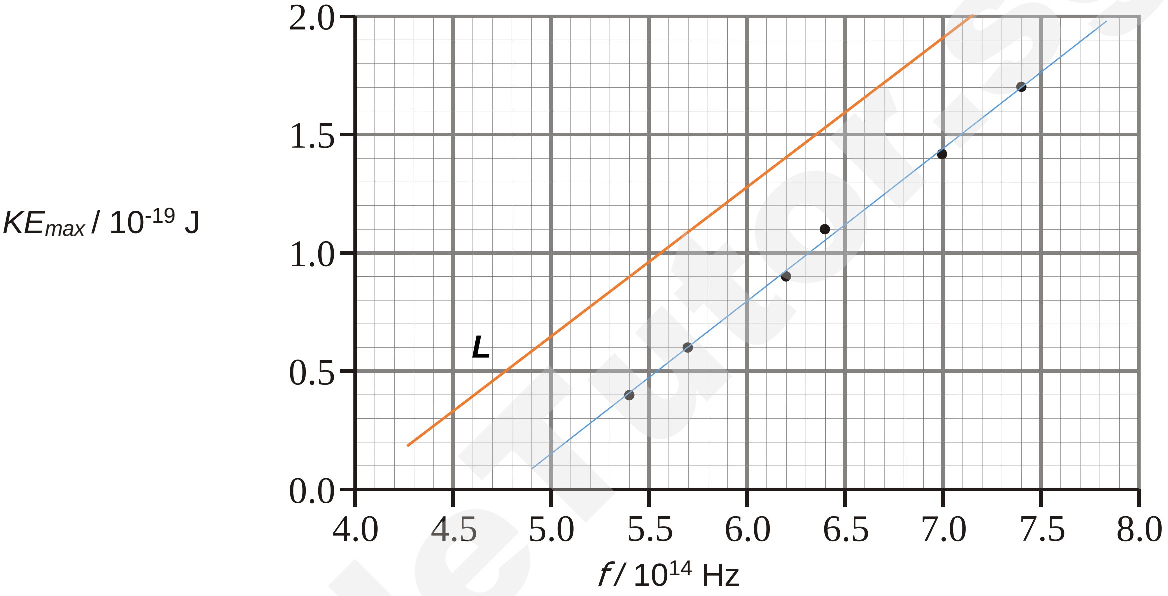


Fig. 5.1

h = slope of the graph = $\frac{(1.90-0.10)\times10^{-19}}{(7.70-4.90)\times10^{14}} = \frac{1.8\times10^{-19}}{2.8\times10^{14}}$

= 6.4 × 10^{-34} J s

($5.9 \leq$ h/10^{-34} Js ≤ 6.8) accepted

[M1] – calculation of gradient using two points on line of best fit (not plotted point)

[A1]- correct calculation of Planck's constant.

(ii) frequency intercept, f_o = 4.9 × 10^{14} Hz; [M1]

therefore work function $\phi = hf_o$ = (4.9 × 10^{14})× (6.9 × 10^{-34})

= 3.4 × 10^{-19} J [A1]

(Students must use value for h obtained in (b)(i) for full credit, to be consistent with KEmax = hf - ϕ, i.e. if answer had been found instead from the vertical intercept)

Minus 1 only if h = 6.63 x 10^{-34} Js used)

(b)

The spectral lines are produced when **<u>photons emitted when the electrons in the atoms de-excite from a higher energy level to a lower energy level</u>**. [B1]

The **<u>photon energy/wavelength/frequency depends on the energy difference</u>** between the 2 energy levels. [B1]

Since the energy levels are discrete, **<u>only light of specific wavelengths</u>/frequency** are produced. [B1]

(c) **(i)** Energy absorbed by the ground state electron to transit to higherst possible level 4 = (5.45 – 0.78) $\times 10^{-19}$ = 4.67 $\times 10^{-19}$ J [C1]

Kinetic energy of the scattered electron, K = (5.00 – 4.67) $\times 10^{-19}$ [M1]
= 0.33 $\times 10^{-19}$ J [A0]

(ii)

Momentum of the scattered electron, p = $\sqrt{2mK}$
$= \sqrt{2 \times 9.11 \times 10^{-31} \times 0.33 \times 10^{-19}}$ [C1]
= 2.45 $\times 10^{-25}$ kg m s^{-1}

de-Broglie wavelength = h/p = [M1]

$$= \frac{6.63 \times 10^{-34}}{2.45 \text{x} 10^{-25}} = 2.70 \text{x} 10^{-9} \text{ m}$$ [A1]

6 **(a)** Mass [B1]

(b) Impulse of a force is defined as the product of force and time of impact, and is equal to the change in momentum. [B1]

(c) **(i)** By Newton's 3rd law, when the machine gun exerts a force on the bullet, the bullet exerts an equal force but opposite direction on the gun and soldier. [B1]

This force causes the soldier and the machine gun to experience a change in momentum according to Newton's 2nd law that propelled the man backwards. [B1]

(ii) By conservation of momentum,
total momentum just before firing = total momentum just after firing

0 = momentum of bullets + momentum of man
[C1- for stating zero initial momentum]

$0 = 10 \times 1.0 \times 10^{-2} \times 750 - [90 - (10 \times 1.0 \times 10^{-2})]\, v$ [M1]

$v = 0.83426 \text{ m s}^{-1}$
$= 0.834 \text{ m s}^{-1}$ [A1]

[Note: deduct one mark for ii, iii, iv if students did not consider reduction in mass due to bullets being shot out]

(iii) Let average force exerted on man be F
$F\Delta t = \Delta p$

$F\Delta t$ = mass of man (final velocity of man – initial velocity of man)

$F(2.0) = [90 - (10 \times 1.0 \times 10^{-2})]\,(0.83426 - 0)$ [M1]

$F = 37.5 \text{ N}$ [A1]
.

(iv) **1.** Perfectly inelastic collision [B1]

2. By conservation of momentum,
initial momentum = final momentum

$$0.010 \times 750 = (0.010 + 0.500)v \quad \text{[M1]}$$
$$v = 14.706 \text{ m s}^{-1}$$

Acceleration of block and bullet,
$F_{net} = ma$
$30 = 0.510a$
$a = 58.82 \text{ m s}^{-2}$ [M1]

By kinematics
$v^2 = u^2 + 2as$
$0 = 14.706^2 + 2(-58.82)s$ [M1]
$s = 1.84 \text{ m}$ [A1]

OR:
By conservation of momentum,
initial momentum = final momentum

$$0.010 \times 750 = (0.010 + 0.500)v \quad \text{[M1]}$$

$$v = 14.706 \text{ m s}^{-1}$$

By conservation of energy,
Loss in KE = Work done by frictional force
½ mv^2 = F s [C1- if using conservation of energy correctly]
½ x 0.510 x 14.706^2 = 30 s [M1]
s = 1.84 m [A1]

3. <u>Part of the loss in KE needs to account for the increase in gravitational potential energy of the block-bullet system</u> besides the work done by frictional force. [M1]

Hence, the distance would be shorter. [A1]

(d) Since the man fired another 10 bullets in 1.0s, the average force acting on the man by the bullets is now doubled; i.e. F = 75 N (along the slope). [M1]

The man also experiences a downward force along the slope due to the component of gravitational force along the slope.
F_{down} = mg sin30° = (90- (20x0.01)) x 9.81 x sin 30 = 440.5 N. [M1]

Therefore, Fnet = ma
440.5 +75 = [90- (20x0.01)] a [M1]
a = 5.74 m s^{-2} [A1]

7 (a) Potential energy of a body is its ability to do work [B1] as a result of the position / shape, etc of an object [B1]

(b) The mass is raised to a vertical height h_f above the ground at a *constant velocity (i.e. there is no change in kinetic energy)* by an external force *F*.

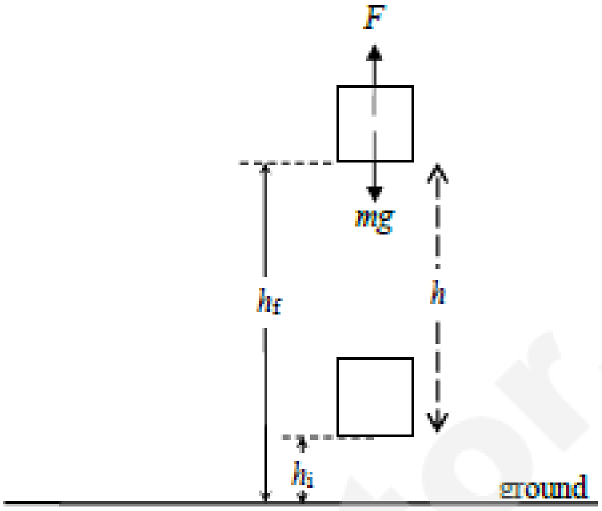


Figure: An object of mass *m* raised vertically by $h = h_f - h_i$.

Since velocity is constant, *Net force = 0*
[M1 given for describing constant velocity/ evidence of understanding that acceleration = 0]

$$F - mg = 0 \rightarrow F = mg$$

Hence,

Work done by external force *F* moving mass m through height
= $mg\ (h_f - h_i)$ = Change in Gravitational Potential energy [M1]
h_i must be shown

Since $h = h_f - h_i$,
Change in gravitational potential energy = mgh [A0]

(c) (i) Loss in GPE = initial GPE – final GPE
= (820)(9.81)(5.0) [M1]
= 4.0 x 10^4 J [A1]

(ii) Gain in KE = $\frac{1}{2}\ m(v_f^2 - v_i^2)$ [C1]
= ½ (820)($25^2 - 10^2$) [M1]
= 215 250 J

Max-Best method
Max change in KE = ½ (820)($28^2 - 9^2$) = 288 230 J
Absolute uncertainty = (288 230 – 215 250) [M1]
= 72 980 J
= 70 000 J (1 s.f.)

Change in KE = (220 000 ± 70 000) J [A1]

(iii) Change in energy = change in GPE + change in KE
= -40 200 + 215 250 [M1]
= 1.751×10^5 J

Energy supplied by fuel = (35/1000) (42×10^6) = 1.47×10^6 J [M1]

Efficiency = $\frac{1.751 \times 10^5}{1.470 \times 10^6} \times 100\%$ = 12 % [A1]

(iv) When the car enters the water, its kinetic energy is converted into sound energy, thermal energy due to work done again resistive forces and kinetic energy of the water splash. [B1]

When there is a large splash, a larger part of the car's initial kinetic energy is converted to KE of the water. Hence a smaller part of the car's initial kinetic energy can be converted to work done against resistive forces in the sea. [B1]

Since work done against resistive force = resistive force x displacement against the force, the car will slow down in a shorter distance if there is a large splash. [B1]

(d) To travel at constant speed, the driving force provided by the car engine must be equal in magnitude to the resistive force such that there is no net force on the car. [B1]

Power provided by the car engine = driving force x velocity of the car, [B1]
(do not accept F_R x v) Unclear workings without explanation gains 2 max 2 marks.

When the car is travelling at 10 m s^{-1}, therefore the driving force = 0.30 kN P = 3.0 kW [B1] [B1]

When the car is travelling at 30 m s^{-1}, therefore the driving force = 1.26 kN. P = 37.8 kW [B1] [B1]

Hence a greater power must be delivered at 30 m s^{-1}.

8 **(a)** **(i)** Resistance of a conductor is the ratio of the potential difference **across** the conductor to the current flowing **through** it. [B1]

(ii)

$$R = \rho \frac{l}{A}$$

$$= (9.0)\left(\frac{7.5}{23}\right) \qquad \text{[M1]}$$

$$= 2.9\ \Omega \qquad \text{[A1]}$$

(iii)

$$I = \frac{V}{R}$$

$$= \frac{12}{2.9} \qquad \text{[M1]}$$

$$= 4.1\ \text{A} \qquad \text{[A1]}$$

(iv) sodium ion = right; chloride ion = left [B1]

(v)

$$Q = It$$

$$= (4.1)(2.0) = 8.2\ \text{C} \qquad \text{[M1]}$$

Each sodium chloride will produce two charge carriers, one of which is chloride ion.

No. of chloride ions

$$= \frac{8.2}{2(1.6 \times 10^{-19})} \qquad \text{[M1]}$$

$$= 2.6 \times 10^{19} \qquad \text{[A1]}$$

(vi)

$$W = IVt$$

$$= (4.1)(12)(2.0) = 98.4\ \text{J} \quad \text{[B1]}$$

Alt:

$$W = qV$$

$$= (8.2)(12) = 98.4\ \text{J} \qquad \text{[B1]}$$

(vii) As chloride ions form chlorine gas, the number of charge carriers per unit volume decreases. [M1]

Hence the current decreases. [A1]

(b) **(i)** Note: When it is dark, the LDR will have high resistance. As such a small voltage will fall across the relay, which will not be sufficient to flip the metal lever to **B**. Hence the lighting circuit should be connected to **OA**.

[B1] – connection of a closed circuit (with power source) to **OA**. (award even if circuit if not workable)
[B1] – a workable lighting circuit drawn using appropriate circuit symbols

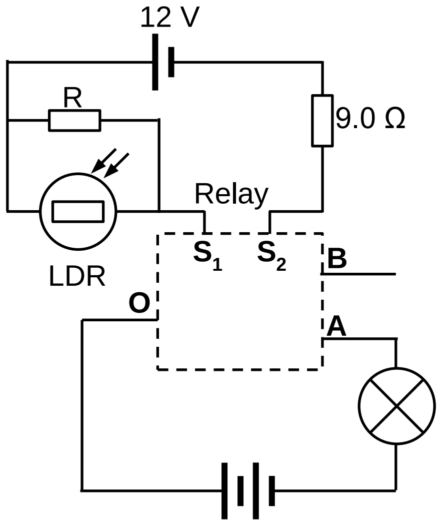


Fig. 8.3

(ii) To activate the relay, I = 80 mA and p.d. across S_1S_2 is 5.0 V

$$\text{Total resistance of circuit} = \frac{\text{"p.d. across LDR, R and 9.0 }\Omega\text{"}}{\text{current}}$$

$$= \frac{12 - 5.0}{80 \times 10^{-3}}$$

$$= 87.5\ \Omega$$

Resistance of LDR and R = $87.5 - 9.0$ [M1]

$= 78.5\ \Omega$

$$\frac{1}{3500} + \frac{1}{R_R} = \frac{1}{78.5} \quad \text{[M1]}$$

$$R_R = 80\ \Omega \quad \text{[A1]}$$

(iii) The new cell may have a <u>different internal resistance</u>. [M1]
At the original threshold brightness, the <u>potential difference across the relay is lower</u> than 5.0V. [A1]
Hence it is not able to trigger the relay.

(iv) <u>Replace the 9.0 Ω with a variable resistor</u>. [B1]
OR
<u>Replace resistor R with a variable resistor</u>.

Class Adm No

Candidate Name: ________________________________

H

2017 Promotional Examination II

Pre-university 2

H1 PHYSICS **8866/01**

Paper 1 MCQ **18 Sep 2017**

Monday **1 hour**

Additional Materials: OMR Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and admission number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OMR Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 15 printed pages and 1 blank page.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	$\rho g h$
resistors in series	R	=	$R_1 + R_2 + \ldots..$
resistors in parallel	1/R	=	$1/R_1 + 1/R_2 + \ldots..$

1 The volume of liquid flowing per second is called the volume flowrate Q and has the unit m^3 s^{-1}. The flowrate of blood in an artery can be estimated with the following equation:

$$Q = \frac{\pi R^{\alpha}(P_2 - P_1)}{8\eta L}$$

The length and radius of the artery are L and R, respectively. P_2 - P_1 gives the pressure difference between the ends of the artery. The viscosity of the blood is given by η which has the unit kg m^{-1} s^{-1}.

What is the value of α?

A 2

B 3

C 4

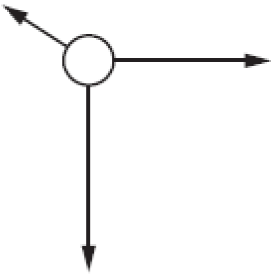
D 8

2 The external and internal diameters of a cylinder are measured. The external diameter of the cylinder is 95.0 ± 0.1 mm and the internal diameter is given by 87.0 ± 0.1 mm. What is the average wall thickness?

A 4.0 ± 0.1 mm **B** 8.0 ± 0.1 mm

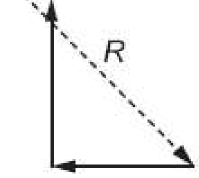
C 4.0 ± 0.2 mm **D** 8.0 ± 0.2 mm

3 Three wires each exert a force along the same horizontal plane on a vertical pole. The top view of the pole is shown below.

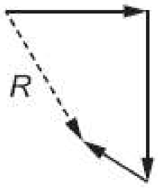


Which vector diagram shows the resultant force R acting on the pole?

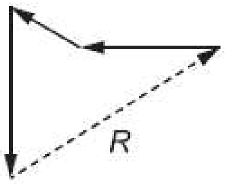
A



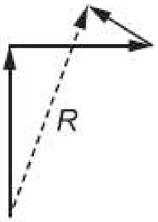
B



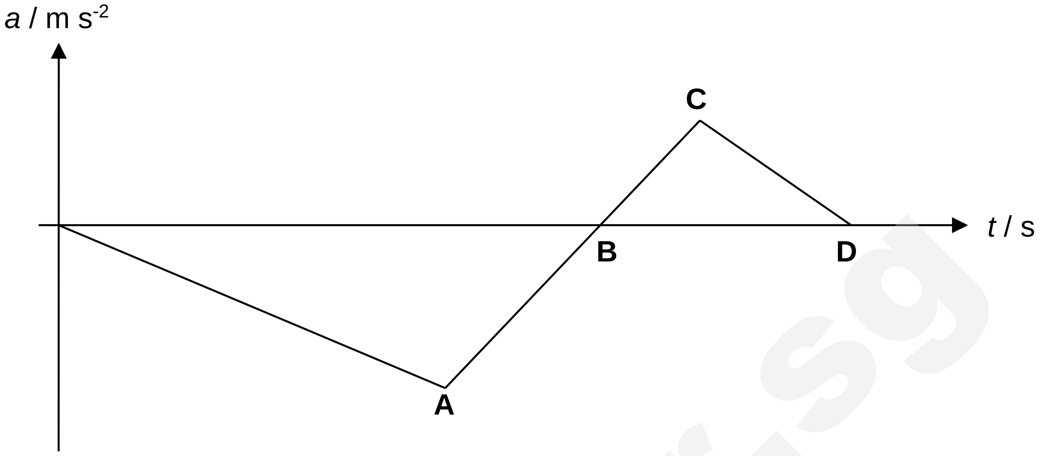
C



D



4 The acceleration-time graph of a car in a straight line is as shown below. The car started its motion from rest.



At which point is the car moving with the largest speed?

5 An object has an initial velocity u and an acceleration a. The object moves in a straight line through a displacement s and has final velocity v. These quantities are related by the equation $v^2 = u^2 + 2as$.

Which condition **must** be satisfied in order for this equation to apply to the motion of the object?

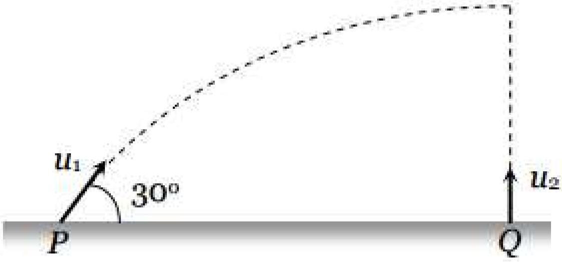
A The direction of a is constant and the direction of a is the same as the direction of s.

B The direction of a is constant and the direction of a is the same as the direction of u.

C The magnitude of a is constant and the direction of a is constant.

D The magnitude of a is constant and the direction of a is the same as the direction of v.

6 Two projectiles **P** and **Q** are launched at the same time. **P** is projected with velocity u_1 at an angle of 30˚ with the horizontal while **Q** is thrown vertically upwards with velocity u_2 from a point vertically below the highest point of path of **P**.



What is the necessary condition for **P** and **Q** to collide at the highest point?

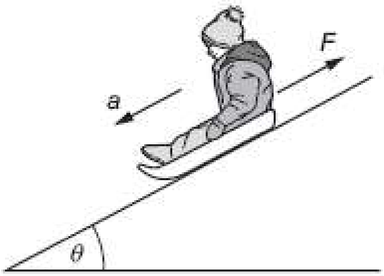
A $u_1 = u_2$ **B** $u_1 = 2u_2$ **C** $u_1 = \frac{1}{2}u_2$ **D** $u_1 = 4u$

7 A 2.0 kg mass travelling at 3.0 m s^{-1} on a frictionless surface collides head-on with a stationary 1.0 kg mass. The masses stick together on impact.

How much energy is lost on impact?

A zero **B** 2.0 J **C** 2.4 J **D** 3.0 J

8 An Eskimo sitting on a sledge slides down a hill with acceleration a. The hill makes an angle θ with the horizontal.



The total mass of the Eskimo and the sledge is m. Given that the acceleration of free fall is g, what is the friction force F?

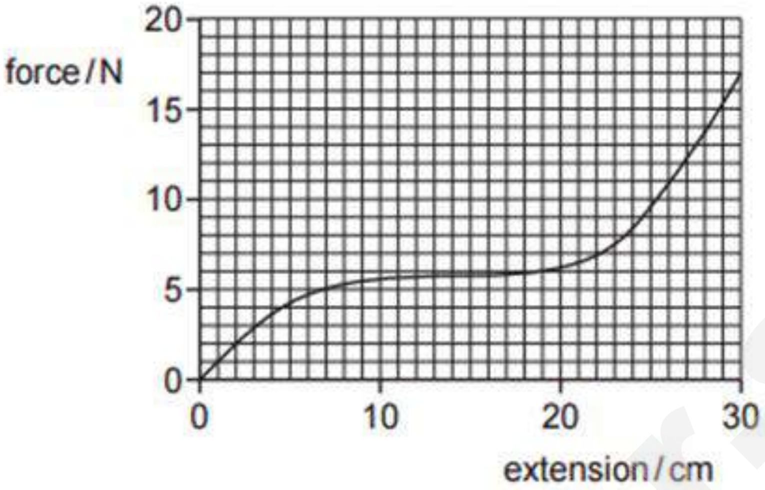
A m(g cosθ – a)

B m(g cosθ + a)

C m(g sinθ – a)

D m(g sinθ + a)

9 A elastic watch strap is stretched by hanging weights on it and the force-extension graph is plotted.



What is the best estimate of the elastic potential energy stored in the watch strap when it is extended by 30 cm?

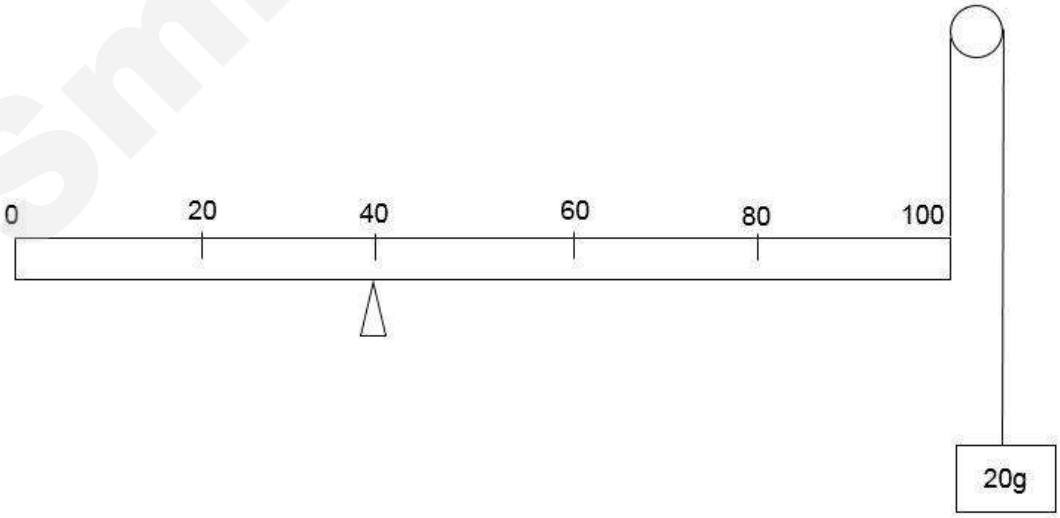
A 2.0 J

B 2.6 J

C 5.1 J

D 200 J

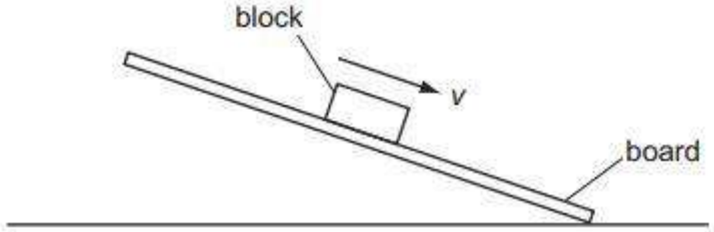
10 A uniform metre rule of mass 100 g is supported by a knife-edge at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.



At which mark on the rule must a 50 g mass be suspended so that the rule balances?

A 4 cm **B** 36 cm **C** 44 cm **D** 96 cm

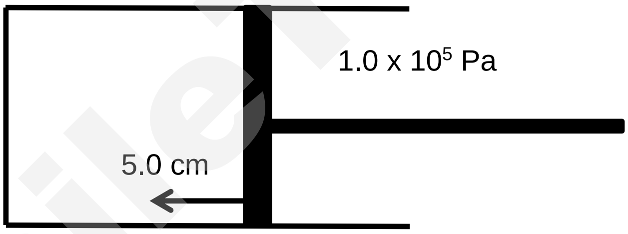
11 A wooden block rests on a rough board. The end of the board is then raised until the block slides down the plane of the board at constant velocity v.



Which row describes the forces acting on the block when sliding with constant velocity?

	frictional force on block	**resultant force on block**
A	down the plane	down the plane
B	down the plane	zero
C	up the plane	down the plane
D	up the plane	zero

12 An ideal gas within a pistol was compressed with a piston as shown below without a change in pressure within the tube. The pistol has a cross-sectional area of 2.0×10^{-4} m^2.



The pressure of the atmosphere is 1.0×10^5 Pa. What is the work done on the gas by the atmosphere, when the piston compresses the gas by 5.0 cm?

A - 0.6 J **B** 0.4 J **C** 0.6 J **D** 1.0 J

13 A body of mass 5.0 kg is initially travelling at a constant speed of 2.0 m s^{-1} on a horizontal frictionless surface. A force of 15 N acts on it and accelerates it to a final velocity of 12.0 m s^{-1}.

What is the work done by the force?

A 150 J **B** 180 J **C** 250 J **D** 350 J

14 Water from a reservoir is fed to the turbine of a hydroelectric system at a rate of 500 kg s^{-1}. The reservoir is 300 m above the level of the turbine. The electrical output from the generator driven by the turbine is 200 A at a potential difference of 6000 V.

What is the efficiency of the system?

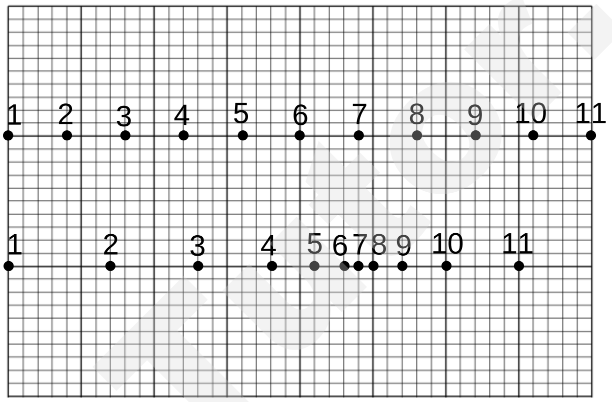
A 8.6 % **B** 12 % **C** 24 % **D** 82 %

15 Fig. 15.1 shows the positions of equally spaced air molecules.

A longitudinal sound wave travels from left to right. At a certain instant, the displaced positions of the air molecules are shown in Fig. 15.2.

Fig. 15.1

Fig. 15.2



Immediately afterwards, what will be the directions of motion of particles 1 and 7?

	particle 1	**particle 7**
A	to the right	to the right
B	to the right	to the left
C	to the left	to the right
D	to the left	to the left

16 A point source of sound emits energy equally in all directions at a constant rate. A detector is placed 3.0 m from the source and it measures an intensity of 5.0 W m^{-2}.

The amplitude at the source is then doubled.

What is the intensity, in W m^{-2} if the detector is now placed at a distance 4.0 m from the source?

A 0.45

B 0.56

C 11

D 15

17 17.1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet. 17.2 shows the same tank with a slit of greater width. In each case, the pattern of the waves incident on the slit and the emergent pattern are shown.

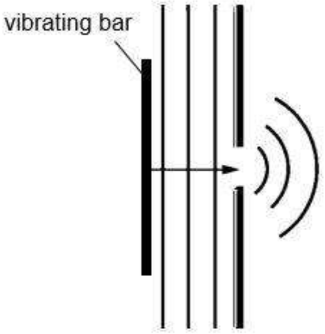


Fig. 17.1

Fig. 17.2

Which action would cause the waves in Fig. 17.1 to be diffracted less and so produce an emergent pattern shown in Fig. 17.2?

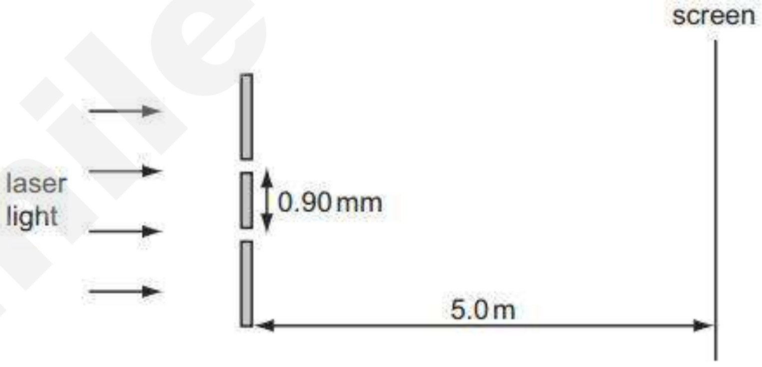
A increasing the frequency of vibration of the bar

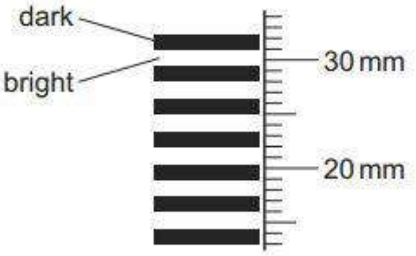
B increasing the speed of the waves by making the water in the tank deeper

C reducing the amplitude of vibration of the bar

D reducing the length of the vibrating bar

18 The diagrams show the arrangement of apparatus for a Young's slits experiment and also part of the pattern formed on the screen with a ruler placed next to it.





What is the wavelength of the light?

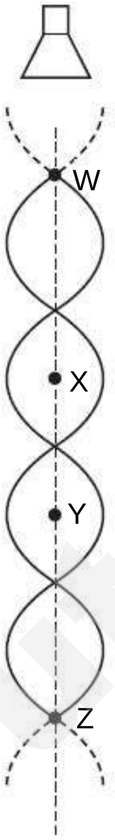
A 4.8×10^{-7} m

B 5.4×10^{-7} m

C 3.2×10^{-6} m

D 3.4×10^{-6} m

19 The diagram represents the pattern of stationary waves formed by the superposition of sound waves from a loudspeaker and their reflection from a metal sheet. The metal sheet is not shown in the diagram.



W, X, Y and Z are four points on the line through the centre of these waves.

Which statement about these stationary waves is correct?

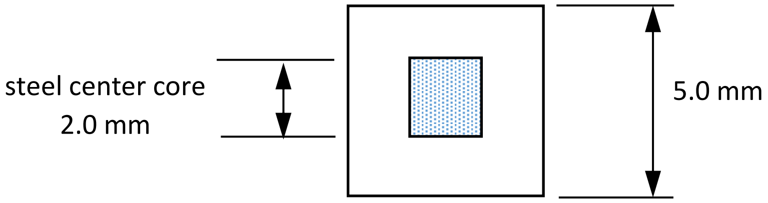
A An antinode is formed at the surface of the metal sheet.

B The oscillations at X are in phase with those at Y.

C The air particles oscillate perpendicular to the line WZ.

D A node is a quarter of a wavelength from an adjacent antinode.

20 A 5.0 mm square wire comprises a steel square center core of length 2.0 mm surrounded by a coating of aluminium.

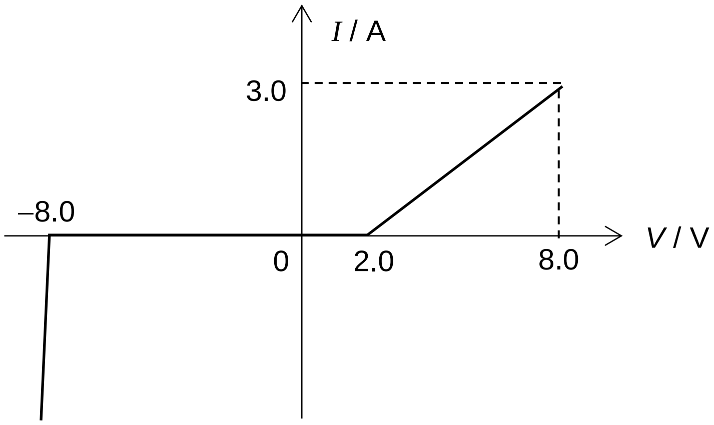


The resistivity of steel and aluminium are 1.0 x 10^{-7} Ω m and 2.8 x 10^{-8} Ω m respectively.

What is the resistance for a length of 1.0 m of such a wire?

A 1.07 mΩ **B** 1.27 mΩ **C** 2.83 mΩ **D** 26.3 mΩ

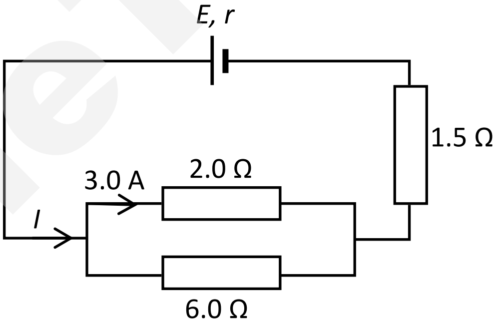
21 The I-V graph for a conductor is shown below.



What are the possible values of its resistance when a potential difference of 6.0 V is applied to it?

A zero, 2.0 Ω **B** zero, 3.0 Ω **C** ∞, 2.0 Ω **D** ∞, 3.0 Ω

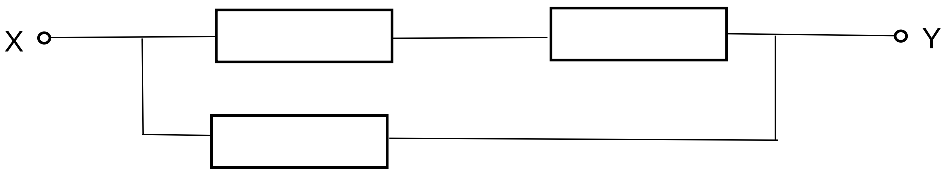
22 Two parallel resistors with resistance 2.0 Ω and 6.0 Ω are connected in series with another resistor of 1.5 Ω and a source of e.m.f. E. The source has internal resistance r. There is a current of 3.0 A in the 2.0 Ω resistor.



It is known that the source has an output efficiency of 90 % in its power delivery to the external circuit. What are the values of the current I delivered by the source and its e.m.f. E?

	I / A	E / V
A	3.0	12.0
B	4.0	10.8
C	4.0	13.3
D	12	18.0

23 Three resistors, each with resistance R, are connected in a network, as shown.



The total resistance between points X and Y is 8.0 Ω.

What is the value of R?

A 2.7 Ω

B 4.0 Ω

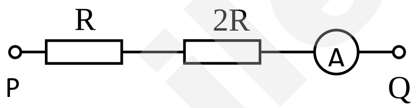
C 5.3 Ω

D 12 Ω

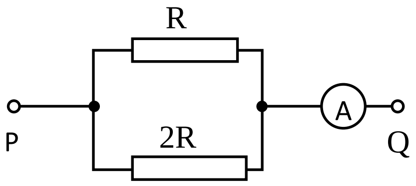
24 An ammeter with a resistance of 2R is connected differently in each of the following configurations.

The same potential difference is applied across P and Q. In which configuration does the ammeter give the smallest reading?

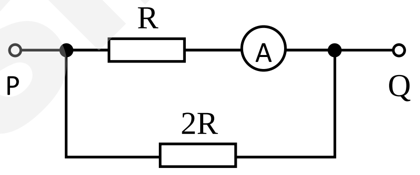
A



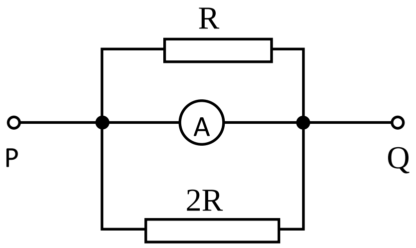
B



C



D



25 Fig. 25.1 shows a vertical square coil of 50 turns, carrying a current of 3.0 A. The length of each side of the coil is 4.0 cm. Fig. 25.2 shows a view of this coil from above when placed within a horizontal magnetic field of flux density 0.20 T.

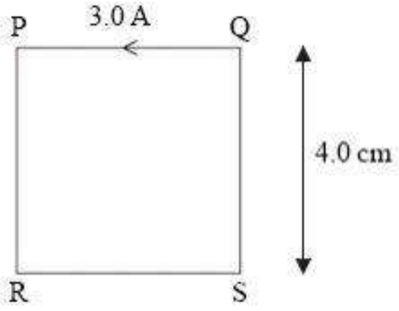


Fig. 25.1

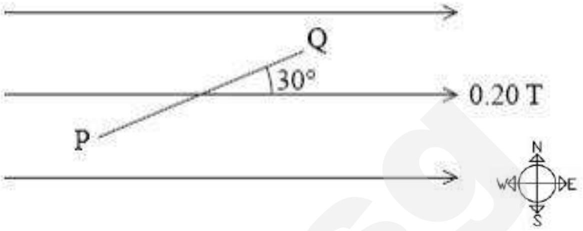
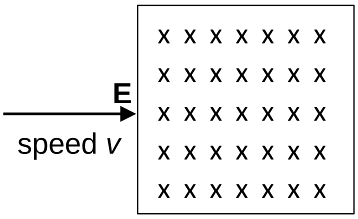


Fig. 25.2

The force on side QS is

	magnitude / N	direction
A	1.2 N	north
B	1.2 N	south
C	0.6	north
D	0.6	south

26 The figure shows a square uniform magnetic field directed into the plane of the paper. An electron with speed v is travelling in the plane of the field from point E.

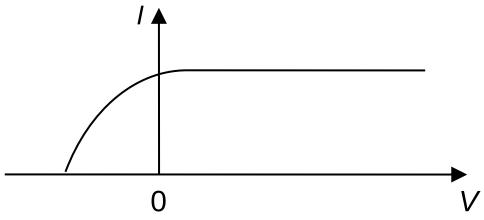


magnetic field

Which of the following correctly describes the deflection and speed of the electron with which it exits the magnetic field?

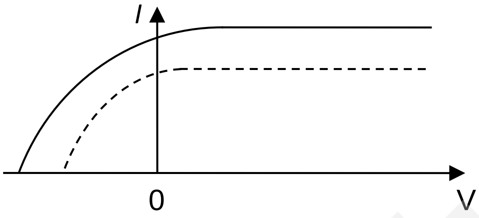
	deflection	exit speed
A	upwards	*v*
B	downwards	*v*
C	upwards	greater than *v*
D	downwards	greater than *v*

27 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photo-electrons which are collected at an adjacent electrode. For a given intensity of light, the way in which the photocurrent *I* depends on the potential difference *V* between the electrodes is as shown in the diagram below.

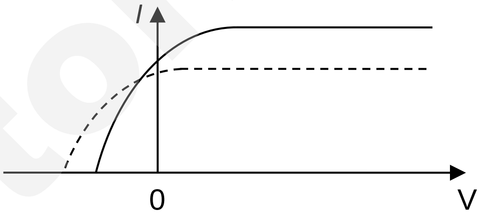


Which of the following graphs show the result when the frequency of the light is increased while the **intensity remains constant**? (The solid curve represents the original graph and the dotted curve represent the new graph.)

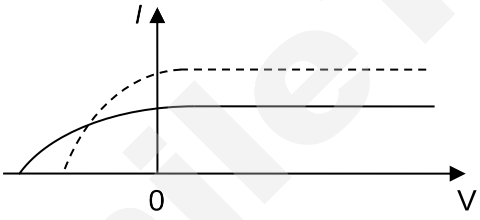
A



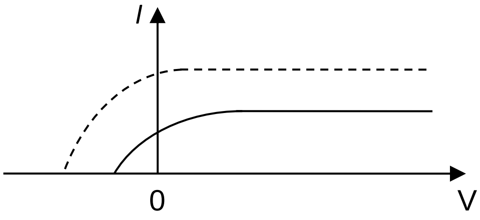
B



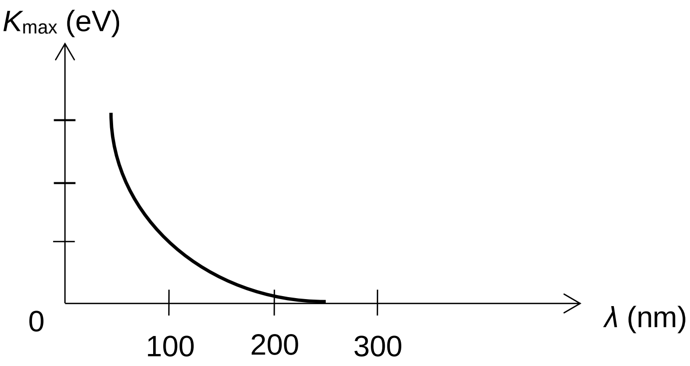
C



D

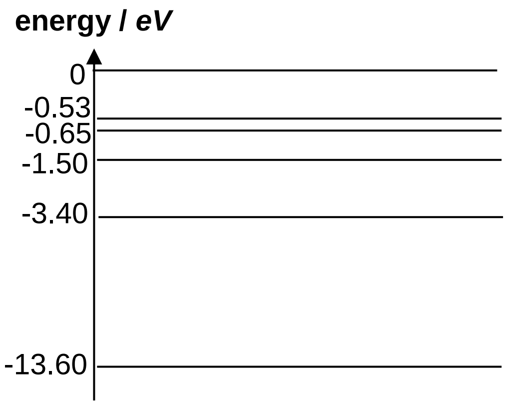


28 In a photoelectric experiment, the maximum kinetic energy of the ejected photoelectrons is measured for various wavelength of incident electromagnetic radiation. A graph of this maximum kinetic energy, K_{max}, as a function of the wavelength λ of the incident electromagnetic radiation falling on the surface of a metal is shown below. What is the work function for this metal?



A 4.97 eV **B** 6.22 eV **C** 7.96 eV **D** 24.9 eV

29 The energy level diagram for an atom is as shown below.



Which one of the following statements is correct?

A The most stable state of the atom is the level with zero energy.

B An electron can transit from the -0.53 eV level to 0 eV level by emitting an electron of energy 0.53 eV.

C An incident photon of energy 11 eV can impart part of its energy during collision with the atom and excite an electron in the atom from ground state to the -3.40 eV level. The photon will be deflected with a smaller energy of 0.8 eV.

D An incident electron of energy 11 eV can impart part of its energy during collision with the atom and excite an electron in the atom from ground state to the -3.40 eV level. The electron will be deflected with a smaller energy of 0.8 eV.

30 When an atom absorbs radiation of wavelength λ_X, the electron within the atom makes a transition from its ground state of energy E_1 to an excited state of energy E_3. Then it makes a second transition to a state of lower energy E_2, emitting radiation of wavelength λ_Y.

What is the wavelength of the radiation λ_Z emitted by the atom when it makes a third transition back to the ground state?

A $\lambda_x - \lambda_Y$

B $\lambda_X + \lambda_Y$

C $\dfrac{\lambda_X \lambda_Y}{\lambda_Y - \lambda_X}$

D $\dfrac{\lambda_Y - \lambda_X}{\lambda_X \lambda_Y}$

End of paper

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Candidate Name: ________________________________

Class	Adm. No.

H

millennia institute

2017 Promotional Examination II

Pre-university 2

H1 PHYSICS **8866/02**

Paper 2 Structured Questions **13 Sep 2017**

2 hours

Candidates answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 6**
2	**/ 9**
3	**/ 5**
4	**/ 11**
5	**/ 9**
Section B	
6	**/ 20**
7	**/ 20**
8	**/ 20**
TOTAL	**/ 80**

This document consists of **26** printed pages.

Data

speed of light in free space c = 3.00 x 10^{8} m s^{-1}

elementary charge e = 1.60 x 10^{-19} C

the Planck constant h = 6.63 x 10^{-34} J s

unified atomic mass constant u = 1.66 x 10^{-27} kg

rest mass of electron m_e = 9.11 X 10^{-31} kg

rest mass of proton m_p = 1.67 X 10^{-27} kg

acceleration of free fall g = 9.81 m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas $W = p\Delta V$

hydrostatic pressure $p = \rho gh$

resistors in series, $R = R_1 + R_2 + ...$

resistors in parallel $1/R = 1/R_1 + 1/R_2 + ...$

Section A

Answer **all** the questions in this section

1 Fig. 1.1 (not to scale) shows an experimental set-up for the Young's double slit experiment in which the source is a coherent light source of wavelength λ.

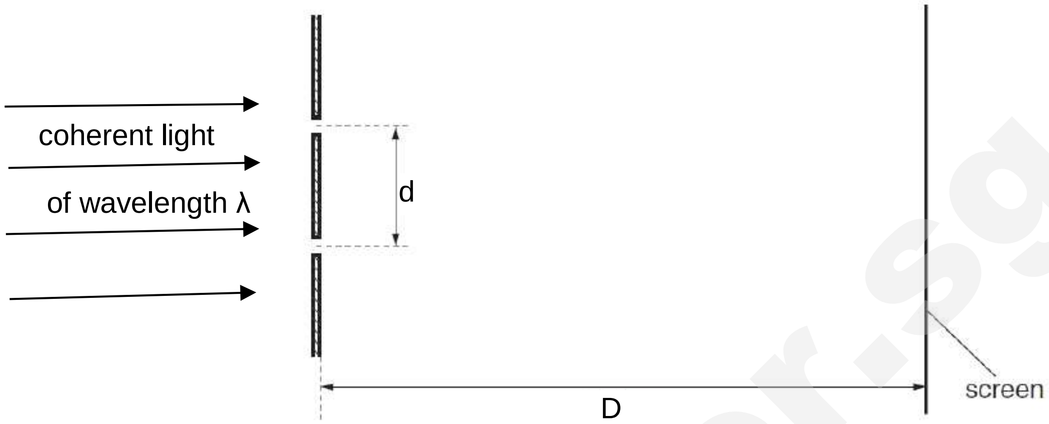


Fig. 1.1 (not drawn to scale)

The following measurements were obtained from the experiment:

slit separation, d = (0.650 ± 0.001) mm
distance between 2 bright fringes, x = (2.33 ± 0.01) mm
distance between the slits and screen, D = (2.80 ± 0.01) m

(i) Determine the wavelength λ and express it with its associated uncertainty.

λ ± Δλ = ………............ ± ……………… m [4]

(ii) Suggest, with reasons, a change to the experimental set-up that would enable the wavelength to be determined to a higher degree of precision.

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………... [2]

2 Two identical trolleys, A and B, moved at 10.0 m s^{-1} toward each other. The two trolleys collided inelastically where 35% of the kinetic energy was dissipated.

(a) Explain why, after the collision, the trolleys moved in opposite directions at the same speed.

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) Show that the final speed of trolley A is about 8.1 m s^{-1}. [2]

(c) Fig. 2.1 shows the variation of the magnitude of the force on trolley A with time during the collision.

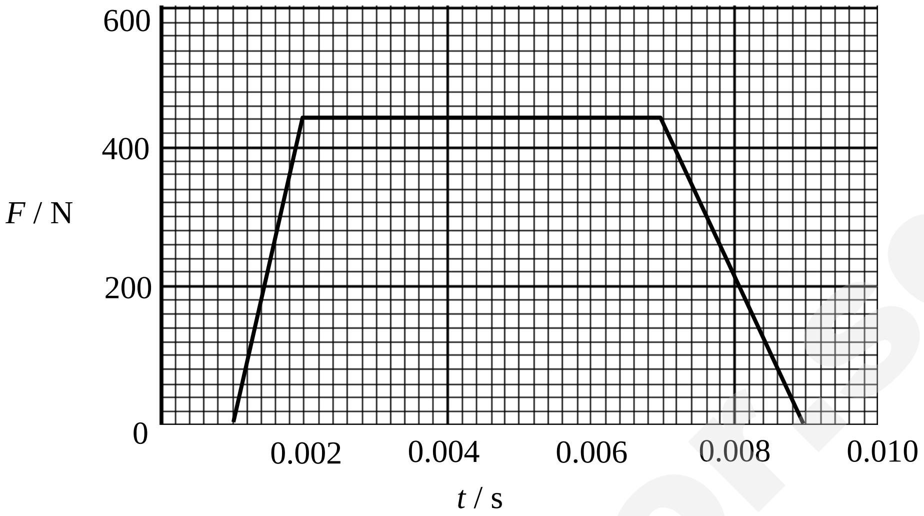


Fig. 2.1

Calculate the impulse trolley B exerts on trolley A during the collision. Give the unit with your answer.

impulse = ……………………unit:…………….. [3]

(d) Hence calculate the mass of each trolley.

mass = ………………………… kg [2]

3 Fig. 3.1 below shows a snapshot of a travelling wave moving from left to right at time t = 0 s. The frequency of this wave is 0.50 Hz.

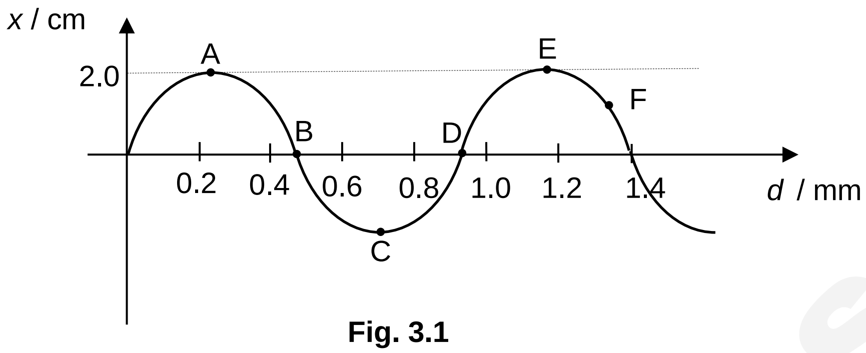


Fig. 3.1

(a) What is the speed of the wave?

speed of wave = ……………………….. m s^{-1} [2]

(b) State which point is $\frac{3\pi}{2}$ rad out of phase with point E.

……………………………………………………………………………………… [1]

(c) On Fig. 3.2, sketch the variation with time t of displacement x of point F from t = 0 s to 5 s. Label all known values on both axes. [2]

Fig 3.2

4 Two long straight wires, X and Y which are at right angle to the plane PQRS, carry equal steady direct currents of 80 A in the opposite direction as shown in the Fig. 4.1. The two wires are separated by a distance of 2.0 m.

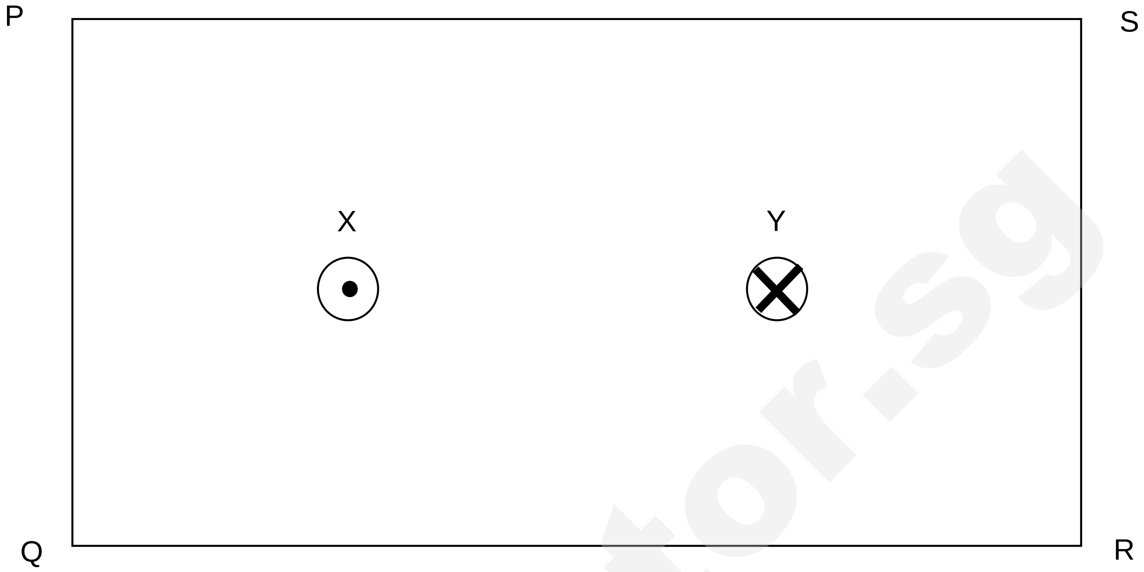


Fig. 4.1

(a) Define *tesla*.

....

.... [2]

(b) On Fig. 4.1, sketch the magnetic flux pattern around the 2 wires within the plane PQRS. [2]

(c) With reference to part **(b)**, state and explain the subsequent motion of both wires.

....

....

....

.... [2]

(d) The magnetic flux density *B*, due to a long straight wire, is given by the expression

$$B = \frac{\mu_o I}{2 \pi r}$$

where μ_o represents the permeability of free space and $\mu_o = 4\pi \times 10^{-7}$ H m^{-1}
I represents the current in the wire, in amperes (A)
r represents the distance from the wire, in metres (m)

Determine the magnetic flux density at Y due to X.

magnetic flux density = ……………………………….. T [2]

(e) Wire X is made into a rigid wire frame ABCD of negligible mass is supported on two knife-edges O and M so that the section OADM of the frame lies within a solenoid. Fig 4.2 shows the top view of the circuit arrangement. The side OA = MD = 15.0 cm and side AD = 8.0 cm

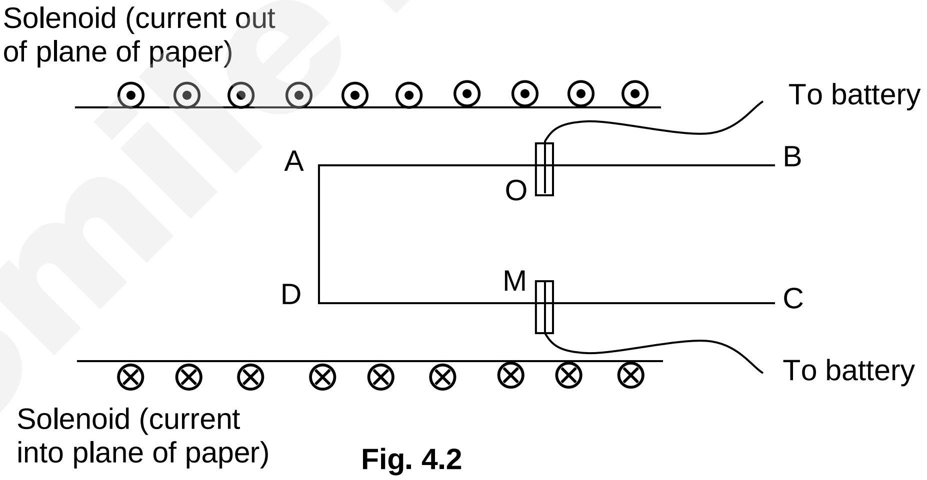


Fig. 4.2

Electrical connections are made to the frame through the knife edges so that the part OADM of the frame is connected in series with the battery.

When there is no current in the circuit, the frame is horizontal.

When the circuit is closed, it is observed that the side AD experiences a force into the page.

(i) State the direction of current flowing along the side AD.

………………………………………………………………………………………… [1]

(ii) A non-conducting rod of mass 5.0 g is placed across BC to keep the frame horizontal as shown in Fig. 4.3.

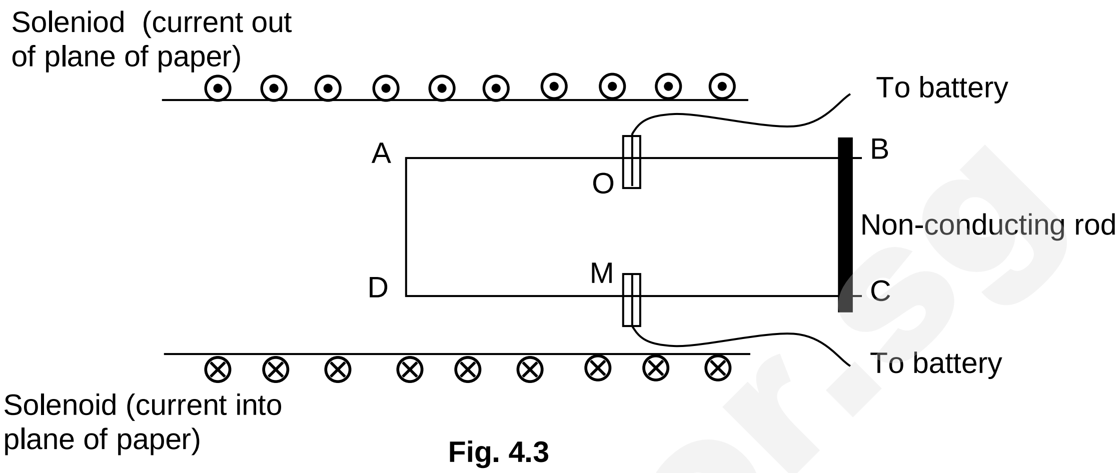


Fig. 4.3

Given that the uniform magnetic flux density in the solenoid is 0.30 T and the current in the circuit is 0.90 A, determine distance OB from the non-conducting rod to the knife edges such that the frame is kept horizontal.

distance OB = ………………..… cm [2]

5 Lucas notices that it is easier to lift up his buddy in water than in air. It is commonly observed that objects submerged in a liquid seems to “lose weight”. He decided to investigate the upward force that a liquid exerts on an object by immersing a rectangular block into water.

The block is attached to a force sensor which allows Lucas to record the weight of the block in the air, T_1. The reading of T_1 is 0.90 N.

Lucas then immerses the same block into water while it is still attached to the force sensor. By varying the submerged depth, h of the block, he obtained a series of new readings T_2 from the force sensor. The experimental setup is shown in Fig. 5.1.

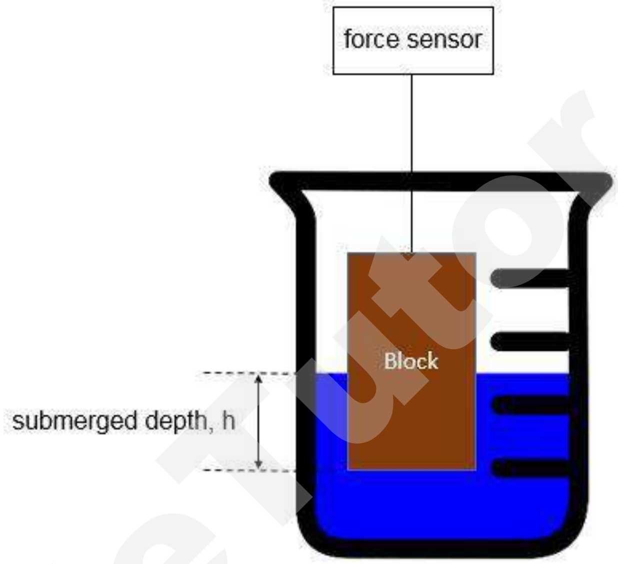


Fig. 5.1

(a) Draw a well-labelled free body diagram of the block to show all the forces acting on the block when it is partially immersed in the water and is still attached to the force sensor. [1]

(b) The variation of T_2 and submerged depth of the block in water, h, is shown in Fig. 5.2.

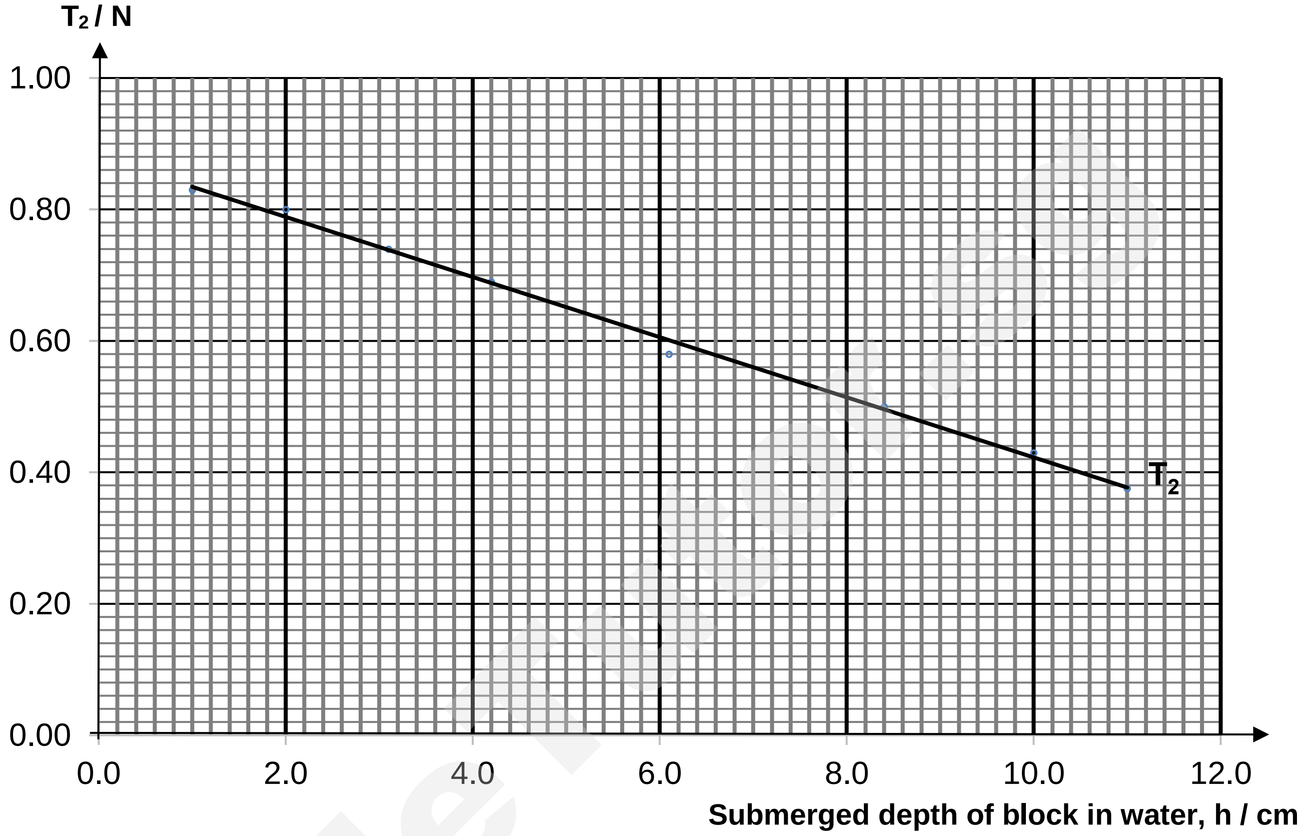


Fig. 5.2

(i) Use **(a)** and values from Fig. 5.2 to complete Fig. 5.3. Determine the values of U, the force that the water exerts on the block.

h / cm	**T_1 / N**	**T_2 / N**	**U / N**
2.0		0.79	
4.0			
6.0			
8.0			
10.0			

[3]

Fig. 5.3

(ii) **1.** Plot a graph of U against h in Fig. 5.4. [2]

Fig. 5.4

2. The relationship between U and h is found to be

$$U = \rho g A h$$

where ρ is the density of water, g is the acceleration due to free fall and A is the cross sectional area of the block. The density of water is 1000 kg m^{-3}.

Use Fig. 5.4 to determine the value of A. Show your working clearly.

cross sectional area A = …………………… m^2 [2]

3. Lucas conducted a second experiment using salt solution. Given that the density of salt solution is 2.16 g cm^{-3}. State and explain how your graph in Fig. 5.4 would change.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

Section B

Answer **two** of the questions in this section.

6 **(a)** A ball bearing, A with mass 50 g, initially at rest, slides down a smooth slope, inclined at an angle of 37° to the horizontal as shown in Fig. 6.1. It travels 5.0 m along the slope before falling freely off the edge E.

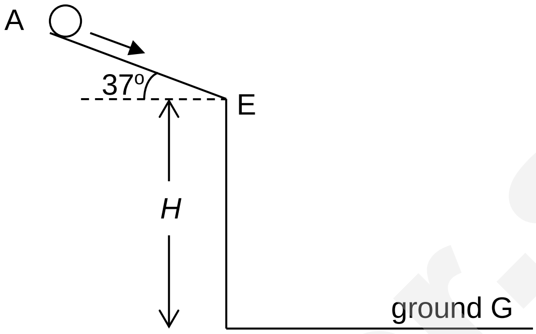


Fig. 6.1

(i) Show that the acceleration of the ball as it slides down the smooth slope from A to E is 5.9 m s^{-2}. [2]

(ii) Calculate the speed of the ball when it reaches the edge E of the slope.

speed of the ball = ……………………….. m s^{-1} [2]

(iii) In Fig. 6.1, sketch the path taken by the ball upon leaving the edge E of the slope. [1]

(iv) The time taken for the ball to reach the ground G after leaving the edge of the slope is 0.85 s. Show that the height *H* of the edge of the slope above the ground is 7.5 m. [2]

(v) Taking reference from edge E, sketch on Fig. 6.2 and Fig. 6.3 the variation with time of the horizontal displacement *x* and the vertical displacement *y* of the ball during its flight from E to G. Label the graphs P and Q respectively. (Indicate appropriate numerical values but no further calculation is required.)

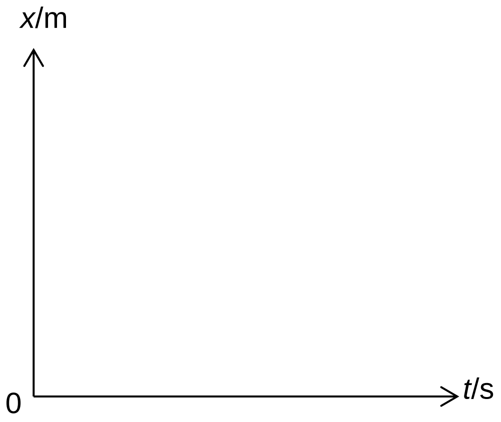


Fig. 6.2

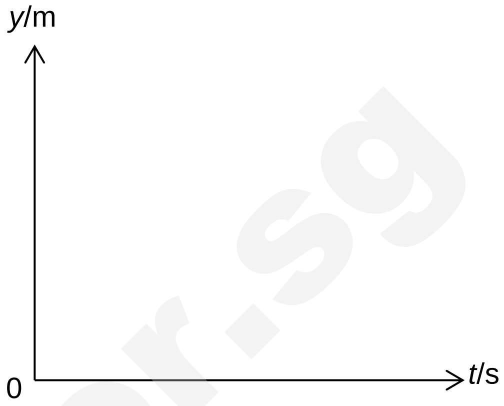


Fig. 6.3

[2]

(vi) Sketch on Fig. 6.2 the corresponding variation with time of the horizontal displacement of the ball during its flight from E to G, if air resistance is **not** negligible. Label the graph R. [1]

(b) Ball A in **(a)** and another ball B are supported by long strings, as shown in Fig. 6.4.

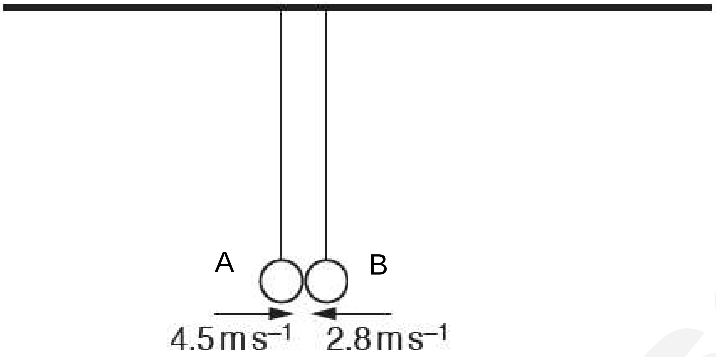


Fig. 6.4

The balls are each pulled back and released such that they moved towards each other. When the balls collide at the position shown in Fig. 6.4, the strings are vertical. The balls rebound in opposite directions.

Fig. 6.5 shows data for A and B during this collision.

ball	velocity just before collision / m s^{-1}	velocity just after collision / m s^{-1}
A	+ 4.5	- 1.8
B	- 2.8	+ 1.4

Fig. 6.5

The positive direction is taken to be horizontal and to the right.

(i) State the principle of conservation of linear momentum.

....

....

.... [2]

(ii) Hence, determine the mass *M* of B.

M = ... g [3]

(iii) By making further calculation, determine if the collision is elastic.

....

....

.... [2]

(iv) Use Newton’s second and third laws of motion to explain why the magnitude of the change in momentum of each ball is the same.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

7 **(a)** Distinguish between the electromotive force of a cell and the potential difference across a conductor.

……………………………………………………………………………………………………….

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(b) A dry cell has an e.m.f. *E* and internal resistance *r* and is connected to an external resistor R as shown in Fig. 7.1. There is a current *I* in the circuit when the potential difference across the terminals of the cell is *V*.

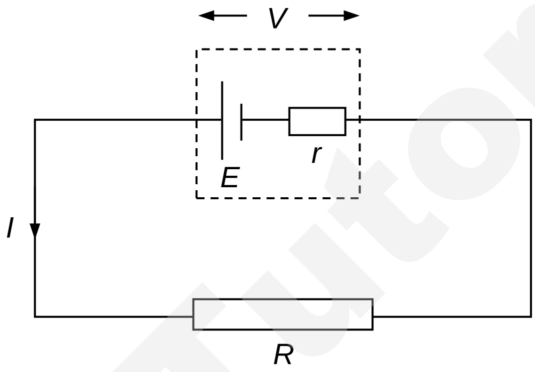


Fig.7.1

Derive an expression for V in terms of E, *I* and *r*. [2]

(c) The variation of *V* with *I* for the dry cell in **(b)** is shown in Fig. 7.2.

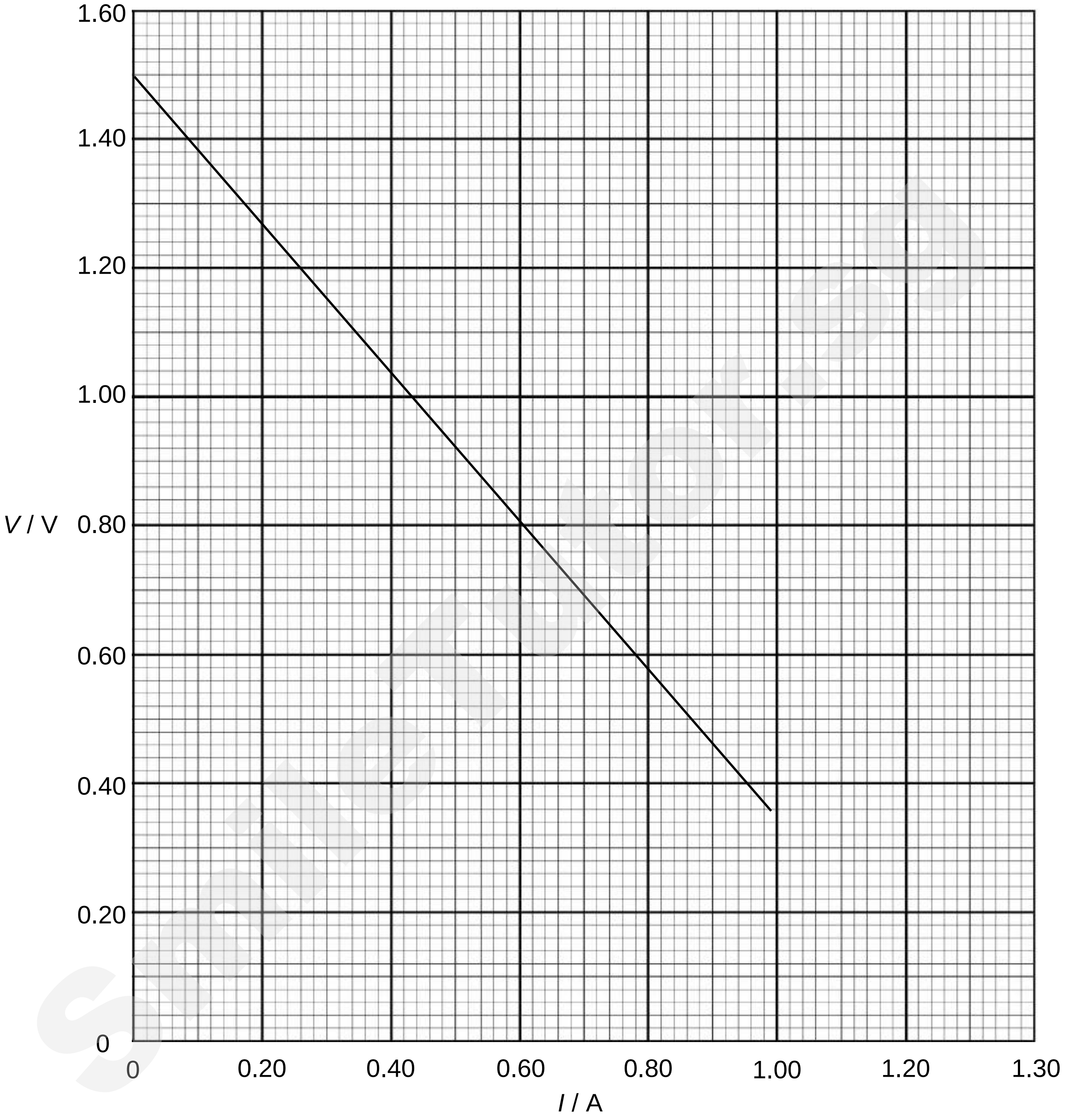


Fig. 7.2

(i) Complete Fig. 7.3 to show a circuit that could be used to obtain the data from which Fig. 7.2 can be plotted. [2]

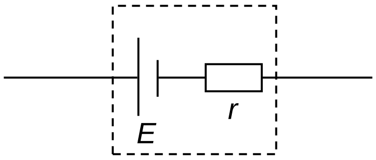


Fig.7.3

(ii) Use Fig. 7.2, explaining your calculations clearly, to determine the following:

1. the e.m.f. *E* of the dry cell,

E = ……………………………V [2]

2. the power dissipated in the external circuit when the current in the circuit is 0.4 A.

power = …………………W [2]

3. the internal resistance r of the cell.

r = …………………..Ω [2]

(iii) Fig. 7.4 shows the resistor of resistance *R* in Fig.7.2 replaced by an electrical device (load) and is connected in series with the dry cell. The current *I* in the circuit is 0.10 A.

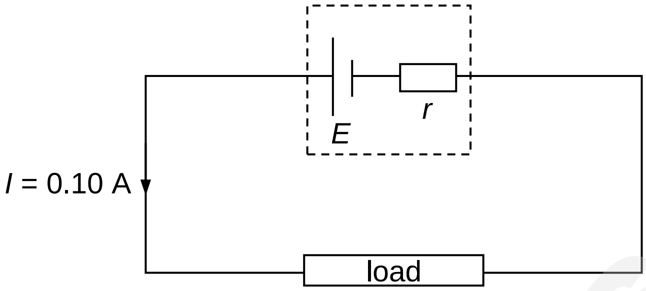


Fig.7.4

The power dissipated in the load is 0.14 W.

Calculate

1. the total power delivered by the dry cell,

power = …………………. W [1]

2. the resistance of the load.

resistance = ………………….Ω [1]

(d) Electric current in microchip circuits is carried through non-ohmic metals and semiconductors. Discuss qualitatively the effects of increasing temperature on the resistance of a semiconductor and filament lamp of the same dimensions.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

(e) Fig. 7.5 shows a circuit of a fire alarm which is set to trigger at a temperature of 80 ºC. The circuit consists of a specially made thermistor whose resistance is 100 Ω at room temperature and its resistance rises with the temperature of its surroundings.

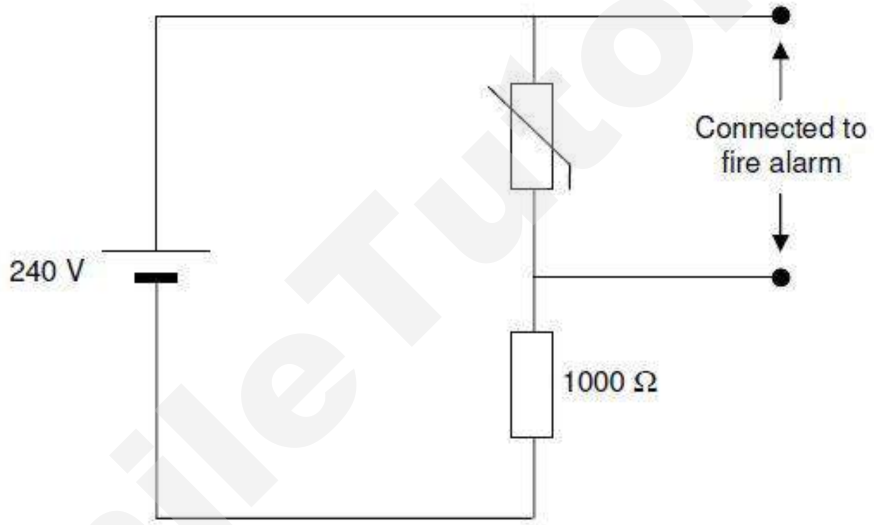


Fig. 7.5

(i) Given that the alarm connected across the thermistor requires a potential of 160 V to work, determine the resistance of the thermistor for the fire alarm to be triggered.

resistance = …………………….. Ω [2]

(ii) Explain whether the fire alarm will work properly if the 1000 resistor is replaced with a connecting wire.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

8 **(a)** **(i)** State a wavelength within the visible light spectrum.

wavelength = ………………… nm [1]

(ii) Calculate the energy of a photon in electron volts for light of the wavelength stated in **(i)**.

energy = …………………… eV [3]

(b) Fig. 8.1 is a graph showing the maximum kinetic energies, in electron volts, of electrons emitted from a sodium surface when light of different frequencies from a hydrogen light source is irradiated on the sodium surface.

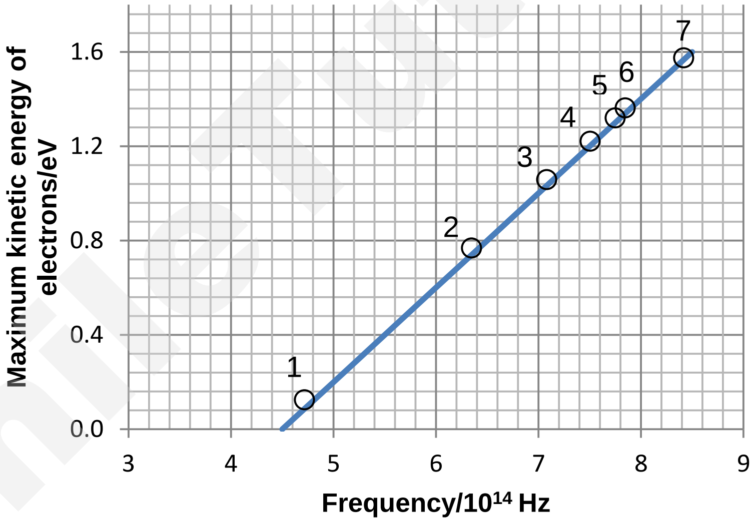


Fig. 8.1

(i) Explain what is meant by the term *threshold frequency of a metal*.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) Using Fig. 8.1 and answer to **(b)(i)**, state and explain the value of threshold frequency of sodium.

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(iii) Calculate the work function energy for sodium.

work function = …………………… J [2]

(iv) In a photoelectric experiment, the sodium surface is illuminated with a beam of monochromatic radiation, of frequency 6.0 x 10^{14} Hz and intensity 0.500 W m^{-2}, over an area of 4.50 x 10^{-5} m^2.

1. Use Fig. 8.1 to determine the stopping potential.

stopping potential = …………………. V [1]

2. Determine the number of photons incident on the sodium surface per unit time.

number of photons = ……………………………. s^{-1} [2]

3. By assuming 50% efficiency in the emission of photoelectrons, determine the maximum photoelectric current.

maximum photoelectric current = …………………. A [2]

(c) An electron beam, which fires individual electrons one after another, is directed at a wall made of a gold-coated silicon membrane. The wall has two 62 nm wide slits in it with a centre-to-centre separation of 272 nm.

The electrons were created using a tungsten filament and accelerated to a kinetic energy of 600 eV. After passing through the double slit, they were detected using a suitable screen placed 240 mm behind the slit. A resulting pattern formed after several hours is shown in Fig. 8.2. *d* is the separation between the centres of adjacent bright spots.

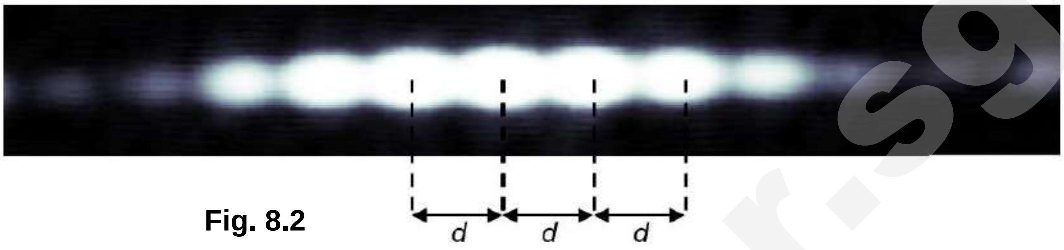


Fig. 8.2

(i) Suggest the significance of this experiment.

…………………………………………………………………………………………..

………………………………………………………………………………………….. [1]

(ii) Show that the momentum of the electron when it is at the double slit wall is 1.32×10^{-23} N s. [2]

(iii) Determine the de Broglie wavelength of the electrons.

wavelength = ………………….. m [1]

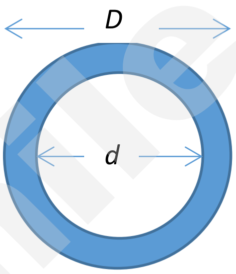
(iv) Hence, determine the separation *d*.

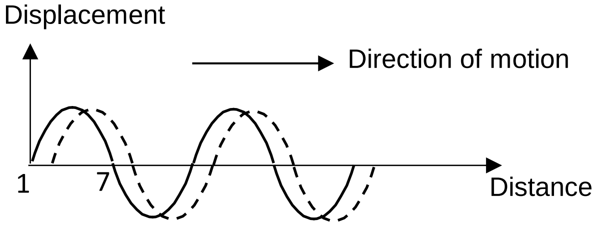
d = …………………..… m [2]

End of Paper

Answer Key for PU2 PE2 H1 8866
Paper 1

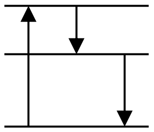
1	C	**2**	A	**3**	B	**4**	B	**5**	C
6	B	**7**	D	**8**	C	**9**	A	**10**	C
11	D	**12**	D	**13**	D	**14**	D	**15**	C
16	C	**17**	A	**18**	B	**19**	D	**20**	B
21	D	**22**	C	**23**	D	**24**	A	**25**	A
26	B	**27**	B	**28**	A	**29**	D	**30**	C

1	C	[P] = $\frac{kg\ m\ s^{-2}}{m^2}$ = kg m^{-1} s^{-2} Comparing the units in the equation: $m^3 s^{-1} = \frac{m^{\alpha}(kg\ m^{-1} s^{-2})}{kg\ m^{-1} s^{-1}\ (m)}$ Rearranging, $m^4 s^{-2} = m^{\alpha} s^{-2}$
2	A	Let *D* and *d* be external and internal diameters of the cylinder respectively. Let *t* be the thickness of the wall of the cylinder  The mean wall thickness is $t = \frac{1}{2}(D - d)$ = $\frac{1}{2}(95.0 - 87.0) = 4.0$ mm $\Delta t = \frac{1}{2}(\Delta D + \Delta d)$= 0.1 mm Hence the radius is 4.0 ± 0.1 mm.
3	B	
4	B	Area under a-t graph represents the change in velocity. Hence, the speed at point B will be greatest.
5	C	
6	B	For P and Q to collide, they must travel the same vertical displacement. Since $v_y = u_y+2as$, u_y must be the same for P and Q.

		For Projectile P → $v_y = u_1\sin30° + 2as$ For Projectile Q → $v_y = u_2 + 2as$ Hence, $u_1\sin30° = u_2$
7	D	Applying Principle of Conservation of Momentum: $(2.0 \times 3.0) + (1.0 \times 0) = (2.0 + 1.0)\ v$ $V = 2.0\ \text{m s}^{-1}$ KE lost = $\frac{1}{2}(2.0)(3.0)^2 - \frac{1}{2}(2.0+1.0)(2.0)^2 = 3.0\ \text{J}$
8	C	FR = ma $mg\sin\theta - F = ma$ $F = mg\sin\theta - ma$
9	A	Area under the F-t graph
10	C	Let the distance of mass 50g from pivot be x and on left side of the pivot Applying the Principle of moments $100\ (10) + 50\ x = 20 \times 60$ x = 4 (from the left side of the pivot)
11	D	
12	D	Work done on gas = $1 \times 10^5 \times 2 \times 10^{-4} \times 5.0 \times 10^{-2} = 1.0\ \text{J}$
13	D	WD by force = gain in KE = $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = \frac{1}{2}(5)(12)^2 - \frac{1}{2}(5)(2)^2 = 350\ \text{J}$
14	D	$efficiency = \frac{P_{out}}{P_{in}} \times 100\% = \frac{IV}{mgh/t} \times 100\% = \frac{200 \times 6000}{500 \times 9.81 \times 300} \times 100\% = 82\%$
15	C	Taking to the right to be +ve displacement,  At the next instant of time, particle 1 has –ve displacement (which means it is moving to the left) while particle 7 has +ve displacement (which means it is moving to the right)
16	C	$I = k\frac{A^2}{r^2}$

		$\frac{I'}{I}=\frac{A'^2}{A^2}\frac{r^2}{r'^2}$ $I'=5\frac{(2A)^2}{A^2}\frac{3^2}{4^2}=11.25\approx 11\,\mathrm{W}\,m^{-2}$
17	A	When the width of the slit is equal to the wavelength, maximum diffraction occurs and Fig. 17.1 is observed (the wavefronts are almost semicircular). When the width of the slit is larger than the wavelength, the wave passes through the slit and does not spread out much on the other side (as illustrated in Fig. 17.2). To reduce the effect of diffraction, the wavelength has to decrease. Since v=fλ, frequency of the vibration bar has to increase.
18	B	5 bright fringe separations are 15 mm long. Therefore, x = 3 mm $\lambda=\frac{xa}{D}=\frac{0.003\times 0.0009}{5.0}$ = 5.4x10^{-7} m
19	D	A is incorrect as a node is form at the surface of the metal sheet. B is incorrect as X and Y are out of phase. C is incorrect as sound waves are travelling along WXYZ. As sound waves are longitudinal waves, the air particles will be vibrating in the same direction as the travel of wave.
20	B	$R=\frac{\rho L}{A}$ Resistance of steel = $\frac{1\times 10^{-7}\times 1}{0.002^2}$ = 0.025 Ω Resistance of steel = $\frac{2.8\times 10^{-8}\times 1}{0.005^2-0.002^2}$ =1.333 x 10^{-3} Ω Effective resistance = $(\frac{1}{R_S}+\frac{1}{R_{Al}})^{-1}=1.27\ m\Omega$
21	D	R = $\frac{V}{I}=\frac{-6.0}{0}=\infty$ R = $\frac{V}{I}=\frac{6.0}{2}=3.0\Omega$
22	C	Current *I* = 3.0 + (3.0 x 2.0)/6.0 = 4.0 A Total resistance of external circuit, *R* = 1.5 + (2.0 x 6.0)/(2.0 + 6.0) = 3.0 Ω. Efficiency output of emf source, η, is given by $\eta=\frac{IV}{IE}=0.90$, where *V* is the terminal p.d. Thus, *E*= *V*/0.90 = (4.0 x 3.0)/0.90 = 13.3 V Short cut: After working out I=4 A and total p.d. = 12 V, can eliminate choice B without further calculation.
23	D	$R'=(\frac{1}{R}+\frac{1}{2R})^{-1}=\frac{2R}{3}=8.0\Omega$ R = 12.0 Ω
24	A	Option A: $R_{eff}=R+2R+2R$=5R

		$I_{ammeter} = \frac{V_{PQ}}{5R} = 0.2\frac{V_{PQ}}{R}$ Option B: $R_{eff} = 2R + (\frac{1}{R}+\frac{1}{2R})^{-1}$= $\frac{8}{3}$R $I_{ammeter} = \frac{V_{PQ}}{\frac{8}{3}R} = 0.375\frac{V_{PQ}}{R}$ Option C: $R_{eff}\,\text{on the upper branch} = 2R + R$ = 3R $I_{ammeter} = \frac{V_{PQ}}{3R} = 0.333\frac{V_{PQ}}{R}$ Option D: $I_{ammeter} = \frac{V_{PQ}}{2R} = 0.5\frac{V_{PQ}}{R}$
25	A	F = n BIL sinθ = 0.2 x 3.0 x 0.04 x sin 0 x 50 = 1.2 N Apply FLHR to determine the direction of force. (From Fig. 25.2, current QS is flowing out of the page)
26	B	
27	B	When the frequency of light increases, each photon carries more energy. However, since the intensity remains constant, the total energy of the light wave per unit time is constant. Thus there must be fewer photons and hence fewer photoelectros produced. Thus the current must fall. Since the energy per photon is now higher, the photoelectrons emerge with a larger KE. Thus a larger stopping potential is needed to have zero photocurrent.
28	A	K_{max} = 0 eV occurs when λ = 250 nm. Therefore, the threshold wavelength is 250 nm. By photoelectric equation, $\frac{hc}{\lambda} = \Phi + K_{\max}$ Hence, $\Phi = \frac{hc}{\lambda} - K_{\max} = \frac{6.63\times10^{-34}(3.0\times10^{8})}{250\times10^{-9}} - 0$ $\Phi = 7.956\times10^{-19}$ J = 4.97 eV
29	D	Option A - The most stable state of the atom is the ground state, i.e. when energy level is -13.60 eV. Option B - An electron can transit from the -0.53 eV level to 0 eV level by absorbing an electron of energy 0.53 eV. Option C - The incident photon of energy must have the exact amount of energy corresponding to the energy level difference.

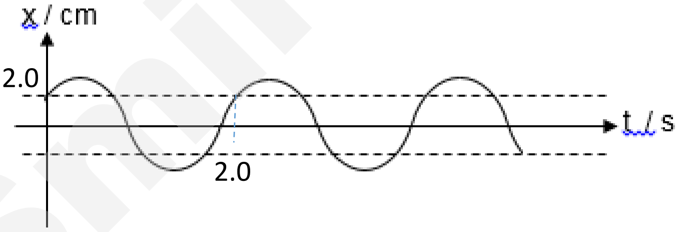
30	C	E_1 (photon absorbed) = $E_2 + E_3$ (photons emitted) $hc / \lambda_X = hc / \lambda_Y + hc / \lambda_Z$ $1 / \lambda_X = 1 / \lambda_Y + 1 / \lambda_Z$ $1 / \lambda_Z = 1 / \lambda_X - 1 / \lambda_Y$ $= (\lambda_Y - \lambda_X) / \lambda_X \lambda_Y$ 

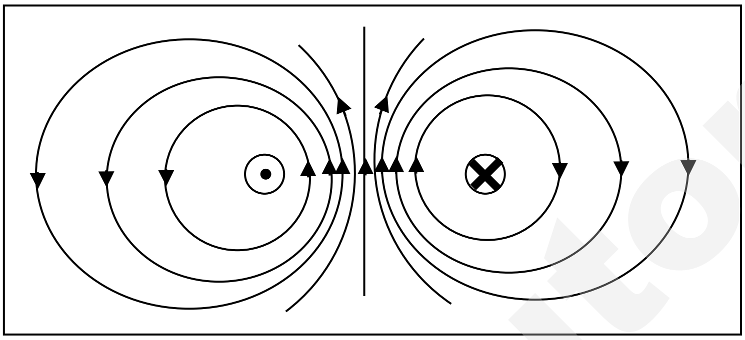
Paper 2 Answer Key

1	**(i)**	$\lambda = \frac{xd}{D} = \frac{(2.33 \times 10^{-3})(0.650 \times 10^{-3})}{2.80}$ $= 5.41 \times 10^{-7}$ m $\frac{\Delta\lambda}{\lambda} = \frac{\Delta x}{x} + \frac{\Delta d}{d} + \frac{\Delta D}{D}$ $\frac{\Delta\lambda}{\lambda} = \frac{0.01}{2.33} + \frac{0.001}{0.650} + \frac{0.01}{2.80}$ $\Delta\lambda$ $= 0.0509 \times 10^{-7}$ m $= 0.05 \times 10^{-7}$ m (1 SF) **$\Delta\lambda = (5.41 \pm 0.05) \times 10^{-7}$** m (correct s.f and d.p.)	**C1** **C1** **C1** **A1**
	(ii)	By increasing *D*, the fringe separation *x* will also increase. Hence, the fractional uncertainty due to *x* and *D* is reduced.	**B1** **B1**

2	**(a)**	The initial total momentum of the two trolleys is zero because the two trolleys have the same mass and have the same speed but travel in opposite directions. In equation form (let mass of each cart be M): $M(10) + M(-10) = Mv_1 + Mv_2$ $0 = v_1 + v_2$ This means that after the collision, the total momentum of the carts must be zero. Since the two trolleys have the same mass, the velocities of the two trolleys will be equal in magnitude but in opposite directions.	**B1** **B1**
	(b)	Since the mass, initial speeds, final speeds, of the two trolleys are the same, the two carts must have lost the same amount of kinetic energy. Appropriate comparison of masses. We can focus on just one trolley. Alternatively, award mark if total kinetic energy of both trolleys are added. Initial speed = 10 m s^{-1} Initial KE = $\frac{1}{2}$ m $(10)^2$ Let final speed be v. Final KE = $\frac{1}{2} m v^2 = 0.65 (\frac{1}{2} m (10)^2)$ [M1 for correct comparison of KE] $v^2 = 65$ v = 8.06 = 8.1 m s^{-1}	**B1** **M1**

	(c)	Area under graph: Impulse = ½ (440)(0.001) + (440)(0.005) + ½ (440)(0.002) = 2.86 N s Or area of trapezium = ½ (0.005 + 0.008)(440) = 2.86 N s N s OR kg m s^{-1}	**M1** **A1** **B1**
	(d)	Impulse on trolley A = change in momentum = 2.86 Ns (can ecf from part (c)) Magnitude of change in velocity of trolley A = 10 – (–8.1) = 18.1 m s^{-1}. Mass = change in momentum / change in velocity = 2.86 / 18.1 = 0.158 kg	 **C1** **A1**

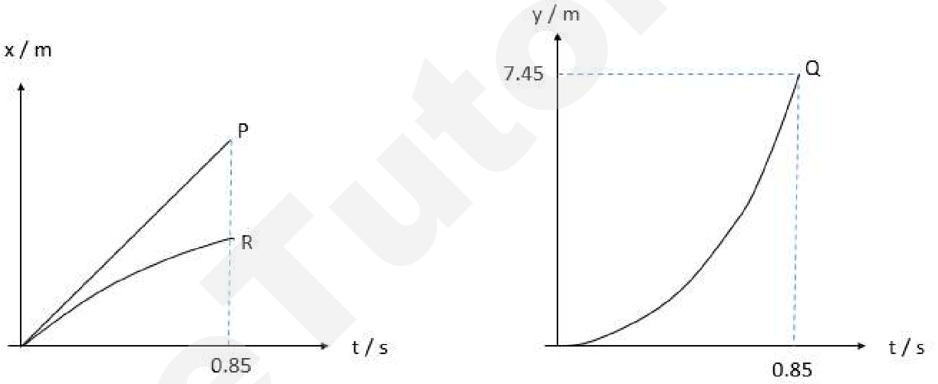
3	**(a)**	1.5 λ = 1.4 mm $\lambda = \dfrac{1.4 \times 10^{-3}}{1.5} = 9.33 \times 10^{-4}$ m Speed of the wave = f λ = (0.50)(9.33×10^{-4}) = 4.67×10^{-4} m s^{-1}	**C1** **A1**
	(b)	Point B	**A1**
	(c)	 1. Correct shape of graph and correct number of cycles i.e. 2 2. Starting point of graph must be between the positive y-values and equilibrium. 3. Amplitude and period labelled	**A1** **A1**

4	(a)		The tesla is defined by reference to the equation for the motor effect, namely $F = BIl$. 1 tesla is the field strength of a magnetic field where 1 newton of force is experienced by a metre long straight conductor carrying a current of 1 ampere, placed perpendicular to the magnetic field. All 3 underlined points. 2 underlined points (allow A1) 1 underlined point (no mark)	A2
	(b)			
			Students must show the closely spaced field lines in the region between the wires. Whereas for the “external” region the field lines must be spaced out further apart from each other. Vertical line must be shown at the midpoint between the two wires. Correct field lines direction	A1 A1
	(c)		There is a magnetic force exerted on each wire, with magnitude F = BIL. Using Fleming Left hand rule, the direction of Fx is towards the left while Fy is towards the right. The forces acting in opposite direction will cause the 2 wires to repel. Accept: The magnetic field lines in the region between the two wires are highly concentrated. This creates a tendency for these field lines to redistribute itself towards the region of lower concentration. Hence the wires experience a force that pushes them away from each other.	B1 B1 B1 B1
	(d)		$B = \mu_o I / (2 \pi r)$ $B = (4\pi \times 10^{-7})(80) / (2 \pi (2.0))$ $B = 8.0 \times 10^{-6}$ T	C1 A1
	(e)	(i)	By FLHR, direction is D to A.	A1
		(ii)	By Principle of Moments, $0.30(0.90)(0.08)(0.15)=5.0\times10^{-3}(9.81)(x)$ x = 0.0661 m = 6.61 cm	C1 A1

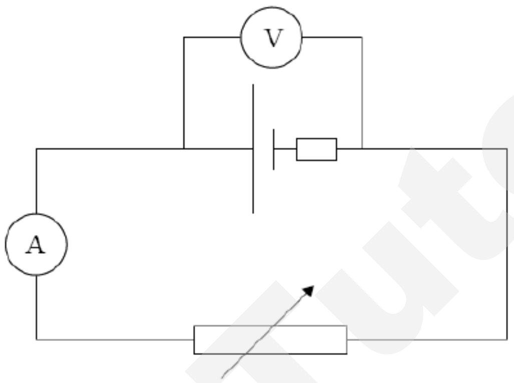
<table>
<tr><td>5</td><td>(a)</td><td colspan="3">2 upward forces, T_2 and force exerted by water
1 downward force which is the weight of the block
Sum of the upward forces must balance weight of the block s</td><td>A1</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td colspan="2">
<table>
<tr><th>h / cm</th><th>T_1 / N</th><th>T_2 / N</th><th>U / N</th></tr>
<tr><td>2.0</td><td>0.90</td><td>0.79</td><td>0.11</td></tr>
<tr><td>4.0</td><td>0.90</td><td>0.70</td><td>0.20</td></tr>
<tr><td>6.0</td><td>0.90</td><td>0.60</td><td>0.30</td></tr>
<tr><td>8.0</td><td>0.90</td><td>0.50</td><td>0.40</td></tr>
<tr><td>10.0</td><td>0.90</td><td>0.42</td><td>0.48</td></tr>
</table>
2 marks for reading T_2 accurately from the graph (2 correct T_2 – 1 mark)
1 mark for the correct value of U</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>1.</td><td>Accurate plots (check at least 2 plots)
Axis labelled with units
Award ecf from b(i)</td><td>A1
A1</td></tr>
<tr><td></td><td></td><td></td><td>2.</td><td>Correct calculation of gradient

Gradient = ρgA = 1000 x 9.81 x A
A = 0.000460 m^2</td><td>M1

A1</td></tr>
<tr><td></td><td></td><td></td><td>3.</td><td>Since density of salt solution is higher than water, the gradient will be larger. Hence the slope of Fig. 5.4 will be steeper.</td><td>B1</td></tr>
</table>

6	**(a)**	**(i)**	A component of weight down the slope is causing the acceleration. $F_{net} = ma$ $mg \sin \theta = m\ 9.81 \sin 37° = ma$ $a = 5.9 \text{ m s}^{-2}$	 **M1** **C1**
		(ii)	$v^2 = u^2 + 2as$ $= 0 + 2\ (5.9) \times 5.0$ $v = 7.68 \text{ m s}^{-1}$ Alternatively, solve using conservation of energy.	 **C1** **A1**
		(iii)	Trajectory path from E to G	**A1**
		(iv)	s = ut + ½ at2 $= 7.68 \sin 37° (0.85) + ½ (9.81) (0.85)^2$ $= 7.45$ m	 **C1** **A1**
		(v)	 Correct linear P Correct curve for Q with vertical displacement labelled in Q at t=0.85s and at t=0s, gradient (i.e. vertical velocity) = 0	 **A1** **A1**
		(vi)	Correct trend of R	**A1**
	(b)	**(i)**	The principle of conservation of momentum states that <u>in the absence of external forces</u>, total momentum of system before the collision is equal to the total momentum of system after the collision.	**B1** **B1**
		(ii)	$4.5 \times 50 - 2.8 \times M$ (= ...) $(...) = -1.8 \times 50 + 1.4 \times M$ $M = 75$ g	**C1** **C1** **A1**
		(iii)	total initial kinetic energy = $0.5\ (0.075)\ (-1.8)^2 + 0.5\ (0.050)\ (4.5)^2 = 0.52$ J total final kinetic energy = $0.5\ (0.075)(1.4)^2 + 0.5\ (0.050)\ (-2.8)^2 = 0.27$ J total initial kinetic energy/KE not equal to the total final kinetic energy/KE, so not elastic or is inelastic Accept alterative: relative speed of approach is not equal to relative speed of separation	 **M1** **B1**
		(iv)	force on X is equal and opposite to force on Y (Newton III)	**M1**

				force equals/is proportional to rate of change of momentum (Newton II) time of collision same for both balls hence change in momentum is the same	M1 A1

7	(a)			Electromotive force of the cell is defined as the amount of chemical energy that is converted into electrical energy when a unit charge flows through the circuit while potential difference across a conductor is the amount of electrical energy converted to other forms of energy when a unit charge flows through it.	B1 B1
	(b)			By conservation of energy, energy supplied by cell is dissipated as heat in r and R, i.e. $E I = I^2 r + V I$ Hence $E = I r + V$ (or $V = E - I r$)	M1 A1
	(c)	(i)			
				correct position of variable resistor correct positions of ammeter and voltmeter	A1 A1
		(ii)	1.	$E = V$ when $I = 0$ from graph E = 1.5 V	M1 A1
			2.	P = IV = 0.4 x 1.03 = 0.412 W	C1 A1
			3.	r is the slope of the graph. from graph E = 1.5 V (sensible choice of triangle, at least half the line as hypothenuse) r = 0.7 /0.6 = 1.2 (±0.1) Ω	M1 A1
		(iii)	1.	P = IE = 0.10 x1.5 = 0.15 W Alternative P = I^2r + 0.14 = 0.10^2 (1.2) + 0.14 = 0.152 W	A1
			2.	$0.14 = I^2 R$ $R = 14\ \Omega$	A1
	(d)			For filament lamp, mobile charge carriers are the free electrons. Increase in temperature results in atomic vibrations increases, hence leading to an increase in resistance with temperature.	B1

			For semiconductors, with increase in temperature, atomic vibrations increase but mobile charge carriers increase as well. Effect of increase in mobile charge carriers on lowering resistance is greater than effect of greater atomic vibrations on increasing resistance.	B1 B1
	(e)	**(i)**	When the fire alarm is working, Current flow in the circuit = $\frac{240-160}{1000} = 0.080\ A$ Resistance of thermistor when fire alarm working = $\frac{V}{I} = \frac{160}{0.080} = 2000\Omega$ *Note: The thermistor used in the question is that of a positive temperature coefficient where its resistance rises with temperature.* *The conventional thermistor has a negative temperature coefficient where its resistance drops with temperature.*	**C1** **A1**
		(ii)	If the 1000 W resistor is replaced by a connecting wire, the p.d. across the alarm will always be 240 V. It will not work properly as the alarm will always be triggered.	**B1**

8	**(a)**	**(i)**	Wavelength is between 390 to 750 nm		**B1**
		(ii)	E = hc/λ = 5.1×10^{-19} to 2.6×10^{-19} J E = 1.7 to 3.2 eV		**M1** **C1** **A1**
	(b)	**(i)**	Threshold frequency of the metal is the minimum frequency of light with which photoelectrons will be emitted when it is irradiated onto the metal surface.		**B1**
		(ii)	The graphs cuts the x-axis at 4.5×10^{14} Hz, below which no photoelectrons were detected hence the threshold frequency of sodium is 4.5×10^{14} Hz		**A1** **B1**
		(iii)	$\phi = E = hf$ E = 2.98×10^{-19} J		**M1** **A1**
		(iv)	**1.**	$eV_s = KE_{max}$ = 0.6 eV (from Fig. 8.1) V_s = 0.6 V	**A1**
			2.	Int = $\frac{P}{A} = \frac{E}{tA} = \frac{N_{photons}\times hf}{tA}$ $\frac{N_{photons}}{t} = \frac{Int \times A}{hf} = \frac{0.500 \times 4.5 \times 10^{-5}}{6.63 \times 10^{-34} \times 6 \times 10^{14}}$ = 5.66×10^{13} s^{-1}	**C1** **A1**
			3.	Efficiency = 50% $\frac{N_{photoelectrons}}{t} = 50\% \times 5.66 \times 10^{13} = 2.828 \times 10^{13}$ I = $\frac{N_{photoelectrons}\times e}{t} = 2.828 \times 10^{13} \times 1.6 \times 10^{-19}$ $= 4.52 \times 10^{-6} A$	**C1** **A1**

	(c)	**(i)**	Electrons have a wave-like nature.	**B1**
		(ii)	Kinetic energy of electron at wall, E_k = 600 eV = 9.6 x 10^{-17} J Momentum of electron at wall, p $p^2 = 2mE_k$ $p = \sqrt{2(9.11\times10^{-31})(9.6\times10^{-17})}$ $=1.32\times10^{-23}$ N s	**C1** **C1**
		(iii)	de Broglie wavelength λ of electron at wall $=\dfrac{h}{p}$ $=\dfrac{6.63\times10^{-34}}{1.32\times10^{-23}}$ $=5.01\times10^{-11}$ m	**A1**
		(iv)	$d=\dfrac{\lambda D}{a}$ $=\dfrac{(5.01\times10^{-11})(0.240)}{272\times10^{-9}}$ $=4.42\times10^{-5}$ m	**C1** **A1**

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

PHYSICS

8866/01

Paper 1 Multiple Choice Questions

26 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions in this section. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages.

[Turn over

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space, $\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + ½at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

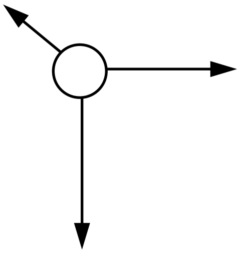
resistors in series $R = R_1 + R_2 + \ldots$

resistors in parallel $1/R = 1/R_1 + 1/R_2 + \ldots$

1 A body, dropped from the edge of a cliff, is timed to take (2.0 ± 0.1) s to fall to the surface of the sea. If the acceleration of free fall is taken as (9.8 ± 0.2) m s^{-2}, the calculated height of the cliff above the water surface should be quoted in metres as

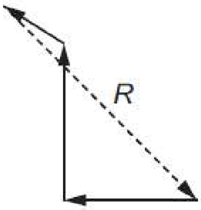
A 20 ± 0.1 **B** 20 ± 0.2 **C** 20 ± 1 **D** 20 ± 2

2 Three wires each exert a horizontal force on a vertical pole, as shown.

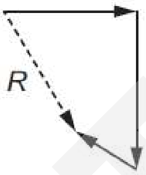


Which vector diagram shows the resultant force *R* acting on the pole?

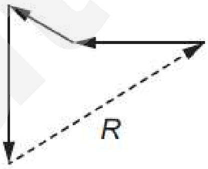
A



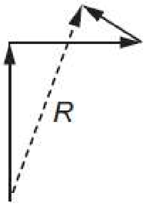
B



C



D

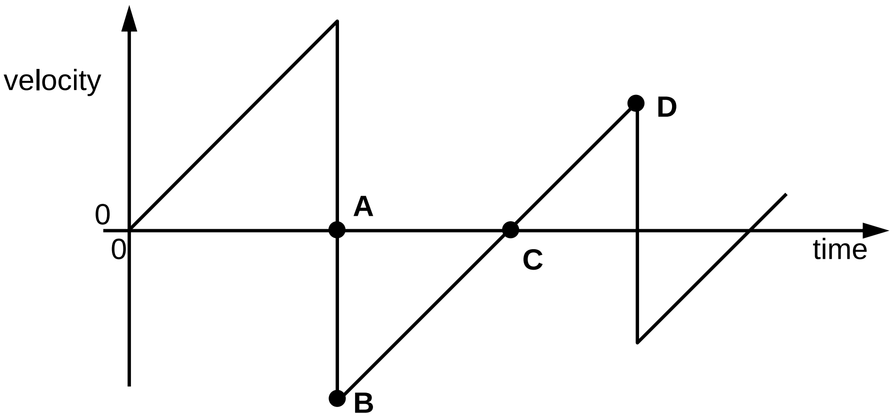


3 If a car can be brought to rest from 15 ms^{-1} in a distance of 12 m, what would be the braking distance if it is traveling at 30 ms^{-1} ? Assuming braking force and road conditions are the same.

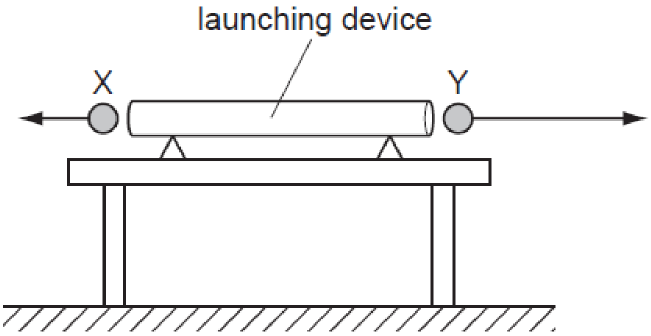
A 18 m **B** 24 m **C** 36 m **D** 48 m

4 A ball is released from rest above a hard, horizontal surface. The graph shows how the velocity of the bouncing ball varies with time.

At which point on the graph does the ball reach its maximum height after the first bounce?



5 A double-ended launching device fires two identical steel balls X and Y at exactly the same time. The diagram shows the initial velocities of the balls. They are both launched horizontally but Y has greater speed.



Which statement explains what an observer would see?

A Both X and Y reach the ground simultaneously, because air resistance will cause both to have the same final speed.

B Both X and Y reach the ground simultaneously, because gravitational acceleration is the same for both.

C X reaches the ground before Y, because X lands nearer to the launcher.

D Y reaches the ground before X, because Y has greater initial speed.

6 A tractor of mass 1000 kg pulls a trailer of mass 1000 kg via a tow-bar. The total resistance to motion has a constant value of 4000 N. One quarter of this resistance acts on the trailer. At first the acceleration of the tractor and trailer is 2.0 m s^{-2} but eventually they move at a constant speed of 6.0 m s^{-1}.

What is the force exerted on the tractor by the tow-bar when the acceleration of the tractor and trailer is 2.0 m s^{-2}?

A 1000 N **B** 3000 N **C** 5000 N **D** 8000 N

7 A student is studying Newton's third law of motion. He states that a rocket travelling in deep space can never accelerate because when the rocket's engines burn, the forwards force acting on the rocket is cancelled by an equal and opposite force.

Which statement explains why the student is wrong?

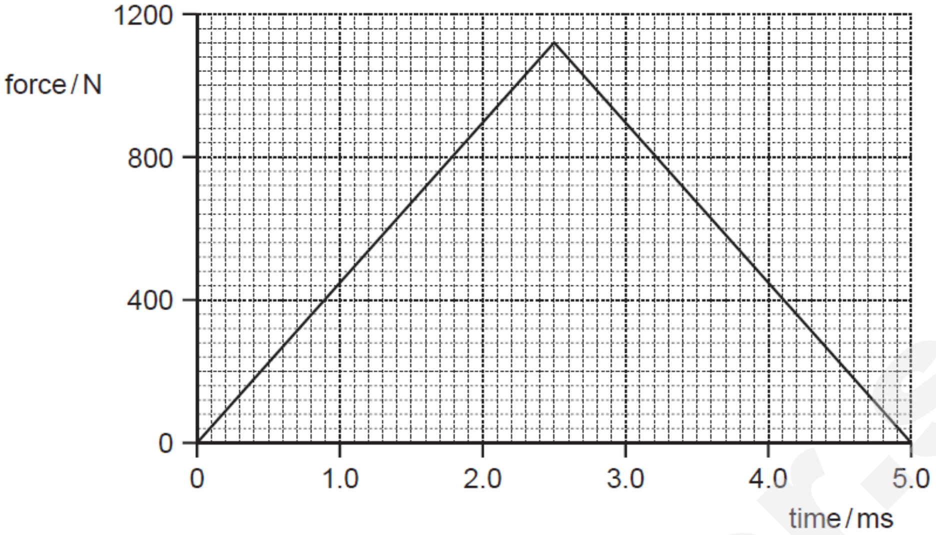
A The equal and opposite force does not act on the rocket.

B The equal and opposite force has a different line of action.

C The equal and opposite force is a reaction force.

D The equal and opposite force will be a different type of force.

8 A tennis ball of mass 56 g is struck by a tennis racquet. The graph shows how the force exerted on the ball by the racquet varies with time.



What is the change in the velocity of the tennis ball?

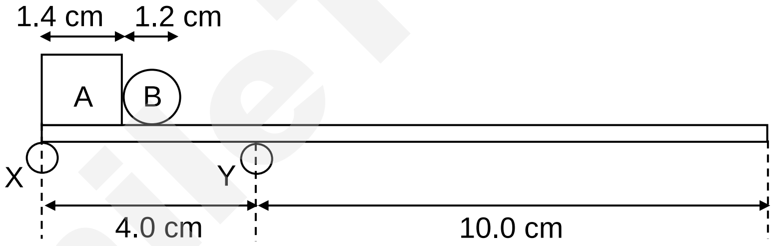
A 50 cm s^{-1}

B 100 cm s^{-1}

C 50 m s^{-1}

D 100 m s^{-1}

9 A beam of negligible mass is supported by two rods X and Y. A block A of mass 200 g and a ball B of mass 100 g rest on the beam as shown. Both A and B have uniform density.



If ball B were to start rolling to the right, what is the distance it would have moved before the beam just loses contact with rod X? Assume that there is negligible friction.

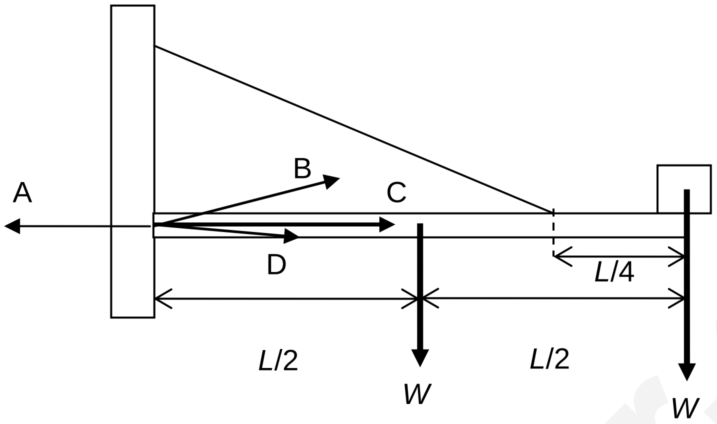
A 6.6 cm

B 8.0 cm

C 8.6 cm

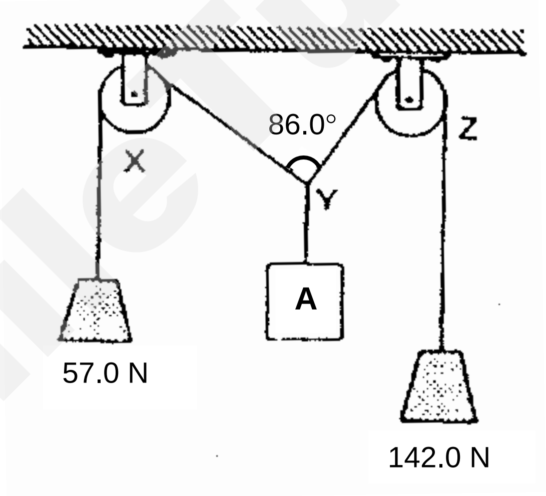
D 9.4 cm

10 A block of weight *W* is resting at one end of a horizontal, uniform rigid beam of the same weight. The other end of the beam is mounted on a wall and the length of the beam is *L*. A rope from the wall is attached to the beam at a point of *L*/4 from the far end of the beam as shown in the diagram.



Which of the arrows labelled from A to D shows the direction of the force of the wall acting on the beam? (The arrow vectors only show the directions but not their magnitudes.)

11 The diagram shows a body A supported by strings passing over two smooth pulleys with the weights attached. The system is in equilibrium with angle XYZ = 86.0°.



The weight of A is

A 126 N **B** 130 N **C** 134 N **D** 157 N

12 A gas is enclosed in a cylinder by a frictionless piston of cross-sectional area 3.0×10^{-3} m^2. When atmospheric pressure is 1.01×10^5 N m^{-2}, the piston is at a distance 80 mm from the end of the cylinder as shown in Fig.12.1. The gas is then heated and it expands by pushing the piston against atmospheric pressure until the piston is 160 mm from the end of the cylinder as shown in Fig 12.2. What is the work done by the gas?

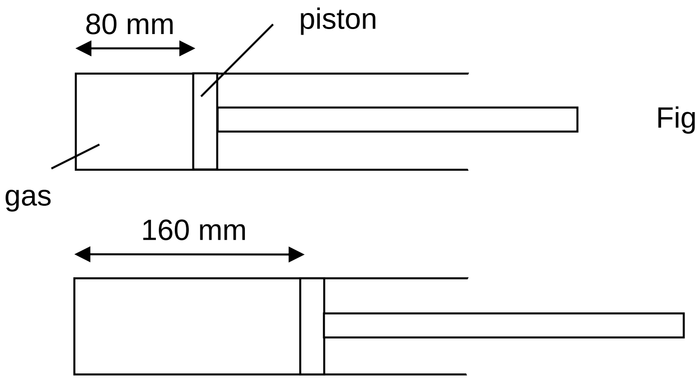


Fig.12.1

Fig.12.2

A 8.0 J **B** 24 J **C** 30 J **D** 48 J

13 In a tidal power station, 100 km^2 of water is raised to a height of 1.2 m by the tide behind a tidal barrier. What would be the mean power output of such a station if its efficiency is 20% and there are two tides per day? (Assume density of water to be 1000 kg m^{-3}.)

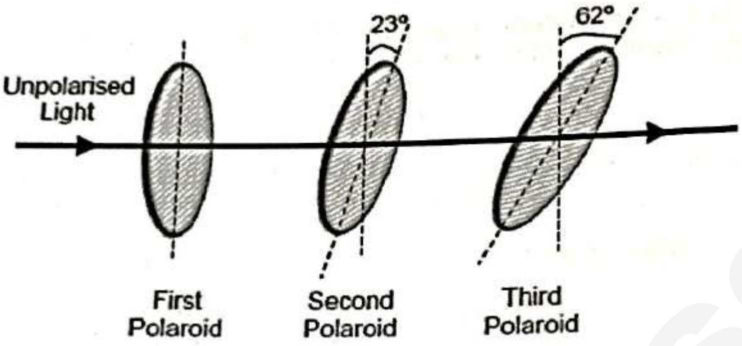
A 1.6 MW **B** 3.3 MW **C** 6.5 MW **D** 16 MW

14 A plane wave of amplitude *A* is incident on a surface area *S* placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time intercepted by the surface is *E*.

The amplitude of the wave is increased to 3*A* and the area of the surface is reduced to *S*/3. How much energy per unit time is intercepted by this smaller surface?

A $\frac{1}{9}E$ **B** E **C** $3E$ **D** $9E$

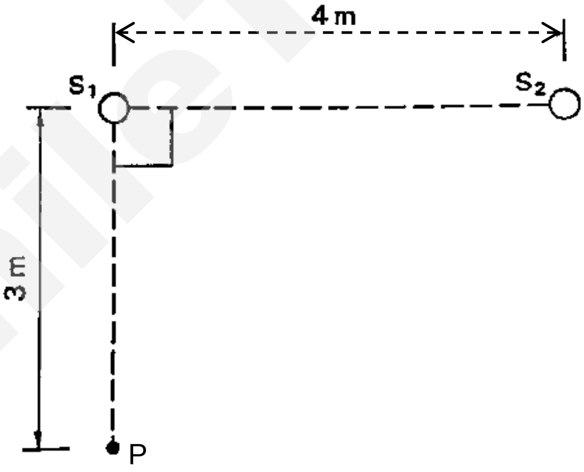
15 Light is polarised when it passes through a sheet material known as a polaroid. Three polaroids are stacked, with the polarising axis of the second and third polaroids at 23° and 62° respectively, to that of the first polaroid, as shown in the diagram below.



When unpolarised light of amplitude A_o is incident on the stack of polaroids, the light has amplitude of A_1 after it passes through the first polaroid, A_2 after it passes through the second polaroid, and A_3 after it passes through the third polaroid. What is the value of $\frac{A_3}{A_1}$?

A 0.25 **B** 0.31 **C** 0.43 **D** 0.72

16 Two wave generators S_1 and S_2 each produces water waves of wavelength 4 m. They are placed 4 m apart in a water tank and a detector P is placed on the water surface 3 m from S_1 as shown below.



When operated alone, each generator produces a wave at P which has an amplitude *A*. When the generators are operating together and in phase, what is the resultant amplitude at P?

A 0 **B** ½ A **C** 2A **D** 4A

17 A resonance tube open at both ends and responding to a tuning fork

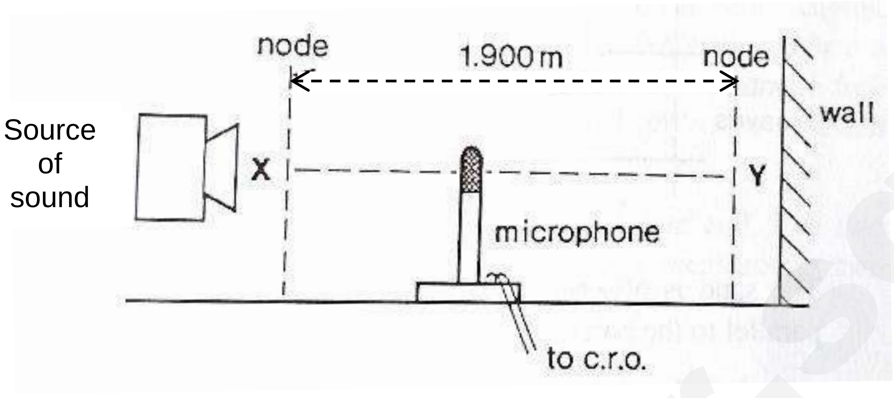
A always has a central node.

B always has an odd number of nodes.

C always has an even number of nodes.

D always has an odd number of nodes and antinodes.

18 A source of sound of frequency 2500 Hz is placed several metres from a plane reflecting wall in a large chamber containing a gas. A microphone, connected to a cathode-ray oscilloscope, is used to detect nodes and antinodes along the line XY between the source and the wall.



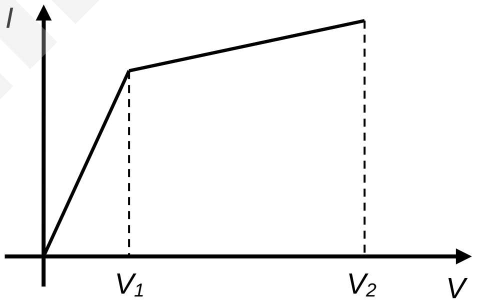
The microphone is moved from one node through 20 antinodes to another node, over a distance of 1.900 m. What is the speed of sound in the gas?

A 238 m s^{-1} **B** 250 m s^{-1} **C** 330 m s^{-1} **D** 475 m s^{-1}

19 There are 1.3 x 10^{19} electrons passing through a point in a series circuit in 1.0 hour. If the potential difference across a resistor connected in series to the source is 10 kV, what is the power dissipated in the resistor?

A 3.6 W **B** 5.1 W **C** 5.8 W **D** 21 W

20 The graph plots current *I* against potential difference *V* for an electrical component.



The resistance of the component

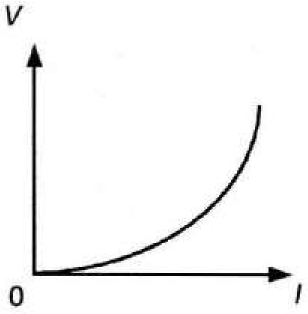
A is constant from 0 to V_1, then increases to another constant from V_1 to V_2.

B is constant from 0 to V_1, then decreases to another constant from V_1 to V_2.

C is constant from 0 to V_1, then decreases continuously from V_1 to V_2.

D is constant from 0 to V_1, then increases continuously from V_1 to V_2.

21 The figure shows the variation of current *I* through a filament lamp with the p.d. *V* applied across it.



It is not a straight line graph because

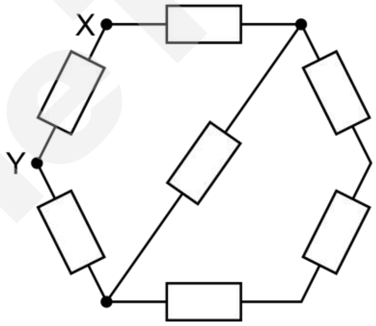
A the lamp is placed in a forward-biased position.

B the filament has a negative temperature coefficient.

C more mobile charge carriers are liberated due to a rise in temperature.

D the mobility of electrons decreased due to a rise in temperature.

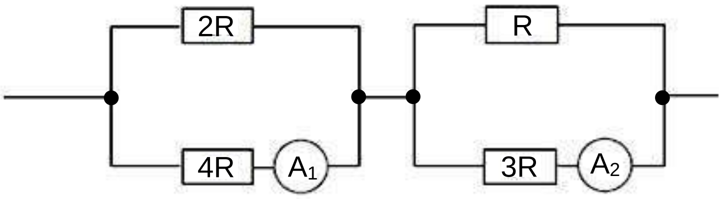
22 The diagram shows a network of 7 resistors, each with resistance R.



What is resistance between points X and Y?

A $\frac{2}{3}$ R **B** $\frac{3}{5}$ R **C** $\frac{5}{7}$ R **D** $\frac{11}{15}$ R

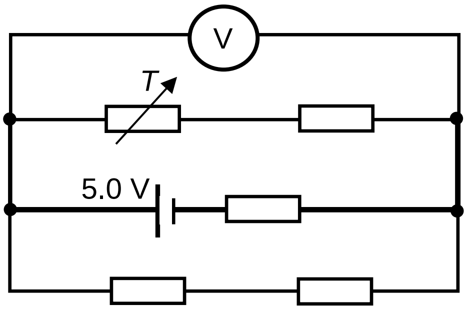
23 The ammeter A_1 of the circuit below reads 6.0 A.



Assuming that both ammeter have negligible resistance, what is the reading on A_2?

A 4.5 A **B** 6.0 A **C** 13.5 A **D** 18.0 A

24 A cell of e.m.f. 5.0 V and negligible internal resistance is connected to four identical resistors and a variable resistor *T*, as shown.

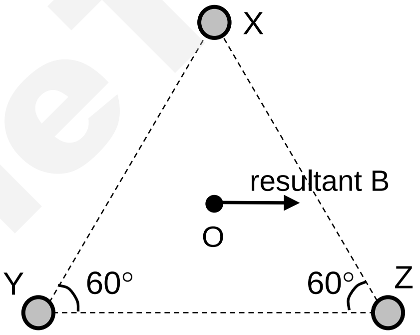


The resistance of each resistor is 1.0 kΩ and the resistance of *T* is 5.0 kΩ.

What is the reading on the ideal voltmeter?

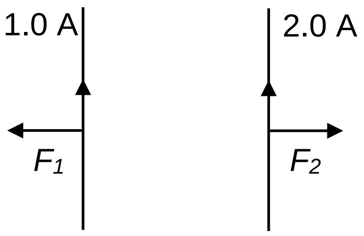
A 0 V **B** 2.0 V **C** 3.0 V **D** 5.0 V

25 Three parallel conductors each carrying current of the same magnitude, pass vertically through the three corners X, Y and Z of a horizontal equilateral triangle as shown in the diagram below. A resultant magnetic flux density *B,* acting at the centre of the triangle O acts in the direction as shown below. What must be the directions of the currents in X, Y and Z?



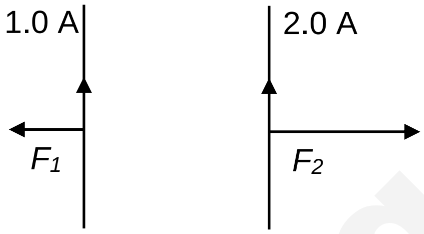
	Into the page	Out of the page
A	X	Y and Z
B	Z	X and Y
C	Y and Z	X
D	X, Y and Z	None

26 Two long straight parallel wires carry currents of 1.0 A and 2.0 A respectively. Which diagram shows the directions and relative magnitudes F_1 and F_2 of the forces per unit length on each of the wires?



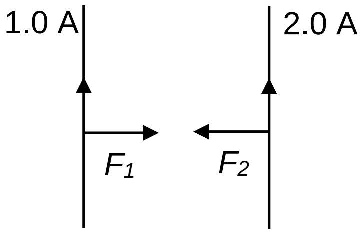
$F_1 = F_2$

A



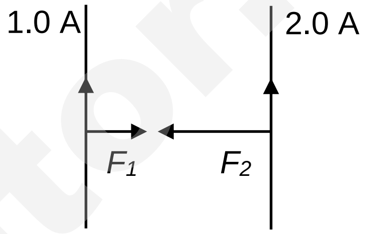
$2F_1 = F_2$

B



$F_1 = F_2$

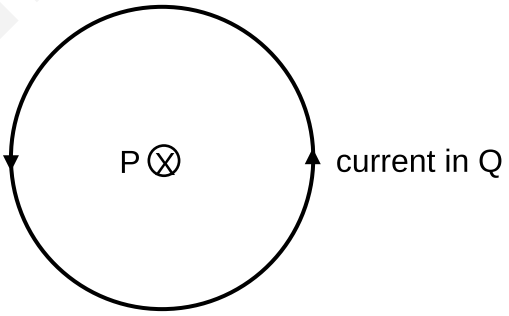
C



$2F_1 = F_2$

D

27 A long straight wire P is placed along the axis of a flat circular coil Q. The wire and the coil each carry a current as shown. Current in P is into the plane of the diagram.



What can be deduced about the force acting on each part of Q due to the current in P?

A No force acts.

B The force acts perpendicular to the plane of the diagram.

C The force acts towards P.

D The force acts away from P.

28 The first excitation energy and the ionization energy of a certain atom are 21.2 eV and 28.8 eV respectively. An electron of energy 22.4 eV strikes the atom at the ground state. What happens to the atom?

A The atom remains at the ground state.

B The atom is excited to the first excited state.

C The atom is excited to the second excited state.

D The atom is ionized.

29 Photons are emitted when the electrons transit from a higher energy level to a lower energy level. Consider the three lowest energy levels of a hydrogen atom. When electrons transit from the second lowest or third lowest energy level, the possible frequencies of photons emitted are f_1, f_2, and f_3, whose values are in ascending order. The magnitude of f_2 is equal to

A $f_3 - f_1$ **B** $\frac{1}{2}(f_1 + f_3)$ **C** $\frac{f_3 - f_1}{f_1 f_3}$ **D** $\sqrt{f_1 f_3}$

30 The de Broglie wavelength of a moving particle of mass m is λ. If the kinetic energy of the particle is halved, the de Broglie wavelength will become

A $\frac{\lambda}{2}$ **B** $\frac{\lambda}{\sqrt{2}}$ **C** $\sqrt{2}\lambda$ **D** 2λ

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

SOLUTION

PHYSICS

8866/01

Paper 1 Multiple Choice Questions

26 September 2017

1 hours

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions in this section. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **13** printed pages.

[Turn over

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space, $\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}$ F m^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + ½at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series $R = R_1 + R_2 + \ldots$

resistors in parallel $1/R = 1/R_1 + 1/R_2 + \ldots$

1	2	3	4	5	6	7	8	9	10
D	B	D	C	B	B	A	C	C	C
11	12	13	14	15	16	17	18	19	20
D	B	C	C	D	A	D	D	C	D
21	22	23	24	25	26	27	28	29	30
D	D	A	C	C	C	A	B	A	C

1 A body, dropped from the edge of a cliff, is timed to take (2.0 ± 0.1) s to fall to the surface of the sea. If the acceleration of free fall is taken as (9.8 ± 0.2) m s^{-2}, the calculated height of the cliff above the water surface should be quoted in metres as

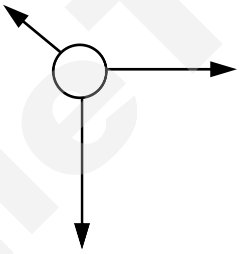
A 20 ± 0.1 **B** 20 ± 0.2 **C** 20 ± 1 **D** 20 ± 2

Answer: D

$s = ut + 1/2at^2 = 1/2at^2$

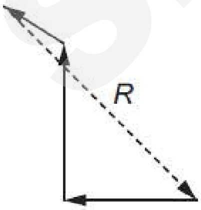
$$\frac{\Delta s}{s} = \frac{\Delta a}{a} + 2\frac{\Delta t}{t}$$

2 Three wires each exert a horizontal force on a vertical pole, as shown.

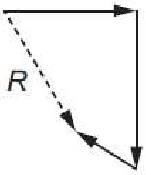


Which vector diagram shows the resultant force R acting on the pole?

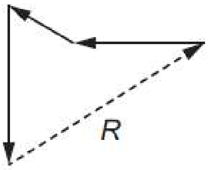
A



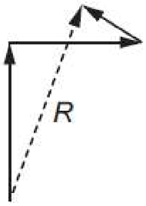
B



C



D



Answer: B

3 If a car can be brought to rest from 15 ms^{-1} in a distance of 12 m, what would be the braking distance if it is traveling at 30 ms^{-1} ? Assuming braking force and road conditions are the same.

A 18 m **B** 24 m **C** 36 m **D** 48 m

Answer : D

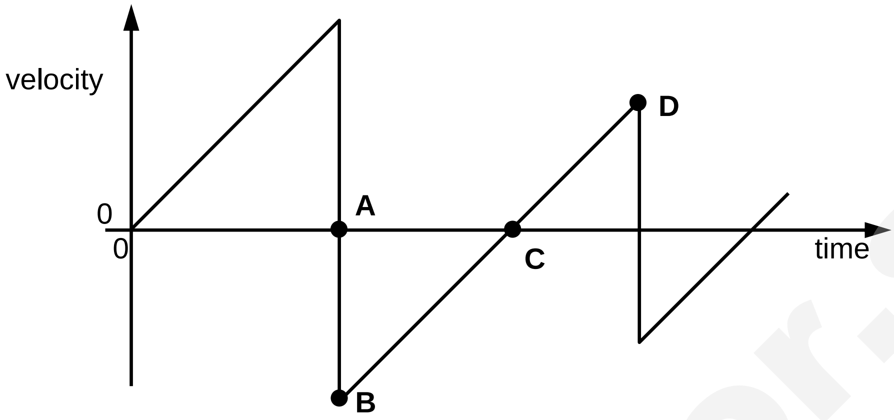
Using $v^2 = u^2 + 2as$

$u^2 \propto s$

Hence distance = 4(12) = 48 m

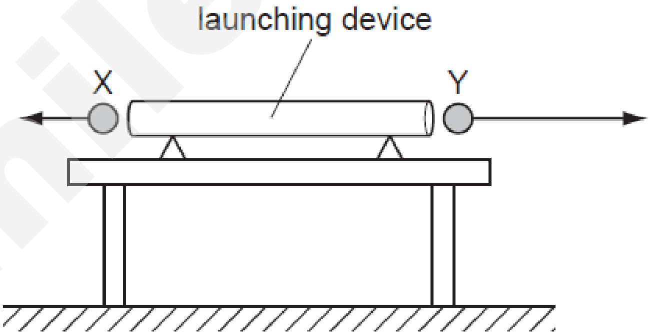
4 A ball is released from rest above a hard, horizontal surface. The graph shows how the velocity of the bouncing ball varies with time.

At which point on the graph does the ball reach its maximum height after the first bounce?



Answer : C
At the maximum height v = 0 and acceleration is still 9.81 m s^{-2}.

5 A double-ended launching device fires two identical steel balls X and Y at exactly the same time.
The diagram shows the initial velocities of the balls. They are both launched horizontally, but Y has greater speed.



Which statement explains what an observer would see?

A Both X and Y reach the ground simultaneously, because air resistance will cause both to have the same final speed.

B Both X and Y reach the ground simultaneously, because gravitational acceleration is the same for both.

C X reaches the ground before Y, because X lands nearer to the launcher.

D Y reaches the ground before X, because Y has greater initial speed.

Answer : B
Since the vertical distance travelled is the same and $u_y = 0$ for both case, the time taken should be the same.

6 A car pulls a trailer of mass 500 kg. The friction acting on the car is 1200 N and that on the trailer is 400 N. At first, the acceleration of the car and trailer system is 2 m s^{-1}.
What is the tension in the coupling between the car and trailer for this acceleration?

A zero **B** 1400 N **C** 1800 N **D** 2600 N

T-400 = (500)(2)
T = 1400 N

7 A student is studying Newton's third law of motion. He states that a rocket travelling in deep space can never accelerate because when the rocket's engines burn, the forwards force acting on the rocket is cancelled by an equal and opposite force.
Which statement explains why the student is wrong?

A The equal and opposite force does not act on the rocket.

B The equal and opposite force has a different line of action.

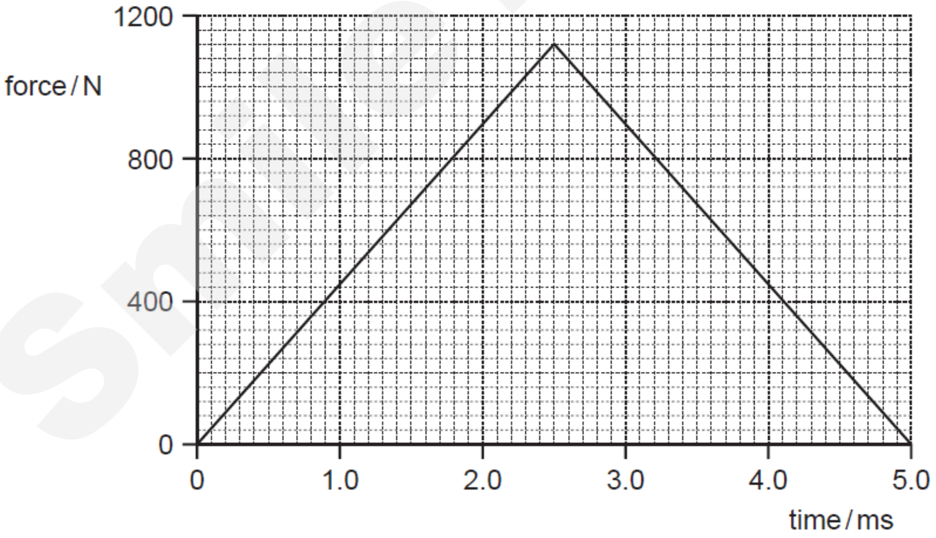
C The equal and opposite force is a reaction force.

D The equal and opposite force will be a different type of force.

Answer : A

Action and reaction has to be on different bodies.

8 A tennis ball of mass 56 g is struck by a tennis racquet. The graph shows how the force exerted on the ball by the racquet varies with time.



What is the change in the velocity of the tennis ball?
A 50 cm s^{-1} **B** 100 cm s^{-1} **C** 50 m s^{-1} **D** 100 m s^{-1}

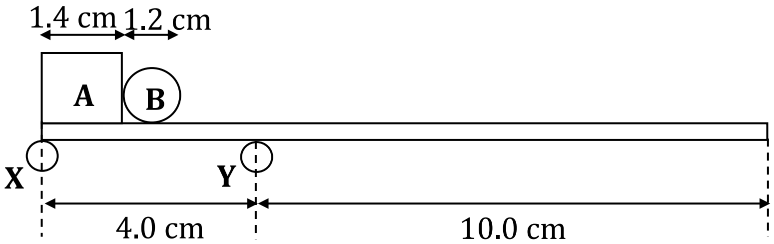
Answer: C

m Δv = area under F-t graph

0.056 Δv = ½ (5.0 X 10^{-3})(1120)

Δv = 50 m s^{-1}

9 A beam of negligible mass is supported by two rods **X** and **Y.** A block **A** of mass 200 g and a ball **B** of mass 100 g rest on the beam as shown. Both **A** and **B** have uniform density.



If ball **B** starts to roll to the right, what is the distance it has moved when the beam just loses contact with rod **X**?

A 6.6 cm **B** 8.0 cm **C** 8.6 cm **D** 9.4 cm

Answer : C

For losing contact, taking moments about pivot at Y,
Clockwise moment = anticlockwise moment
(0.100)(g)x = (0.200)(g)(3.3 cm)
x = 6.6 cm. (from Y)
distance moved = 10.6 – 2.0 = 8.6 cm

10 A block of weight *W* is resting at one end of a horizontal, uniform rigid beam of the same weight. The other end of the beam is mounted on a wall and the length of the beam is *L*. A rope from the wall is attached to the beam at a point of *L*/4 from the far end of the beam as shown in Fig. 10.

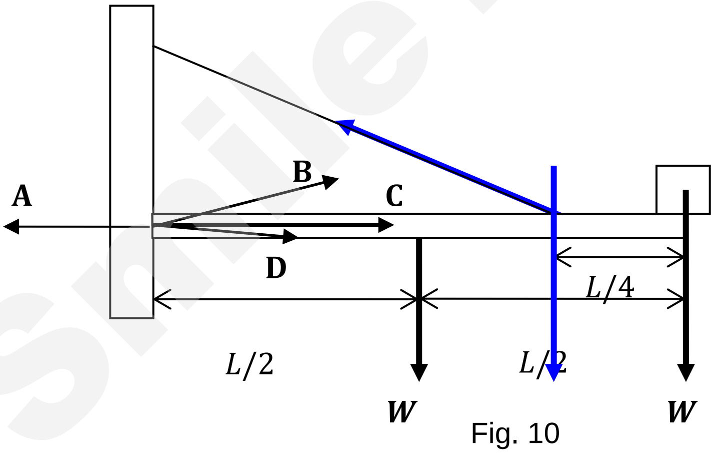


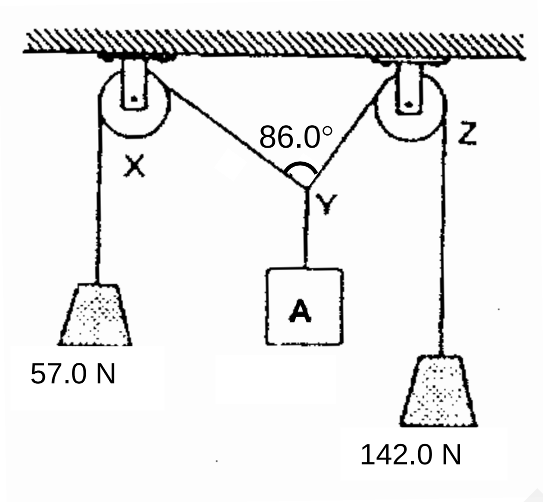
Fig. 10

Which of the arrows labelled from A to D shows the direction of the force of the wall acting on the beam? (The arrow vectors only show the directions but not their sizes.)

Answer : C

Since only C pass thru the intersection point.

11 The diagram shows a body A supported by strings passing over two smooth pulleys with the weights attached. The system is in equilibrium with angle XYZ = 86.0°.



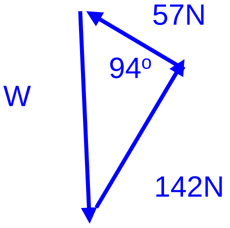
The weight of A is

A 126 N **B** 130 N **C** 134 N **D** 157 N

Answer : D

By considering the forces of triangle,

Using cosine rule,
$W^2 = 57^2 + 142^2 - (2)(57)(142)\cos(94)$
W = 157 N



12 A gas is enclosed in a cylinder by a frictionless piston of cross-sectional area 3.0×10^{-3} m^2. When atmospheric pressure is 1.01×10^5 N m^{-2}, the piston settles 80 mm from the end of the cylinder as shown in Fig.12.1. The gas is then heated and it expands by pushing the piston against atmospheric pressure until the piston is 160 mm from the end of the cylinder as shown in Fig 12.2. What is the work done by the gas?

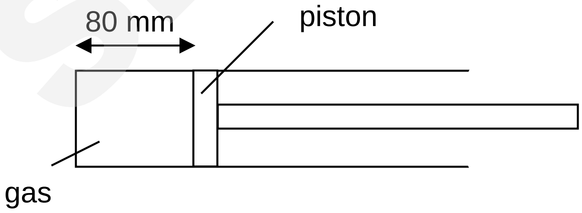


Fig.12. 1

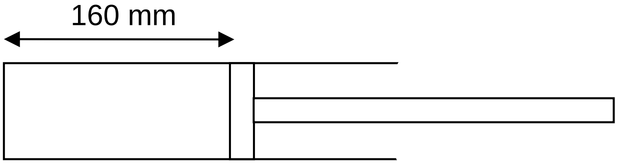


Fig.12.2

A 8.0 J **B** 24 J **C** 30 J **D** 48 J

Answer : B
Work done = P ΔV = $(1.01 \times 10^5)(3 \times 10^{-3})(0.080)$ = 24 J

13 In a tidal power station, 100 km^2 of water is raised to a height of 1.2 m by the tide behind a tidal barrier. What would be the mean power output of such a station if its efficiency is 20% and there are two tides per day? (Assume density of water to be 1000 kg m^{-3})

A 1.6 MW **B** 3.3 MW **C** 6.5 MW **D** 16 MW

Answer : C

Power = rate of work done
= increase in gpe / time taken
= 2x (100 x 10^6)(1.2)^2(1000)(9.81)(0.2) / (24 x 60 x 60) = 6.5 M W

14 A plane wave of amplitude *A* is incident on a surface area *S* placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time intercepted by the surface is *E*.

The amplitude of the wave is increased to 3*A* and the area of the surface is reduced to *S*/3. How much energy per unit time is intercepted by this smaller surface?

A $\frac{1}{9}E$ **B** E **C** $3E$ **D** $9E$

Ans: **C**

$$I = \frac{E}{S}$$

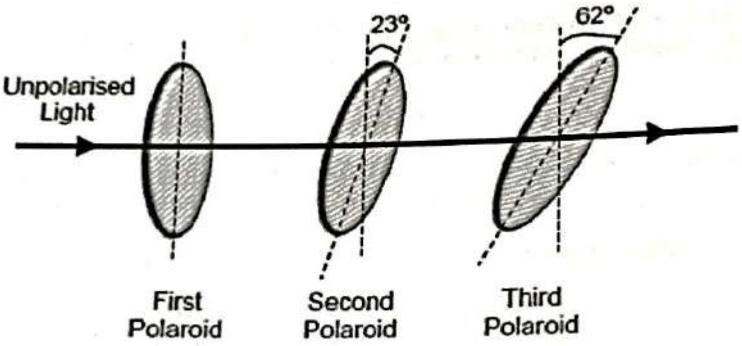
$$I \propto A^2$$

$$\Rightarrow \frac{E}{S} \propto A^2$$

$$E \propto A^2 S$$

$$E' = 3^2\left(\frac{1}{3}\right)E = 3E$$

15 Light is polarised when it passes through a sheet material known as a polaroid. Three polaroids are stacked, with the polarising axis of the second and third polaroids at 23° and 62° respectively, to that of the first polaroid, as shown in the diagram below.

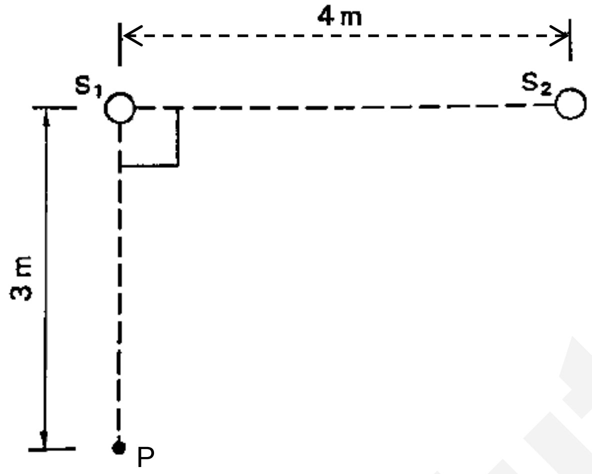


When unpolarised light of amplitude A_o is incident on the stack of polaroids, the light has amplitude of A_1 after it passes through the first polaroid, A_2 after it passes through the second polaroid, and A_3 after it passes through the third polaroid. What is the value of $\frac{A_3}{A_1}$?

A 0.25 **B** 0.31 **C** 0.43 **D** 0.72

Ans: **D**

16 Two wave generators S_1 and S_2 each produces water waves of wavelength 4 m. They are placed 4 m apart in a water tank and a detector P is placed on the water surface 3 m from S_1 as shown below.



When operated alone, each generator produces a wave at P which has an amplitude *A*. When the generators are operating together and in phase, what is the resultant amplitude at P?

A 0 **B** ½ A **C** 2A **D** 4A

Ans: **A**

$S_2P = 5$ m

Path difference = 2 m = $\lambda/2$

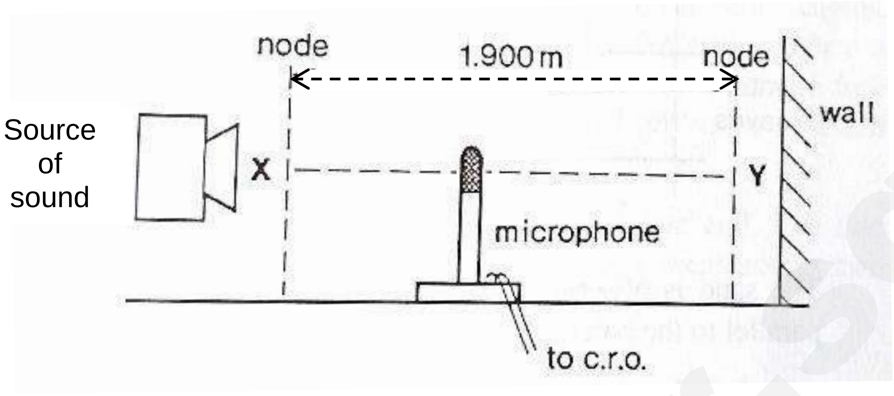
Hence destructive interference will occur at P.

17 A resonance tube open at both ends and responding to a tuning fork

- **A** always has a central node.
- **B** always has an odd number of nodes.
- **C** always has an even number of nodes.
- **D** always has an odd number of nodes and antinodes.

Ans: **D**

18 A source of sound of frequency 2500 Hz is placed several metres from a plane reflecting wall in a large chamber containing a gas. A microphone, connected to a cathode-ray oscilloscope, is used to detect nodes and antinodes along the line XY between the source and the wall.



The microphone is moved from one node through 20 antinodes to another node, over a distance of 1.900 m. What is the speed of sound in the gas?

A 238 m s^{-1} **B** 250 m s^{-1} **C** 330 m s^{-1} **D** 475 m s^{-1}

Ans: **D**

$10\lambda = 1.900$

$\lambda = 0.190$ m

$v = f\lambda = (2500)(0.190) = 475$ m s^{-1}

19 There are 1.3 x 10^{19} electrons passing through a point in a series circuit in 1.0 hour. If the potential difference across a resistor connected in series to the source is 10 kV, what is the power dissipated in the resistor?

A 3.6 W **B** 5.1 W **C** 5.8 W **D** 21 W

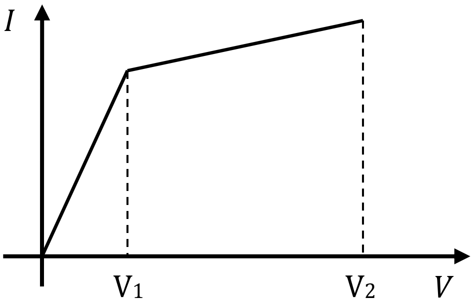
Ans: **C**

$$P_{dissipated} = I_{resistor}V_{resistor}$$

$$P_{dissipated} = \frac{Ne}{t}V_{resistor}$$

$$P_{dissipated} = \frac{1.3\times10^{19}\times1.6\times10^{-19}}{3600}\times 10000 = 5.8\text{ W}$$

20 The graph plots current *I* against potential difference *V* for an electrical component.



The resistance of the component

A Is constant from 0 to V_1, then increases to another constant from V_1 to V_2

B Is constant from 0 to V_1, then decreases to another constant from V_1 to V_2

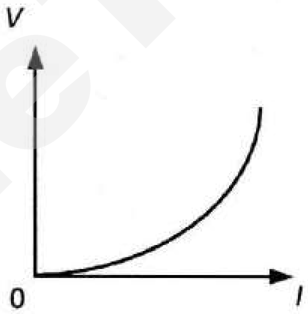
C Is constant from 0 to V_1, then decreases continuously from V_1 to V_2

D Is constant from 0 to V_1, then increases continuously from V_1 to V_2

Ans: **D**

From V_1 to V_2, the ratio I/V decreases. Since $R = V/I$, the resistance increases.

21 The figure shows the current *I* through a filament lamp changes with the p.d. *V* applied across it

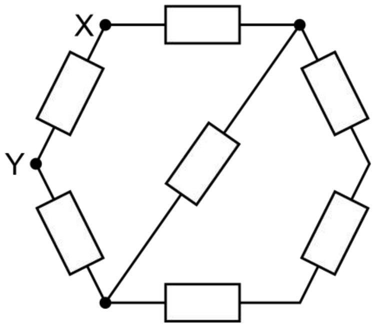


It is not a straight line graph because

- **A** the lamp is placed in a forward-biased position
- **B** the filament has a negative temperature coefficient
- **C** more mobile charge carriers are liberated due to a rise in temperature
- **D** the mobility of electrons decreased due to a rise in temperature

Ans: **D**

22 The diagram shows a network of 7 resistors, each with resistance R.



What is resistance between points X and Y?

A $\frac{2}{3}$ R

B $\frac{3}{5}$ R

C $\frac{7}{11}$ R

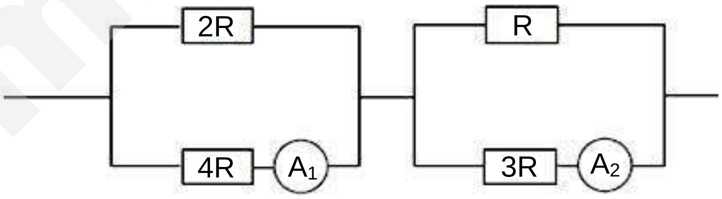
D $\frac{11}{15}$ R

Ans: **D**

$$(R_{XY})^{-1} = \left(R + \frac{3R \times R}{3R + R} + R\right)^{-1} + R^{-1}$$

$$R_{XY} = \frac{11}{15}R$$

23 The ammeter A_1 of the circuit below reads 6.0 A.

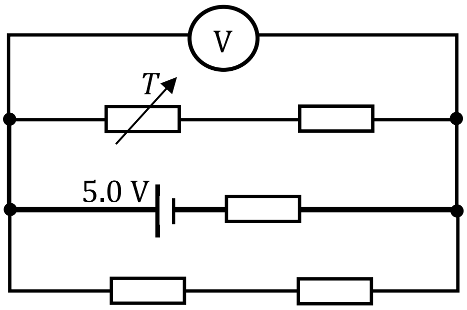


Assuming that both ammeter have negligible resistance, what is the reading on A_2?

A 4.5 A **B** 6.0 A **C** 13.5 A **D** 18.0 A

Ans: **A**

24 A cell of e.m.f. 5.0 V and negligible internal resistance is connected to four similar resistors and a variable resistor *T*, as shown.



The resistance of each resistor is 1.0 kΩ and the resistance of *T* is 5.0 kΩ.

What is the reading on the ideal voltmeter?

A	0 V	**B**	2.0 V	**C**	3.0 V	**D**	5.0 V

Ans: **C**

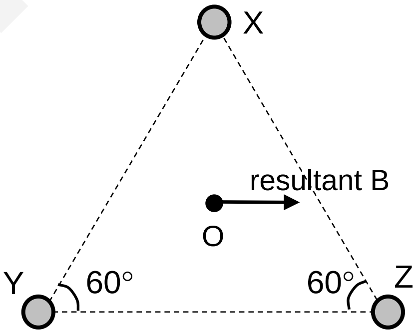
Effective resistance of the circuit

$$= 1000 + \frac{(1000 + 1000)(5000 + 1000)}{(1000 + 1000) + (5000 + 1000)}$$
$$= 2500$$

p.d. across voltmeter

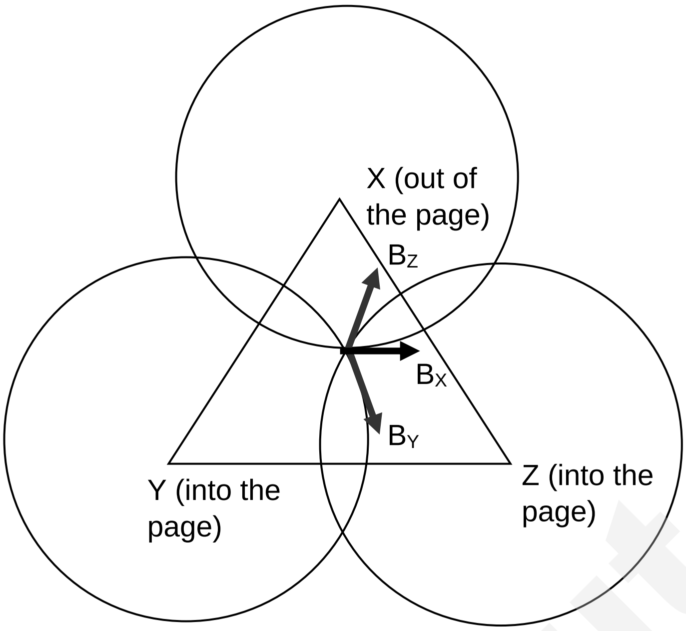
$$= 5 - 5 \times \frac{1000}{2500}$$
$$= 3.0\ V$$

25 Three parallel conductors, carrying currents of the same magnitude, pass vertically through the three corners X, Y and Z of a horizontal equilateral triangle as shown in the diagram below. A resultant magnetic flux density, B, acting at the centre of the triangle, O, acts in the direction as shown below. What must be the directions of the currents in X, Y and Z?

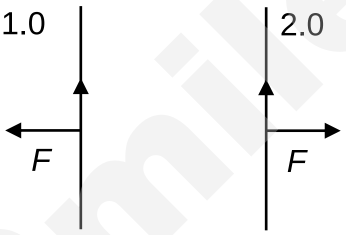


	Into the page	Out of the page
A	X	Y and Z
B	Z	X and Y
C	Y and Z	X
D	X, Y and Z	None

Ans: C
For the resultant flux density at O to be as shown, the directions of B_X, B_Y and B_Z must be as shown in diagram below. Using the Right Hand Grip Rule, the corresponding direction of current can be found.

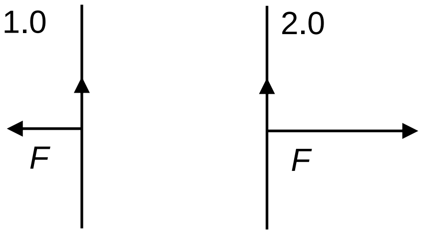


26 Two long straight parallel wires carry currents of 1.0 A and 2.0 A. Which diagram shows the directions and relative magnitudes F_1 and F_2 of the forces per unit length on each of the wires?



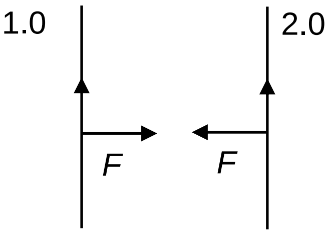
$F_1 = F_2$

A



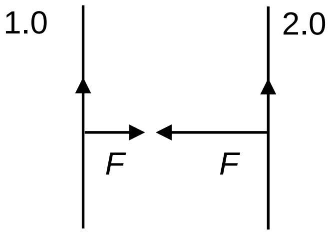
$2F_1 =$

B



$F_1 = F_2$

C



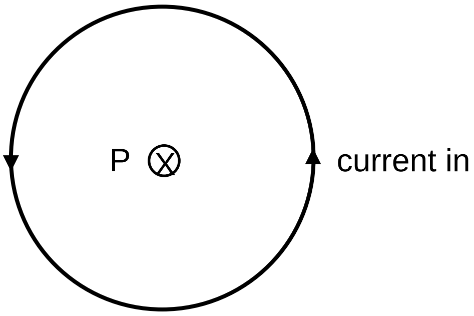
$2F_1 =$

D

Ans: C

Using Fleming's Left Hand Rule, the forces F_1 are F_2 found to act towards each other. By Newton's Third Law, the magnitude of the forces should be equal.

27 A long straight wire P is placed along the axis of a flat circular coil Q. The wire and the coil each carry a current as shown. Current in P is into the plane of the diagram.



What can be deduced about the force acting on each part of Q due to the current in P?

A No force acts.
B The force acts perpendicular to the plane of the diagram.
C The force acts towards P.
D The force acts away from P.

Ans: A

Since the magnetic flux density at P due to Q acts along the same axis as the current of P, no electromagnetic force will be experienced by P.

28 The first excitation energy and the ionization energy of a certain atom are 21.2 eV and 28.8 eV respectively. An electron of energy 22.4 eV strikes the atom at the ground state. What happens to the atom?

A The atom remains at the ground state.
B The atom is excited to the first excited state.
C The atom is excited to the second excited state.
D The atom is ionized.

Ans B

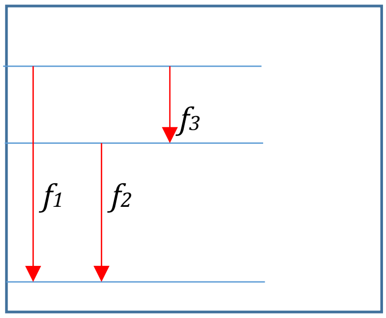
The answer has to be B. There is no information offered regarding the 2nd excited state, hence it cannot be determined whether the atom can reach the 2nd state but it will definitely reach the 1st excited state.

29 Photons are emitted when the electrons drop from a higher energy level to a lower energy level. Consider the three lowest energy levels of a hydrogen atom. When electrons drop from the second lowest or third lowest energy level, the possible frequencies of photons emitted are f_1, f_2, and f_3, which are in ascending order. The magnitude of f_2 is equal to

A $f_3 - f_1$ **B** ½ $(f_1 + f_3)$ **C** $\frac{f_3 - f_1}{f_1 f_3}$ **D** $\sqrt{f_1 f_3}$

Ans A

Consider the 3 lowest energy levels of the atom:



Since $E_1 = E_2 + E_3$
$hf_1 = hf_2 + hf_3$

Therefore
$f_2 = f_1 - f_3$

30 The de Broglie wavelength of a moving particle of mass m is λ. If the kinetic energy of the particle is halved, the de Broglie wavelength will become

A $\frac{\lambda}{2}$ **B** $\frac{\lambda}{\sqrt{2}}$ **C** $\sqrt{2}\lambda$ **D** 2λ

Ans C

$E_k = \frac{p^2}{2m}$
If $E_k' = \frac{1}{2}E_k$
Then $p' = \frac{1}{\sqrt{2}}p$

Since $\lambda = \frac{h}{p}$
Therefore $\lambda' = \sqrt{2}\lambda$

H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

CLASS

TUTOR'S NAME

PHYSICS

8866/02

Paper 2 Structured Questions

18 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required

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Section **A**
Answer **all** questions.

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Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

This document consists of **21** printed pages.

[Turn over

Data

speed of light in free space, $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$

permeability of free space, $\mu_o = 4\pi \times 10^{-7}\ \text{H m}^{-1}$

permittivity of free space, $\varepsilon_o = 8.85 \times 10^{-12}\ \text{F m}^{-1}$

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uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series $R = R_1 + R_2 + \ldots$

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Section A

Answer **all** the questions in this section.

1 A uniform plank AB of length 5.0 m and weight 200 N is placed across a stream, as shown in Fig. 1.1.

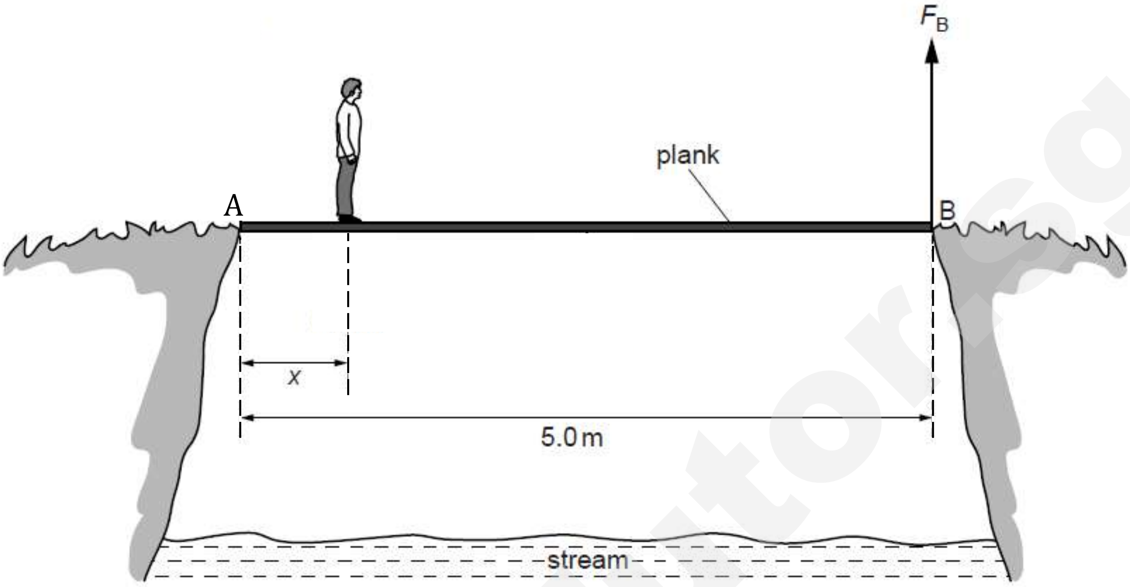

Fig. 1.1

A man of weight 880 N stands at a distance x from end A. The ground exerts a vertical force F_B on the plank at end B. As the man moves along the plank, the plank is always in equilibrium.

(a) **(i)** Draw all other forces on the plank and label them clearly. [3]

(ii) Define moment of a force.

....

....

....[1]

(iii) The man stands at a distance x = 0.50 m from end A. Calculate the magnitude of F_B.

F_B =.......................................N [2]

(b) If the plank is not uniform and the centre of gravity is nearer to point B, state and explain if there is any change to the magnitude of F_B.

....

....

....

....

....[2]

2 **(a)** **(i)** By using the equations of motion, show that the kinetic energy E_K of an object travelling with speed v is given by

$$E_K = \frac{1}{2}mv^2$$

[2]

(ii) State one assumption, other than that of the object having a constant acceleration.

....

....[1]

(b) State the principle of conservation of energy.

....

....

....[2]

(c) The cable of a passenger lift of mass 1800 kg snaps when the lift is at rest at the first floor of a high rise building as shown in Fig. 2.1. At this moment, the bottom of the lift is at a height *h* = 3.7 m above an uncompressed spring of spring constant *k* = 0.15 MN m^{-1}. A safety device that is activated because of this fault, clamps the lift against guide rails so that a constant frictional force *F* of 4.4 kN opposes the lift's motion at all times.

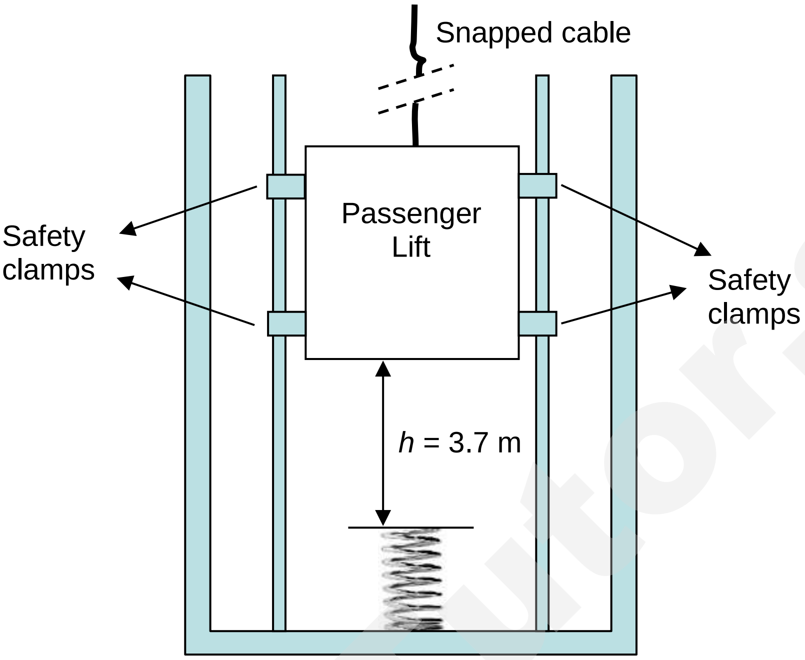

Fig. 2.1

Assuming that the frictional force still acts during the spring's compression, determine the maximum compression of the spring.

maximum compression = ... m [3]

3 **(a)** State the principle of superposition.

....

....

....

....[1]

(b) A double slit with slit separation 0.800 mm is situated a distance 2.50 m from a thin jet of high speed smoke as shown in Fig. 3.1.

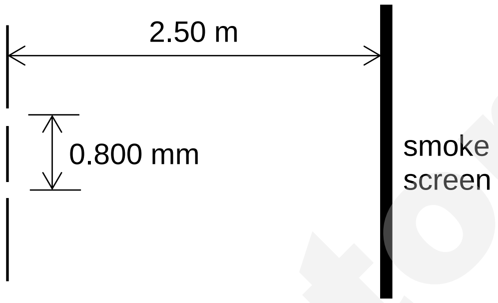

Fig. 3.1

The double slit is illuminated with coherent light of wavelength 589 nm. Fringes are observed in the moving smoke.

(i) Calculate the separation of these fringes.

separation = ... m [2]

(ii) Describe changes that would be observed in the pattern of fringes, if the following adjustments were made in the experimental arrangement. In each case, only one adjustment is made and all the other arrangements are the same as those in **(b)(i)**.

1. The coherent light of wavelength 589 nm is replaced with coherent monochromatic red light.

....

....

....

....[1]

2. The speed of the smoke screen is doubled.

....

....

....[1]

3. The direction of the smoke stream is rotated through 45° as shown in Fig. 3.2.

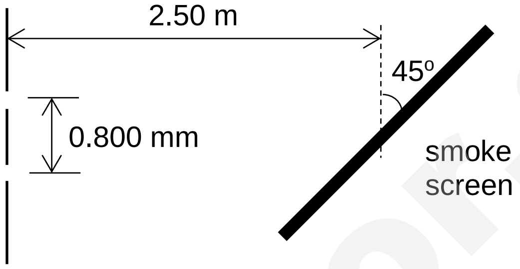

Fig. 3.2

....

....

....

....

....[2]

4 A conducting rod of mass 15.0 g rests on a set of smooth parallel horizontal rails as shown in Fig. 4.1. The rod and rails are in a region where there is a magnetic field.

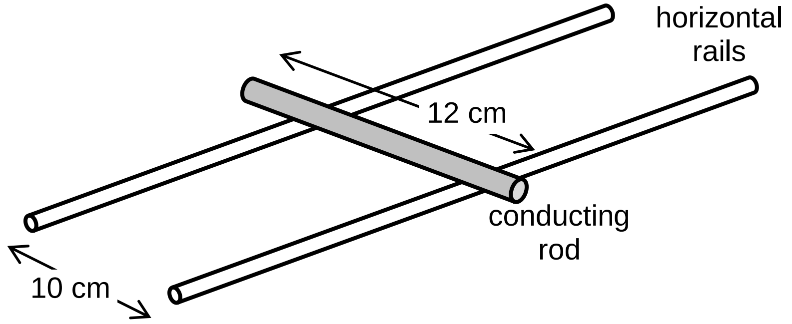

Fig. 4.1

When a potential difference is applied across the rails, the rod experiences an initial horizontal acceleration of 1.20 m s^{-2} due to a 3.0 A current passing through the rod.

(a) Determine the magnitude of the magnetic force on the rod.

magnetic force = ... N [1]

(b) Show that the minimum flux density of a magnetic field that can produce this acceleration is 60 mT.

[2]

(c) The actual flux density due to the magnetic field is 120 mT. To produce the same magnetic force in (a), draw the directions of this magnetic field, the force on the rod and the current in the rod clearly on Fig. 4.2 which shows the front view of the rod on the rails.

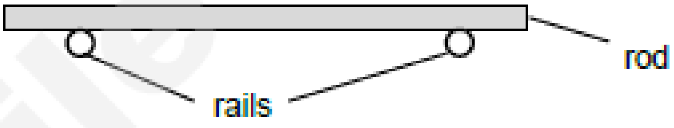

Fig. 4.2 (Front view)

[2]

(d) The rails may be inclined at an angle to restore the equilibrium of the rod. Determine the angle of inclination of the rails such that the net force on the rod is zero.

angle of inclination = ...° [2]

5 The walls of music halls are acoustically covered with a sound-absorbing panel that is able to absorb certain sound frequencies more than others.

One particular design is to use the resonance of a perforated panel as shown in Fig. 5.1.

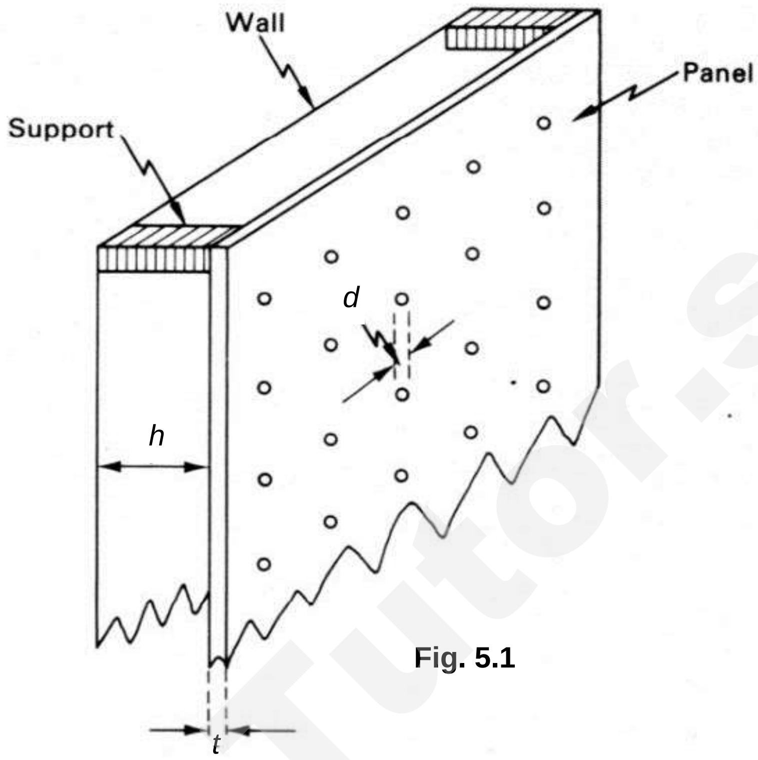

Fig. 5.1

It is found that this panel resonates at a particular frequency and hence can absorb sounds of that frequency more than others. A suggested formula for this resonant frequency f is given as:

$$f = k\sqrt{\frac{x}{h(t+0.8d)}} \qquad \text{--- Equation 5.1}$$

where k = 5000 mm s^{-1},
h = depth of airspace with unit mm,
t = thickness of panel with unit mm,
d = hole diameter with unit mm, and
x = percentage of panel surface area occupied by holes (e.g. x = 10 %)

Using identical hardboard panels having holes of the same diameter of 10 mm, the resonant frequencies f for different x values are measured, keeping h and t constant. The results are shown in Fig. 5.2:

x / %	2	4	6	8	10	12
f / Hz	530	750	920	1070	1190	1300

Fig. 5.2

(a) Fig.5.3 shows the plot of some of the data from Fig. 5.2. Plot a point in Fig. 5.3 corresponding to the data for x = 10 %. [1]

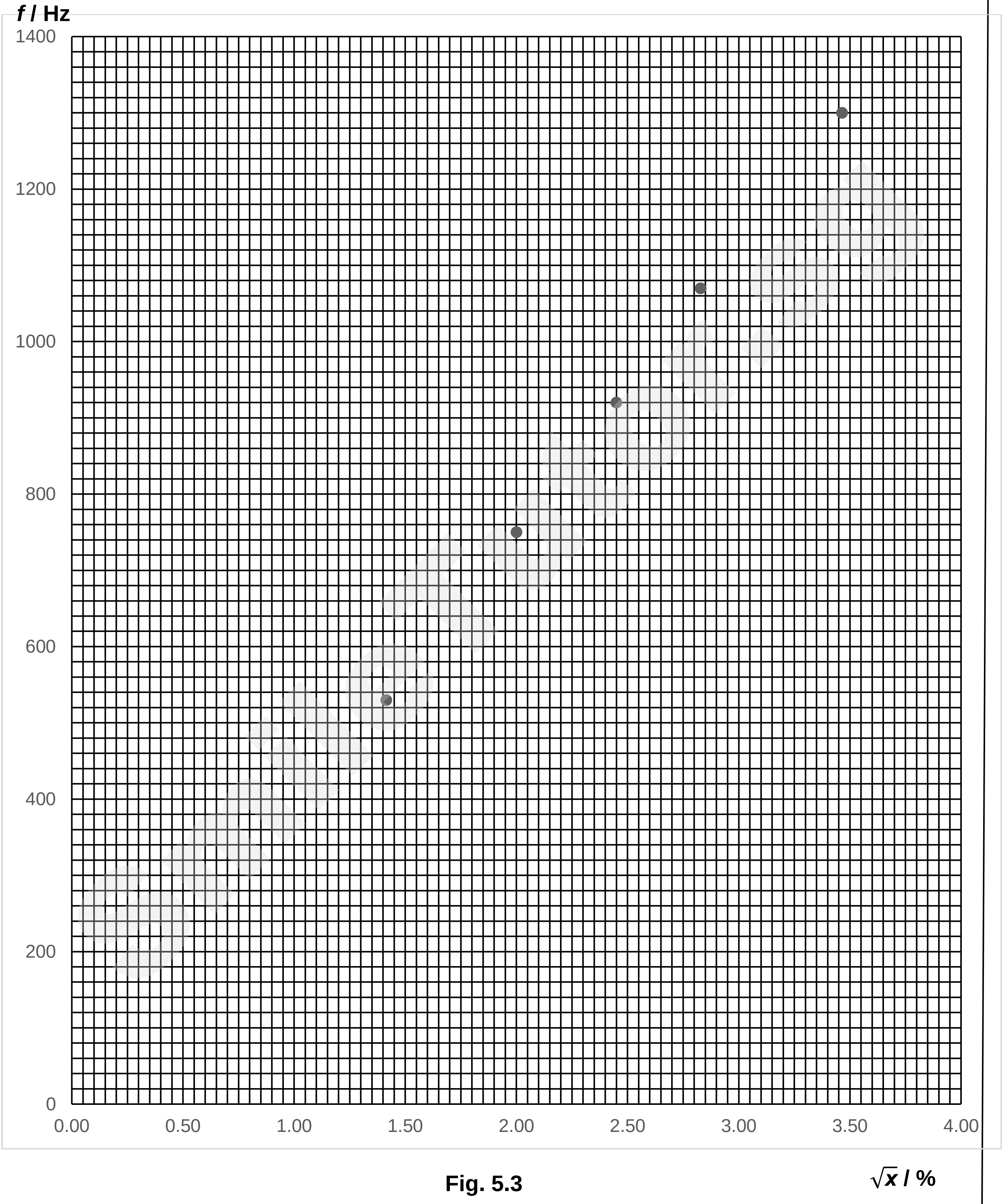

Fig. 5.3

(b) Explain whether the graph of Fig. 5.3 supports the suggestion that *f* is proportional to $\sqrt{x}$.

....

....

....

....

....[2]

(c) Determine the gradient of the graph in Fig. 5.3.

gradient = ... [2]

(d) Hence suggest suitable values for *h* and *t* when *x* = 10 %.

h = ...mm

t = ...mm [2]

(e) Using a panel with *x* fixed at 10 % and *d* fixed at 5 mm, the engineer decides to investigate the effect of filling the air space with 2 different absorbers. He obtains the absorption characteristics shown in Fig. 5.4.

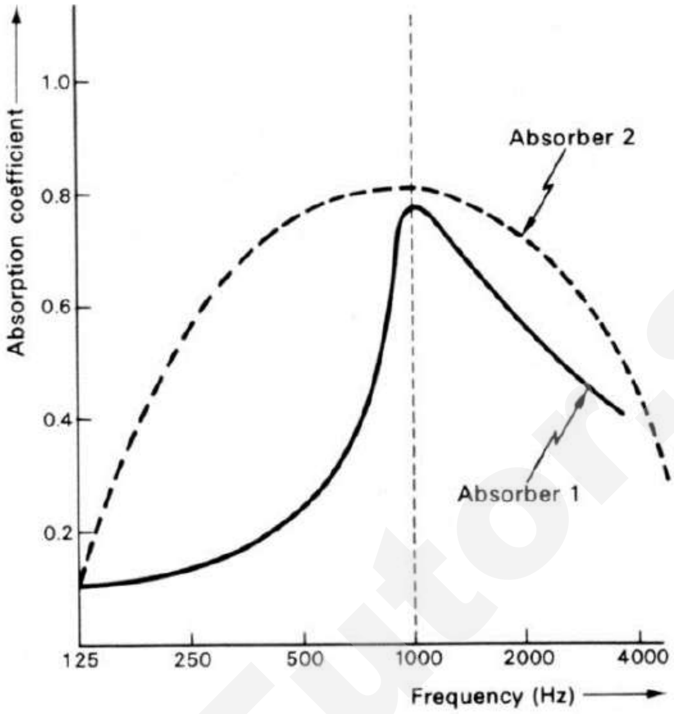

Fig. 5.4

Absorption coefficient is an indication of how much sound waves can be absorbed, i.e. the higher the absorption coefficient, the stronger the absorption.

(i) Suggest how the absorption coefficient is calculated.

....

....[1]

(ii) State and explain which of the two absorbers would be preferred in a room in which

1. absorption over a wide frequency range is required,

....

....

....[1]

2. sounds below 500 Hz need amplification.

....

.... [1]

Section B

Answer **two** of the questions from this section**.**

6 **(a)** Write down in terms of the mass *m* and the velocity *v* of a body, expressions for its momentum *p* and its kinetic energy *K*.

p = ...

K = ...[2]

(b) A tennis ball has a horizontal momentum of 2.40 N s and a kinetic energy of 45.0 J at the instant just before it is struck by a tennis racket.
Calculate the mass and the velocity of the tennis ball.

mass = ...kg

velocity = ...m s^{-1} [3]

(c) When the racket hits the ball it strikes the ball with a constant force of 60 N in a direction opposite to the momentum of the ball, bringing it to rest momentarily.

(i) Show that the time taken for the tennis ball to come to rest is 0.040s.

[2]

(ii) Calculate the distance travelled by the tennis ball travels from the time it is hit by the racket till the time when it comes to rest.

distance = ...m [2]

(iii) Suggest why, in practice, it is impossible for a constant force to be applied to the ball.

....

....

....

....[2]

(d) The force of 60 N then continues to act on ball for a further 0.060 s.

(i) Without performing any calculations, predict and explain whether the final velocity of the ball will have a larger magnitude than that of the velocity before impact with the racket.

....

....

....

....[2]

(ii) State the principle of conservation of linear momentum.

....

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....

....[2]

(iii) Explain whether the law of conservation of linear momentum applies to the racket and the ball in this collision between the racket and the ball.

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....

....[2]

(e) The ball leaves the racket horizontally. By considering the forces acting on the ball, describe and explain the subsequent motion of the ball before it reaches the ground. Assume viscous force by air is negligible.

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....

....[3]

7 A student wants to light a lamp marked '3.00 V, 0.600 W' but has only a 12.00 V battery of unknown internal resistance. In order to reduce the battery voltage, the student sets up the circuit as shown in Fig. 7.1 below. The digital voltmeter is included so that the voltage can be checked before connecting the lamp. The variable resistor CD has a maximum resistance of 1000 Ω.

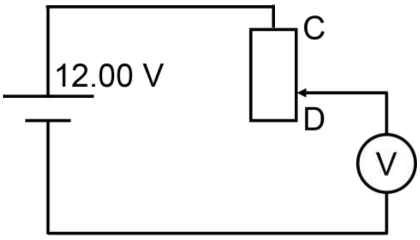

Fig. 7.1

(a) Explain what is meant by the "12.00 V" when applied to a 12.00 V battery.

....

....

....[1]

(b) It is found that when the sliding contact of the rheostat is placed at C, the digital voltmeter reading is 11.99 V. When the sliding contact is moved down from C to D, the digital voltmeter reading drops from 11.99 V to 11.00 V.

(i) State the potential difference across the internal resistance of the battery when the sliding contact of the rheostat is placed at C.

potential difference: .... V [1]

(ii) Using the potential divider concept or otherwise, determine the internal resistance *r* of the battery and the resistance *R* of the voltmeter.

r = ... Ω

R = ... Ω [4]

(iii) Explain**,** using the concept of a potential divider, why the presence of internal resistance reduces the output power of the 12.00 V battery.

....

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....[2]

(c) The circuit in Fig. 7.1 is modified as shown in Fig. 7.2 and the potentiometer is adjusted to give a digital voltmeter reading of 3.00 V.

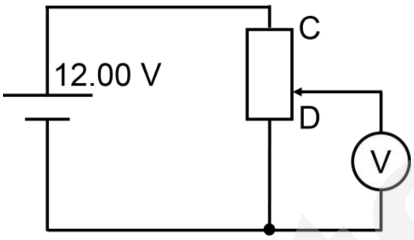

Fig. 7.2

(i) Determine the current through the digital voltmeter given that its resistance is 11.1 kΩ.

current =.. A [1]

(ii) Deduce the effect on the current through the battery if a voltmeter of lower resistance is used.

....

....[1]

(d) The student removes the digital voltmeter and connects the lamp in its place.

(i) Explain the significance of the marking '3.00 V, 0.600 W' on the lamp.

....

....[1]

(ii) Calculate the resistance of the lamp when it is operating normally.

resistance = ... Ω [1]

(iii) A fuse in the lamp is introduced to prevent the lamp from operating above 0.800 W at 3.00 V. Determine the current needed to blow the fuse.

current = ... A [1]

(e) The characteristic *I*−*V* graph in Fig.7.3 is that of a filament lamp.

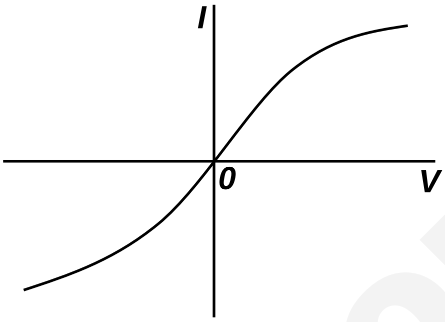

Fig. 7.3

Explain why, as the voltage is increased either positively or negatively from zero, the graph has the form shown in the Fig.7.3.

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....[4]

(f) In order to light up another set of lamps, each having a resistance of 20 Ω, the student sets up another circuit as shown in Fig. 7.4.

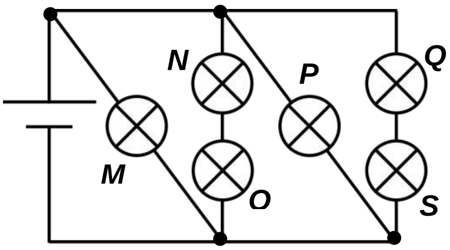

Fig. 7.4

(i) Determine the effective resistance of the circuit.

effective resistance = ... Ω [1]

(ii) State and explain which (if any) of the lamps is likely to blow if the battery connected to the circuit is marked 4.50 V and lamps are marked '4.50 V, 0.800 W'. Assume that internal resistance of the battery is negligible.

....

....[2]

8 **(a)** Observations from the photoelectric experiment provided the first evidence for the particulate nature of light. Describe two of these observations and how each deviates from predictions of the classical wave theory of light.

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....

....[4]

(b) Two metal plates X and Y are contained in an evacuated container and are connected to a circuit as shown in Fig. 8.1. Graph A shown in Fig. 8.2 shows the current I through the microammeter as a function of the p.d. applied across XY when monochromatic light is allowed to fall on plate X.

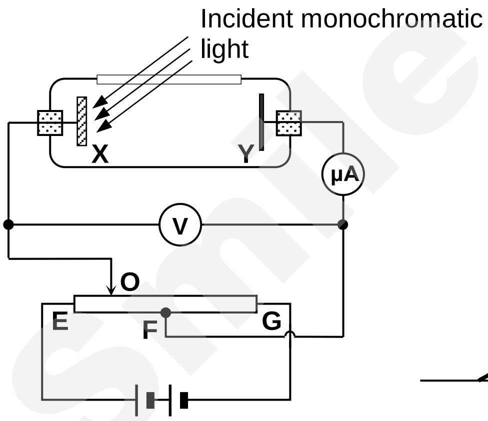

Fig. 8.1

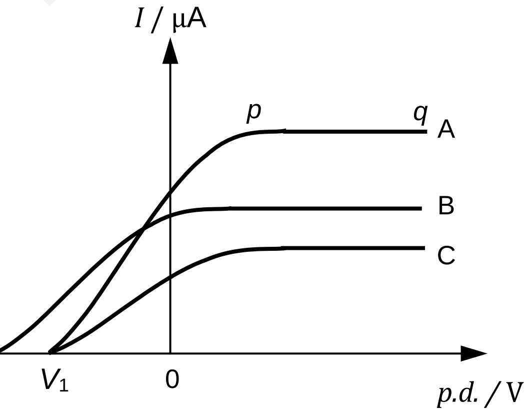

Fig. 8.2

(i) Suggest and explain where the sliding contact **O** should be to give the part of the graph pq.

....

....

....

....

....

....[2]

(ii) Given that the work function of X is 1.3 eV and the wavelength of the light is 550 nm, calculate the value of V_1.

V_1 = ... V [2]

(iii) Suggest the changes that can be made to the experiment in Fig. 8.1 to produce the lines B and C.

....

....

....

....[2]

(c) The graph in Fig. 8.3 shows part of the visible region of the spectrum of a hot star far away from Earth.

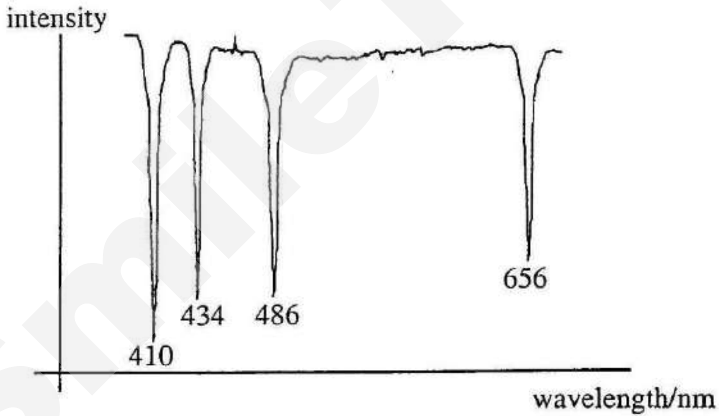

Fig. 8.3

The absorption lines are due to the large number of excited hydrogen atoms on the star.

(i) Explain how absorption lines are produced by the hydrogen atoms.

....

....

....

....

....

....[2]

(ii) Sketch a labelled graph of intensity against wavelength for the emission spectrum of hydrogen. [1]

(iii) Fig. 8.4 shows the first six energy levels of a hydrogen atom. Draw arrows to represent the energy transitions that give rise to the emission lines corresponding to those shown in Fig. 8.3. Label the transitions with the corresponding wavelengths. Hence calculate the values of E_2, E_5 and E_6.

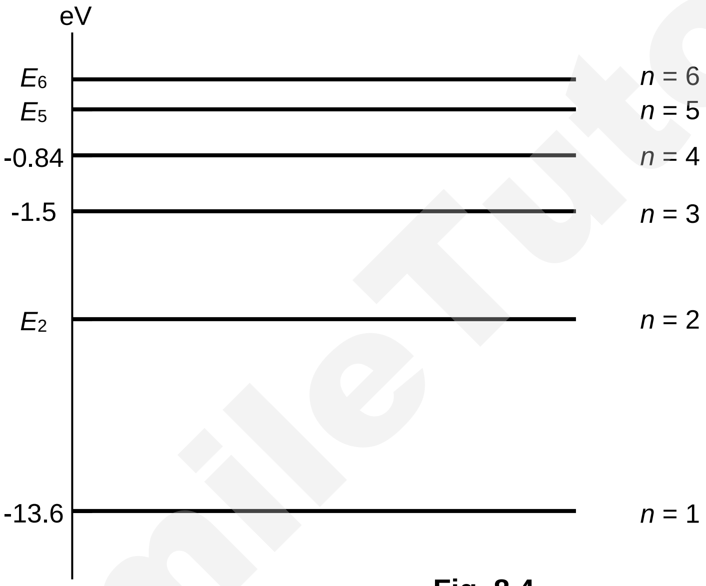

Fig. 8.4

E_2 = ... eV

E_5 = ...eV

E_6 = ...eV [6]

(iv) State the region of the electromagnetic spectrum in which radiation corresponding to a transition between n = 4 and n = 3 would lie.

....[1]

H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME: SOLUTION

CLASS:

TUTOR'S NAME:

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8866/02

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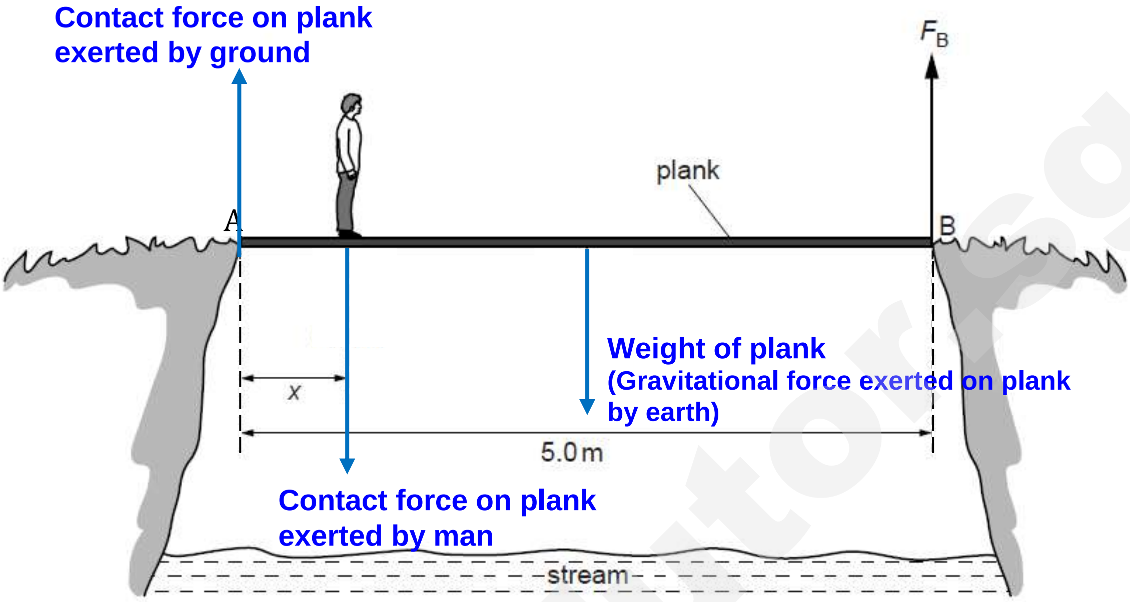


Fig. 1.1

A man of weight 880 N stands at a distance x from end A. The ground exerts a vertical force F_B on the plank at end B. As the man moves along the plank, the plank is always in equilibrium.

(a) **(i)** Draw all other forces on the plank and label them clearly. [3]

(ii) Define moment of a force.

The moment of a force about a point is defined as the product of the force and the perpendicular distance from the line of action of the force to that point.

....[1]

(iii) The man stands at a distance x = 0.50 m from end A. Calculate the magnitude of F_B.

(anticlockwise moments) = (clockwise moments)

$F_B \times 5.0 = 880 \times 0.5 + 200 \times 2.5$

$F_B = (440 + 500) / 5.0 = 188$ N

F_B =...N [2]

(b) If the plank is not uniform and the centre of gravity is nearer to point B, state and explain if there is any change to the magnitude of F_B.

The clockwise moment due to the weight will increase, thus, the anticlockwise moment due to F_B will have to increase as well and magnitude of F_B will increase.

....[2]

2 **(a)** **(i)** By using the equations of motion, show that the kinetic energy E_K of an object travelling with speed *v* is given by

$$E_K = \frac{1}{2}mv^2$$

Work Done = Force x displacement = ma s
($v^2 = u^2 + 2as$, so as = ½ ($v^2 - u^2$))
Since work done by external agent to move a body from rest converts to kinetic energy of the body,
E_k = m ½ ($v^2 - u^2$)
Since body is at rest initially,
Hence E_k = ½ mv^2

[2]

(ii) State one assumption, other than that of the object having a constant acceleration.

There is no change in gravitational potential energy, (no increase in vertical distance)
The initial speed is zero.

....[1]

(b) State the principle of conservation of energy.

The principle of conservation of energy states that in a closed system, the total energy is constant.
Or
Energy can neither be created nor destroyed in any process. It can only be transformed (converted) from one form to another.
....[2]

(c) The cable of a passenger lift of mass 1800 kg snaps when the lift is at rest at the first floor of a high rise building as shown in Fig. 2.1. At this moment, the bottom of the lift is at a height *h* = 3.7 m above an uncompressed spring of spring constant *k* = 0.15 MN m^{-1}. A safety device that is activated because of this fault, clamps the lift against guide rails so that a constant frictional force *F* of 4.4 kN opposes the lift's motion at all times.

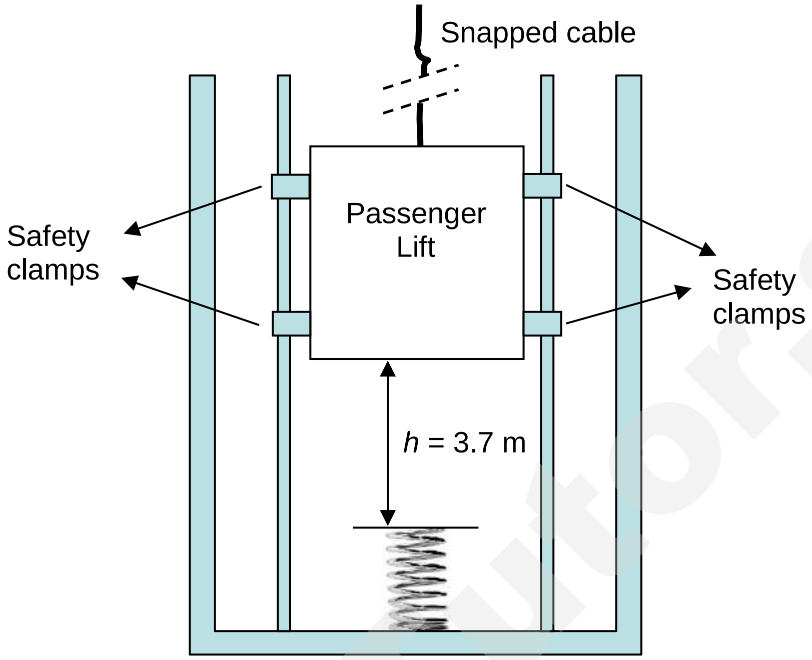


Fig. 2.1

Assuming that the frictional force still acts during the spring's compression, determine the maximum compression of the spring.

Let the spring compression height be *x* m.
By the principle of conservation of energy,
GPE Loss = Energy stored in the spring + Work done against friction

$$mg(h+x)=\frac{1}{2}kx^2+F(h+x)$$

$$\frac{1}{2}kx^2+(F-mg)x+h(F-mg)=0$$

$$(7.5 \text{ x } 10^4)x^2+\left[4.4 \text{ x } 10^3-(1800)(9.81)\right]x+\left[4.4 \text{ x } 10^3-(1800)(9.81)\right](3.7)=0$$

$$x^2-0.1768x-0.6541=0$$

$$x=\frac{-(-0.1768)\pm\sqrt{(-0.1768)^2-4(1)(-0.6541)}}{2(1)}$$

Taking *x* > 0, *x* = 0.902 m

maximum compression = ... m [3]

3 **(a)** State the principle of superposition.

When waves meet, the displacement of the resultant wave is the vector sum of the separate displacements of the individual waves, and each wave proceeds as though no other waves exist.

....[1]

(b) A double slit with slit separation 0.800 mm is situated a distance 2.50 m from a thin jet of high speed smoke as shown in Fig. 3.1.

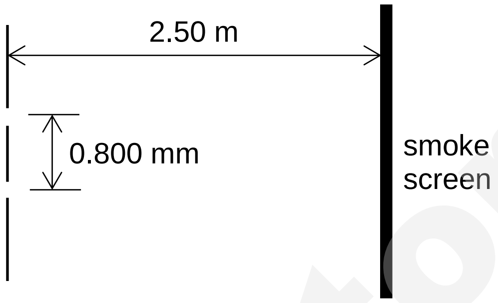


Fig. 3.1

The double slit is illuminated with coherent light of wavelength 589 nm. Fringes are observed in the moving smoke.

(i) Calculate the separation of these fringes.

$$\lambda = \frac{ax}{D}$$

$$589 \times 10^{-9} = \frac{\left(0.800 \times 10^{-3}\right)x}{2.50}$$

$$x = 1.84 \times 10^{-3} \text{ m}$$

separation = ... m [2]

(ii) Describe changes that would be observed in the pattern of fringes, if the following adjustments were made in the experimental arrangement. In each case, only one adjustment is made and all the other arrangements are the same as those in **(b)(i)**.

1. The coherent light of wavelength 589 nm is replaced with coherent monochromatic red light.

Since the wavelength of the light increases, the separation of the fringes will increase.
The fringes will still be uniformly separated and the positions of the maxima and minima remain unchanged.

....[1]

2. The speed of the smoke screen is doubled.

There will be no change to the fringe pattern.

....[1]

3. The direction of the smoke stream is rotated through 45° as shown in Fig. 3.2.

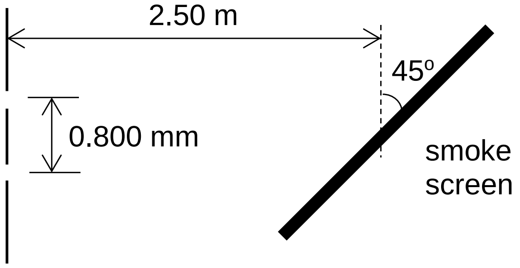


Fig. 3.2

Since the distance between the slits and the smoke screen (i.e. *D*) is now different at different positions along the smoke screen, the separation of the fringes will no longer be uniform. Moving from one end of the screen nearer the slits to the other end of the screen, the separation of the fringes will increase progressively.

Bright fringes observed on the part of the smoke screen which is nearer to the slits will have greater intensity than the other parts which are further away from the slits, hence the contrast between the bright and dark fringes on this part of the screen will also be greater. [2]

The positions of the maxima and minima remain unchanged.

4 A conducting rod of mass 15.0 g rests on a set of smooth parallel horizontal rails as shown in Fig. 4.1. The rod and rails are in a region where there is a magnetic field.

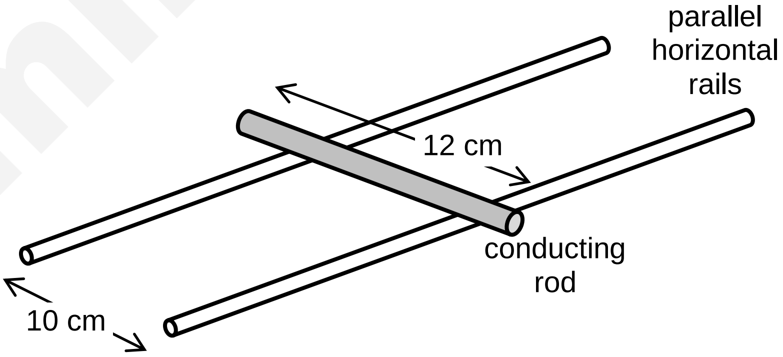


Fig. 4.1

When a potential difference is applied across the rails, the rod experiences an initial horizontal acceleration of 1.20 m s^{-2} due to a 3.0 A current passing through the rod.

(a) Determine the magnitude of the magnetic force on the rod.

$\Sigma F = m a$
$F_B = 0.0150 \times 1.20$
$= 1.80 \times 10^{-2}$ N

magnetic force = ... N [1]

(b) Show that the minimum flux density of a magnetic field that can produce this acceleration is 60 mT.

$F_B = B\ I\ L$
$B = F_B / I\ L$
$= 1.80 \times 10^{-2} / (3.0 \times 0.10)$
$= 6.0 \times 10^{-2}$ T [shown]

[2]

(c) The actual flux density due to the magnetic field is 120 mT. To produce the same magnetic force in **(a)**, draw the directions of this magnetic field, the force on the rod and the current in the rod clearly on Fig. 4.2 which shows the front view of the rod on the rails.

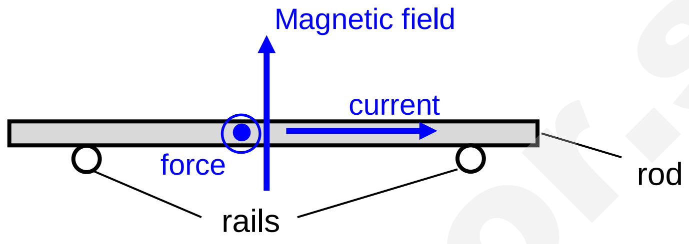
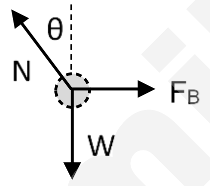


Fig. 4.2 (Front view)

4 possible sets of answers. As long as the components obey Fleming's Left Hand Rule and that current is along the rod, force is in or out of page and flux density is up or down.

[2]

(d) The rails may be inclined at an angle to restore the equilibrium of the rod. Determine the angle of inclination of the rails such that the net force on the rod is zero.



$\Sigma F = m\ a$
Horizontal: $N \sin \theta = F_B$
Vertical: $N \cos \theta = W$
Solving: $\tan \theta = F_B / W$
$= 1.8 \times 10^{-2} / 0.015 \times 9.81$
$\theta = 7.0°$

angle of inclination = ... ° [2]

5 The walls of music halls are acoustically covered with a sound-absorbing panel that is able to absorb certain sound frequencies more than others.

One particular design is to use the resonance of a perforated panel as shown in Fig. 5.1.

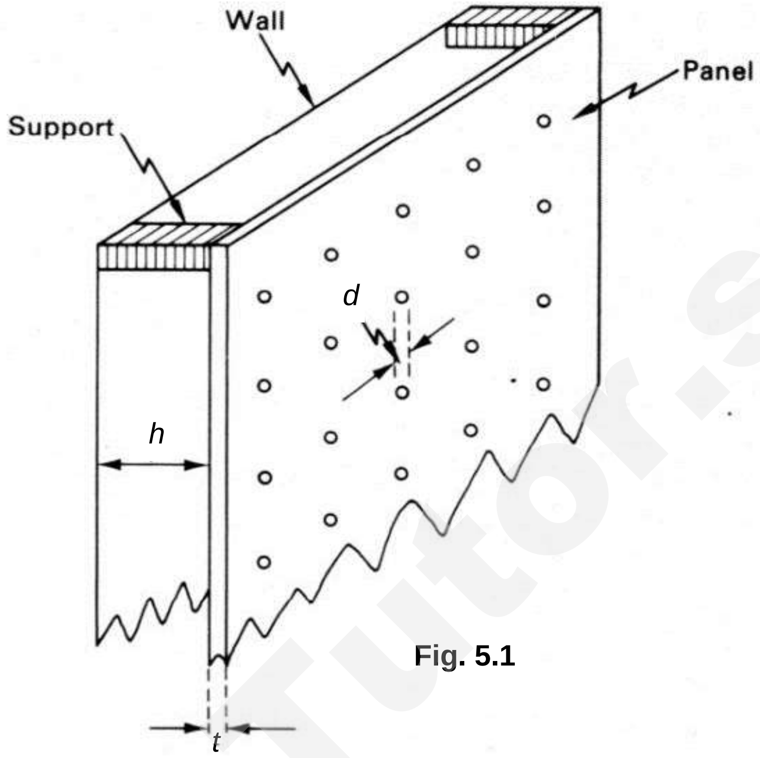


Fig. 5.1

It is found that this panel resonates at a particular frequency and hence can absorb sounds of that frequency more than others. A suggested formula for this resonant frequency f is given as:

$$f = k\sqrt{\frac{x}{h(t+0.8d)}} \quad \text{--- Equation 5.1}$$

where k = 5000 mm s^{-1},
h = depth of airspace with unit mm,
t = thickness of panel with unit mm,
d = hole diameter with unit mm, and
x = percentage of panel surface area occupied by holes (e.g. x = 10 %)

Using identical hardboard panels having holes of the same diameter of 10 mm, the resonant frequencies f for different x values are measured, keeping h and t constant. The results are shown in Fig. 5.2:

x / %	2	4	6	8	10	12
f / Hz	530	750	920	1070	1190	1300

Fig. 5.2

(a) Fig.5.3 shows the plot of some of the data from Fig. 5.2. Plot a point in Fig. 5.3 corresponding to the data for x = 10 %. [1]

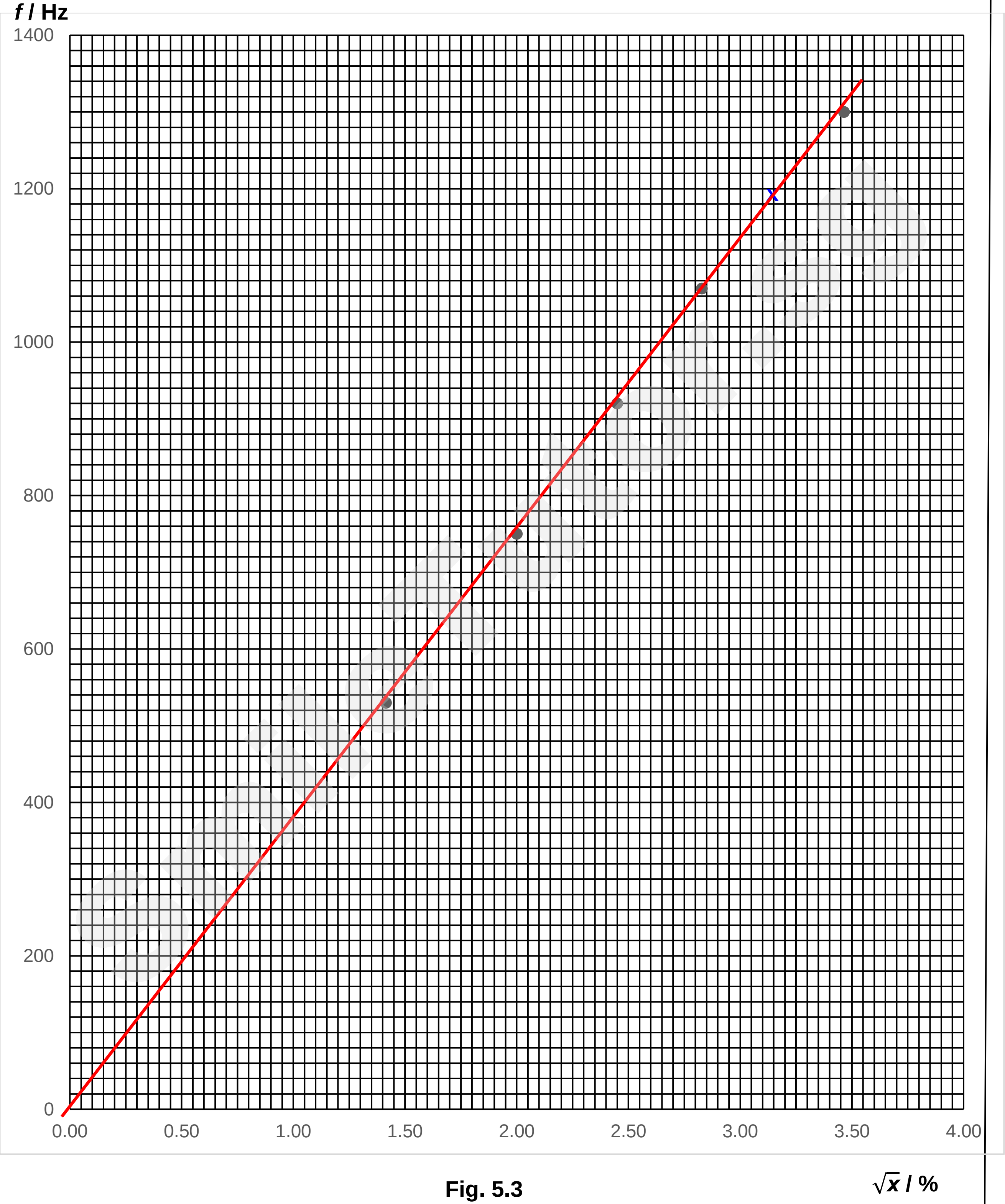


Fig. 5.3

(b) Explain whether the graph of Fig. 5.3 supports the suggestion that *f* is proportional to $\sqrt{x}$.

Since the line of best fit is a straight line passing the origin, f is proportional to √x

....

....

....[2]

(c) Determine the gradient of the graph in Fig. 5.3.

Gradient = $\frac{1200-200}{3.20-0.53}=375$

gradient = ... [2]

(d) Hence suggest suitable values for *h* and *t* when *x* = 10 %.

A = 375, ⇒ $\frac{k}{\sqrt{h(t+0.8d)}}=375$

Assume t = 2mm , h = 18 mm

Acceptable range for t: 1 – 6 mm
Acceptable range for h = 18 – 12 mm

h = ...mm

t = ...mm [2]

(e) Using a panel with *x* fixed at 10 % and *d* fixed at 5 mm, the engineer decides to investigate the effect of filling the air space with 2 different absorbers. He obtains the absorption characteristics shown in Fig. 5.4.

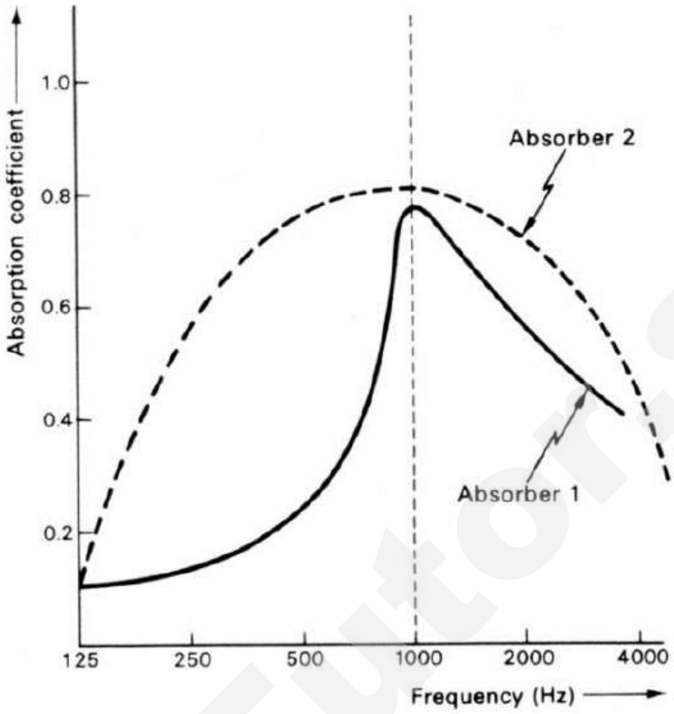


Fig. 5.4

Absorption coefficient is an indication of how much sound waves can be absorbed, i.e. the higher the absorption coefficient, the stronger the absorption.

(i) Suggest how the absorption coefficient is calculated.

It is calculated by taking the ratio of the intensity of sound after passing though absorber to intensity of sound directed at absorber. [1]

(ii) State and explain which of the two absorbers would be preferred in a room in which

1. absorption over a wide frequency range is required,

From the graph, the absorption coefficient for absorber 2 is higher than absorber 1 for all frequencies. Hence absorber 2 is preferred.

[1]

2. sounds below 500 Hz need amplification.

From the graph, the absorption coefficient for absorber 1 for frequency < 500 Hz is significantly lower than those values above 500 Hz. Hence absorber 1 is preferred. [1]

Section B

Answer **two** of the questions from this section.

6 **(a)** Write down in terms of the mass *m* and the velocity *v* of a body, expressions for its momentum *p* and its kinetic energy *K*.

p = mv ....

K = $\frac{1}{2}$ kx^2 .... [2]

(b) A tennis ball has a horizontal momentum of 2.40 N s and a kinetic energy of 45.0 J at the instant just before it is struck by a tennis racket.
Calculate the mass and the velocity of the tennis ball.

$m\ v = 2.4$

$\frac{1}{2}\ m\ v^2 = 45$

$$\frac{\frac{1}{2}\ m\ v^2}{m\ v} = \frac{4.5}{2.4}$$

$v = 37.5\ \text{m s}^{-1}$

$$m = \frac{2.4}{37.5} = 0.0641\ \text{kg}$$

mass = ... kg

velocity = ... m s^{-1} [3]

(c) When the racket hits the ball it strikes the ball with a constant force of 60 N in a direction opposite to the momentum of the ball, bringing it to rest momentarily.

(i) Show that the time taken for the tennis ball to come to rest is 0.040s.

$$F = m\left(\frac{v - u}{t}\right)$$

$$60 = 0.0641\left(\frac{0 - 37.5}{t}\right)$$

t = 0.040 s

[2]

(ii) Calculate the distance travelled by the tennis ball travels from the time it is hit by the racket till the time when it comes to rest.

$s = u\ t + \frac{1}{2}\ a\ t^2$

$$= 37.5\ (0.040)\ +\ \frac{1}{2}\left(\frac{60}{0.0641}\right)(0.040)^2\ = 0.75\text{m}$$

distance = ... m [2]

(iii) Suggest why, in practice, it is impossible for a constant force to be applied to the ball.

When the ball strikes the strings of the racket, the strings stretch but the force of stretching is not uniform

[2]

(d) The force of 60 N then continues to act on ball for a further 0.060 s.

(i) Without performing any calculations, predict and explain whether the final velocity of the ball will have a larger magnitude than that of the velocity before impact with the racket.

The velocity will be larger. With a force of the same magnitude and a longer impact time, the change in velocity will be larger. The initial velocity being zero, the final velocity will be larger.

[2]

(ii) State the principle of conservation of linear momentum.

When bodies in a system interact, the total momentum remains constant provided no resultant external force acts on the system.

[2]

(iii) Explain whether the law of conservation of linear momentum applies to the racket and the ball in this collision between the racket and the ball.

The momentum of the racket and the ball is not conserved because the player is exerting a force on the racket.

[2]

(e) The ball leaves the racket horizontally. By considering the forces acting on the ball, describe and explain the subsequent motion of the ball before it reaches the ground. Assume viscous force by air is negligible.

The ball will execute a parabolic path downwards towards the ground. Gravitational force acts on the ball in the downwards direction. Gravitational force causes an increase in the downwards velocity of the ball while the horizontal component of the velocity remains the same.

[3]

7 A student wants to light a lamp marked '3.00 V, 0.600 W' but has only a 12.00 V battery of unknown internal resistance. In order to reduce the battery voltage, the student sets up the circuit as shown in Fig. 7.1 below. The digital voltmeter is included so that the voltage can be checked before connecting the lamp. The variable resistor CD has a maximum resistance of 1000 Ω.

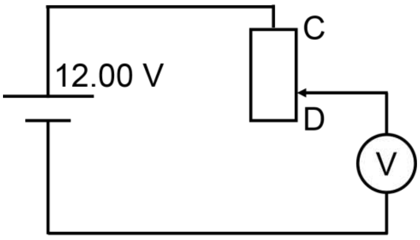


Fig. 7.1

(a) Explain what is meant by the "12.00 V" when applied to a 12.00 V battery.

The potential difference across the battery is 12.00 V when 12.00 J of electrical energy is converted from other forms of energy when 1 C of charge passes the terminals of the battery. [1]

(b) It is found that when the sliding contact of the rheostat is placed at C, the digital voltmeter reading is 11.99 V. When the sliding contact is moved down from C to D, the digital voltmeter reading drops from 11.99 V to 11.00 V.

(i) State the potential difference across the internal resistance of the battery when the sliding contact of the rheostat is placed at C.

potential difference: 0.01 V [1]

(ii) Using the potential divider concept or otherwise, determine the internal resistance *r* of the battery and the resistance *R* of the voltmeter.

Using potential divider concept,

$$\left(\frac{r}{r+R}\right)\varepsilon = V_r$$
$$r\varepsilon = rV_r + RV_r$$
$$r(\varepsilon - V_r) = RV_r$$
$$r = \frac{V_r}{\varepsilon - V_r}R \qquad -(1)$$
$$\left(\frac{R}{r+1000+R}\right)\varepsilon = V_R$$
$$R\varepsilon = rV_R + RV_R + 1000V_R$$
$$rV_R = R(\varepsilon - V_R) - 1000V_R$$
$$r = \frac{\varepsilon - V_R}{V_R}R - 1000 \qquad -(2)$$

Substitute (1) into (2),

$$\frac{V_r}{\varepsilon - V_r}R = \frac{\varepsilon - V_R}{V_R}R - 1000$$
$$\frac{0.01}{12.00 - 0.01}R = \frac{12.00 - 11.00}{11.00}R - 1000$$

$R = 11100\ \Omega$

Substitute $R = 11100\ \Omega$ into (1),

$$r = \frac{V_r}{\varepsilon - V_r} 11100$$

$$r = 9.26\ \Omega$$

r = ... Ω

R = ... Ω [4]

(iii) Explain**,** using the concept of a potential divider, why the presence of internal resistance reduces the output power of the 12.00 V battery.

Internal resistance reduces the terminal potential difference of the battery. Since the output power is proportional to its terminal p.d., the presence of internal resistance reduces the output power of the battery.

....[2]

(c) The circuit in Fig. 7.1 is modified as shown in Fig. 7.2 and the potentiometer is adjusted to give a digital voltmeter reading of 3.00 V.

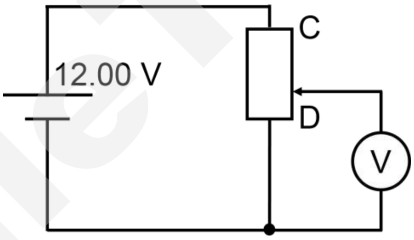


Fig. 7.2

(i) Determine the current through the digital voltmeter given that its resistance is 11.1 kΩ.

$$I_{meter} = \frac{V_{meter}}{R_{meter}}$$

$$I_{meter} = 0.270\ \text{mA}$$

current = ... A [1]

(ii) Deduce the effect on the current through the battery if a voltmeter of lower resistance is used.

Effective resistance of the circuit decreases hence current through battery increases.

....[1]

(d) The student removes the digital voltmeter and connects the lamp in its place.

(i) Explain the significance of the marking '3.00 V, 0.600 W' on the lamp.

For optimum performance at a power of 0.600 W, the lamp needs a p.d. of 3.00 V across it. [1]

(ii) Calculate the resistance of the lamp when it is operating normally.

$$P = \frac{V^2}{R}$$

$$R = 15.0\ \Omega$$

resistance = ... Ω [1]

(iii) A fuse in the lamp is introduced to prevent the lamp from operating above 0.800 W at 3.00 V. Determine the current needed to blow the fuse.

$$P = IV$$

$$I = 0.27\text{ A}$$

current = ... A [1]

(e) The characteristic *I*−*V* graph in Fig.7.3 is that of a filament lamp.

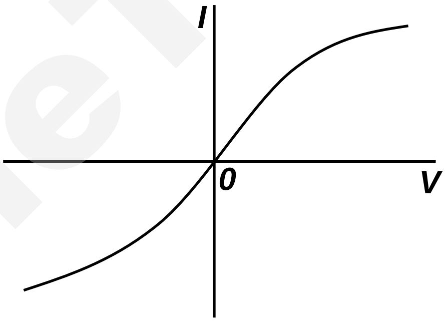


Fig. 7.3

Explain why, as the voltage is increased either positively or negatively from zero, the graph has the form shown in the Fig.7.3.

As p.d. across lamp increases, temperature of lamp increases.

Rise in temperature causes conducting electrons to collide more frequently with lattice ions in the filament.

Resistance of filament lamp increases with temperature.

Since resistance is the ratio of p.d. across lamp to the current through it, hence the graph curves towards the voltage axis.

[4]

(f) In order to light up another set of lamps, each having a resistance of 20 Ω, the student sets up another circuit as shown in Fig. 7.4.

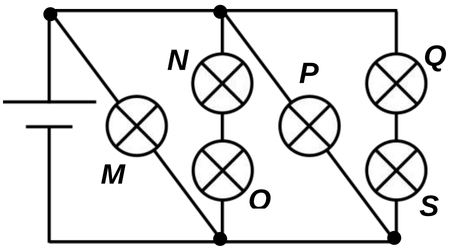


Fig. 7.4

(i) Determine the effective resistance of the circuit.

Since the 4 branches have the same p.d., they are in parallel arrangement.

$$\frac{1}{R}=\frac{1}{20}+\frac{1}{40}+\frac{1}{20}+\frac{1}{40}$$
$$R=6.66$$

effective resistance = ... Ω [1]

(ii) State and explain which (if any) of the lamps is likely to blow if the battery connected to the circuit is marked 4.50 V and lamps are marked '4.50 V, 0.800 W'. Assume that internal resistance of the battery is negligible.

Consider power delivered to each of the lamps *M* and *P*,

$$P=\frac{V^2}{R}$$

$$P=\frac{4.5^2}{20}=1.01\ W$$

Consider lamps *N*, *O*, *Q* and *S* individually,

$$P=\frac{2.25^2}{20}=0.253\ W$$

Since the power supplied to lamps *M* and *P* is more than the suggested power rating, they are likely to blow

....[2]

8 **(a)** Observations from the photoelectric experiment provided the first evidence for the particulate nature of light. Describe two of these observations and how each deviates from predictions of the classical wave theory of light.

Observations:

1) Existence of a threshold frequency below which no photoelectric emission occurs

2) Maximum K.E. of the emitted photoelectrons is independent of the intensity of the radiation

3) Maximum K.E. of the emitted photoelectrons is dependent on the frequency of the electromagnetic radiation.

4) Photoelectric emission takes place instantaneously.

[4]

(b) Two metal plates X and Y are contained in an evacuated container and are connected to a circuit as shown in Fig. 8.1. Graph A shown in Fig. 8.2 shows the current I through the microammeter as a function of the p.d. applied across XY when monochromatic light is allowed to fall on plate X.

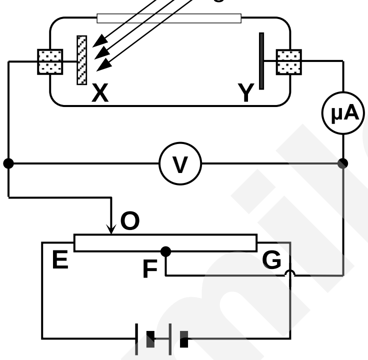


Fig. 8.1

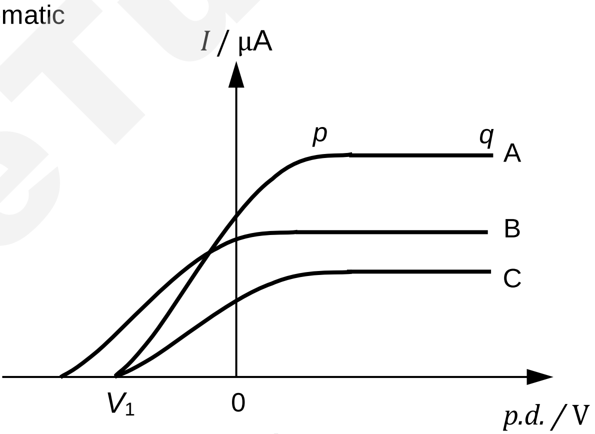


Fig. 8.2

(i) Suggest and explain where the sliding contact **O** should be to give the part of the graph *pq*.

The sliding contact **O** must be in the region **FG**.

The region *pq* of the graph indicates that photoelectric current is independent of the potential difference across XY. This is only possible if **X** is at a lower potential than **Y** so that the emitted electrons are accelerated towards **Y**.

[2]

(ii) Given that the work function of X is 1.3 eV and the wavelength of the light is 550 nm, calculate the value of V_1.

hf = K.E.$_{max}$ + Φ

$$\frac{hc}{\lambda} = eV_s + \Phi$$

$$\frac{6.63\times10^{-34}\times3.0\times10^{8}}{550\times10^{-9}} = (1.6\times10^{-19})V_s + (1.3\times1.6\times10^{-19})$$

V_s = 0.96 V

V_1 = ... V [2]

(iii) Suggest the changes that can be made to the experiment in Fig. 8.1 to produce the lines B and C.

Graph B has a smaller maximum current and larger stopping potential than A. The larger stopping potential indicates that an incident radiation of higher frequency **OR** incident radiation of lower wavelength **OR** a metal of smaller work function must be used. [2]

AND The lower maximum photocurrent is due to the smaller intensity of incident radiation.

Graph C has a smaller maximum photocurrent but the same stopping potential as A. Since the stopping potential is the same as A, the frequency of the incident radiation must be the same as in A. The lower maximum photocurrent is due to the smaller intensity of incident radiation.

(c) The graph in Fig. 8.3 shows part of the visible region of the spectrum of a hot star far away from Earth.

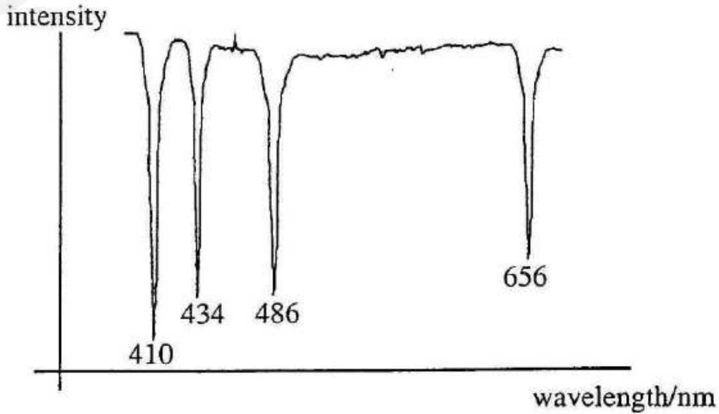


Fig. 8.3

The absorption lines are due to the large number of excited hydrogen atoms on the star.

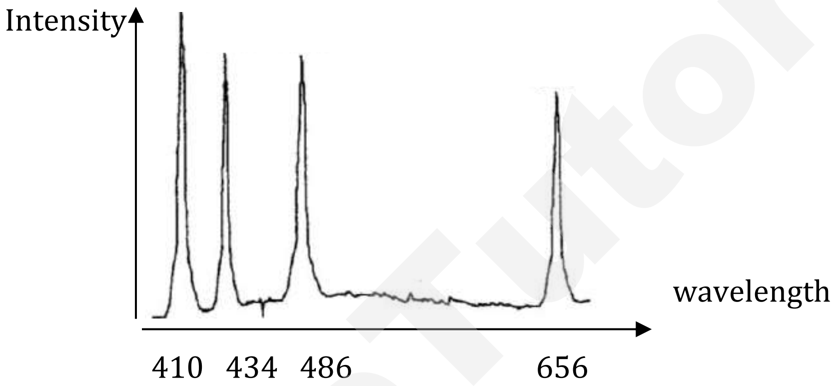
(i) Explain how absorption lines are produced by the hydrogen atoms.

The energy levels in the hydrogen atom are **discrete**.

When electromagnetic radiation passes through the hydrogen gas, photons of energy corresponding to the exact difference in energy between two energy levels in the atom are absorbed.

This results in lines missing from the spectrum after the radiation passes through the gas. (or mention absorption in the process) [2]

(ii) Sketch a labelled graph of intensity against wavelength for the emission spectrum of hydrogen. [1]



(iii) Fig. 8.4 shows the first six energy levels of a hydrogen atom. Draw arrows to represent the energy transitions that give rise to the emission lines corresponding to those shown in Fig. 8.3. Label the transitions with the corresponding wavelengths. Hence calculate the values of E_2, E_5 and E_6.

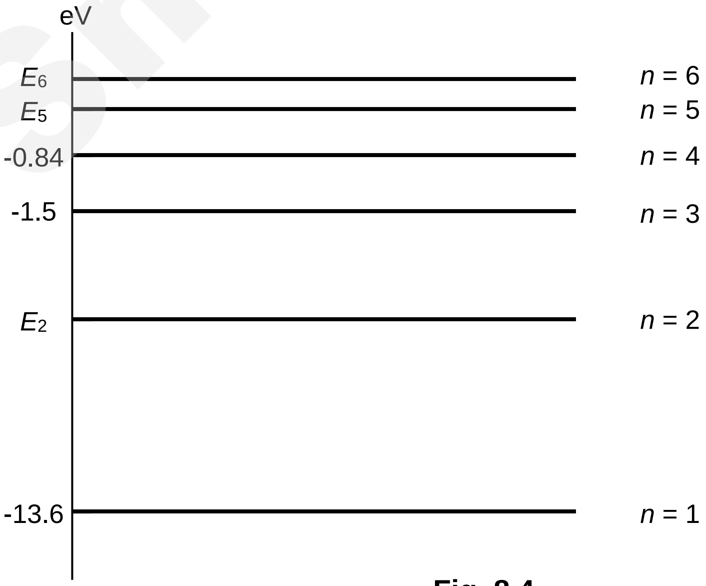
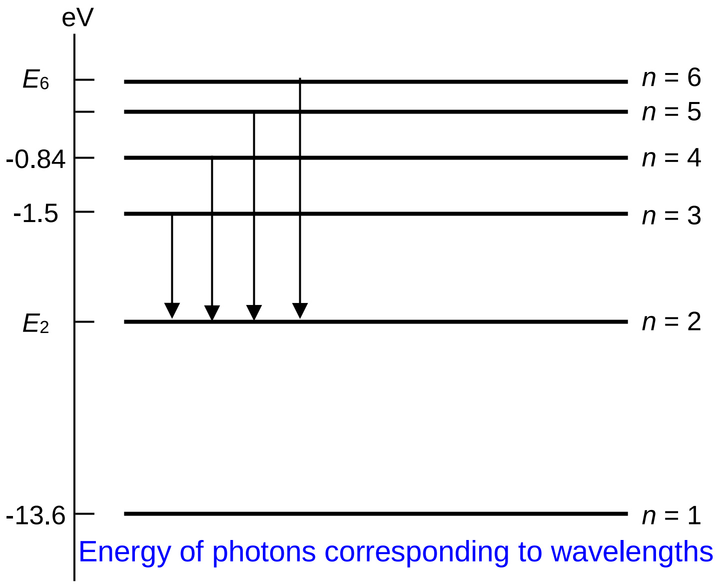


Fig. 8.4



Energy of photons corresponding to wavelengths in figure 6.2a.

λ = 410 nm:

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{410\times10^{-9}}$$ = 4.85 × 10^{-19} J = 3.03 eV

λ = 434 nm:

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{434\times10^{-9}}$$ = 4.58 × 10^{-19} J = 2.86 eV

λ = 486 nm:

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{486\times10^{-9}}$$ = 4.09 × 10^{-19} J = 2.56 eV

λ = 656 nm:

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{656\times10^{-9}}$$ = 3.03 × 10^{-19} J = 1.90 eV

$-1.5 - E_2 = 1.90$ eV
$E_2 = -3.4$ eV

$E_5 - E_2 = 2.86$ eV
$E_5 = 2.86 + (-3.4)$
$E_5 = -0.54$ eV

$E_6 - E_2 = 3.03$ eV
$E_6 = 3.03 + (-3.4)$
$E_6 = -0.37$ eV

E_2 = ... eV

E_5 = ...eV

E_6 = ...eV [6]

(iv) State the region of the electromagnetic spectrum in which radiation corresponding to a transition between *n* = 4 and *n* = 3 would lie.

Infra-red region.

....[1]

H

NATIONAL JUNIOR COLLEGE

SENIOR HIGH 2 PRELIMINARY EXAMINATIONS

Higher 1

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

PHYSICS

8866/01

Paper 1 Multiple Choice

2017

Additional Materials: Multiple Choice Answer Sheet

1 hour

READ THE INSTRUCTION FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This document consists of 10 printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\,\mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\,\mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$
acceleration of free fall,	$g = 9.81\,\mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 Which of the following shows the base units of magnetic flux density?

A T **B** kg s^{-2} A^{-1} **C** kg m^{-1} s^{-1} **D** Wb m^{-2}

2 An astronaut stands by the rim of a crater on the moon, where the acceleration of gravity is 1.62 m s^{-2}. To determine the depth of the crater, she drops a rock and measure the time it takes for it to hit the bottom. If the time is 6.3 s, what is the depth of the crater?

A 10 m **B** 14 m **C** 26 m **D** 32 m

3 A projectile is launched at 45° to the horizontal with initial kinetic energy E.
Assuming air resistance to be negligible, what will be the kinetic energy of the projectile when it reaches its highest point?

A 0.50 E **B** 0.71 E **C** 0.87 E **D** E

4 A boy kicks a football from ground level with a certain initial velocity at an angle 30.0° above the horizontal. In 2.00 s the ball completes its trajectory and hits the ground. What is the initial velocity of the ball?

A 4.90 m s^{-1} **B** 9.80 m s^{-1} **C** 19.6 m s^{-1} **D** 39.2 m s^{-1}

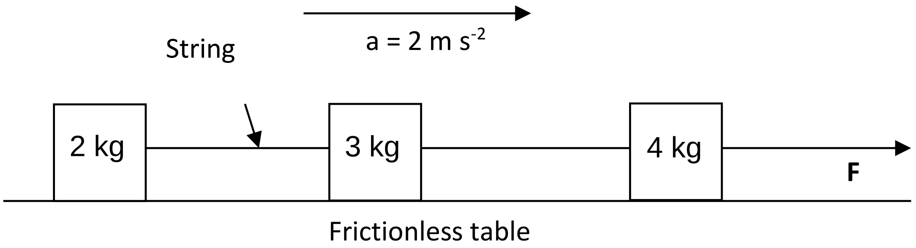
5 A passenger on a bus moving forward at constant speed notices that a ball which has been at rest in the aisle suddenly starts to roll towards the front of the bus. What can be concluded about the motion of the bus from this observation?

A The bus is moving at constant speed.
B The bus is decelerating.
C The bus is accelerating.
D The bus is making a turn.

6 A stream of water from a pipe travels horizontally at 10 m s^{-1}. The stream strikes a wall and splashes back horizontally at 5 m s^{-1}. What is the pressure exerted by the wall on the water? (density of water = 1000 kg m^{-3})

A 50 kPa **B** 100 kPa **C** 150 kPa **D** 200 kPa

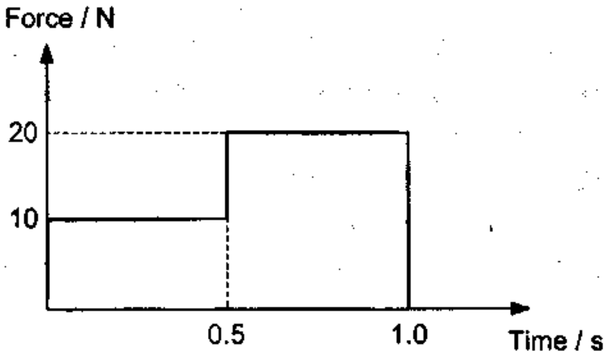
7 Three blocks of masses 2 kg, 3 kg and 4 kg are connected by an inextensible string on a horizontal frictionless table as shown. The blocks are pulled to the right with an acceleration of 2 m s^{-2} by an applied force *F*.



What is the tension in the string which connects the 3 kg mass to the 4 kg mass?

A 4 N **B** 6 N **C** 10 N **D** 14 N

8 A 2.0 kg object is initially moving at a speed of 5.0 m s^{-1} *on a frictionless horizontal* surface. A force as indicated in the graph is applied on the object in the direction of travel.



After one second, the speed of the object is

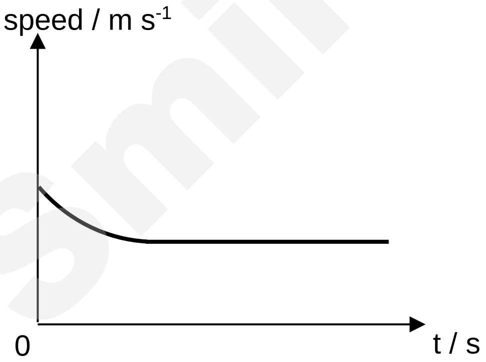
A 7.5 m s^{-1} **B** 10 m s^{-1} **C** 12.5 m s^{-1} **D** 15 m s^{-1}

9 A mass of 2 kg travelling at 3 m s^{-1} undergoes elastic collision with a group of four 1 kg masses that are at rest in contact with each other. The four masses are lined up in the same direction as the velocity of the 2 kg mass. As a result of the collision

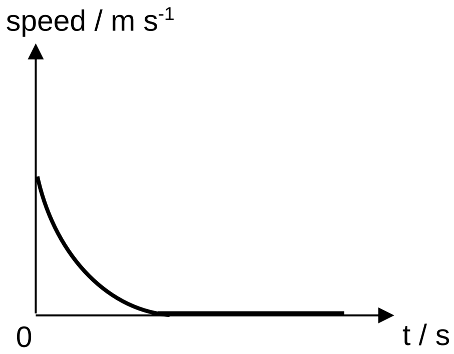
A the 2 kg mass comes to a stop and one of the 1 kg masses takes off at 6 m s^{-1}.
B the 2 kg mass comes to a stop and two of the 1 kg masses takes off at 3 m s^{-1}.
C the 2 kg mass comes to a stop and three of the 1 kg masses takes off at 2 m s^{-1}.
D the 2 kg mass and the four other masses travel at 1 m s^{-1}.

10 A ball is dropped from a great height into the sea and enters the sea at high speed. The density of the ball is less than the density of sea water. If viscous force cannot be ignored, which of the following is the speed-time graph of the ball after it enters the sea?

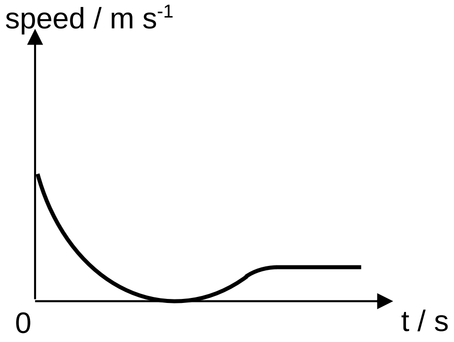
A



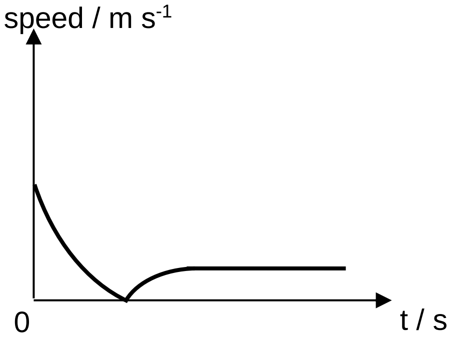
B



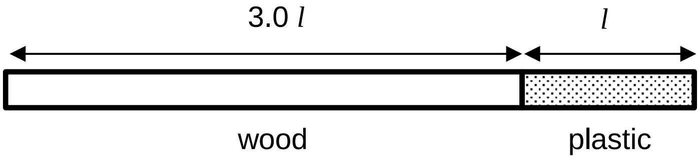
C



D



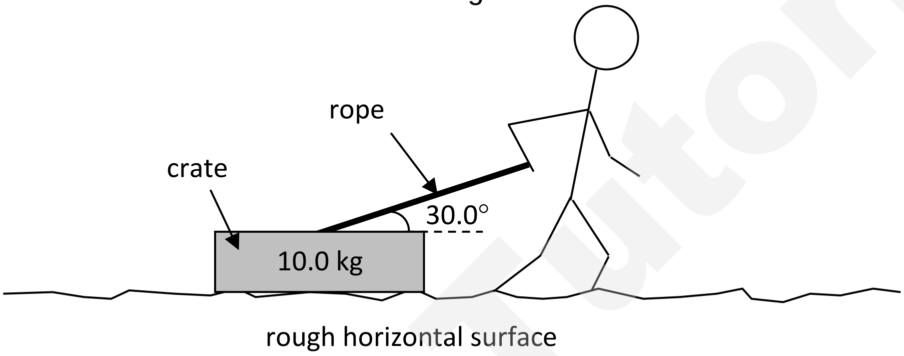
11 A rod consists of a uniform wood section and a uniform plastic section, as shown.



The length of the wooden section is 3.0 *l* and the length of the plastic section is *l*. The density of the wooden section is 600 kg m^{-3} and the density of the plastic section is 1000 kg m^{-3}. What is the distance of the centre of gravity of the entire rod from its left end?

A 1.1 *l* **B** 1.8 *l* **C** 2.2 *l* **D** 2.9 *l*

12 A man drags a crate of mass 10.0 kg across a rough horizontal surface at a constant speed of 0.800 m s^{-1}. The rope makes an angle of 30.0 ° with the horizontal. The average frictional force between the crate and the rough surface is 200 N.



What is the instantaneous power input by the man on the crate 2.00 seconds after he starts to accelerate the crate uniformly at 1.00 m s^{-2}? The angle which the rope makes with the crate remains unchanged.

A 0 W **B** 194 W **C** 588 W **D** 679 W

13 A block of mass *m* is pushed against a spring of spring constant *k*. The spring is compressed by a distance *d*, the block is then released. It is launched by the spring along a horizontal frictionless surface with a final speed *v*. A second block, this one having mass 4*m* is pushed against the same spring by distance 6*d* and released. What is the final speed of the block in this case?

A *v* **B** 2*v* **C** 3*v* **D** 4*v*

14 Which statement describes a situation when polarisation could not occur?

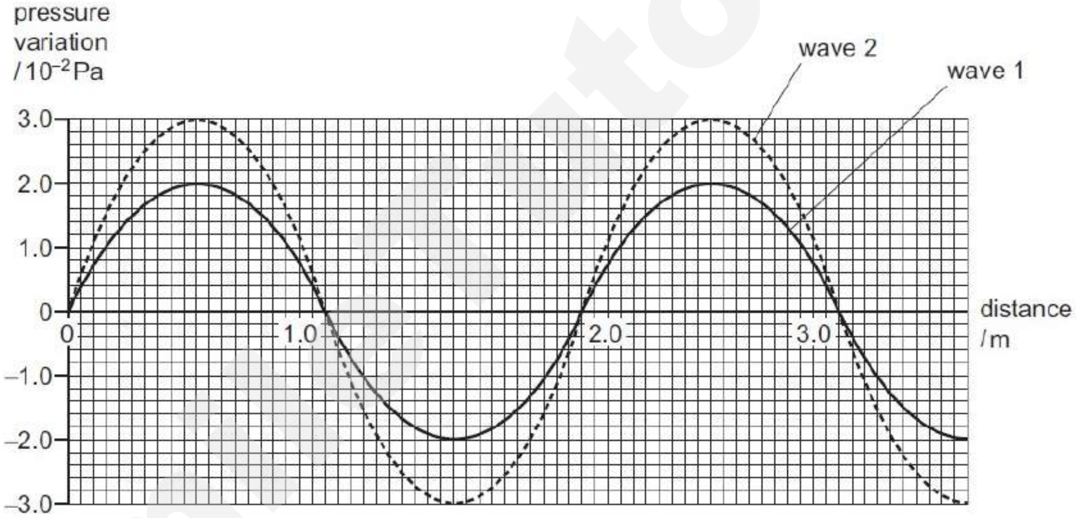
A Light waves are reflected.
B Light waves are scattered.
C Microwaves pass through a metal grid.
D Sound waves pass through a metal grid.

15 A vertical aerial (vertical transmission axis) can detect EM waves of intensity I_o from signals from a source. However, during a thunderstorm, the aerial was bent in a particular angle θ and the intensity detected now is $\frac{3}{4}I_O$. What is the angle θ ?

A 15° **B** 30° **C** 45° **D** 60°

16 A sound wave consists of a series of moving pressure variations from the normal, constant air pressure.

The graph shows these pressure variations for two waves at one instant in time.



Wave 1 has an intensity of 1.6×10^{-6} W m^{-2}.

What is the intensity of wave 2?

A 2.4×10^{-6} W m^{-2} **B** 3.0×10^{-6} W m^{-2} **C** 3.6×10^{-6} W m^{-2} **D** 4.5×10^{-6} W m^{-2}

17 A tube with one end open and the other end closed, has a harmonic of frequency of 448 Hz and the next higher harmonic has a frequency of 576 Hz. What is the length of the tube? (Take the speed of sound in air as 343 m s^{-1}.)

A 1.34 m **B** 0.670 m **C** 0.335 m **D** 1.00 m

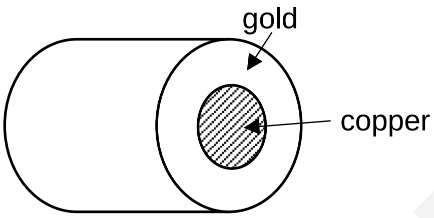
18 In a Young's double-slit experiment, the separation between the first and third dark fringe is 3.5 mm when the wavelength used is 6.6×10^{-7} m. The distance from the slits to the screen is 0.80 m. The separation of the two slits is

A 0.15 mm **B** 0.25 mm **C** 0.30 mm **D** 0.45 mm

19 Which one of the following is a correct statement for a number of resistors connected in series or parallel?

A The total resistance in a series circuit decreases as more resistors are added.
B The flow of current is different through resistors connected in a series circuit.
C The voltage is different across resistors connected in a parallel circuit.
D The total resistance in a parallel circuit decreases as more resistors are added.

20 A composite wire of diameter 4.0 mm consists of a copper core of diameter 2.0 mm surrounded by layer of gold as shown in the figure.



The resistivity of copper is 1.7×10^{-8} Ω m and the resistivity of gold is 2.4×10^{-8} Ω m.
What is the resistance of 1.0 m of the composite wire?

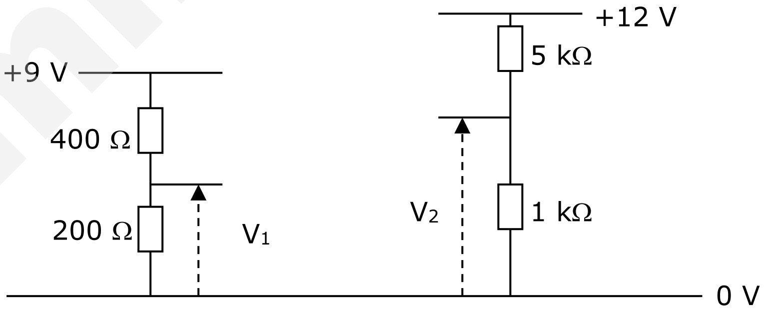
A 4.3×10^{-4} Ω **B** 1.7×10^{-3} Ω **C** 3.2×10^{-3} Ω **D** 8.0×10^{-3} Ω

21 The drift velocity of the electrons through a cylindrical metal conductor is *v* when the current flowing through the conductor is *I*.

What is the new drift velocity of the electrons if the diameter of the cylindrical conductor is doubled and the current flowing through is also doubled?

A v/2 **B** v **C** **2**v **D** **4**v

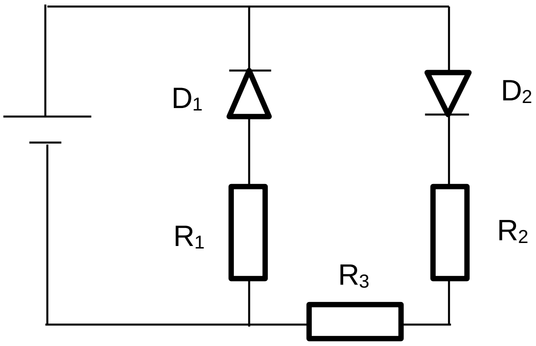
22



In the above circuit, which one of the following is equal to (V2 – V1) in volts?

A - 4 **B** - 1 **C** 4 **D** 7

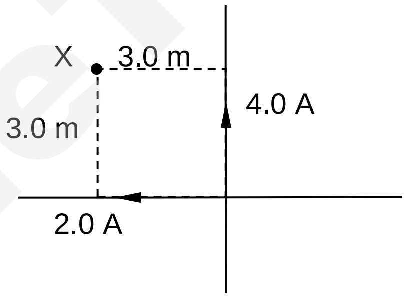
23 A circuit consisting of diodes and resistors is shown below.



Which of the following options correctly show the relative magnitude of the potential differences across the components D₁, R₁ and R₂?

	Greatest to smallest potential difference		
A	D_1	R_1	R_2
B	D_1	R_2	R_1
C	R_1	R_2	D_1
D	R_2	R_1	D_1

24 Two long current carrying conductors are placed perpendicular to each other. The current flowing through one of the wires is 4.0 A upwards, while the current through the other wire is 2.0 A towards the left.



Given that the magnetic flux density of a wire can be calculated with $B = \frac{2 \times 10^{-7} I}{d}$.

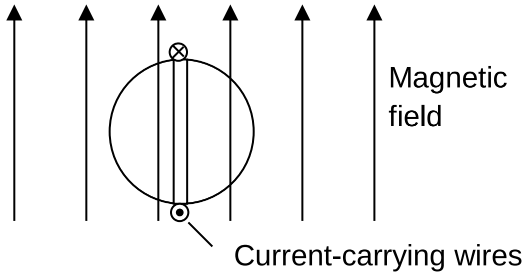
What is the magnitude and direction of the resultant magnetic field at a point X, which is 3.0 m perpendicularly away from both wires? Ignore the Earth's magnetic field.

A 1.33×10^{-7} T out of the plane of the page
B 1.33×10^{-7} T into the plane of the page
C 4.00×10^{-7} T out of the plane of the page
D 4.00×10^{-7} T into the plane of the page

25 Two long parallel wires carry currents of different magniitudes. If the amount of curent in each wire is doubled, what happens to the magnitude of the force between the wires?

A It is quadrupled.
B It is tripled.
C It is doubled.
D It stays the same.

26 A light cylinder with a radius of 0.05 m and a length of 0.20 m is in a region of vertical magnetic field of 0.5 T in strength and direction as shown in the diagram below. The cylinder has 10 turns of wire wrapped around it in the vertical axis.



If the current in the wire is 1 A, the torque acting on the cylinder is

A 0.05 N m clockwise
B 0.05 N m anti - clockwise
C 0.1 N m clockwise
D 0.1 N m anti - clockwise

27 A metallic surface X is irradiated with red light while another identical metallic surface Y is irradiated with violet light of much lower intensity than the red light. Which of the following statements is **false?**

A The stopping voltage for X is lower than for Y.
B The photoelectrons from Y have a higher maximum speed than those from X.
C Y emits more photoelectrons per unit time than X.
D The photons incident on Y have higher energies than those on X.

28 In a series of photoelectric emission experiments, different metal pieces of various work function ϕ were illuminated with monochromatic light of different frequencies f and intensities I. It was found that, for each experiment, the emitted electrons emerged with a spread of kinetic energies up to a certain maximum value. This maximum kinetic energy depends on

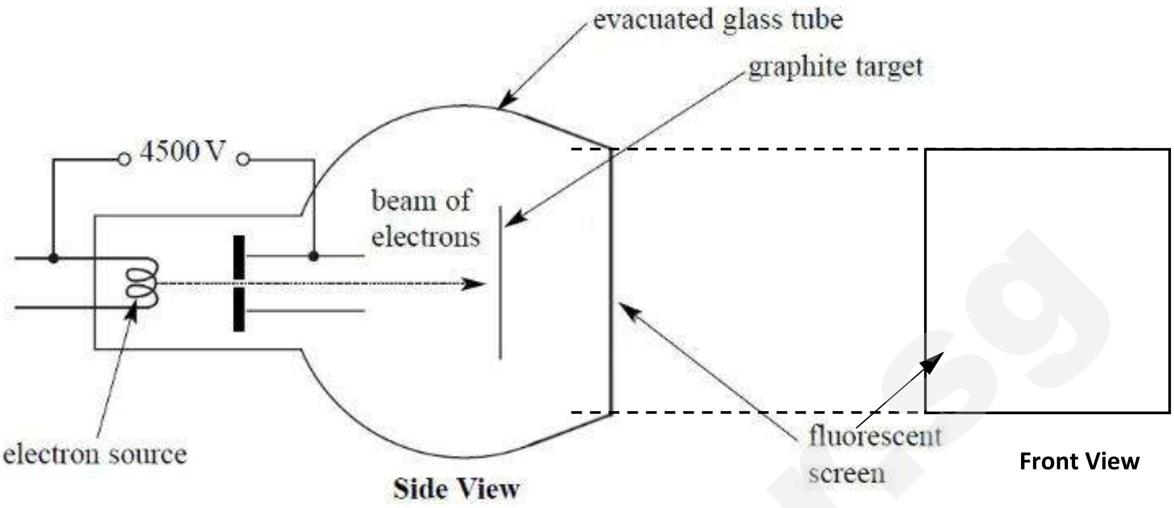
A ϕ but not on f, or I.
B ϕ and I but not on f.
C ϕ and f but not on I.
D ϕ, f, and I.

29 A beam of electrons is incident on a crystal lattice. The regularly spaced parallel planes of ions in the lattice can serve as diffraction grating.

The spacing between each plane is 1 x 10^{-8} m. In order for significant diffraction to occur, the kinetic energy of the each electron should be of the order

A 10^{-34} eV **B** 10^{-26} eV **C** 10^{-21} eV **D** 10^{-2} eV

30 Electrons being fired at a polycrystalline graphite target in a vacuum as shown. The inside surface on the far side of the chamber is coated with fluorescent material that emits light when the electrons release their energy to it.

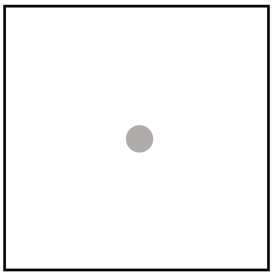


Which of the following shows the correct image seen on the fluorescent screen?

A

Front View

B

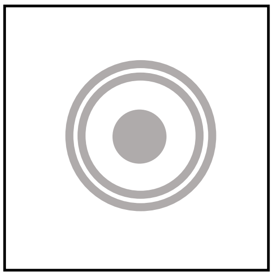


Front View

C

Front View

D



Front View

END OF PAPER

NATIONAL JUNIOR COLLEGE
SENIOR HIGH 2 PRELIMINARY EXAMINATIONS
Higher 1

CANDIDATE NAME

SUBJECT CLASS

REGISTRATION NUMBER

PHYSICS
Paper 2 Structured Questions
Candidate answers on the Question Paper.

8866/02
25 August 2017
2 hours

No Additional Materials are required.

READ THE INSTRUCTION FIRST

Do not flip over the cover page until you are told to do so.

Write your subject class, registration number and name on all the work you hand in.

Write in dark blue or black pen in the spaces provided on the Question Paper.

You may use a soft pencil for any diagrams, graphs or rough working. Do not use staples, paper clips, highlighters, glue or correction fluid.

This paper consists of 2 sections. All answers will be written in spaces provided on the Question Paper.

Section A (40 marks). Answer **all** questions.

Section B (40 marks). Answer **2** questions. **Circle on the cover page the questions you have attempted.**

You are advised to spend about one hour on each section. The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 6**
2	**/ 9**
3	**/ 6**
4	**/ 7**
5	**/ 12**
Section B	
6	**/ 20**
7	**/ 20**
8	**/ 20**
Total (80m)	

This document contains 19 printed pages, including this cover page.

Data

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work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section

1 A car is travelling along a horizontal road with speed v. The power P, required to overcome external forces opposing the motion is given by the expression

$$P = cv + kv^3$$

where c and k are constants.

(a) Use base units to obtain an SI unit for the constant *k*.

SI unit for constant *k* = _______________ [2]

(b) For one particular car of 1000 kg, the numerical values, in SI units, of c and k are 240 and 0.98 respectively.
Calculate the power required to enable the car to travel on a horizontal road at 20 m s^{-1}.

Power = _____________W [1]

(c) The car approaches and travels up a slope inclined at 20^0 to the horizontal.

Calculate the power required to maintain the constant speed of 20 m s^{-1}, assuming the car is experiencing the same external resistive force.

Power = _____________W [3]

2 **(a)** Distinguish between *speed* and *velocity*.

....

....

.... [2]

(b) A car is travelling along a straight road at speed *v*. A hazard suddenly appears in front of the car. In the time interval between the hazard appearing and the brakes on the car coming into operation, the car moves forward a distance of 29.3 m. With the brakes applied, the front wheels of the car leave skid marks on the road that are 12.8 m long, as illustrated in Fig. 2.1.

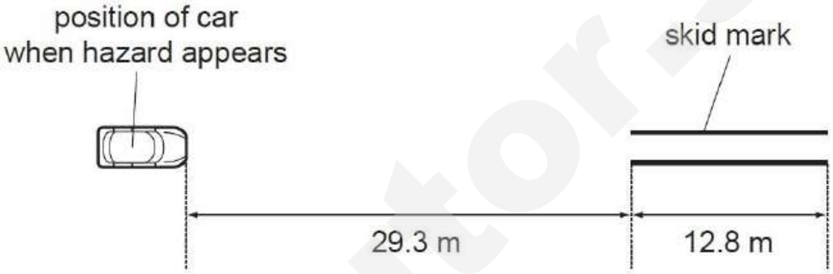


Fig. 2.1

It is estimated that, during the skid, the magnitude of the deceleration of the car is 0.85 g, where g is the acceleration of free fall.

(i) **1.** Show that the speed *v* of the car before the brakes are applied is 14.6 m s^{-1}. [2]

2. Determine the time interval between the hazard appearing and the brakes being applied.

time = __________ s [2]

2 **(b)** **(ii)** The legal speed limit on the road is 60 km h^{-1}. Use **both** of your answers in **(b)(i)** to comment on the driver's standard of driving.

....

....

....

.... [3]

3 A cell of e.m.f. E and internal resistance r is connected to three bulbs X, Y and Z as shown in the circuit of Fig. 3.1.

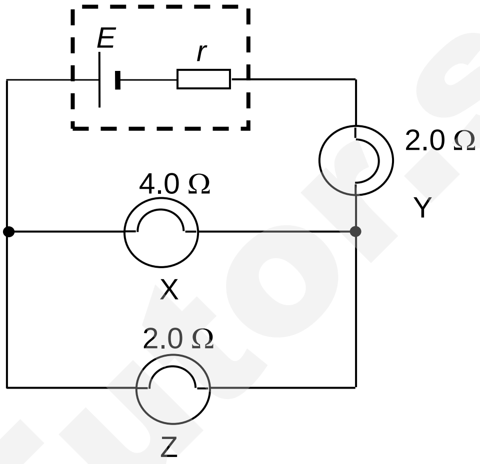


Fig. 3.1

(a) Calculate the effective resistance of the three bulbs in the circuit of Fig. 3.1.

Effective resistance = ______________Ω [2]

(b) List the light bulbs X, Y and Z in order of *increasing* brightness.

In order of increasing brightness:___________, __________, __________ [1]

(c) When a voltmeter is placed across the battery in Fig. 3.1, a reading of 3.44 V was obtained, current reading across the battery was 0.93 A. When bulb Y was removed, the voltmeter reading was 2.96 V and the current reading was 1.73 A. Find the e.m.f. E and internal resistance r of the battery.

E = _________________V,

r = _______________Ω [3]

4 A side view of a simple electron gun is shown in Fig. 4.1. When the potential difference between the cathode and the anode is 1200V, the speed with which electrons emerge from the anode of this gun will be about 2×10^7 m s^{-1}.

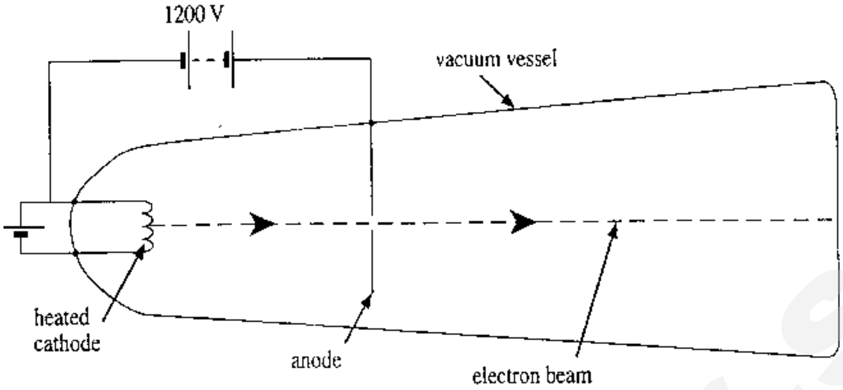
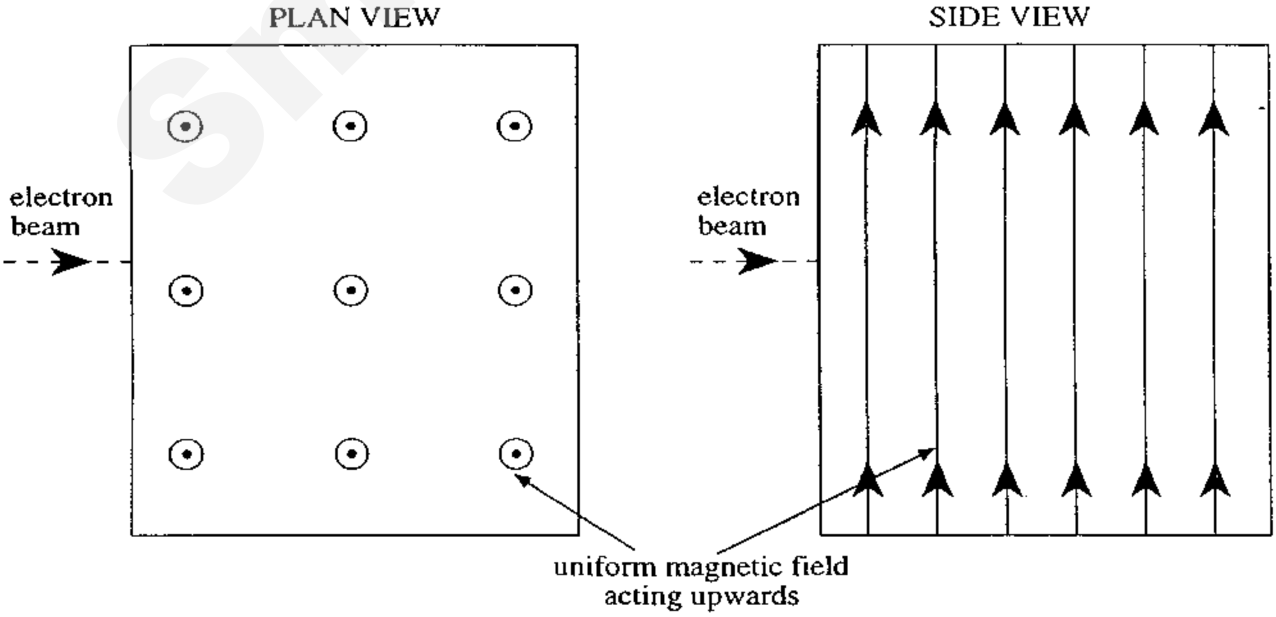


Fig. 4.1

(a) Electrons emerges horizontally from the electron gun and enters a uniform magnetic field which is directed upwards in the plane of the diagram. Calculate the magnitude of the force on an electron in this magnetic field of flux density 0.080 T.

Force = _______________ N [1]

(b) Draw the path of an electron passing through the field described in part **(a)** on each of the two diagrams shown in the figure below. No further calculations are expected. [2]



4 **(c)** **(i)** State and explain whether the speed of an electron changes while it is in the magnetic field.

....

....

.... [2]

(ii) State, with a reason, whether the force on the electron alters while it is in the magnetic field.

....

....

.... [2]

5 Read the following passage and then answer the questions which follow it. (Numbers near to the right-hand margin of the passage indicate the line numbers.)

Lithium solid-state batteries

Lithium solid-state batteries represent a new concept in battery technology. Solid-state means that the liquids and pastes present in ordinary battery systems are replaced by a solid plastic film which cannot leak. This plastic film separates a lithium anode (positive electrode) from a composite cathode (negative electrode) which is in contact with aluminium foil. (See Fig. 5.1) The resultant cell can be constructed so that it has a large electrode area but is less than 0.2 mm thick. It is in many ways similar to a sheet of paper and can be cut and formed into almost any shape. Lithium solid-state cells such as this are rechargeable and can be incorporated into the cases of equipment or into such items as credit cards.

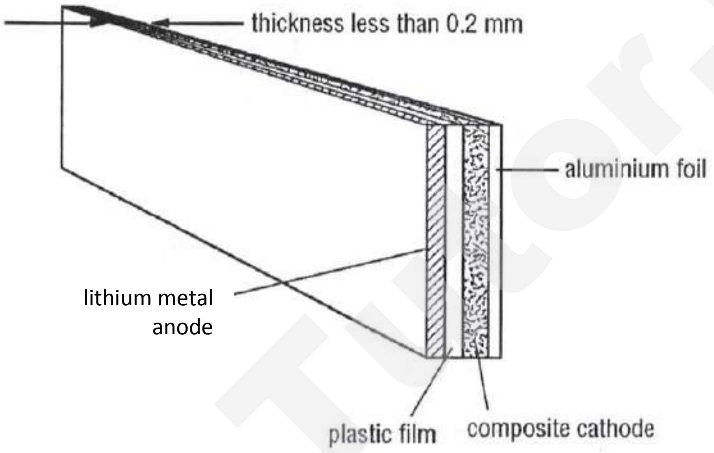


Fig. 5.1

The initial e.m.f. of the cell at full charge is 3.4 V but it rapidly falls to about 2.8 V on load and thereafter falls as shown in Fig. 5.2.

The cell needs to be recharged when the e.m.f. reaches 2.0 V. In practice, its average e.m.f. is 2.5 V.

The current density, energy density and charge capacity all have to be considered for a particular application.

Current density is the amount of current which the lithium cell can provide per unit area of the electrode area. Energy density is the total energy stored in the lithium cell per unit mass of the lithium cell. Charge capacity is the amount of charge available per unit area of the electrode area.

Recommended maximum values:
Discharge current density = 0.15 mA cm^{-2}
Energy density = 120 W h kg^{-1}
Charge capacity = 3.6 C cm^{-1}

Charging one of these cells should be carried out with a constant applied voltage of 3.4 V and with a current density limited to 2.5 mA cm^{-2}. A typical charging current against time graph is shown in Fig. 5.3 for a cell of electrode area 50 cm^2.

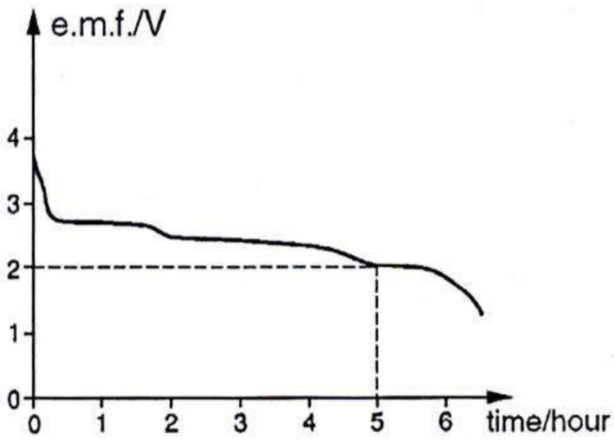


Fig. 5.2

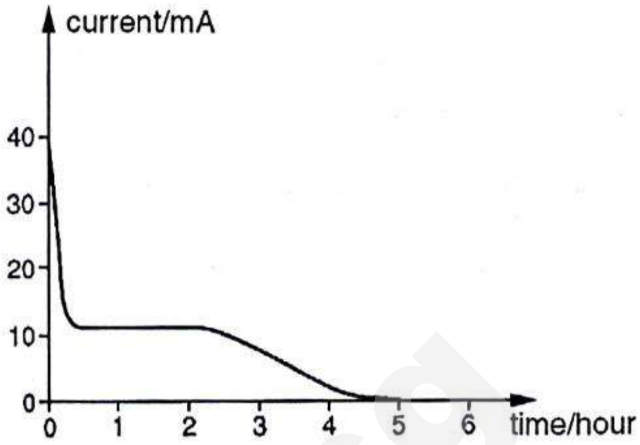


Fig. 5.3

5 **(a)** By reference to lines 9-24 of the passage, answer the following questions for a cell of electrode area 50 cm^2.

(i) Calculate the charge-storage capacity of this cell.

Charge storage capacity = ________ C [1]

(ii) Calculate the recommended maximum value of the discharge current.

Maximum discharge current = ________ mA [1]

(iii) Calculate how long this cell can supply this maximum current.

Time maximum current can be supplied = ___________ s [1]

(iv) Calculate the energy it supplies in this time, assuming that the e.m.f. has a constant value of 2.5 V.

Energy supplied = __________ J [2]

5 **(b)** Fig. 5.3 shows the charging graph for a cell of the same electrode area as in **(a)**.

(i) From the graph, estimate the average charging current over the 5-hour charging time.

Average charging current = __________ mA [2]

(ii) Calculate the energy used in charging the cell.

Energy used in charging the cell = __________ J [2]

(c) Using your answers to **(a)(iv)** and **(b)(ii)**, deduce the electrical efficiency of the charge/discharge cycle.

Electrical efficiency = ____________ [1]

(d) Draw a diagram, using circuit symbols, to illustrate how you would connect a battery of cells which could produce a current up to 300 mA at a voltage of approximately 10 V. In your answer specify the electrode area of the individual cells.

[2]

Section B

Answer **all** the questions in this section

6 **(a)** A uniform metal rod AB of mass 1.5 kg and length 0.50 m is freely pivoted at A as shown in Fig. 6.1.

The end B is suspended by a light spring. The other end of the spring is supported at X. When the rod is in equilibrium, it makes an angle of 30° with the horizontal and the angle between the rod and the spring is 90°.

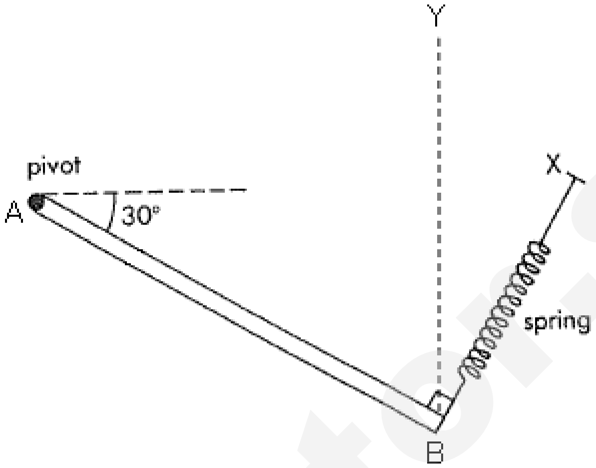


Fig. 6.1

(i) On Fig. 6.1, draw and label the forces acting on the metal rod AB. [2]

(ii) Show that the tension in the spring is 6.4 N. [2]

(iii) Calculate the magnitude and direction of the reaction force at pivot A.

magnitude = ____________ N, direction = _________________________ [4]

6 **(a)** **(iv)** Explain if there will be any change in the tension of the spring if the spring is aligned vertically along YB instead, so that the angle between the lever and the spring is no longer 90°.

....

....

.... [2]

(b) State the principle of conservation of linear momentum.

....

.... [1]

(c) An object A of mass 0.300 kg travelling with a speed 1.5 m s^{-1} collides with another identical object B with a spring of force constant 200 N m^{-1} attached in front as shown in Fig. 6.2. Both objects are originally at rest on a smooth surface.

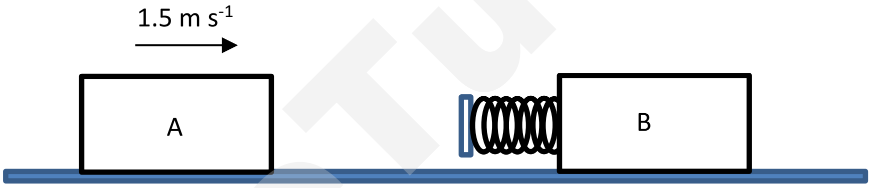


Fig. 6.2

(i) Given that the collision between A and B is elastic, determine the maximum compression of the spring.

Maximum compression = ________________m [4]

6 **(c)** **(ii)** Determine with clear working the velocity of A and B after the collision.

Velocity of A = ____________m s^{-1}

Velocity of B = ____________m s^{-1} [3]

(iii) The experiment is reset to the initial conditions. B was replaced by another object C which is twice the mass of A. The spring was replaced by a device that attach both mass together upon contact. Determine the new velocity of object A after the collision.

New Velocity of A = ____________m s^{-1} [2]

7 (a) The spectrum of electromagnetic waves is divided into a number of regions such as radio waves, visible light and gamma radiation.

(i) State two distinct features of waves that are common to all regions of the electromagnetic spectrum.

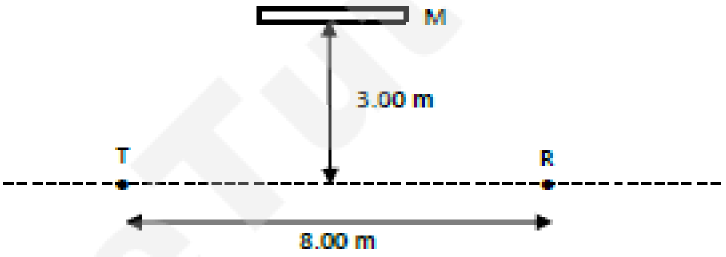
1. ....

2. .... [2]

(ii) State a typical wavelength for x-rays.

.... [1]

(b) The diagram below shows a transmitter T of electromagnetic waves of wavelength λ = 0.40 m. A receiver R is placed 8.00 m away as shown and a plane reflecting surface M is held in such a way that the perpendicular distance from M to the line TR is 3.00 m.



(i) Show that path difference of the waves (from paths TR and TMR) which can reach R from T is 5 λ. [2]

(ii) In reflecting from M, the wave which follows the path TMR undergoes a phase change which is equivalent to it having travelled an extra distance of λ/2. Determine if the receiver R detected a maximum or a minimum signal. Explain.

....

....

.... [2]

7 **(b)** **(iii)** Describe how the signal received at R varies as M is slowly moved towards the line TR until it almost lies on it.

....

....

....

....

.... [3]

(c) A string is stretched between two fixed points. It is plucked at its centre and the string vibrates, forming a stationary wave as illustrated in Fig. 7.1.v

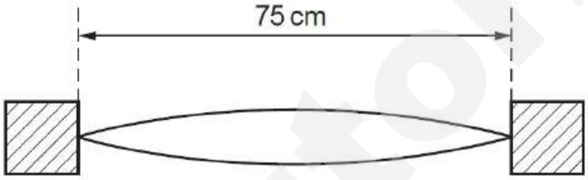


Fig. 7.1

The length of the string is 75 cm.

(i) The frequency of vibration of the string is 360 Hz. Calculate the speed of the wave on the string.

Speed = ___________ m s^{-1} [2]

(ii) By reference to the formation of the stationary wave on the string, explain what is meant by the speed calculated in **(b)(i)**.

....

....

....

.... [3]

7 **(d)** The setup in **(c)** is brought near a tube of water which is filled up to the brim as shown in Fig. 7.2. A tap at the bottom of the tube may be used to release the water in the tube. Determine the length of the air column when the first loud sound is heard. (Speed of sound in air = 330 m s^{-1})

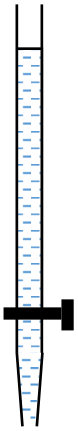


Fig. 7.2

Length of air column = ____________ m [2]

(e) Two ripple tank dippers S_1 and S_2 are vibrating in phase. Draw a series of arcs to represent the wavefronts from S_1 and S_2, using a wavelength such that $S_1S_2 = 3.5\lambda$. [3]
(e.g. make λ =1.0 cm and S_1S_2 = 3.5 cm.)
Mark on your diagram the antinodal lines.

8 **(a)** Explain the terms *ground state, excitation energy* and *ionization energy* as applied to the hydrogen atom. Illustrate your answer with an energy level diagram.

....

....

....

....

....

.... [4]

(b) A student uses a spectrometer and diffraction grating to view a hydrogen emission spectrum. He was able to find maxima for wavelengths of 433 nm, 484 nm and 651 nm.

These emission lines all arise from transitions to the same final state.

(i) Sketch part of the complete energy level diagram relevant to these transitions. Mark in the transitions and identify the three lines. [3]

8 **(b)** **(ii)** How many other transitions could occur between these energy levels?

Number of possible transitions = ______________ [1]

(iii) The energy change for the *least* energetic of these other transitions is 4.8×10^{-20} J. Calculate the wavelength of the corresponding emission line. In which region of the electromagnetic spectrum is it found?

Wavelength = ______________ m [1]

Region of EM spectrum = _________________ [1]

(c) The hydrogen emission spectrum in **(b)** was created through thermal excitation. State, with energy considerations, 2 other ways of that a cool hydrogen gas can be excited.

1. ....

....

....

2. ....

....

.... [2]

(d) Ultraviolet radiation of wavelength 253 nm falls on a zinc surface of work function 3.6 eV.

(i) Determine the maximum kinetic energy of the emitted photoelectrons.

Kinetic energy = ___________________eV [2]

8 **(d)** **(ii)** Determine the corresponding de Broglie wavelength of the emitted photoelectrons.

Wavelength = ________________m [1]

(iii) Explain why the maximum possible kinetic energy of a photoelectron is independent of the intensity of the incident light

....

....

....

.... [2]

(iv) The surface area of the zinc surface is 7.5 cm^2. The intensity of the UV radiation at the surface is 60 mW m^{-2} and it is assumed that 1% of the photons emit electrons from the surface. Determine the photoelectric current.

Current = __________________A [3]

------------------------ End of Paper ----------------------

2017 NJC SH2 Prelim H1 Physics Suggested Solution

Paper 1

1	B	11	C	21	A
2	D	12	C	22	B
3	A	13	C	23	B
4	C	14	D	24	A
5	B	15	B	25	A
6	C	16	C	26	C
7	C	17	A	27	C
8	C	18	C	28	C
9	B	19	D	29	D
10	D	20	B	30	D

Paper 2

1. (a) Units of P = units of kv^3

Power P = Energy / time = Force x displacement / time

Units of k = units of P / units of v^3

= $kg\ m^2\ s^{-3} / m^3\ s^{-3}$

= $kg\ m^{-1}$

(b) P = $240\ v + 0.98\ v^3$

= $240\ (20) + 0.98\ (20)^3$ = 12640 W = 12700 W

(c) On a horizontal road,

R = F = P/v = 12640 / 20 = 632 N

On the slope,

F'= R + mg sinθ = 632 + (1000)(9.81) sin 20° = 3987.2 N

P'= F'v = 3987.2 x 20 = 7.97×10^4 W

2. (a) (i) speed is only the magnitude of velocity.

velocity has a stated direction as well.

(b) (i)1. $v^2 = u^2 + 2as$

$0 = u^2 + 2 \times (-0.85 \times 9.81) \times 12.8$

$v = 14.6\ m\ s^{-1}$

(i)2. s = ut

29.3 = 14.6 t

t = 2.0 s

2. (b) (ii) 60 km h^{-1} = 16.7 m s^{-1} or 14.6 m s^{-1} = 53 km h^{-1}

Thus he is driving within speed limit.

The driver's reaction time is too slow though OR the braking distance is too long.

3. (a) $R_{eff} = \left(\frac{1}{4.0} + \frac{1}{2.0} \right)^{-1} + 2.0 = 3.33\Omega$

(b) X, Z, Y.

The brightness of the bulbs depends on the power dissipated in them. Comparing bulbs X and Z, since they are in parallel, the voltage drop across them is the same, and using $P = V^2/R$, we conclude that bulb Z is brighter than bulb X.

Next, use $P = I^2R$ to compare between bulbs Y and Z, and bulb Y is brighter as the current through Y is larger.

(c) E = 0.93r + 3.44 -----(1)

E = 1.73r + 2.96 ------(2)

(2) – (1)

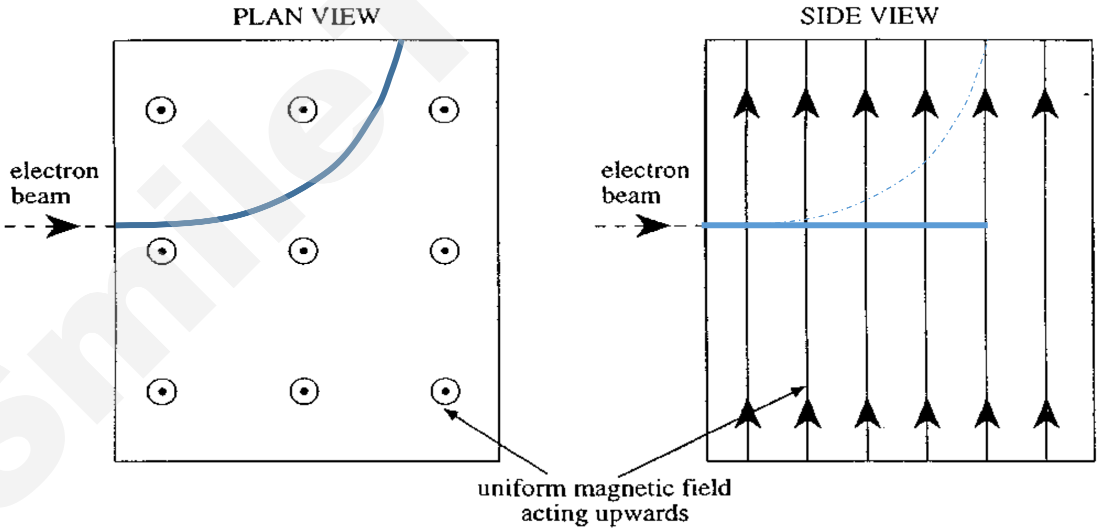
0 = 0.8r – 0.48

r = 0.6 Ω ---------------- sub into (1)

E = 4.00 V

4. (a) F = Bqv = (0.080)(1.6 x10^{-19})(2x10^7) = 2.56 x 10^{-13} N

(b)



(c) (i) As the magnetic force on the electron is perpendicular to it's direction of motion, there is not change in the magnitude of velocity, hence speed remains unchanged.

(ii) The magnitude of magnetic force on the electron depends on the magnetic flux density, charge as well as the speed of the electron, since these are constant, the magnitude of the magnetic force does not change. However, the direction of the magnetic force is perpendicular to the motion of the electron. Since the direction of motion changes (due to the force), the direction of magnetic force changes.

5. (a) (i) $3.6 \times 50 = 180\, C$

(ii) $0.15 \times 50 = 7.5\, mA$

(iii) $I = \frac{Q}{t}$

$$t = \frac{Q}{I} = \frac{180}{7.5 \times 10^{-3}} = 24000\, s$$

(iv) $P = IV = 2.5 \times 7.5 \times 10^{-3} = 0.01875W$

$E = Pt = 0.01875 \times 24000 = 450J$

(b) (i) Average current = area / total time

= (7.5+20+12.5)/5=8 mA

(ii) $P = IV = 8 \times 10^{-3} \times 3.4 = 0.0272W$

$E = Pt = 0.0272 \times 5 \times 60 \times 60 = 490\, J$

(c) Efficiency $= \frac{energy\ during\ charging}{energy\ during\ discharing} \times 100\%$

$$= \frac{450}{490} \times 100\% = 92\%$$

(d) Show 4 cells in series. Each cell will produce 2.5 V so total is 10 V

State area is 2000 cm^2 to get 300 mA.

6. (a) (i) Weight, tension, reaction force, all 3 forces intersecting

(ii) Using the principle of moments and choosing A as the pivot,
Anticlockwise moment of tension = clockwise moment of weight of rod
$T\times0.50=W\cos30^\circ\times0.25$
$T\times0.50=1.5\times9.81\times\cos30^\circ\times0.25$
$T=6.4$ N

(iii) Resultant force is zero hence horizontal component of reaction force is equal to horizontal component of tension.
Horizontal component of reaction force = 6.4 sin30°=3.2 N to the left
Vertical component of reaction force + vertical component of tension = weight
Vertical component of reaction force = 1.5×9.81-6.4 cos30°=9.17N upwards

Reaction force = $\sqrt{3.2^2+9.17^2}=9.7N$

$tan\theta=\frac{9.17}{3.2}\rightarrow\theta=71^\circ$ clockwise above the horizontal

(iv) The clockwise moment provided by weight remains unchanged.
For the rod to be in equilibrium, the net moment must zero. Since the perpendicular distance between tension and the pivot A is reduced when the tension is along YB, the tension must increase.

(b) Principle of Conservation of Momentum states that if there is no resultant external force acting on a system of bodies, the total linear momentum of the system in any direction always remain constant.

(c) (i) For maximum compression, the system should be moving at the same speed.
By Principle of conservation of linear momentum,
$M_Au_A = (M_A + M_B)\,v$
$(0.300)\,(1.5) – (0.300 + 0.300)v$
$V = 0.75$ m s^{-1}
Gain in elastic potential energy = Loss in kinetic energy
$½\,k\,x^2 = ½\,M_A\,u_A^2 – ½\,(M_A + M_B)\,v^2$
$½\,(200)x^2 = ½\,(0.300)(1.5)^2 – ½\,(0.600)\,(0.75)^2$
$x = 0.041$ m

(ii) By Principle of conservation of linear momentum,
$M_Au_A = M_Av_A + M_Bv_B$
$1.5 = v_A + v_B$ ------------(1)
Relative speed of approach = Relative speed of separation
$u_A – u_B = v_B – v_A$
$1.5 = v_A + v_B$ -----------(2)
(1) – (2), $v_A = 0$ m s^{-1}
$v_B = 1.5$ m s^{-1}

(iii) By Principle of conservation of linear momentum,
$M_Au_A = (M_A + M_C)\,v$
$(0.300)(1.5) = (0.300 + 0.600)v$
$v = 0.50$ m s^{-1}

7. (a) (i) 1. EM waves are transverse waves.

2. EM waves can be transmitted through a vacuum.

3. EM waves travel at the speed of light [Any 2]

(ii) 0.01 nm to 10 nm

(b) (i) path difference Δx = TMR – TR

$= (5+5) – 8 = 2 \text{ m} = (2/0.4)\lambda = 5\lambda$

(ii) Since there is a phase change after reflecting from M, the total path difference of the two ways is 5 ½ λ. This meets the criteria for destructive interference and hence a minimum signal is detected.

(iii) As M is move towards the line TR, the path difference of the signals will decrease. There will be a variation of maximum and minimum signal detected. When the total path difference is of the value n λ where n = 1,2,3,4,5 a maximum signal will be detected (i.e. there will be 5 maxima detected). When the total path difference is of the value (2n – 1)/2 λ, a minima signal will be detected.

(c) (i) wavelength = 2 x 75 cm = 150 cm

$v = f\lambda = 360 \times 1.50 = 540 \text{ m s}^{-1}$

(ii) When the string is plucked, it sent a wave traveling in the string. This wave hits the fixed end, gets reflected, and superpose with itself to form the stationary wave. The wave mentioned, travels at a speed that was calculated in (b)(i).

(d) $v = f\lambda$

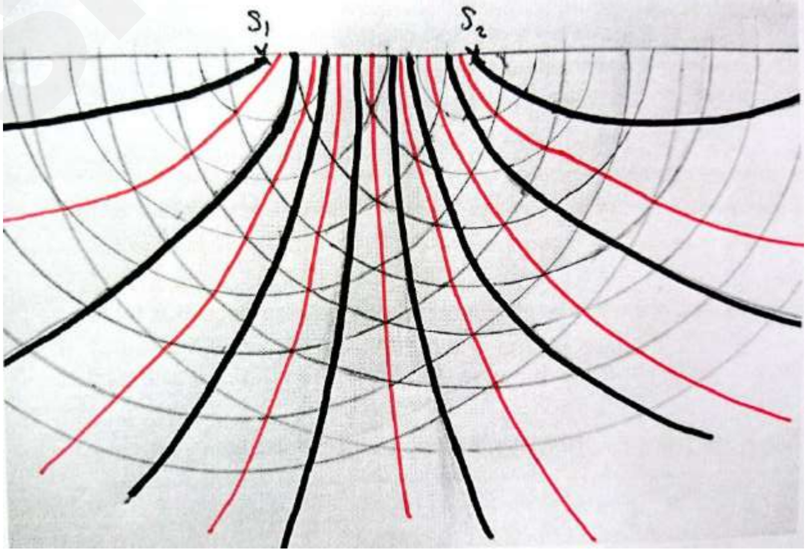
$330 = 360 \times \lambda$

$\lambda = 0.92 \text{ m}$

Since it is the fundamental mode,

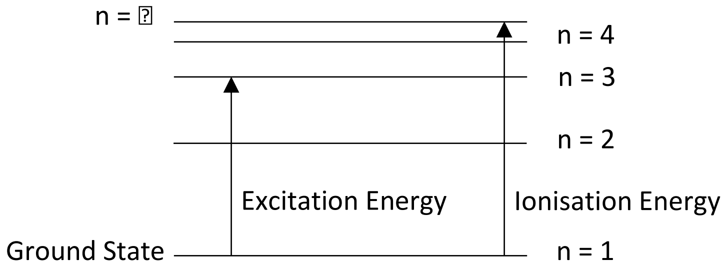
the length of the air column = ¼ λ = 0.23 m

(e)



Red lines (anti-nodal) Black lines (nodal)

8. (a)

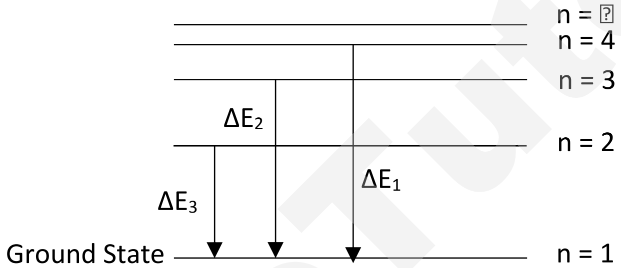


Ground State is the lowest energy state of an atom. This is the state where the atom is the most stable.

The amount of energy required for an electron in the hydrogen atom to be excited to a higher energy state (e.g. from n = 1 to n = 2 or n = 2 to n = 3) is called the excitation energy.

The amount of energy required for an electron in the hydrogen atom to ionised (removed infinitely far away from the hydrogen atom) is the ionisation energy.

(b) (i)



$\Delta E = hc/\lambda$

$\Delta E_1 = hc/(432.8 \times 10^{-9}) = 2.87$ eV

$\Delta E_2 = hc/(483.8 \times 10^{-9}) = 2.57$ eV

$\Delta E_3 = hc/(651.1 \times 10^{-9}) = 1.91$ eV

(ii) Total number of possible transitions = ${}^4C_2 = 6$

Hence Number of other transitions = 6-3 = 3

(iii) Least energetic transition will be from n = 4 to n = 3

$\Delta E = hc/\lambda = (2.87 - 2.57) \times 1.6 \times 10^{-19}$ J

$\lambda = 4.14 \times 10^{-6}$ m (infra-red spectrum)

(c) 1. Cool hydrogen gas can be excited by collisions will electrons or other atoms. During the collision, the electron in the hydrogen atom will gain energy equal to the energy difference in energy levels from the kinetic energy of the particle. The rest of the kinetic energy remains with the particle.

2. Cool hydrogen gas can also be excited by radiating it with photons of energies which are equal to the energy difference in energy levels.

(d) (i) $hf = \phi + \frac{1}{2} mv^2$

$\frac{1}{2} mv^2 = hf - \phi = hc/(253 \times 10^{-9} \times 1.6 \times 10^{-19}) - (3.6 \text{ eV}) = 1.31$ eV

(ii) $p^2/2m = E_k \Rightarrow p^2 = 2mE_k$

$\lambda = h/ p = h / (2mE_k)^{1/2} = h/ (2 \times 9.11 \times 10^{-31} \times 1.31 \times 1.6 \times 10^{-19})^{1/2} = 1.07 \times 10^{-9}$ m

(iii) When the photons are incident on the metal surface, the energy of the photon is used to overcome the work function of the metal surface while the rest of the energy will be passed to the emitted photoelectron as its kinetic energy. As each electron can only absorb one photon, the intensity of the incident light (which determines the number of incident photons), does not affect the maximum kinetic energy of the photoelectron.

(iv) Power = Intensity x Area = Energy/ time

$I \times A = (n_p/t)\ (hc/\lambda)$

$(60 \times 10^{-3})(7.5 \times 10^{-4}) = (n_p/t)(\ hc/\ 253 \times 10^{-9})$

$n_p/t\ = 5.724 \times 10^{13}$ photons per second

$n_e/t\ = 5.724 \times 10^{13} \times 0.01 = 5.724 \times 10^{11}$ electrons per second

Current = $Q/t = q(n_e/t\ ) = (1.6 \times 10^{-19})(\ 5.724 \times 10^{11}) = 9.16 \times 10^{-8}$ A

Name	Class	Index Number

PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination

PHYSICS
Higher 1

8866/01

Paper 1 Multiple Choice

22 September 2017

Additional Material: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **16** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

1 What is a reasonable estimate of the energy of a photon of yellow light?

A 1.6×10^{-19} J

B 2.8×10^{-19} J

C 3.6×10^{-19} J

D 5.0×10^{-19} J

2 A bus accelerates uniformly from rest and travels a distance of $(50.4 \pm 0.5)\,\text{m}$ in a time of $(8.4 \pm 0.2)\,\text{s}$.

What is the acceleration of the bus together with its associated uncertainty?

A $(1.4 \pm 0.2)\ \text{m s}^{-2}$

B $(1.4 \pm 0.7)\ \text{m s}^{-2}$

C $(1.43 \pm 0.05)\ \text{m s}^{-2}$

D $(1.43 \pm 0.08)\ \text{m s}^{-2}$

3 The speedometer in a car consists of a pointer which rotates. The pointer is situated several millimetres from a calibrated scale.

What could cause a random error in the driver's reading of the car's speed?

A The car's speed is affected by the wind direction.

B The speedometer does not read zero when the car is at rest.

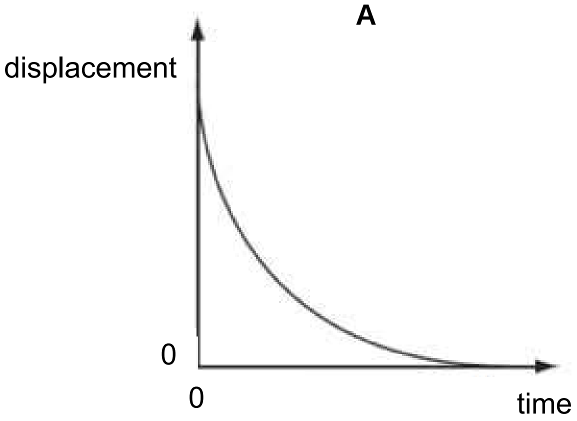
C The speedometer reads 5% higher than the car's actual speed.

D The driver's eye is not always in the same position in relation to the pointer.

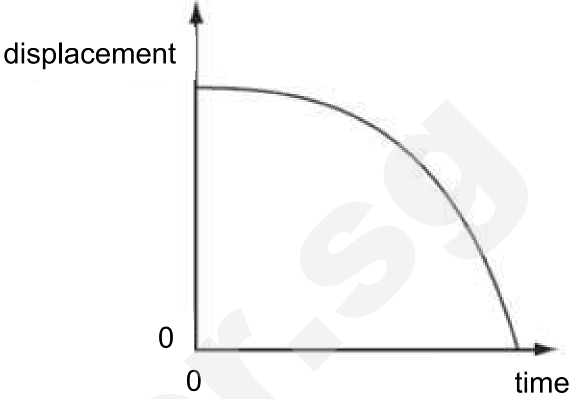
4 An object is released from rest and falls vertically. Its initial acceleration decreases until it eventually reaches terminal velocity.

Which graph best represents how the displacement of the object varies with time?

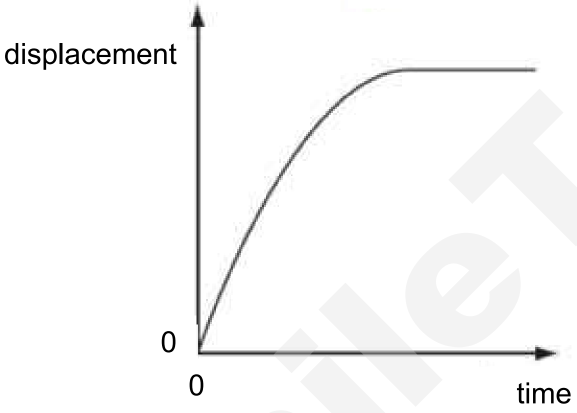
A



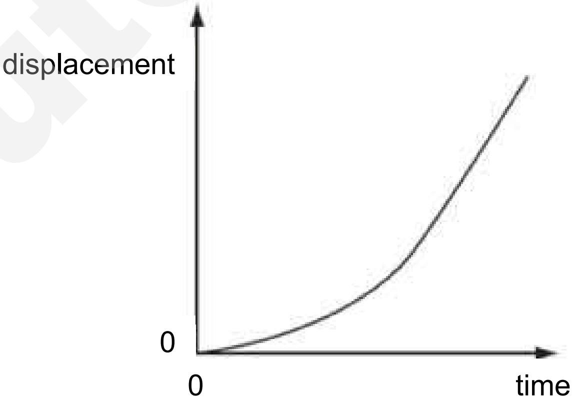
B



C



D



5 The acceleration of free fall on Earth is six times of that on Moon.

It takes time t for a rock on Moon to fall a distance of 3.0 m from rest.

What is the time taken for a rock on Earth to fall a distance of 2.0 m from rest?

A $\frac{t}{9}$

B $\frac{t}{4}$

C $\frac{t}{3}$

D $\frac{t}{2}$

6 A ball is thrown across a flat ground.

Which statement describes the motion of the ball, when the effects of air resistance are negligible?

A The ball lands with the same velocity at which it is thrown.

B The velocity of the ball is zero at the highest point of the motion.

C The vertical acceleration of the ball is zero at the highest point of the motion.

D The horizontal and vertical components of acceleration are constant throughout the motion.

7 Water is pumped through a hose-pipe at a rate of 5100 kg per hour. It emerges from the hose-pipe horizontally with a speed of 15 m s^{-1}.

What is the force required from a person holding the hose-pipe to prevent it from moving backwards?

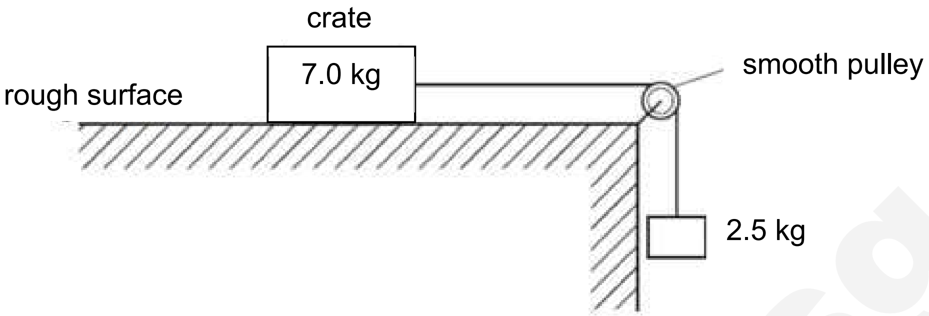
A 11 N

B 21 N

C 340 N

D 77000 N

8 A crate of mass 7.0 kg rests on a rough horizontal surface. A light string attached to the crate passes over a smooth pulley and supports a load of mass 2.5 kg at its other end.



When the crate is released, a frictional force of 5.0 N acts on it.

What is the acceleration of the crate?

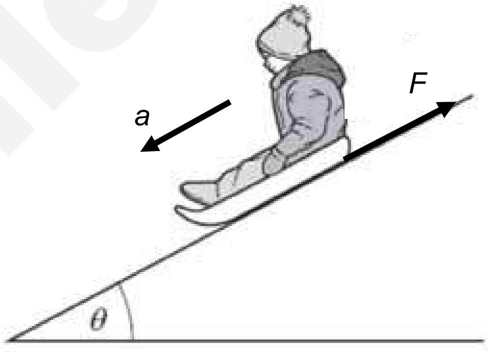
A 2.1 m s^{-2}

B 3.1 m s^{-2}

C 4.5 m s^{-2}

D 9.8 m s^{-2}

9 A child on a sledge slides down a slope with acceleration a. The slope is inclined at angle θ above the horizontal.



The mass of the child is m and the mass of the sledge is M. The acceleration of free fall is g. Ignore the effects of air resistance.

What is the frictional force F?

A $m(g\cos\theta + a)$

B $m(g\sin\theta - a)$

C $(m+M)(g\cos\theta - a)$

D $(m+M)(g\sin\theta - a)$

10 Two lorries of masses m and $2m$ travel towards each other in opposite directions with speeds $2v$ and v respectively. The lorries make a head-on collision and coalesce.

What is the speed of the lorries after collision?

A 0

B $\frac{3}{4}v$

C v

D $\frac{4}{3}v$

11 A beam of electrons is directed horizontally into a vertical downward field of force.

Which row shows the possible nature of the force acting on the beam with the correct path of the beam?

	force	path of beam
A	gravitational	horizontal
B	electric	curve upwards
C	gravitational	vertically downwards
D	electric	vertically upwards

12 The density of liquid Q is twice that of liquid R.

In liquid R, the pressure at depth x is 4.0 kPa.

What is the depth in liquid Q where the pressure is 7.0 kPa?

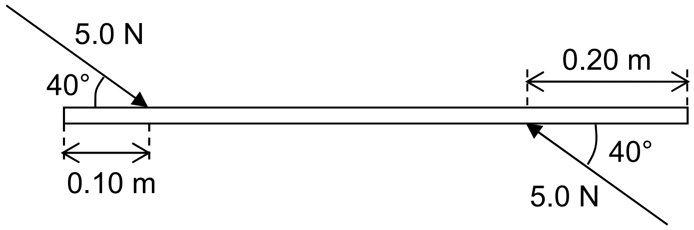
A $\frac{2x}{7}$

B $\frac{7x}{8}$

C $\frac{8x}{7}$

D $\frac{7x}{2}$

13 Two forces of magnitude 5.0 N act on a plank of length 0.90 m. The forces are parallel and act in opposite directions as shown.



What is the torque of the couple?

A 1.9 N m

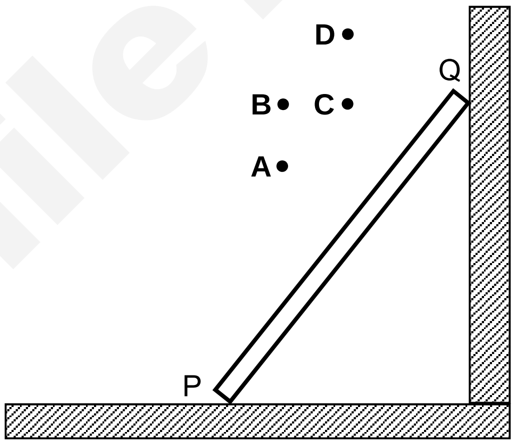
B 2.3 N m

C 2.9 N m

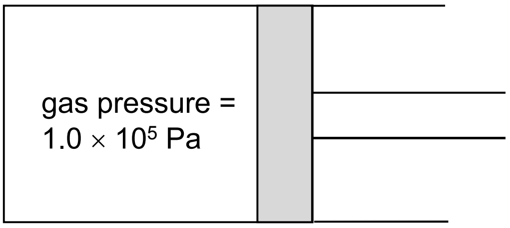
D 3.4 N m

14 The diagram shows a non-uniform plank PQ resting against a wall. The resultant forces at P and Q are F_P and F_Q respectively.

If the plank is in equilibrium, which point must F_P and F_Q act through?



15 A gas of pressure 1.0×10^5 Pa is enclosed in a cylinder fitted with a gas-tight, frictionless piston of cross-sectional area 32 cm^2. The gas is heated and the piston moves a distance of 6.0 mm outwards in order to keep the pressure of the gas constant.



What is the work done on the gas?

A -1.9×10^7 J

B -1.9 J

C 1.9 J

D 1.9×10^7 J

16 Trains supply coal to a power station. The table below gives quantities describing the operation of the power station.

	symbol	unit
power station output	P	W
number of trains per day	N	
mass of coal on a train	M	kg
energy from 1 kg of coal	J	J
number of seconds in one day	S	

Which expression gives the efficiency of the power station?

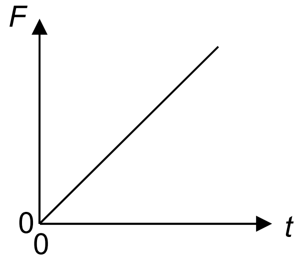
A $\dfrac{NM}{PSJ}$

B $\dfrac{NMJ}{PS}$

C $\dfrac{PS}{NMJ}$

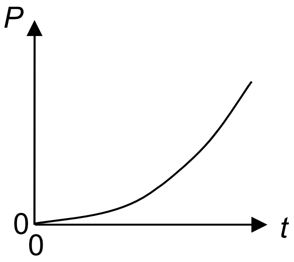
D $\dfrac{PSN}{MJ}$

17 The graph shows the variation with time *t* of the driving force *F* exerted by the engine on a vehicle.

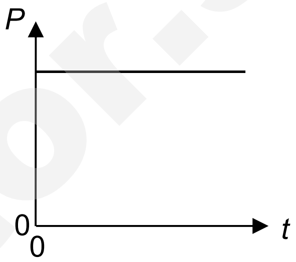


Which graph shows the variation with time *t* of the power *P* delivered by the engine?

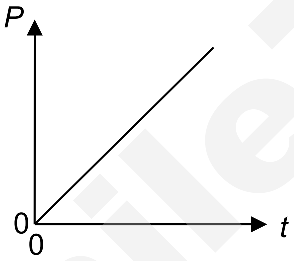
A



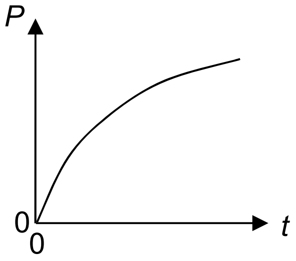
B



C



D



18 In a transverse progressive wave of frequency 200 Hz, the least distance between two adjacent points which have a phase difference of $\frac{\pi}{4}$ is 0.040 m.

What is the speed of the wave?

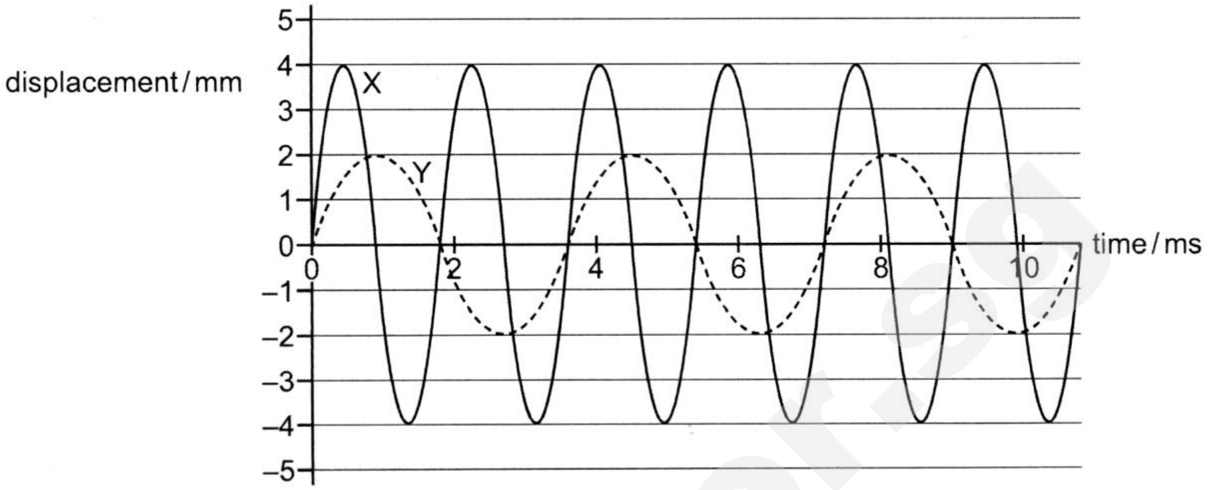
A 16 m s^{-1}

B 32 m s^{-1}

C 48 m s^{-1}

D 64 m s^{-1}

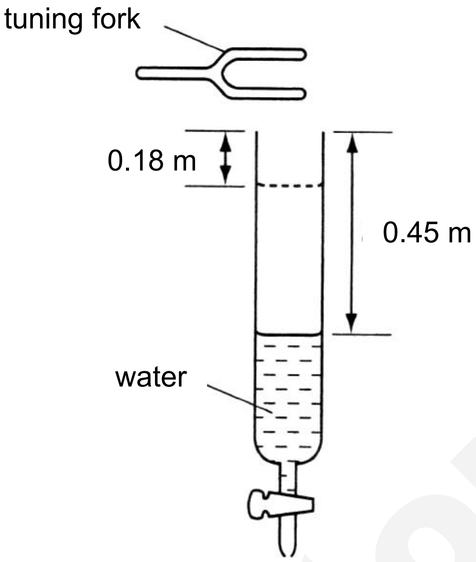
19 The graph represents two waves, X and Y.



Which row shows the frequency and intensity ratios for X and Y?

	$\frac{\text{frequency of X}}{\text{frequency of Y}}$	$\frac{\text{intensity of X}}{\text{intensity of Y}}$
A	$\frac{1}{2}$	2
B	2	2
C	$\frac{1}{2}$	4
D	2	4

20 A tuning fork is made to vibrate above a burette filled with water. The water is allowed to run out of the tube.



A loud sound is heard when the length of the air column is 0.18 m and again when the length is 0.45 m.

What is the wavelength of the sound in the tube?

A 0.27 m

B 0.36 m

C 0.54 m

D 1.1 m

21 Two coherent waves, of intensities I and $4I$ meet in anti-phase at a point.

What is the resultant intensity at that point?

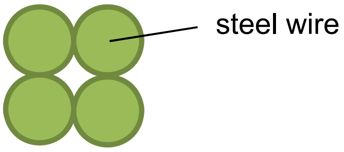
A 0

B I

C $3I$

D $5I$

22 An electrical supply cable consists of four identical steel wires arranged next to one another. Each wire has a cross-sectional area of 50 mm^2 and a resistivity of 9.0×10^{-8} Ω m. The cross section of the cable is as shown.



What is the resistance of the cable if its length is 100 m?

A 4.5×10^{-8} Ω

B 7.2×10^{-7} Ω

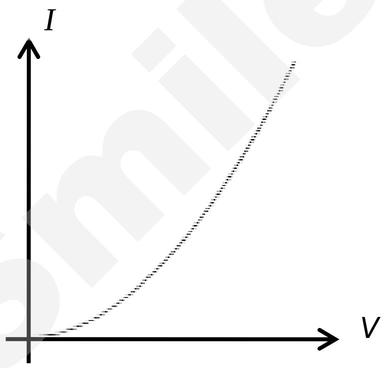
C 0.045 Ω

D 0.72 Ω

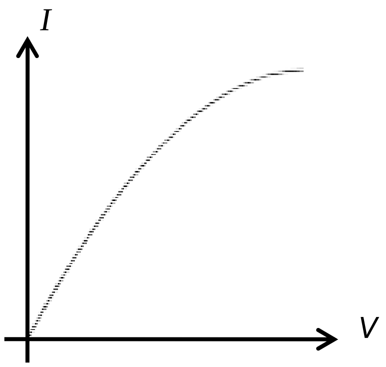
23 Some electric light bulb filaments are made of carbon. It is known that the resistance of carbon filaments decreases as their temperature increases.

Which graph shows how the current I through such a bulb varies with the potential difference V across it?

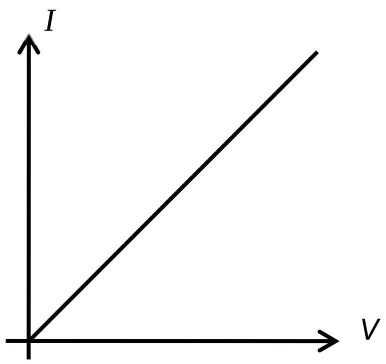
A



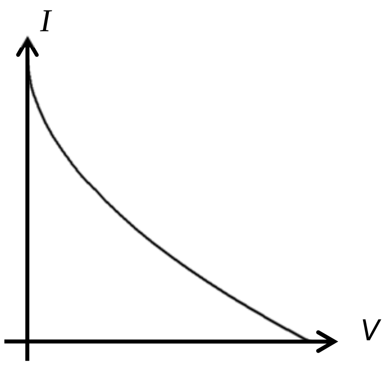
B



C

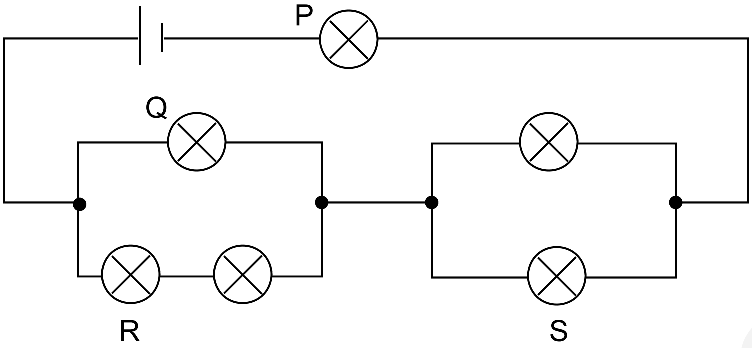


D



[Turn over

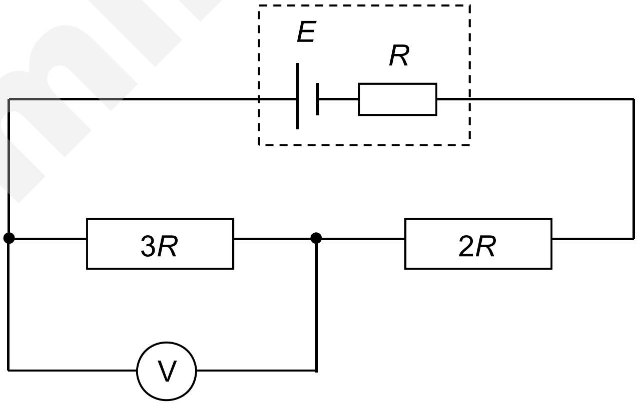
24 Six identical light bulbs are connected as shown in the diagram below.



Which are the dimmest and brightest bulbs?

	dimmest	brightest
A	P	Q
B	R	P
C	P	R
D	S	P

25 A cell of e.m.f. E and internal resistance R is connected to resistors of resistances $3R$ and $2R$. An ideal voltmeter is connected to the circuit, as shown in the diagram below.

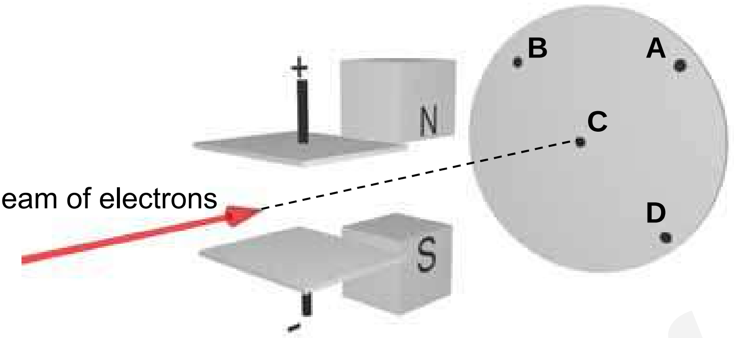


What is the reading in the voltmeter?

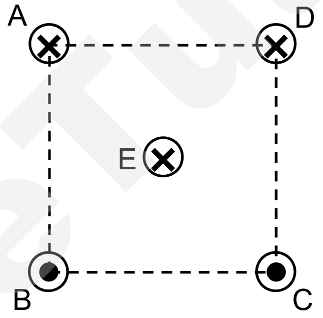
A $\frac{E}{5}$ **B** $\frac{E}{3}$ **C** $\frac{E}{2}$ **D** $\frac{2E}{3}$

26 A beam of electrons passes through the centre of a pair of parallel plates connected to a power source, with the polarity as shown, and a pair of permanent magnets.

Which is the likely position that the beam will end up on the screen?



27 Four parallel conductors A, B, C and D, carrying equal currents, pass vertically through the four corners of a square. In conductors A and D, the current is flowing into the page, and in conductors B and C, current is flowing out of the page.



Which of the following **incorrectly** describes the resultant force on conductor E, with current flowing into the page, at the centre of the square?

A The resultant force due to wires A and D points towards line AD, perpendicular to AD.

B The resultant force due to wires B and C points towards line AD, perpendicular to AD.

C The resultant force due to wires B and D points towards line AD, perpendicular to AD.

D The resultant force due to wires A, B, C and D points towards line AD, perpendicular to AD.

28 The line spectrum of hydrogen includes no X-ray frequencies.

The reason for this is

A the ionisation energy is too low.

B the work function energy is too high.

C there is only one electron in a hydrogen atom.

D there are too few electronic energy levels in the hydrogen atom.

29 The de Broglie wavelength of a moving particle with kinetic energy E_k is λ.

When the kinetic energy of the particle is decreased to $\frac{E_k}{2}$, its de Broglie wavelength is

A $\frac{\lambda}{2}$.

B $\frac{\lambda}{\sqrt{2}}$.

C $\sqrt{2}\lambda$.

D 2λ.

30 In a photoelectric experiment, one photoelectron is ejected from the metal for every ten photons incident.

Given that the photocurrent is 2.5 μA and the frequency of the source is 6.0×10^{14} Hz, what is the power of the source?

A 2.4×10^{-9} W

B 8.1×10^{-7} W

C 6.2×10^{-5} W

D 2.6×10^{-3} W

PJC Answers to JC2 Preliminary Examination Paper 1 (H1 Physics)

1	**C**	**6**	**D**	**11**	**B**	**16**	**C**	**21**	**B**	**26**	**A**
2	**D**	**7**	**B**	**12**	**B**	**17**	**A**	**22**	**C**	**27**	**C**
3	**D**	**8**	**A**	**13**	**A**	**18**	**D**	**23**	**A**	**28**	**A**
4	**D**	**9**	**D**	**14**	**B**	**19**	**D**	**24**	**B**	**29**	**C**
5	**C**	**10**	**A**	**15**	**B**	**20**	**C**	**25**	**C**	**30**	**C**

Suggested Solutions:

1 Wavelength of yellow light is approximately 550 nm.

$$E = \frac{hc}{\lambda}$$
$$= \frac{\left(6.63\times10^{-34}\right)\left(3.00\times10^{8}\right)}{550\times10^{-9}}$$
$$= 3.62\times10^{-19}\ \text{J}$$

Answer: C

2 Using $s = ut + \frac{1}{2}at^2$,

$$a = \frac{2s}{t^2}$$
$$= \frac{2\times50.4}{8.4^2}$$
$$= 1.429\ \text{m s}^{-2}$$
$$\frac{\Delta a}{a} = \frac{\Delta s}{s} + 2\frac{\Delta t}{t}$$
$$\Delta a = \left[\frac{\Delta s}{s} + 2\frac{\Delta t}{t}\right]a$$
$$= \left[\frac{0.5}{50.4} + 2\frac{0.2}{8.4}\right](1.429)$$
$$= \pm0.08\ \text{m s}^{-2}$$
$$a = (1.43 \pm 0.08)\ \text{m s}^{-2}$$

Answer: D

3 Option A does not affect the driver’s reading of the car’s speed.
Option B causes a systematic error.
Option C causes a systematic error.
Option D causes a parallax error which is a random error.

Answer: D

4 Gradient of graph gives the velocity. Graph D shows the speed of the object increasing from zero to a constant maximum value.

Answer: D

5 Using: $s = ut + \frac{1}{2}at^2$

On Moon:

$$3 = \frac{1}{2}a_{\text{moon}}t^2 \text{ } --- (1)$$

On Earth:

$$2 = \frac{1}{2}(6a_{\text{moon}})t_{\text{Earth}}^2 \text{ } --- (2)$$

Solving (1) and (2)

$$\frac{2}{3} = \left(\frac{6a_{\text{moon}}}{a_{\text{moon}}}\right)\frac{t_{\text{Earth}}^2}{t^2}$$

$$t_{\text{Earth}} = \frac{t}{3}$$

Answer: C

6 When the effects of air resistance are negligible, the horizontal component of velocity of the ball is constant. Hence horizontal component of acceleration is zero.
The vertical component of acceleration of the ball is constant and has the same value as the acceleration of free fall.

Answer: D

7 $$\text{force} = \Delta v \frac{dm}{dt}$$

$$= 15\left(\frac{5100}{60 \times 60}\right)$$

$$= 21 \text{ N}$$

Answer: B

8 Let tension in string be T

For crate: $T - 5.0 = (7.0)a$ .... (1)

For 2.5 kg mass: $(2.5)(9.81) - T = (2.5)a$ .... (2)

(1)+(2):

$$T - 5.0 + 2.5(9.81) - T = 7.0a + 2.5a$$

$$a = 2.1 \text{ m s}^{-2}$$

Answer: A

9 Resultant force $= (m+M)a$

$(m+M)a = (m+M)g\sin\theta - F$

$F = (m+M)g\sin\theta - (m+M)a$

$\quad = (m+M)(g\sin\theta - a)$

Answer: D

10 Using the principle of conservation of momentum,

$m(2v) - 2m(v) = 3m(v_f)$

$v_f = 0 \text{ m s}^{-1}$

Answer: A

11 The beam of electrons will follow an upward parabolic path if the electric field is directed vertically downward.

Answer: B

12 For liquid R, $4 \text{ kPa} = \rho g x$

For liquid Q, $7 \text{ kPa} = 2\rho g h$

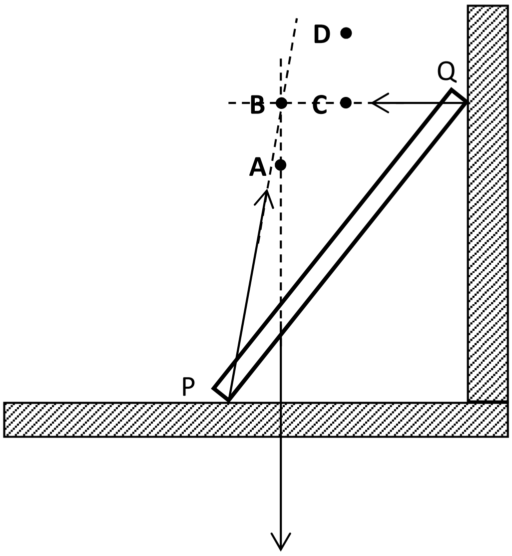
$h = \dfrac{7x}{8}$

Answer: B

13 Torque of couple $= (5.0)(0.60\sin 40°) = 1.9 \text{ N m}$

Answer: A

14



Answer: B

15 Work done by gas against external pressure of 1.0 × 10^5 Pa

$= (1.0\times10^5)(32\times10^{-4})(6.0\times10^{-3}) = 1.9$ J

Work done on gas = −1.9 J

Answer: B

16 Energy output = *PS*

Energy input = *NMJ*

Efficiency of power station $= \dfrac{PS}{NMJ}$

Answer: C

17 $P = Fv = F(u+at) = (kt)(u+\frac{kt}{m}t) = kut + \frac{k^2}{m}t^3$

P increases at an increasing rate.

Answer: A

18

$$\frac{\Delta x}{\lambda} = \frac{\Delta\phi}{2\pi}$$

$$\frac{0.040}{\lambda} = \frac{\pi/4}{2\pi}$$

$$\lambda = 0.32 \text{ m}$$

$$v = f\lambda$$

$$= (200)(0.32)$$

$$= 64 \text{ m s}^{-1}$$

Answer: D

19 From the graph, the period of Y is 2 times the period of X. Therefore, $\frac{f_X}{f_Y} = 2$

$$I \propto A^2$$

$$\frac{I_X}{I_Y} = \frac{4^2}{2^2} = 4$$

Answer: D

20 First resonance is $\frac{1}{4}\lambda$, while second resonance is $\frac{3}{4}\lambda$.

Difference in the length = 0.45 – 0.18 = $\frac{1}{2}\lambda$.

Therefore, wavelength of the sound wave is 0.54 m.

Answer: C

21 $I \propto A^2$

Since waves are in anti-phase → resultant amplitude is *A*. Therefore intensity is I.

Answer: B

22

$$R_{wire} = \frac{(9.0\times10^{-8})(100)}{(50\times10^{-6})} = 0.18\ \Omega$$

Wires are in parallel,

$$R_{cable} = \frac{0.18}{4} = 0.045\ \Omega$$

Answer: C

23 The resistance of the filament drops for higher values of I and V. Hence, the ratio of I/V must increase for higher values of I and V.

Answer: A

24 The bulb with the lowest current flowing through it will have the dimmest. R has the least current and P has the largest current. Hence, R is the dimmest and P is the brightest.

OR

If the e.m.f. of the cell is *E*, the potential difference across each of the four bulbs is in an increasing order of $V_R=0.15E$, $V_S=0.23E$, $V_Q=0.31E$, $V_P=0.46E$. The power rating of each bulb can be calculated using $P=\frac{V^2}{R}$, where the resistance of each of the bulb is the same. Hence bulb R has the smallest power rating (hence dimmest) and bulb P has the largest rating (brightest).

Answer: B

25 By potential divider concept,

Voltmeter reading = $\frac{3}{3+2+1}(E)=\frac{E}{2}$

Answer: C

26 The electrons are deflected upwards towards the positive plate and towards the right by the magnetic force.

Answer: A

27 For option C, the resultant force points towards conductor D.

Answer: C

28 The energy of a photon of X-ray is much higher than the ionisation energy of hydrogen (13.6 eV).

Answer: A

29 Since $E_k=\frac{p^2}{2m}$, we have $E_k=\frac{h^2}{2m\lambda^2}$.

$E_k \propto \frac{1}{\lambda^2}$ ----- (1)

$\frac{1}{2}E_k \propto \frac{1}{\lambda'^2}$ ----- (2)

Solving (1) and (2), we have

$$\frac{E_k}{\frac{1}{2}E_k}=\frac{\lambda'^2}{\lambda^2}$$

$$\lambda'=\sqrt{2}\lambda$$

Answer: C

30 Power of source = $n_1 h f$ where n_1 is the no. of photons arriving per second.
Current $I = n_2 e$ and n_2 is the no. of electrons emitted per second

$$n_2 = \frac{I}{e}$$

Given that $\frac{n_1}{n_2} = 10$, $n_1 = 10 n_2$

Thus power of source = $10 n_2 hf$

$$= 10 \frac{I}{e} h f$$

$$= \frac{10(2.5\times10^{-6})(6.63\times10^{-34})(6.0\times10^{14})}{1.6\times10^{-19}}$$

$$= 6.22\times10^{-5}\,\text{W}$$

Answer: C

Name	Class	Index Number

PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination

PHYSICS **8866/02**
Higher 1

Paper 2 Structured Questions

15 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/ 9
2	/ 6
3	/ 5
4	/ 8
5	/ 5
6	/ 7
Section B	
7	/ 20
8	/ 20
9	/ 20
Total	/ 80

This document consists of **24** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this Section.

1 **(a)** A ball of mass 0.050 kg is dropped from rest onto a hard floor and bounces vertically repeatedly. The height from which the ball is dropped is measured to be 2.0 m. Assume air resistance is negligible.

(i) Determine the speed of the ball just before the first impact.

speed = ... m s^{-1} [2]

(ii) The speed of the ball decreases by 30 % just after the first bounce.

1. Determine the corresponding momentum of the ball.

momentum = ... kg m s^{-1} [2]

2. Given that the duration of the first impact is 0.10 s, calculate the magnitude of the average force exerted on the ball by the floor.

force = ... N [2]

(b) A rock climber is stranded on a ledge. The rescuer on the ground shoots a rescue kit to him. The rescue kit is directed at an initial angle of 60° above the horizontal and has a launch speed of 17 m s^{-1}. Assume air resistance is negligible.

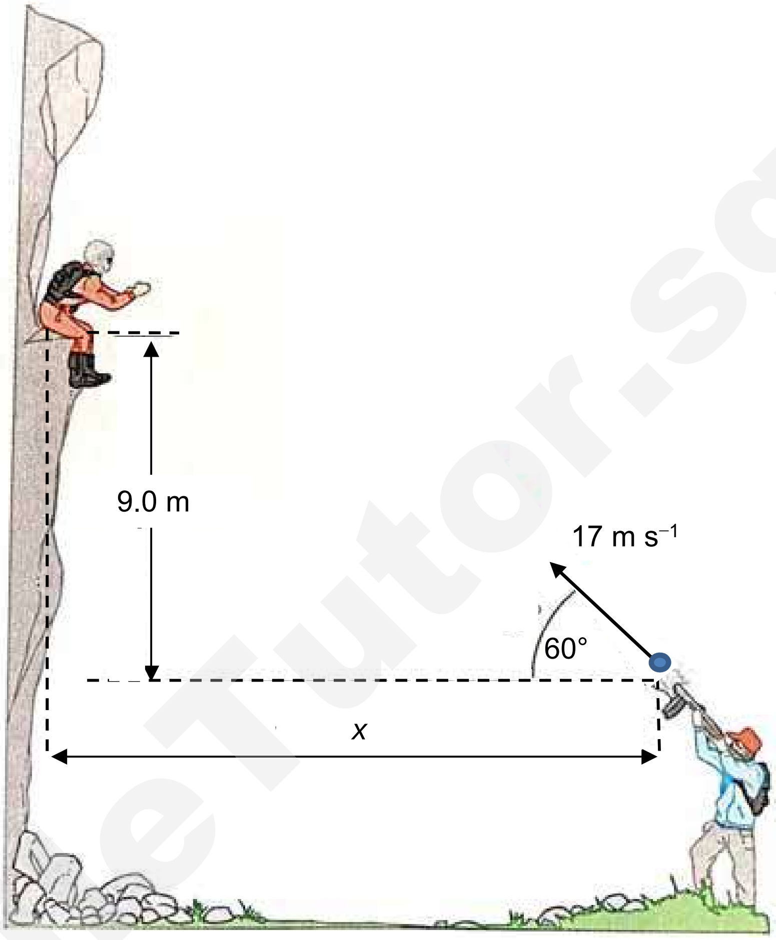


Fig. 1.1 (not drawn to scale)

(i) The kit reaches the top of its trajectory and then falls towards the climber.

Determine the time the kit takes to reach the climber.

time = ... s [2]

(ii) Hence, determine the horizontal distance *x* travelled by the kit.

x = ... m [1]

2 **(a)** Explain what is meant by the following terms when used in the context of forces.

(i) centre of gravity: …………………………………………………………………………

....

.... [1]

(ii) torque of a couple: ……………………………………………………………………..

....

.... [1]

(b) Fig. 2.1 shows a uniform metal beam PQ pivoted on a vertical wall at P and held in equilibrium by a cable attached to Q.

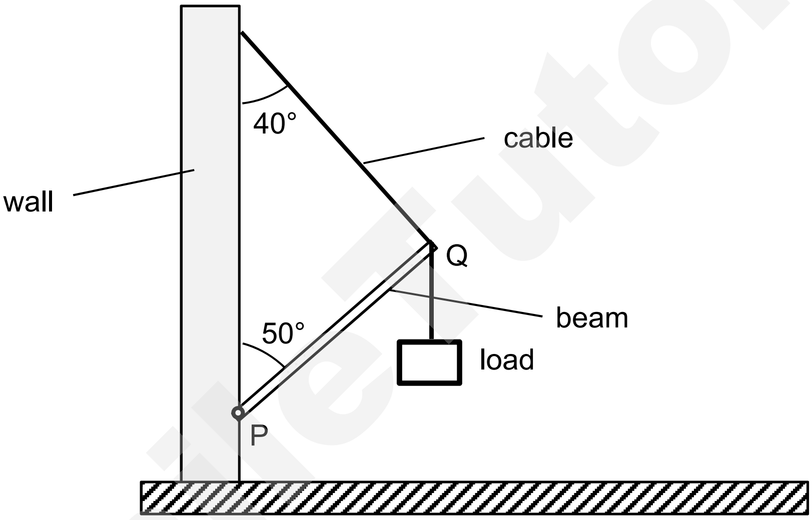


Fig. 2.1

The beam makes an angle of 50° with the wall and the cable makes an angle of 40° with the wall. The beam has weight 600 N and length 2.8 m. A load of 4000 N is hung from Q.

(i) By taking moments about P, calculate the tension in the cable.

tension = ... N [2]

(ii) A force acts on the beam at P.

Explain why a force is required to act on the beam at P to keep the beam in equilibrium.

....

....

....

.... [2]

3. Light is polarised when it passes through a sheet of material known as polaroid.

Three parallel sheets of polaroids P, Q and R are placed close to each other. The polarising axis of each polaroid is shown by an arrow. The polarising axis of Q and R are at 30° and 45° respectively, to that of P, as shown in Fig. 3.1.

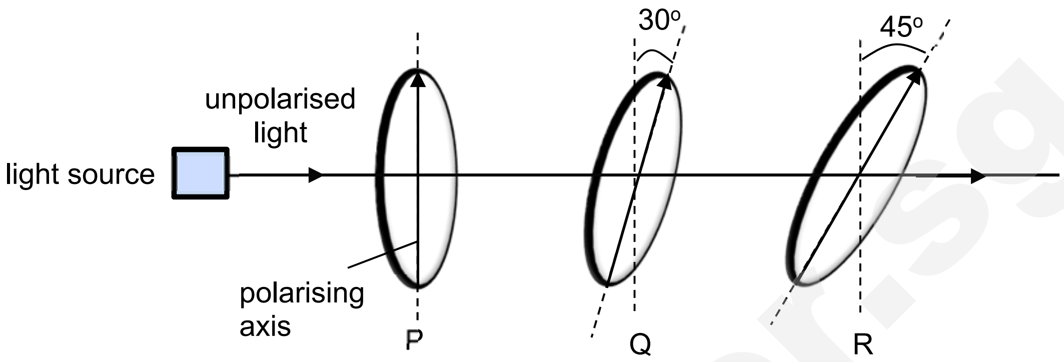


Fig. 3.1 (not drawn to scale)

A parallel beam of light is incident normally on P. The beam after emerging from P has amplitude *A* and intensity I.

(a) State what polarisation suggests about the nature of light.

.... [1]

(b) Determine the amplitude of light that emerges from R in terms of *A*.

amplitude = ... *A* [2]

(c) Hence, determine the intensity of light that emerges from R in terms of I.

intensity = ... I [2]

4 The wavelength of the monochromatic light from a source can be determined using the experimental setup as shown in Fig. 4.1. The slit separation *a* is 0.030 mm and the distance between the double slits and the screen *D* is 1.2 m.

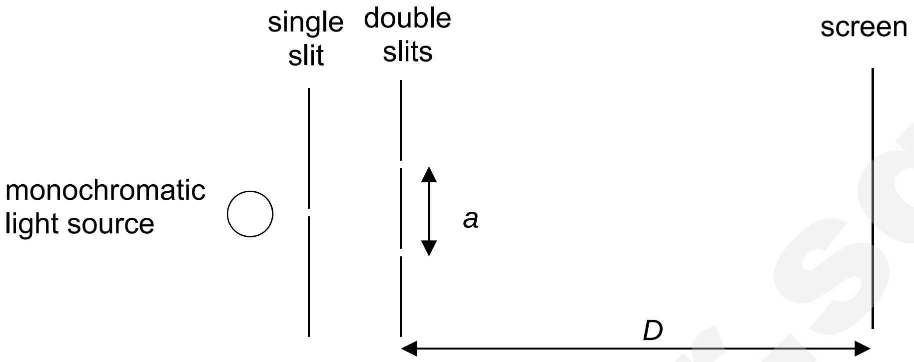


Fig. 4.1

When the monochromatic light is incident on the slits the separation of the bright fringes on the screen is 1.7 cm.

(a) Calculate the wavelength of the monochromatic light source.

wavelength = ... m [2]

(b) The following changes are made independently. Describe, in each case, the effect of the changes on the fringe separation and on the contrast between dark and bright fringes.

(i) The distance *D* is increased to 2*D*, keeping *a* and λ constant.

....

.... [2]

(ii) The monochromatic light source is changed to red light, keeping *a* and *D* constant.

....

.... [2]

(iii) A polariser is placed between the single slit and the double slits.

....

.... [2]

5 A cell of e.m.f 10 V and internal resistance 0.50 Ω is connected to a light-dependent resistor (LDR), as shown in Fig. 5.1. The LDR is found to have resistance 800 Ω in the dark and resistance 160 Ω in the daylight.

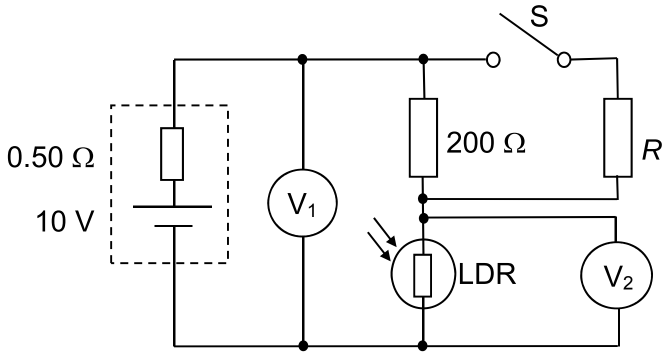


Fig. 5.1

(a) Explain why the reading of voltmeter V_1 is less than the e.m.f. of the cell.

....

.... [1]

(b) When switch S is open in the dark, show that the reading of voltmeter V_2 is 8.0 V.

[1]

(c) When switch S is closed in daylight, the voltmeter V_2 reads the same value in **(b)**.

Calculate the value of the resistance *R*.

R = ... Ω [3]

6 In a railway station, the timetable for trains running between towns is given in the form of a distance-time graph. A modified part of the graph for the times between 0800 hr and noon is shown in Fig. 6.1. Trains run between town A and town H with six intermediate stations. For example, train R runs from town G to H.

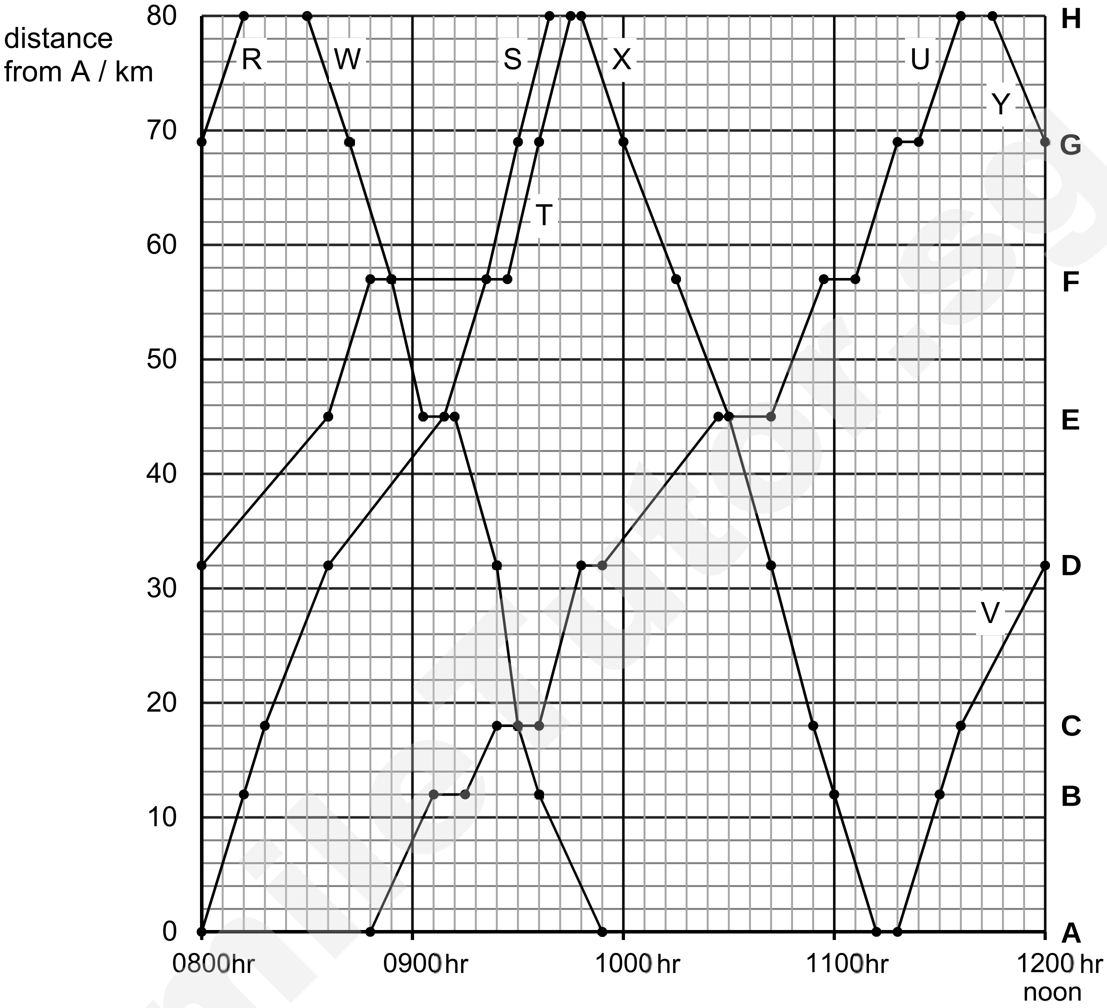


Fig. 6.1

(a) For complete journeys between A and H shown in Fig. 6.1, identify the trains which do not stop at intermediate stations.

.... [1]

(b) Use Fig. 6.1 to draw up a timetable for train W in Fig. 6.2.

Station	H	departure time	……………..
Station	……………	arrival time	……………..
		departure time	……………..
Station	A	arrival time	……………..

Fig. 6.2

[2]

[Turn over

(c) **(i)** State the two stations between which train W is travelling at the maximum speed.

.... [1]

(ii) Calculate the maximum speed.

maximum speed = ... m s^{-1} [1]

(d) Suggest why all trains from D to E run slowly but trains from E to D run quickly.

....

.... [1]

(e) Trains are travelling on a single track and can pass one another only in stations.

On Fig. 6.1, draw a possible line Z for an additional train running from A to H. [1]

Section B

Answer **two** of the questions in this Section.

7 **(a)** Distinguish between *gravitational potential energy* and *elastic potential energy*.

gravitational potential energy: ………………………………………………………………

…………………………………………………………………………………………………

elastic potential energy: ……………………………………………………………………

………………………………………………………………………………………… [2]

(b) A light helical spring is suspended vertically from a fixed point, and a load of weight *W* is suspended from the spring, as shown in Fig. 7.1.

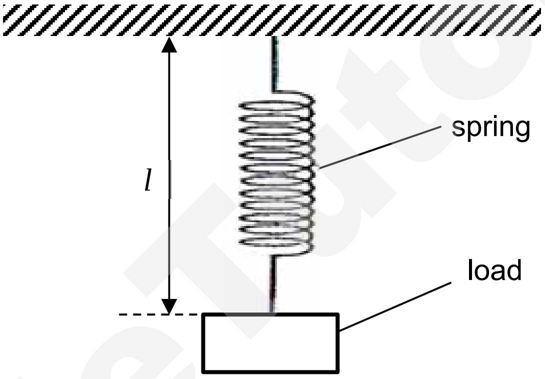


Fig. 7.1

The variation with weight *W* of the length l of the spring is shown in Fig. 7.2.

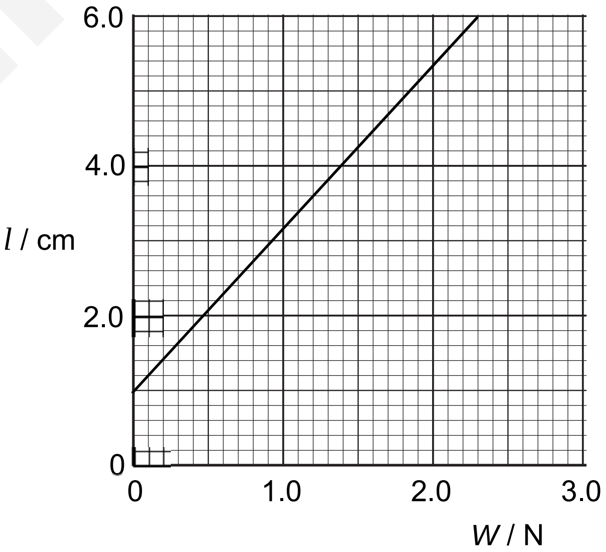


Fig. 7.2

(i) Calculate the spring constant of the spring.

spring constant = ... N m^{-1} [2]

(ii) A load of weight 2.3 N is suspended from the spring. It is raised 2.0 cm by hand and then held stationary.

For the decrease in length of 2.0 cm of the spring, determine the magnitude of the change in the

1. gravitational potential energy of the load,

change = ... J [2]

2. elastic potential energy of the spring.

change = ... J [2]

(iii) Explain why your answers in **(ii)** are not the same.

....

.... [1]

(c) A cyclist travels up an inclined road that makes an angle of 7.8° with the horizontal as shown in Fig. 7.3. The cyclist and his bicycle have a total weight of 790 N. He takes 15 s to reach the top of the inclined road. The variation with time *t* of the speed *v* of the cyclist is shown in Fig. 7.4.

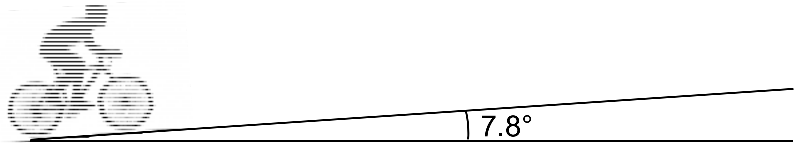


Fig. 7.3

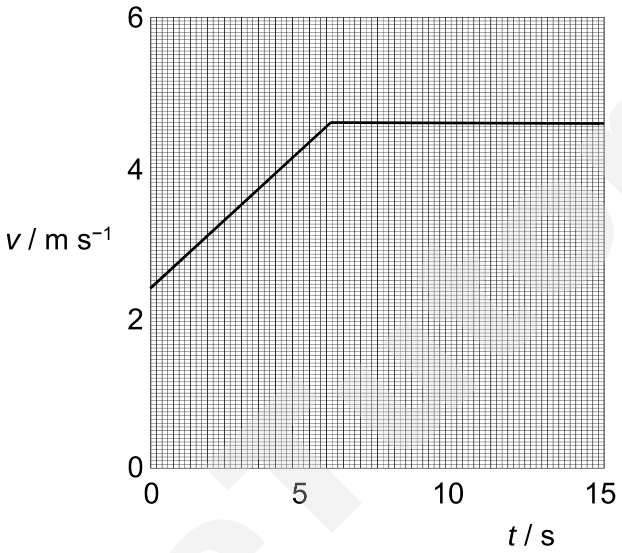


Fig. 7.4

(i) For the movement of the cyclist between $t = 0$ and $t = 6.0$ s,

1. calculate the change in kinetic energy,

change = ... J [2]

2. show that the vertical height through which the cyclist moves is 2.9 m,

[2]

3. calculate the change in gravitational potential energy,

change = ... J [1]

4. calculate the work done against the total resistive force, if the cyclist delivers a power of 550 W.

work done = ... J [2]

(ii) The total resistive force *R* on the cyclist can be given by the equation $R = 15 + 0.90v^2$ where *v* is the speed of the cyclist.

1. State the types of forces that contribute to the total resistive force *R*.

.... [1]

2. For the movement of the cyclist between *t* = 6.0 s and *t* = 15.0 s, calculate the power delivered by the cyclist.

power = ... W [3]

8 A battery of e.m.f. E and internal resistance of 3.0 Ω is connected to a variable resistor of resistance R, as shown in Fig. 8.1.

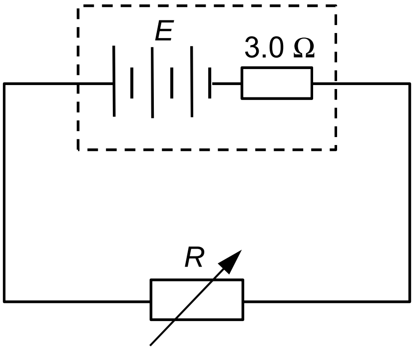


Fig. 8.1

The resistance R in the circuit is varied. The variation with R of the power P dissipated in the variable resistor is shown in Fig. 8.2.

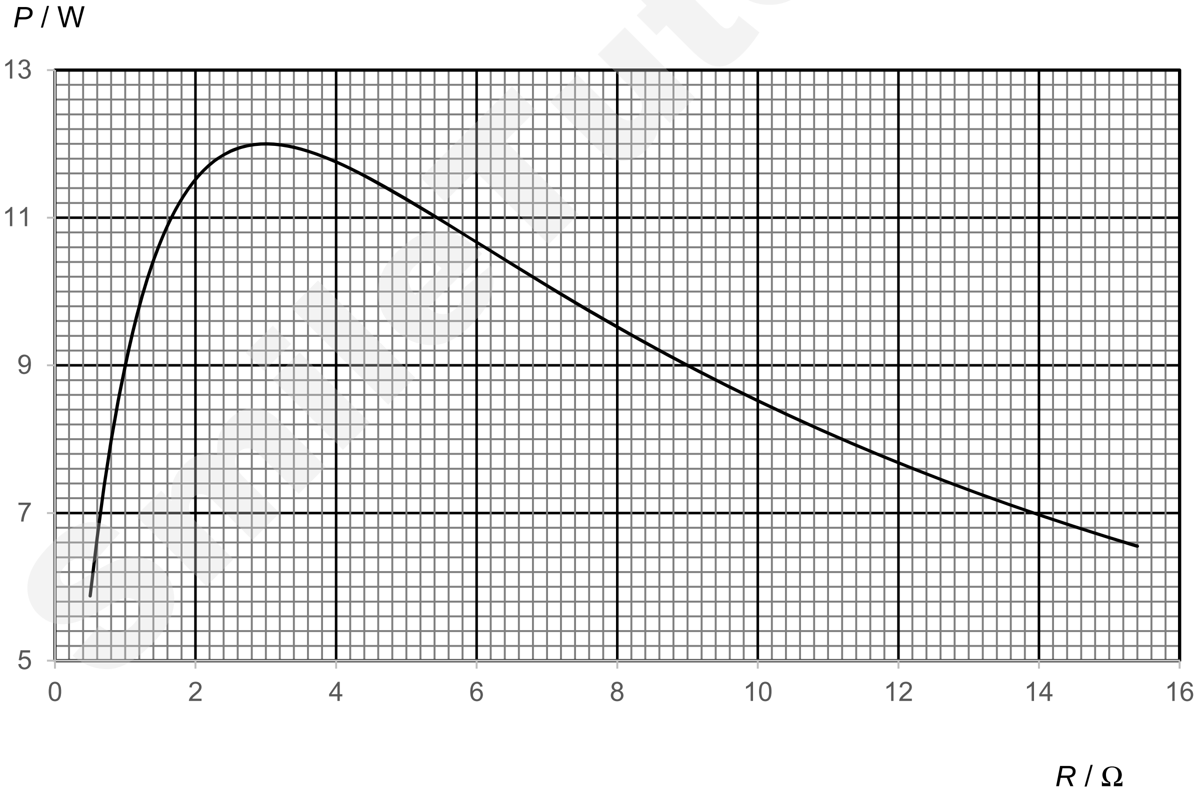


Fig. 8.2

(a) By reference to energy transfers, distinguish between e.m.f. and p.d.

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..

…………………………………………………………………………………………………..

………………………………………………………………………………………………… [2]

(b) When R = 14.0 Ω, calculate

(i) the current in the circuit,

current = ... A [2]

(ii) the e.m.f. E of the battery,

E = ... V [2]

(iii) the total energy supplied by the battery in 10 minutes.

energy = ... J [2]

(c) State the value of R at which the power dissipated in the variable resistor is a maximum.

R = ... Ω [1]

(d) With reference to Fig. 8.2, explain why the graph has a maximum value.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

…………………………………………………………………………………………………… [2]

(e) If the battery has negligible internal resistance, sketch the variation with *R* of the power *P* dissipated in the variable resistor on Fig. 8.3.

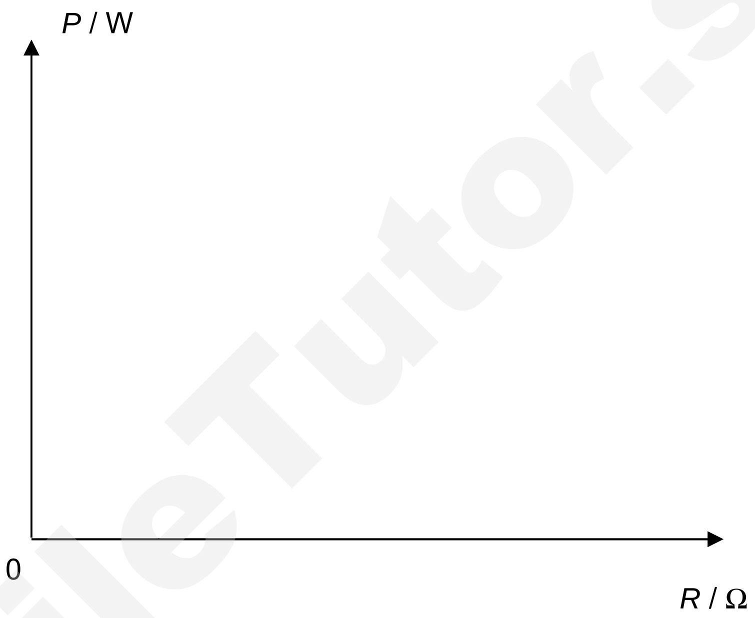


Fig. 8.3

[1]

(f) The battery is now connected to a wire frame ABCD supported on two pivots P and Q so that the section PBCQ of the frame lies within a solenoid, as shown in Fig. 8.4. The length of BC is 8.0 cm and the length of PB and QC is 20 cm. When there is no current in the circuit, the frame is horizontal.

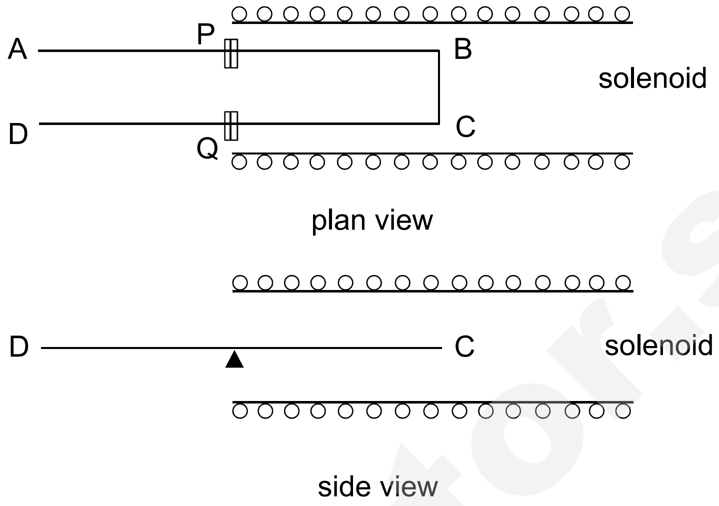


Fig. 8.4

When a current passes through the frame from A to D, a rider of mass 3.0 g is hung on side DQ at a position of 4.8 cm from Q in order to keep the frame horizontal.

(i) State and explain the direction of the magnetic field in the region of the solenoid.

....

....

....

....

....

.... [3]

(ii) Given that the resistance of the frame is 3.0 Ω, calculate the magnitude of the magnetic flux density in the region of the solenoid.

magnetic flux density = ... T [3]

(iii) Describe and explain what would be observed for the frame if it is shifted to the left such that BC is near the edge of the solenoid.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………… [2]

9 **(a)** A strip of clean magnesium ribbon is surrounded by a cylinder of copper gauze, as shown in Fig. 9.1. The copper gauze is maintained at a positive potential of 6.00 V with respect to the magnesium and the metals are connected to an ammeter and resistor R. The work function of magnesium is 2.80 eV and the work function of copper is 5.05 eV.

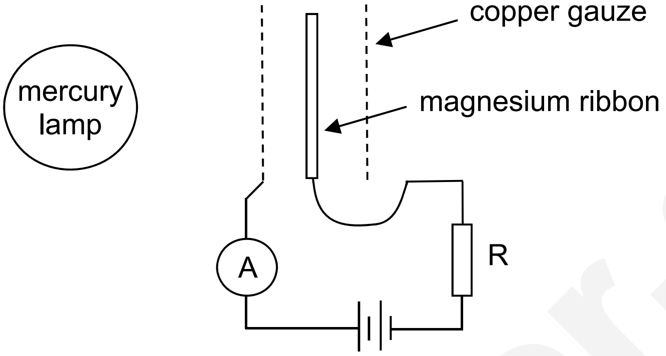


Fig. 9.1

When the magnesium ribbon is illuminated with light of wavelength 254 nm emitted from the mercury lamp, the ammeter detects a current flowing through R.

(i) State the origin of this current.

....

.... [1]

(ii) Calculate the energy of a photon of light of wavelength 254 nm.

energy = ... J [1]

(iii) State and explain what would be observed in the ammeter when each of the following experiments is carried out separately.

1. The mercury lamp is moved further away from the magnesium ribbon.

....

....

.... [2]

2. The mercury lamp is replaced by another lamp which emits light of wavelength 546 nm.

....

....

.... [2]

3. The polarity of the 6.00 V battery is reversed.

....

....

.... [2]

4. The 6.00 V battery is replaced by a 10.0 V battery of the same polarity.

....

....

.... [2]

(b) Hydrogen gases can be placed inside a narrow discharge tube at low pressure, as shown in Fig. 9.2. When high voltage is applied across electrodes A and B, the discharge tube lights up (glow). When the light from the hydrogen gas is examined using a diffraction grating, an emission spectrum line is seen.

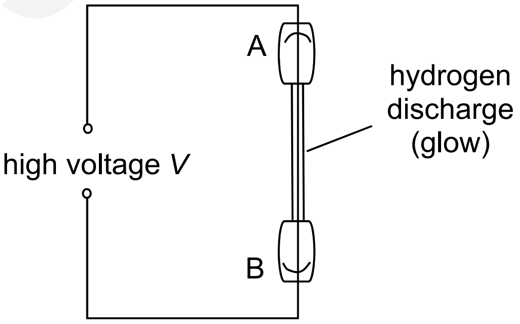


Fig. 9.2

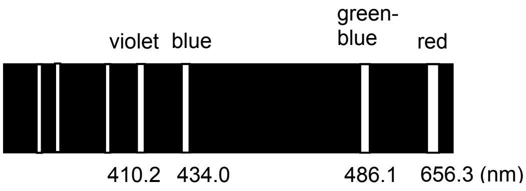


Fig. 9.3

(i) Explain why the discharge lamp lights up when high voltage is applied across it.

....

....

....

.... [3]

(ii) Explain how the emission spectrum lines provide evidence for discrete energy levels in atom.

....

....

....

.... [3]

(iii) Fig. 9.4 shows the lowest electron energy level of a hydrogen atom that gives rise to the Balmer series.

By using the values given in Fig. 9.3, complete the partial electron energy level diagram in Fig. 9.4. Show your calculations clearly.

Fig. 9.4

[4]

End of paper

PJC Answers to JC2 Preliminary Examination Paper 2 (H1 Physics)

Suggested Solutions:

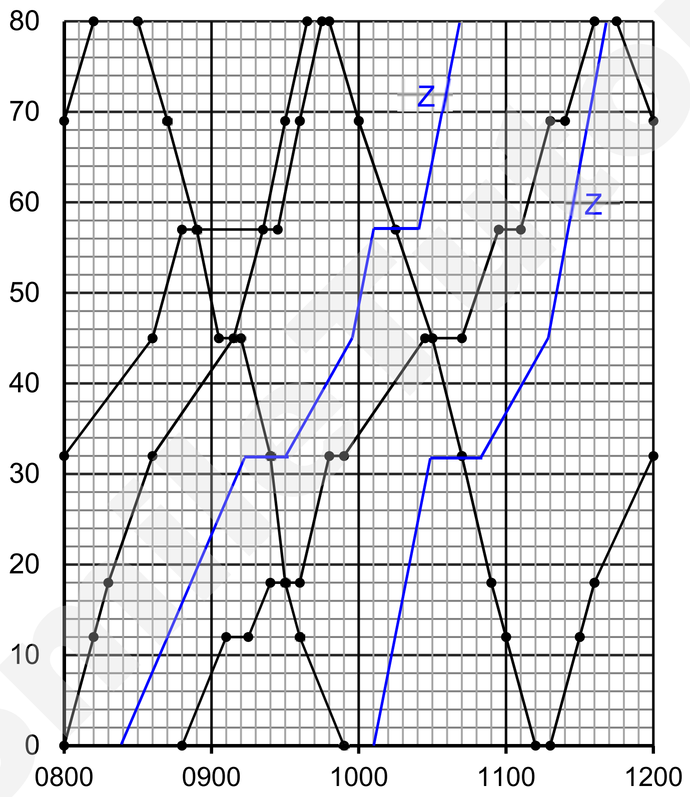
No.	**Solution**	**Remarks**
1(a)(i)	$v^2 = u^2 + 2as$ $= 2as$ $= 2(9.81)(2.0)$ $= 39.24 \text{ m}^2 \text{ s}^{-2}$ $v = 6.3 \text{ m s}^{-1}$	[1] for correct substitution [1] for correct answer
1(a)(ii)1.	$p_{\text{final}} = 0.050(0.70)(6.264)$ $= 0.22 \text{ kg ms}^{-1}$	[1] for substitution [1] for answer
1(a)(ii)2.	Take upwards as positive $\lvert\text{average resultant force}\rvert = \dfrac{\lvert\Delta p\rvert}{\Delta t}$ $= \dfrac{0.050(0.70)(6.264) - [-(0.05)6.264]}{0.1}$ $= 5.3246 \text{ N}$ $N - mg = 5.3246$ $N = 5.3246 + 0.05(9.81)$ $= 5.82 \text{ N}$	[1] for correct resultant force [1] for correct contact force
1(b)(i)	Take upwards as positive. $s_y = u_y t + \frac{1}{2} a_y t^2$ $9.0 = (17 \sin 60°)t + \frac{1}{2}(-9.81)t^2$ $t = 0.855 \text{ s (rejected) or } t = 2.1468 \text{ s}$ $= 2.1 \text{ s (2 s.f.)}$	[1] for correct substitution [1] for correct answer
1(b)(ii)	$s_x = u_x t$ $x = (17 \cos 60°)(2.1468)$ $= 18.248 \text{ m}$ $= 18 \text{ m}$	[1] for correct substitution and answer
2(a)(i)	The centre of gravity of a body is the single point at which the entire weight of the body can be considered to act.	[1]
2(a)(ii)	The torque of a couple is the turning effect of the couple, equal to the product of either force and the perpendicular distance between their lines of action.	[1]

No.	Solution	Remarks
2(b)(i)	$T(2.8) = (600)(1.4\sin 50°) + (4000)(2.8\sin 50°)$ $T = 3294\ \text{N}$ $T \approx 3300\ \text{N}$	[1] for correct substitution [1] for correct answer
2(b)(ii)	The force acting on the beam at Q has a leftward component. The other forces acting on the beam have no horizontal component. Therefore, a force at P that has a rightward component is required, in order to keep the beam in equilibrium.	[1] [1]
3(a)	Light waves are transverse waves	[1]
3(b)	Let amplitude of light that emerges from R be A_R. $A_R = A\cos(30°)\cos(45° - 30°)$ $= 0.84A$	[1] for correct substitution [1] for correct answer
3(c)	Let intensity of light that emerges from R be I_R. $I = kA^2$ $I_R = kA_R^2$ $= k\left(0.8365A\right)^2$ $= 0.70kA^2$ $= 0.70I$	[1] for correct substitution [1] for correct answer
4(a)	$\Delta x = \dfrac{\lambda D}{a}$ $1.7 \times 10^{-2} = \dfrac{\lambda(1.2)}{\left(0.030 \times 10^{-3}\right)}$ $\lambda = 4.25 \times 10^{-7}\ \text{m}$	[1] for correct substitution (conversion) [1] correct answer
4(b)(i)	The fringe separation will increase (by a factor of two), and the brightness will decrease, contrast will decrease.	[1] for fringe separation [1] for constrast
4(b)(ii)	In comparison, red light as a longer wavelength, therefore the fringe separation will increase, but there will be no change in brightness, hence contrast remains the same.	[1] for fringe separation [1] for constrast
4(b)(iii)	The light source is initially unpolarised. With the polariser, the light that passes through will be polarised in a single plane, hence the brightness of the fringe will be lower hence contrast will decrease, no change in fringe separation.	[1] for fringe separation [1] for contrast

<table>
<tr><th>No.</th><th>Solution</th><th>Remarks</th></tr>
<tr><td>5(a)</td><td>V_1 measures the terminal p.d. of the cell. It takes into account the potential drop across the internal resistance of the cell. Hence, V_1 is lower than the e.m.f. of the cell ($V = E - Ir$).</td><td>[1]</td></tr>
<tr><td>5(b)</td><td>In the dark, resistance of LDR = 800 Ω
$\text{voltmeter reading} = \left(\frac{800}{800+200+0.50}\right)10 = 8.0\text{ V}$</td><td>[1] Correct equation and substitution</td></tr>
<tr><td>5(c)</td><td>In daylight, resistance of LDR = 160 Ω
Let R_1 be the effective resistance across the 200 Ω resistor and R.
$\left(\frac{160}{R_1+160+0.50}\right)10 = 8.0\text{ V}$
$R_1 = 39.5\Omega$
$R_1 = \left(\frac{1}{R}+\frac{1}{200}\right)^{-1}$
$39.5 = \left(\frac{1}{R}+\frac{1}{200}\right)^{-1}$
R = 49.2 Ω</td><td>[1] For correct R_1
[1] Correct substitution
[1] Correct final answer</td></tr>
<tr><td>6(a)</td><td>Trains S and X</td><td>[1] for correct answer</td></tr>
<tr><td>6(b)</td><td>
<table>
<tr><td>Station</td><td>H</td><td>departure time</td><td>0830 h</td></tr>
<tr><td>Station</td><td>E</td><td>arrival time</td><td>0903 h</td></tr>
<tr><td></td><td></td><td>departure time</td><td>0912 h</td></tr>
<tr><td>Station</td><td>A</td><td>arrival time</td><td>0954 h</td></tr>
</table>
</td><td>[1] for any 3 correct answers
[2] for all correct answers</td></tr>
<tr><td>6(c)(i)</td><td>Stations D and C</td><td>[1] for correct answer</td></tr>
<tr><td>6(c)(ii)</td><td>Distance between stations D and C
= 14 km
= 14000 m

Time taken
= 6 min
= 360 s

Speed
$= \frac{\text{distance}}{\text{time}}$
$= \frac{14000}{360}$
$= 38.9$
$\approx 39\text{ m s}^{-1}$</td><td>[1] for correct final answer</td></tr>
</table>

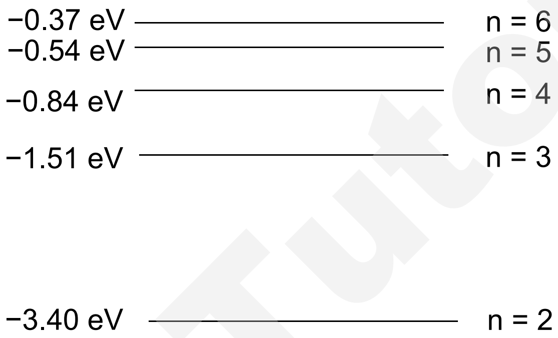
No.	Solution	Remarks
6(d)	The terrain gradient between stations D and E could be steep. Hence, trains travelling upslope from station D and station E go slower than those travelling downslope from station E to station D.	[1] for correct answer Accept any other logical reasoning
6(e)		[1] for correct answer Accept any possible lines Z
7(a)	Gravitational potential energy - Energy possessed by a mass due to its position in a gravitational field Elastic potential energy - Energy stored as a result of deformation of a solid	[1] [1]
7(b)(i)	$k = \dfrac{F}{x} = \dfrac{2.3}{(6.0 - 1.0) \times 10^{-2}} = 46\ \text{N m}^{-1}$	[1] for correct substitution [1] for correct answer

No.	Solution	Remarks
7(b)(ii)1.	Magnitude of change in GPE $=(2.3)(2.0\times10^{-2})$ $=0.046\text{ J}$	[1] for correct substitution [1] for correct answer
7(b)(ii)2.	Magnitude of change in EPE $=\frac{1}{2}(1.4+2.3)(2.0\times10^{-2})$ $=0.037\text{ J}$ OR Magnitude of change in EPE $=\frac{1}{2}(46)(5.0\times10^{-2})^2-\frac{1}{2}(46)(3.0\times10^{-2})^2$ $=0.0368\text{ J}$ $\approx0.037\text{ J}$	[1] for correct substitution [1] for correct answer
7(b)(iii)	There is work done by hand to increase the total energy of the system of load and spring.	[1]
7(c)(i)1.	Change in KE $=\frac{1}{2}\left(\frac{790}{9.81}\right)\left(4.6^2-2.4^2\right)$ $=620.1\text{ J}$ $\approx620\text{ J}$	[1] for correct substitution [1] for correct answer
7(c)(i)2.	Distance travelled up inclined road $=\frac{1}{2}(2.4+4.6)(6.00)$ $=21\text{ m}$ Vertical height $=21\sin7.8^\circ$ $=2.85\text{ m}$ $\approx2.9\text{ m}$	[1] for correct substitution [1] for correct substitution
7(c)(i)3.	Change in GPE $=790(2.850)$ $=2252\text{ J}$ $\approx2300\text{ J}$	[1] for correct substitution and for correct answer
7(c)(i)4.	Work done by cyclist = Gain in KE + Gain in EPE + Work done against resistive forces $(550)(6.00)=620.1+2252+\text{Work done against resistive force}$	[1] for correct substitution [1] for correct answer

No.	Solution	Remarks
	Work done against resistive force $= 427.9\ \text{J} \approx 430\ \text{J}$	
7(c)(ii)1.	Friction and viscous force / drag force / air resistance	[1]
7(c)(ii)2.	$P = Fv$ $P = (W\sin\theta + R)v$ $P = [790\sin 7.8° + 15 + (0.90)(4.6^2)](4.6)$ $P = 649.8\ \text{W}$ $P \approx 650\ \text{W}$	[1] for correct *R* [1] for correct $W\sin\theta$ [1] for correct answer
8(a)	The e.m.f. of a source is the amount of energy converted into electrical energy from other forms of energy when a unit charge passes through it. The p.d. between two points in a circuit is the amount of electrical energy converted into other forms of energy when a unit charge flows through the two points.	[1] for correct description of e.m.f. [1] for correct description of p.d.
8(b)(i)	$P = I^2R$ $7.0 = I^2(14.0)$ $I = 0.71\ \text{A}$	[1] for correct use of equation [1] for correct answer
8(b)(ii)	$E = I(R + r)$ $= 0.71(14.0 + 3.0)$ $= 12.1\ \text{V}$	[1] for correct use of equation [1] for correct answer
8(b)(iii)	$Q = IEt$ $= (0.71)(12.1)(60 \times 10)$ $= 5150\ \text{J}$	[1] for correct use of equation [1] for correct answer
8(c)	$R = 3.0\ \Omega$	[1] for correct answer
8(d)	When *R* is smaller than *r*, a higher percentage of the power supplied by the battery is dissipated in the internal resistance. As *R* increases, the power dissipated in the variable resistor increases. However, the current decreases and this results in decreasing power dissipated in the variable resistor when *R* exceeds the value of *r*.	[1] for explanation of power dissipated when *R* is lower than *r* [1] for explanation of power dissipated when *R* is higher than *r*

No.	Solution	Remarks
8(e)	When $r = 0,\ P = \frac{V^2}{R}$ 	[1] for correct shape of graph
8(f)(i)	The magnetic field is directed towards the left. A magnetic force must be acting downwards on BC which causes a clockwise moment about the pivots therefore the rider is placed to provide a counter moment to keep the frame horizontal. Hence, using Fleming's left hand rule, with the current flowing from B to C and force downwards, the magnetic field is directed towards the left.	[1] for correct direction of B field [1] for correct explanation of magnetic force [1] for applying Fleming's left hand rule
8(f)(ii)	$I = \frac{12.1}{3.0 + 3.0} = 2.02$ A By principle of moments, $F(0.20) = (3.0 \times 10^{-3})(9.81)(0.048)$ $F = 7.06 \times 10^{-3}$ N $F = BIL$ $7.06 \times 10^{-3} = B(2.02)(0.080)$ $B = 0.0437$ T	[1] for calculation of current [1] for applying principle of moments [1] for correct calculation of *B*
8(f)(iii)	The magnetic flux density near the edge of the solenoid is lower hence the magnetic force acting on BC is smaller. This will result in a net anticlockwise moment and the side BC of the frame will tilt upwards.	[1] for correct observation [1] for correct explanation

No.	Solution	Remarks
9(a)(i)	The current is due to the flow of photoelectrons, which are emitted from magnesium metal surface.	[1]
9(a)(ii)	$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34}(3 \times 10^{8})}{254 \times 10^{-9}} = 7.83 \times 10^{-19}\text{J}$	[1]
9(a)(iii) 1.	When the lamp is moved further away, the intensity of the light reaching the metal plate decreases. Since intensity is inversely proportional to the square of the distance apart. The number of photons per unit time reaching the plate decreases. Hence the number of photoelectrons emitted per unit time decreases. The current reading in the ammeter decreases.	[1] intensity related to no. of photons per unit time. [1] Current reading decreases
9(a)(iii) 2.	$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34}(3 \times 10^{8})}{546 \times 10^{-9}} = 2.27$ eV Photon of wavelength 546 nm has energy 2.27 eV. The photon energy is less than the work function of magnesium. Hence, there is no emission of photoelectrons. The ammeter reads zero value.	[1] less than work function of magnesium [1] Meter reads zero value (with correct explanation)
9(a)(iii) 3.	$hf = \Phi + eV_s$ $V_s = \frac{hf - \Phi}{e} = 4.89 - 2.80 = 2.09\text{V}$ When the battery is reversed, a 6.0 V reverse potential difference is applied across the plates. A reverse potential difference of 2.09 V would stop all photoelectrons. Hence, no photoelectrons reach the copper. The ammeter reads zero value.	[1] 6.0 V reverse potential difference is more than the stopping potential [1] Meter reads zero value (with correct explanation)
9(a)(iii) 4.	The ammeter reading remains unchanged. Even at a lower voltage of 6.00 V, all photoelectrons are absorbed by the copper gauze (saturation current reached). Therefore, the current in the circuit is only affected by the intensity of the light reaching the plates and not potential difference between the plate and gauze, for photons of fixed wavelength. Hence the current remains unchanged.	[2] Meter reading unchanged(with correct explanation)
9(b)(i)	Hydrogen gaseous atoms are excited through collisions with electrons from electrical discharge through the gas. The electrical discharge occurs due to the high potential difference between A and B. The electrons are excited to higher energy levels, which are unstable. The electrons transits to lower levels and energy is	[1] [1] [1]

No.	Solution	Remarks
	given off in the form of electromagnetic radiation, as photons. The discharge lamp lights up due to the emission of photons. Note: The energy of the emitted photon is equal to the difference between the energy levels.	
9(b)(ii)	Only specific frequencies of light produce lines in the emission spectrum of isolated atoms. Since light consists of photons, this means that only specific energies are emitted by the atoms, which suggests that there are fixed energy transitions between discrete energy levels responsible for the production of such photons.	[1] [1] [1]
9(b)(iii)	 Workings: For 656.3 nm, $\Delta E_1 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^8)}{656.3\times10^{-9}} = 1.89\text{ eV}$ For 486.1 nm, $\Delta E_2 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^8)}{486.1\times10^{-9}} = 2.56\text{ eV}$ For 434.0 nm, $\Delta E_3 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^8)}{434\times10^{-9}} = 2.86\text{ eV}$ For 410.2 nm, $\Delta E_4 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^8)}{410.2\times10^{-9}} = 3.03\text{ eV}$	[1] 5 energy levels of decreasing energy gap as energy increases. [1] Correct substitution into $E = \frac{hc}{\lambda}$ [2] Correct energy levels values

SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME

CG **INDEX NO.**

PHYSICS 8866/01

Preliminary Examination **21st Sep 2017**
Paper 1 Multiple Choice **1 hour**

Additional Materials: OMS.

READ THIS INSTRUCTIONS FIRST

Write your name, civics group and index number in the spaces at the top of this page.

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions in this section. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

For Examiners' Use	
MCQ	/ 30

This document consists of **17** printed pages and **3** blank pages.

DATA AND FORMULAE

Data

speed of light in free space, $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$

elementary charge, $e = 1.60 \times 10^{-19}\ \text{C}$

the Planck constant, $h = 6.63 \times 10^{-34}\ \text{J s}$

unified atomic mass constant, $u = 1.66 \times 10^{-27}\ \text{kg}$

rest mass of electron, $m_e = 9.11 \times 10^{-31}\ \text{kg}$

rest mass of proton, $m_p = 1.67 \times 10^{-27}\ \text{kg}$

acceleration of free fall, $g = 9.81\ \text{m s}^{-2}$

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$
$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

Answer all questions.

1 Four students conducted an experiment to determine the value of *g*, acceleration of free fall. The values obtained by the students are as shown in the table.

Student	g_1 / m s^{-2}	g_2 / m s^{-2}	g_3 / m s^{-2}	g_4 / m s^{-2}
P	9.40	9.80	9.55	9.65
Q	9.80	9.60	9.90	10.06
R	10.10	9.90	10.15	9.85
S	9.45	9.48	9.52	9.55

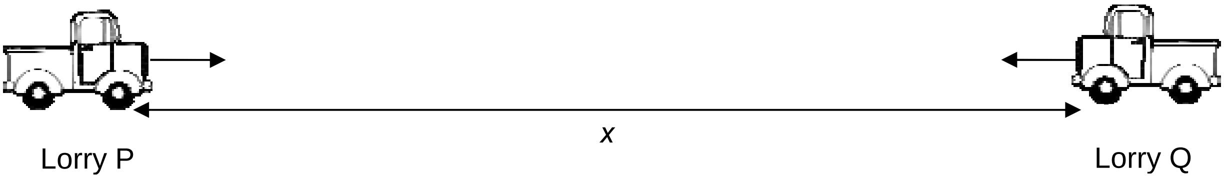
If the correct value of g is 9.82 m s^{-2}, which of the students has/have the largest systematic and random errors in their experiments?

	Largest systematic error	Largest random error
A	Q	S
B	S	Q
C	Q	P
D	P	Q

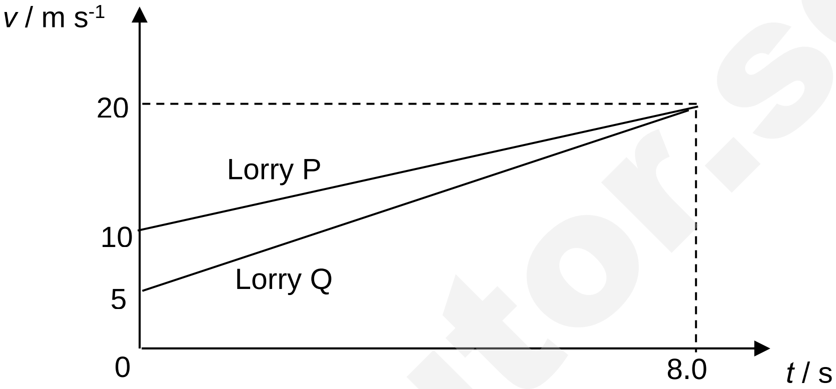
2 A changing magnetic flux Φ can induce an e.m.f. *E* in a coil given by $E = -\frac{d\Phi}{dt}$. What are the base units of magnetic flux ?

A m s^{-2} A^{-1} **B** m s^{-1} A **C** kg m s^{-2} A^{-1} **D** kg m^{2} s^{-2} A^{-1}

3 Lorry P and Lorry Q are initially at a distance *x* metres apart and are travelling in the opposite directions as shown below.



The graph shows the variation with time *t* of the speeds *v* of Lorry P and Lorry Q respectively.

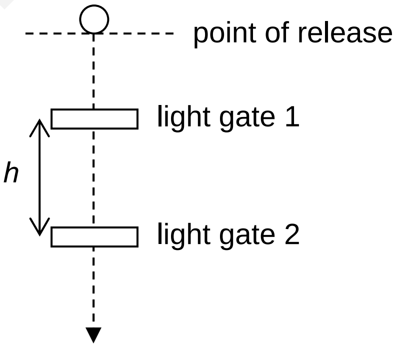


At t = 8.0 s, the two lorries are 40 m apart. What is x?

A 60 m **B** 120 m **C** 220 m **D** 260 m

4 To determine the acceleration of free fall, a steel ball is dropped above two light gates as shown.

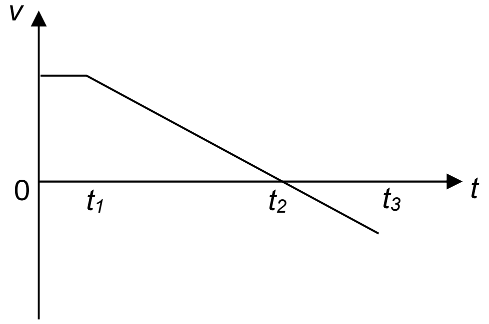
The ball passes light gates 1 and 2 at times t_1 and t_2 respectively after release.



What is the acceleration of free fall?

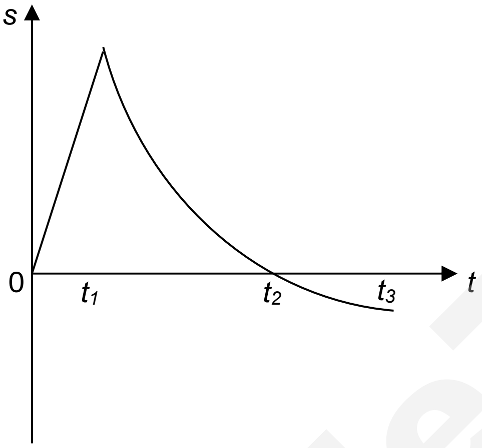
A $\dfrac{2h}{(t_2 - t_1)}$ **B** $\dfrac{2h}{(t_2^2 - t_1^2)}$ **C** $\dfrac{2h}{(t_2 - t_1)^2}$ **D** $\dfrac{2h}{\left(\dfrac{t_2 + t_1}{2}\right)^2}$

5 The graph shows how the speed *v* of an object varies with time *t*.

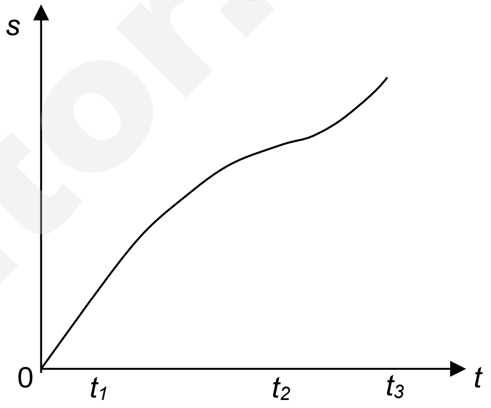


Which graph represents the variation the displacement *s* travelled by the object with time *t*?

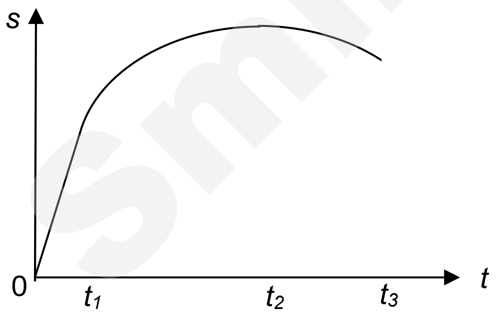
A



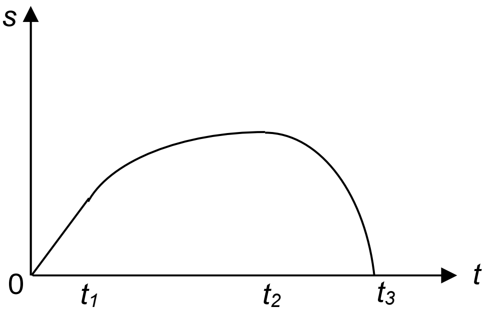
B



C



D



6 A jet of water of density 1000 kg m^{-3} leaves the nozzle of a hose of radius 2.0×10^{-2} m. The water is directed perpendicularly to the wall at a speed of 0.50 m s^{-1}. Assume that the water does not rebound.

What is the force exerted on the wall by the water?

A 0.314 N **B** 0.628 N **C** 1.27 N **D** 15.7 N

7 An astronaut falls vertically from a space vehicle and hops on the moon. The following statements are about the forces acting while the astronaut is in contact with the surface of the moon.

Which statement is correct?

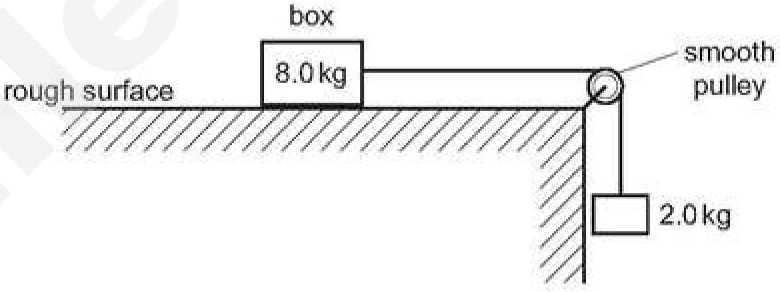
A The force that the astronaut exerts on the moon is always equal to the weight of the astronaut.

B The force that the astronaut exerts on the moon is always less than the weight of the astronaut.

C The weight of the astronaut is always equal in magnitude and opposite in direction to the force that the moon exerts on the astronaut.

D The force that the astronaut exerts on the moon is always equal in magnitude and opposite in direction to the force the moon exerts on the astronaut.

8 A box of mass 8.0 kg rests on a horizontal, rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.

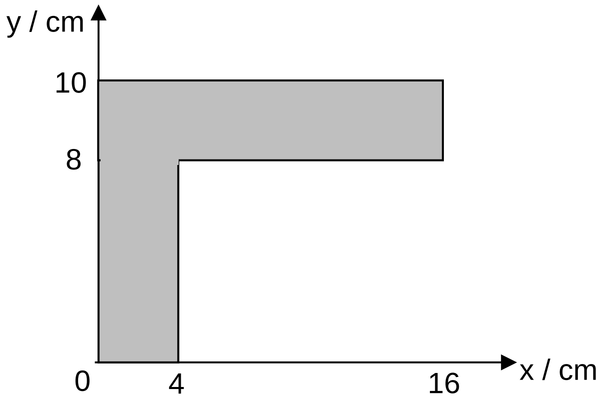


When the box is released, a friction force of 6.0 N acts on it.

What is the acceleration of the box?

A 1.4 m s^{-2} **B** 1.7 m s^{-2} **C** 2.0 m s^{-2} **D** 2.5 m s^{-2}

9 A uniform L-shape object of dimensions in centimetres is placed on a Cartesian plane as shown.



What is the location of the centre of mass of the object in the x-direction?

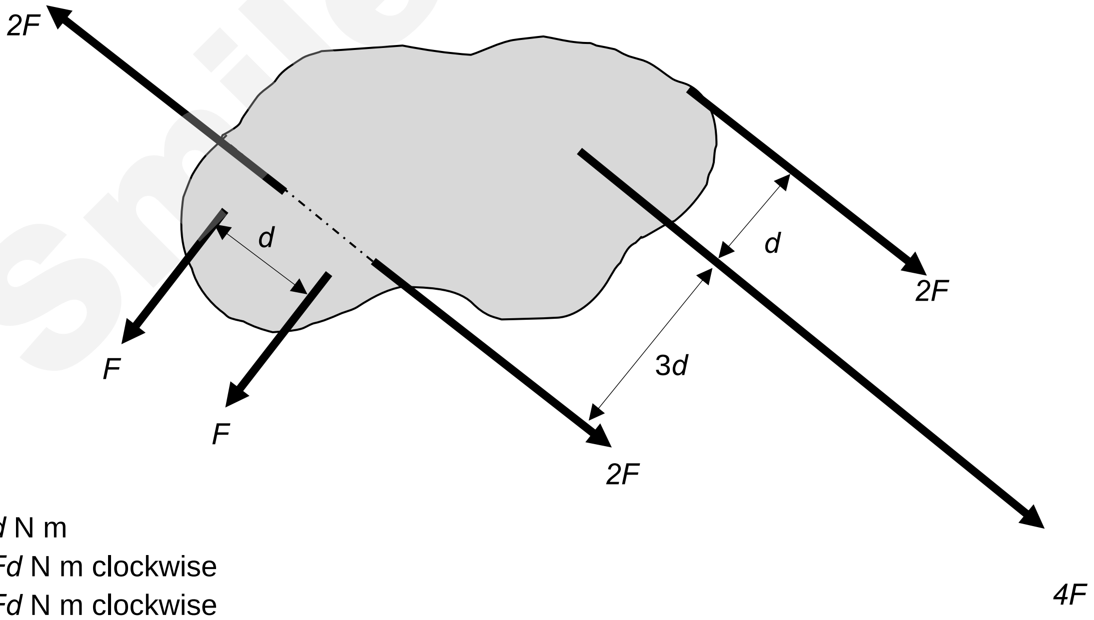
A 2.0 cm **B** 3.5 cm **C** 5.0 cm **D** 8.0 cm

10 A spring of negligible mass has a spring constant of 1600 N m^{-1}. The spring is placed vertically on the floor. A 1.20 kg book is then dropped onto the spring from a height of 0.80 m above the top of the spring.

What is the maximum distance in which the spring will be compressed?

A 0.0117 m **B** 0.0119 m **C** 0.108 m **D** 0.116 m

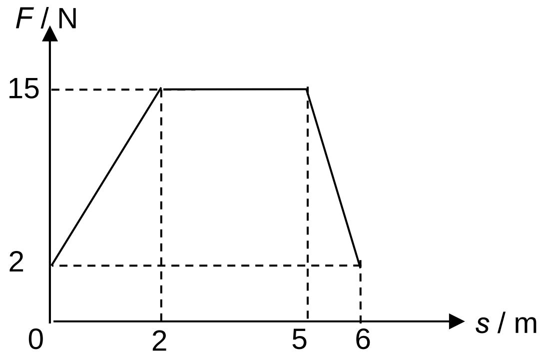
11 There are many forces acting on the flat object as shown. Amongst the forces, there exists a couple. What is the torque of the couple?



A *Fd* N m
B 6*Fd* N m clockwise
C 8*Fd* N m clockwise
D 24*Fd* N m clockwise

12 A student pushes a box from rest along a rough floor with constant friction of 2.0 N.

The graph shows the variation of the force exerted by the student on the box with displacement.

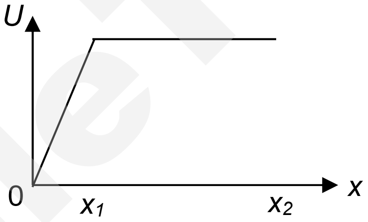


The final speed of the box after travelling 6 m is 5.0 m s^{-1}.

What is the mass of the box?

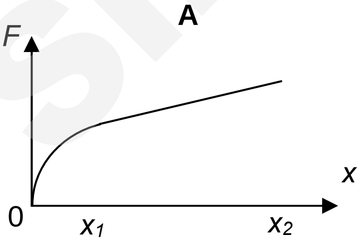
A 4.68 kg **B** 5.64 kg **C** 23.4 kg **D** 28.2 kg

13 The graph how the potential energy *U* of an object varies with displacement x.

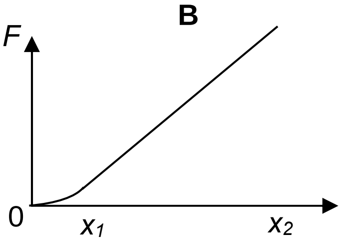


Which of the following graphs represents the variation of force acting on the object with displacement *x*?

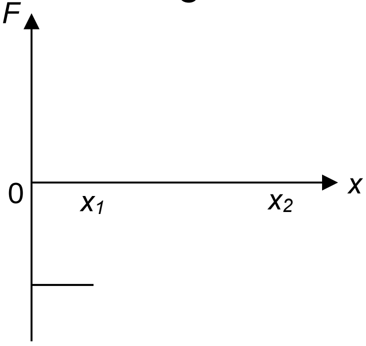
A



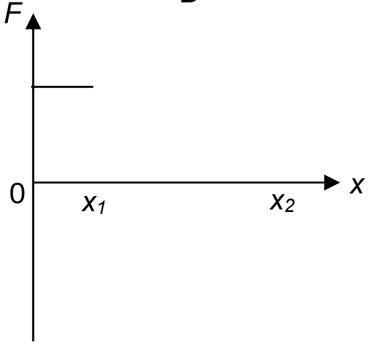
B



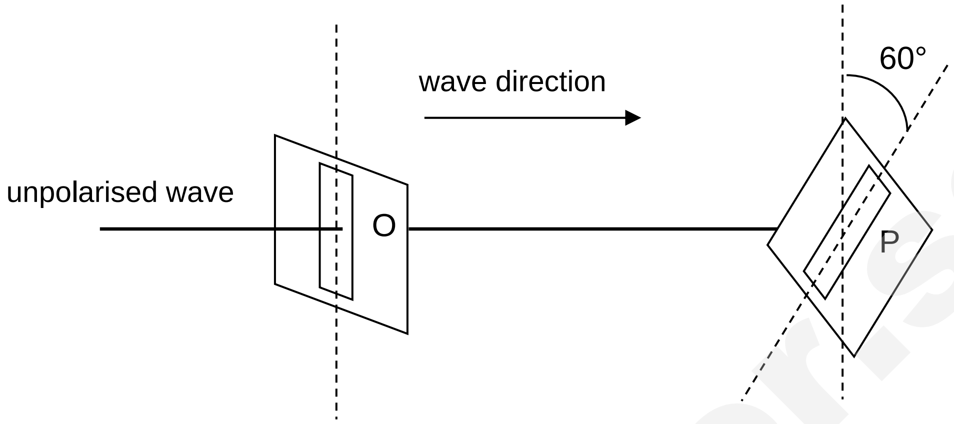
C



D



14 An unpolarised wave passes through polariser O such that the emerging wave is plane-polarized with an intensity of 2.0 W m^{-2}. A second polariser P is placed further such that the plane-polarised wave is incident normally on it. Polariser P is rotated clockwise by an angle of 60°.

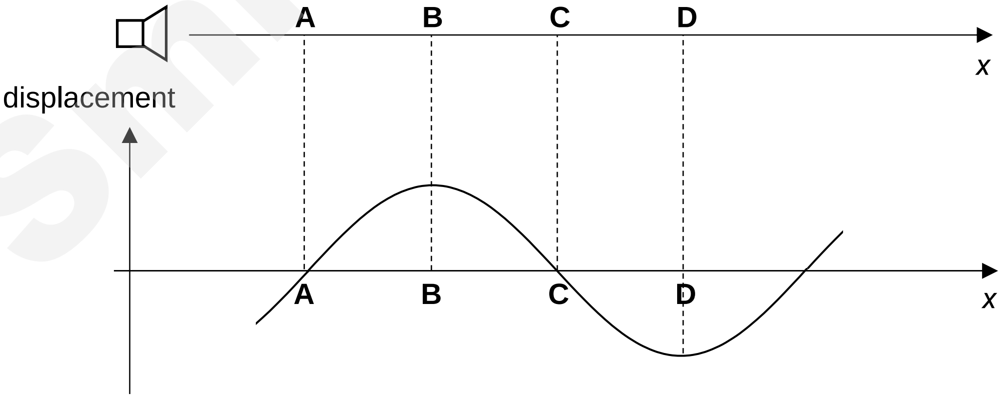


What is the intensity of the wave after passing through polariser P ?

A 0.25 W m^{-2} **B** 0.5 W m^{-2} **C** 1.0 W m^{-2} **D** 2.0 W m^{-2}

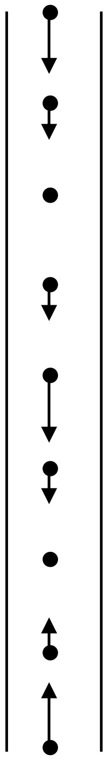
15 The figure shows a loudspeaker which emits a sound of constant frequency. The graph shows the displacements of the air particles from their undisturbed positions at one instant in time along *x*. Direction to the right is taken as positive.

At which of the four points A, B, C, D is the instantaneous pressure at its minimum value?

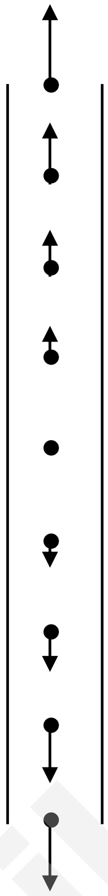


16 The arrows on the diagrams represent the movement of the air molecules in a pipe, opened at both ends, in which a stationary longitudinal wave has been set up. The length of each arrow represents the amplitude of the motion.
Which diagram shows a possible stationary wave in which there are two displacement nodes and three displacement antinodes?

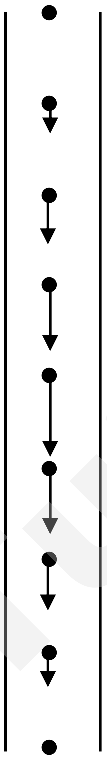
A



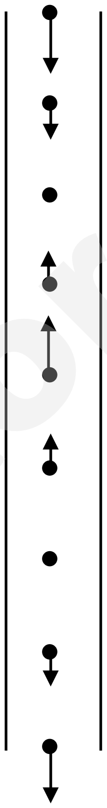
B



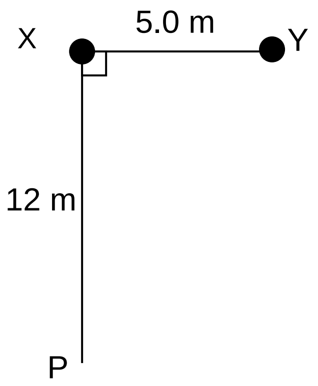
C



D



17 Water waves of wavelength 2.0 m are produced by two generators X and Y, placed 5.0 m apart and operating in phase. A point P is 12 m from X as shown below.



With generator X switched off, the intensity at P due to Y alone is I_o. With generator Y switched off, the intensity at P due to X alone is $4I_o$. When both generators are switched on, what is the intensity at P?

A I_o **B** $3I_o$ **C** $5I_o$ **D** $9I_o$

18 Which two phenomena show appropriate experimental evidence for the wave nature and the particulate nature of electromagnetic radiation?

	wave nature	**particulate nature**
A	photoelectric effect	diffraction
B	interference	photoelectric effect
C	interference	diffraction
D	diffraction	interference

19 A generator, with output power *P* and output voltage *V*, is connected to a factory by cables of total resistance *R*.

What is the power input to the factory?

A P

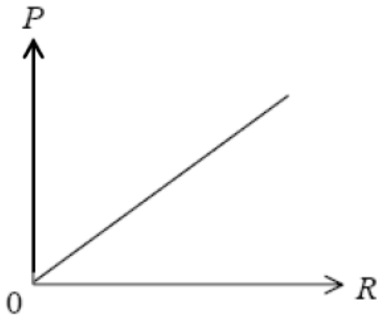
B $P-\left(\frac{P}{V}\right)^2 R$

C $P-\left(\frac{P}{V}\right)^2 \frac{R}{2}$

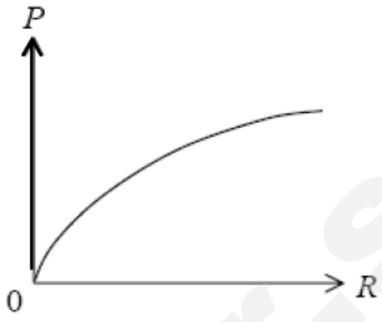
D $\left(\frac{P}{V}\right)^2 R$

20 A d.c. supply of constant e.m.f. and internal resistance is connected to a variable resistor of resistance *R*.
Which of the following graphs best shows how the total power *P* **delivered** by the supply varies with *R*?

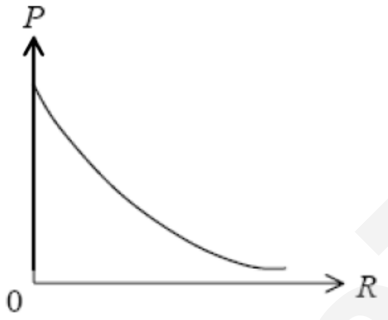
A.



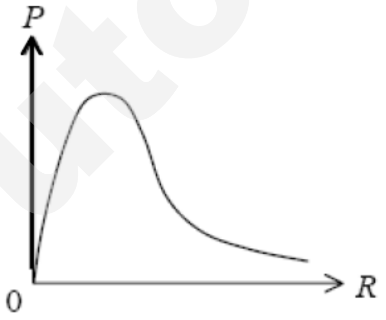
B.



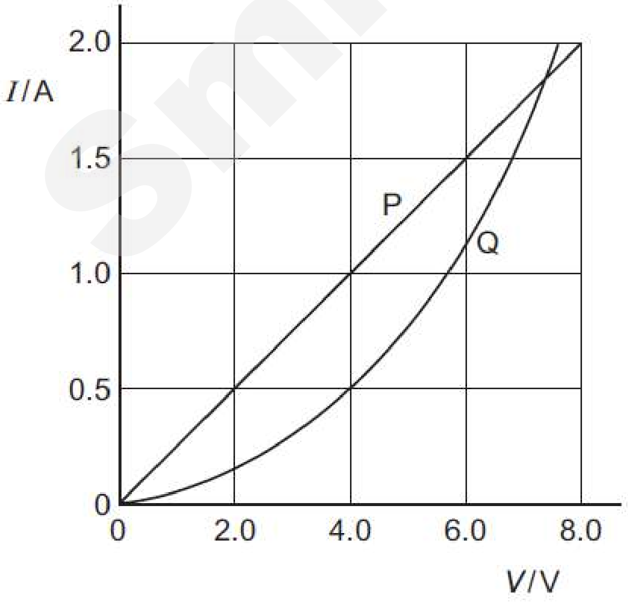
C.



D.



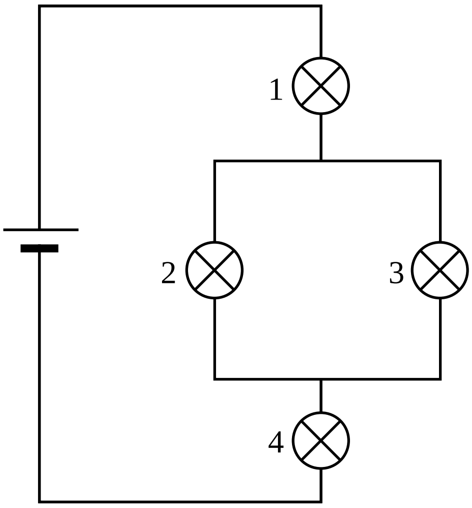
21 The *I*-*V* characteristics of two electrical components P and Q are shown below.



Which statement is correct?

A At 0.5 A the power dissipated in Q is double that in P.
B At 1.9 A the resistance of Q is approximately half that of P.
C The resistance of Q increases as the current in it increases.
D P is a resistor and Q is a filament lamp.

22 An ideal cell and four identical bulbs are connected as shown.

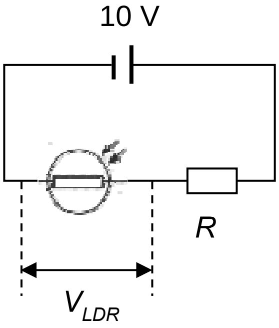


Bulb 3 is removed.

Which of the following describes the changes in the brightness of bulbs 1, 2 and 4?

	Bulb 1	**Bulb 2**	**Bulb 4**
A	dimmer	brighter	brighter
B	dimmer	brighter	dimmer
C	brighter	dimmer	brighter
D	dimmer	dimmer	dimmer

23 A light-dependent resistor (LDR) is connected in series with a fixed resistor of resistance *R* and a cell of e.m.f 10 V, as shown in the diagram below.

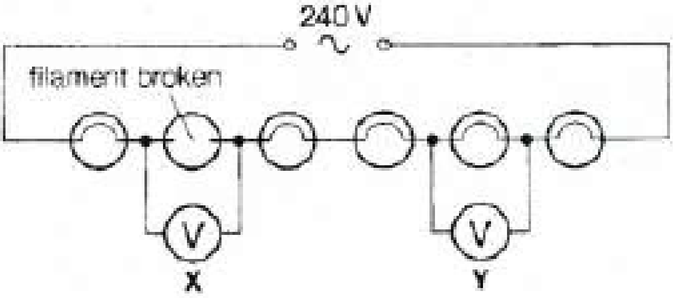


At a particular light intensity, resistance of the LDR is 5.3 Ω and the potential difference V_{LDR} across it is 4.5 V.

What is the value of V_{LDR} if the light intensity is increased and the resistance of the LDR drops to 3.1 Ω?

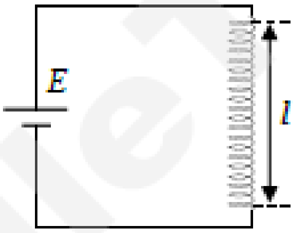
A 1.5 V **B** 2.6 V **C** 3.2 V **D** 3.5 V

24 A mains circuit contains six similar bulbs connected in series.
One of the bulbs has a broken filament.
Voltmeters X and Y of infinite resistance are placed in the circuit shown below.
Which of the following voltmeter readings is correct?

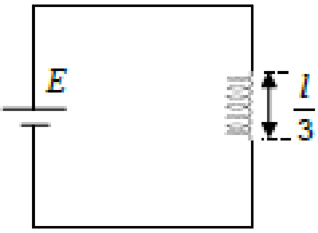


	Voltmeter X	Voltmeter Y
A	0 V	0 V
B	0 V	240 V
C	240 V	240 V
D	240 V	0 V

25 A long solenoid of length *l* is connected to a cell with e.m.f. *E* and negligible internal resistance. The magnetic flux density at the centre of the solenoid is B_s.



The solenoid is subsequently cut to a length of $\frac{l}{3}$ and is reconnected to the same cell as shown below.



The magnetic flux density at the centre of a solenoid is equal to $\mu_0 nI$, where *n* is the number of turns per unit length and *I* is the current through the coil.
What is the magnetic flux density at the centre of the shortened solenoid?

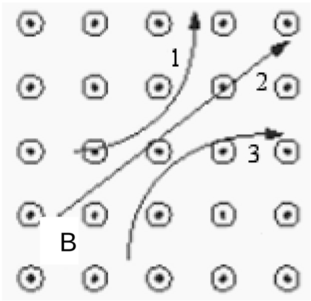
A $\frac{B_s}{3}$

B B_s

C $3B_s$

D $6B_s$

26 Three particles travel through a region of space where the magnetic field is out of the page, as shown in the figure below.



Which statement below about their charges is correct?

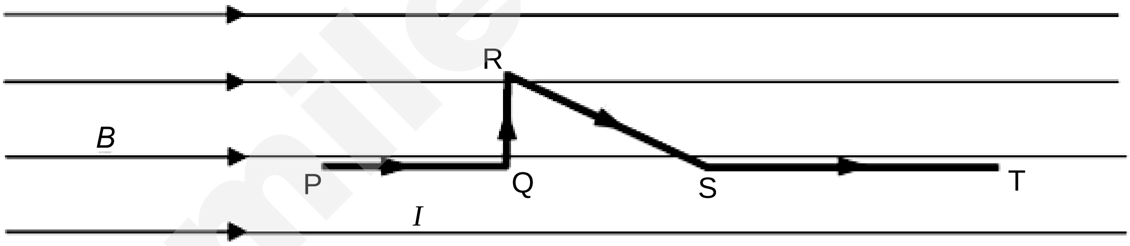
A 1 is negative, 2 is neutral, and 3 is positive.

B 1 is neutral, 2 is negative, and 3 is positive.

C 1 is positive, 2 is negative, and 3 is neutral.

D 1 is positive, 2 is neutral, and 3 is negative.

27 A bent wire PQRST carrying a current I is placed in a magnetic field of flux density B as shown. QR is the shortest and ST is the longest. PQ and RS are equal in length and both are longer than QR.



The forces acting on PQ, QR, RS and ST are given by F_{PQ}, F_{QR}, F_{RS} and F_{ST} respectively.

Which of the following is true?

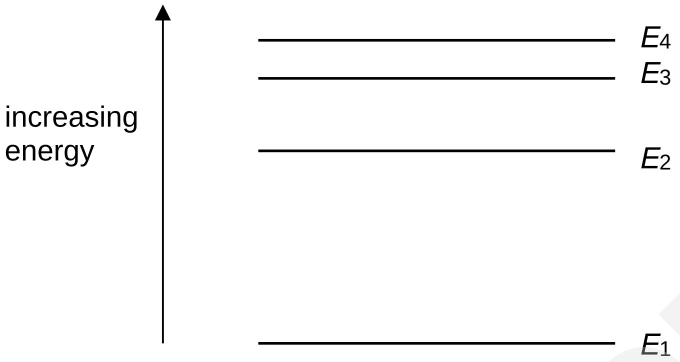
A $F_{QR} \neq F_{RS}$ and $F_{PQ} < F_{ST}$

B $F_{QR} = F_{RS}$ and $F_{PQ} = F_{ST}$

C $F_{QR} > F_{RS}$ and $F_{PQ} < F_{ST}$

D $F_{QR} < F_{RS}$ and $F_{PQ} = F_{ST}$

28 Some of the energy levels of the hydrogen atom are represented in simplified form by the given diagram which has a linear scale. The emission of blue light is associated with the transition of an electron from E_4 to E_2. Which of the following transitions could be associated with the absorption of the red light?



A E_4 to E_1

B E_3 to E_2

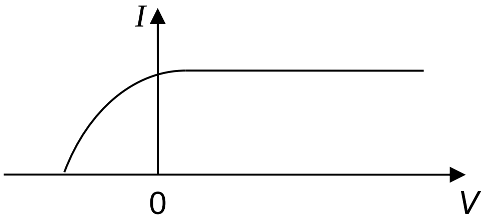
C E_2 to E_3

D E_1 to E_4

29 A particle of mass m has kinetic energy E. Which of the following gives the de Broglie wavelength of the particle?

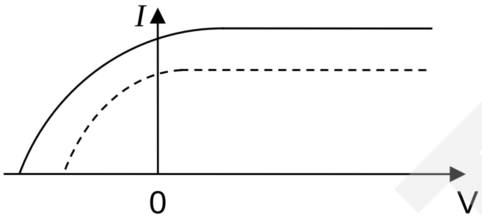
A $h\sqrt{2mE}$ **B** $\frac{\sqrt{2mE}}{h}$ **C** $\frac{h}{\sqrt{mE}}$ **D** $\frac{h}{\sqrt{2mE}}$

30 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photo-electrons which are collected at an adjacent electrode. For a given intensity of light, the way in which the photocurrent I depends on the potential difference V between the electrodes is as shown in the diagram below.

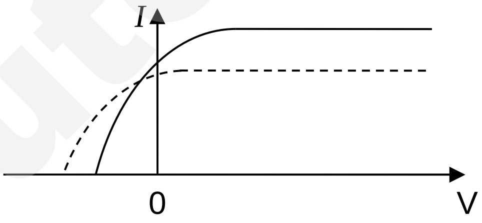


Which of the following graphs shows the result when the intensity of the light is increased? (The solid curve represents the original graph and the dotted curve represents the new graph.)

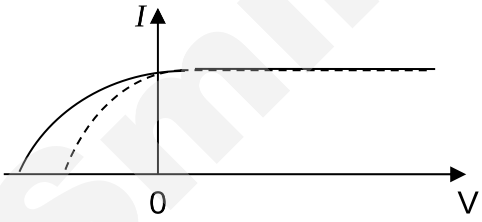
A



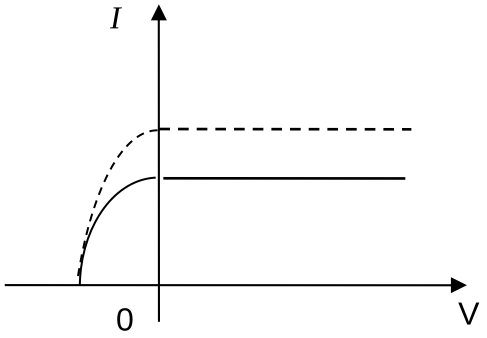
B



C



D



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SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME			
CG		**INDEX NO.**	

PHYSICS 8866/01

Preliminary Examination **21st Sep 2017**
Paper 1 Multiple Choice **1 hour**

Additional Materials: OMS.

READ THIS INSTRUCTIONS FIRST

Write your name, civics group and index number in the spaces at the top of this page.

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions in this section. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the OMS.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

For Examiners' Use	
MCQ	/ 30

This document consist of **22** printed pages.

DATA AND FORMULAE

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2} at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	ρgh
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Answer all questions.

1 Four students conducted an experiment to determine the value of *g*, acceleration of free fall. The values obtained by the students are as shown in the table.

Student	g_1 / m s^{-2}	g_2 / m s^{-2}	g_3 / m s^{-2}	g_4 / m s^{-2}
P	9.40	9.80	9.55	9.65
Q	9.80	9.60	9.90	10.06
R	10.10	9.90	10.15	9.85
S	9.45	9.48	9.52	9.55

If the correct value of g is 9.82 m s^{-2}, which of the students has/have the largest systematic and random errors in their experiments?

	Largest systematic error	Largest random error
A	Q	S
B	S	Q
C	Q	P
D	P	Q

Ans : B

Student	Mean	Range
P	9.60	0.4
Q	9.84	0.46 (biggest range)
R	10.0	0.3
S	9.50 (biggest diff to correct value of 9.82 m s $^{-2}$)	0.1

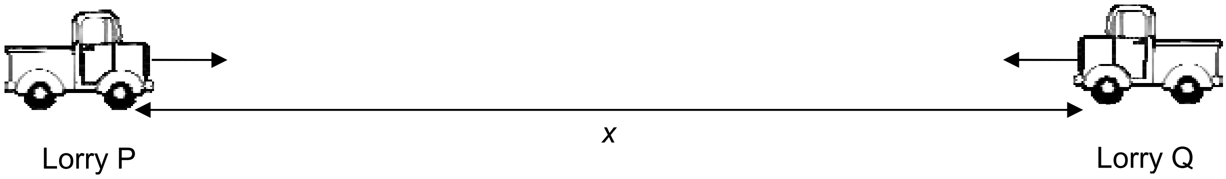
2 A changing magnetic flux Φ can induce an e.m.f. *E* in a coil given by $E = -\frac{d\Phi}{dt}$. What are the base units of magnetic flux ?

A m s^{-2} A^{-1} **B** m s^{-1} A **C** kg m s^{-2} A^{-1} **D** kg m^2 s^{-2} A^{-1}

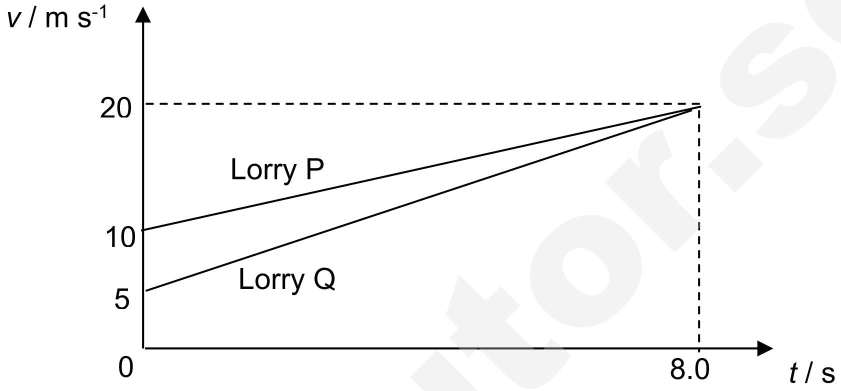
Ans : D

Base unit of Φ = [emf][t]
= [P]/[I] x [t]
= [energy]/([t]x[I]) x [t]
= kg m^2 s^{-2} A^{-1}

3 Lorry P and Lorry Q are initially at a distance *x* metres apart and are travelling in the opposite directions as shown below.



The graph shows the variation with time *t* of the speeds *v* of Lorry P and Lorry Q respectively.



At t = 8.0 s, the two lorries are 40 m apart. What is x?

A 60 m **B** 120 m **C** 220 m **D** 260 m

Answer: D

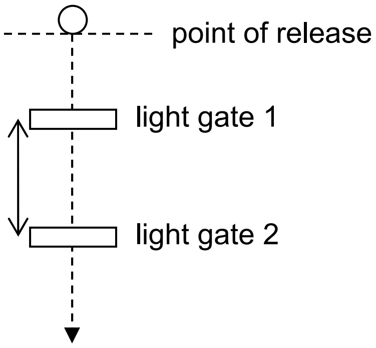
Distance travelled by Lorry P + Distance travelled by Lorry Q + 40 = x

$$\frac{1}{2}(10+20)(8.0)+\frac{1}{2}(5+20)(8.0)+40=x$$

$$x=260\text{ m}$$

4 To determine the acceleration of free fall, a steel ball is dropped above two light gates as shown.

The ball passes light gates 1 and 2 at times t_1 and t_2 respectively after release.



What is the acceleration of free fall?

A $\dfrac{2h}{(t_2-t_1)}$ **B** $\dfrac{2h}{(t_2{}^2-t_1{}^2)}$ **C** $\dfrac{2h}{(t_2-t_1)^2}$ **D** $\dfrac{2h}{\left(\dfrac{t_2+t_1}{2}\right)^2}$

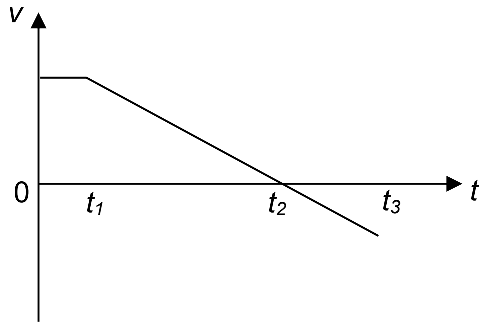
Answer: B

$h = s_2 - s_1$

$= \dfrac{1}{2}gt_2{}^2 - \dfrac{1}{2}gt_1{}^2$ since u = 0

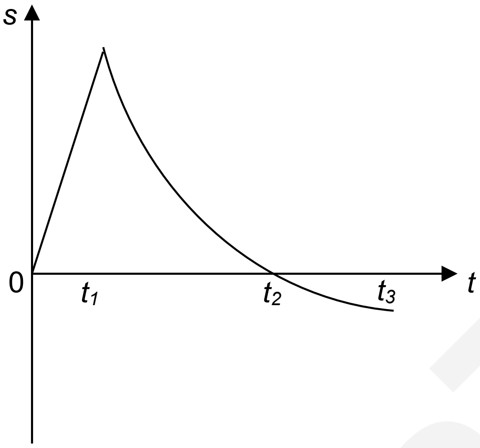
$g = \dfrac{2h}{(t_2{}^2 - t_1{}^2)}$

5 The graph shows how the speed *v* of an object varies with time *t*.

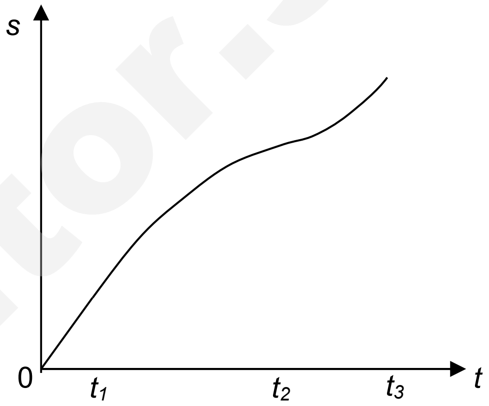


Which graph represents the variation the displacement *s* travelled by the object with time *t*?

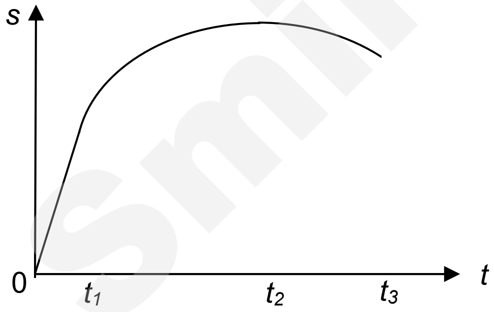
A



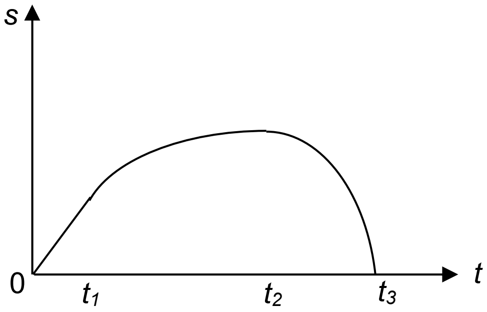
B



C



D



Answer: C
The area under v-t graph represents the change in displacement.

6 A jet of water of density 1000 kg m^{-3} leaves the nozzle of a hose of radius 2.0×10^{-2} m. The water is directed perpendicularly to the wall at a speed of 0.50 m s^{-1}. Assume that the water does not rebound.

What is the force exerted on the wall by the water?

A	0.314 N	**B**	0.628 N	**C**	1.27 N	**D**	15.7 N

Answer: A

$$\text{Force by wall on water} = \langle F_{net} \rangle = \text{mass per unit time} \times \Delta v$$

$$= \frac{m}{\Delta t}\Delta v = \frac{\rho(Vol)}{\Delta t}\Delta v \qquad \text{since } m = \rho(Vol)$$

$$= \frac{\rho \times \pi r^2 L}{t}\Delta v$$

$$= \rho \times \pi r^2 v \Delta v$$

$$= \rho \pi r^2 v(0 - v)$$

$$= -\rho \pi r^2 v^2$$

$$= -1000\pi(2.0 \times 10^{-2})^2(0.50)^2$$

$$= -0.314 \text{ N}$$

By Newton's 3rd Law, Force by water on wall = Force by wall on water = 0.314 N

7 An astronaut falls vertically from a space vehicle and hops on the moon. The following statements are about the forces acting while the astronaut is in contact with the surface of the moon.

Which statement is correct?

A The force that the astronaut exerts on the moon is always equal to the weight of the astronaut.

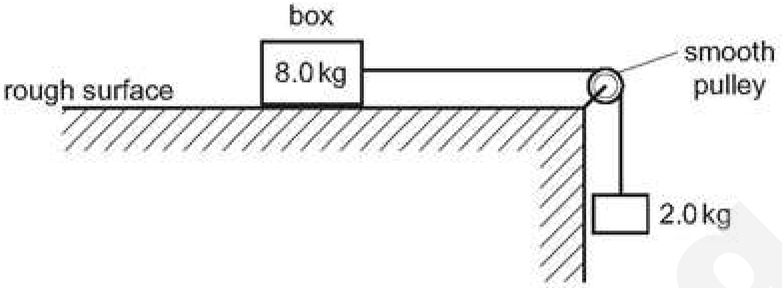
B The force that the astronaut exerts on the moon is always less than the weight of the astronaut.

C The weight of the astronaut is always equal in magnitude and opposite in direction to the force that the moon exerts on the astronaut.

D The force that the astronaut exerts on the moon is always equal in magnitude and opposite in direction to the force the moon exerts on the astronaut.

Answer: D
Newton's third law

8 A box of mass 8.0 kg rests on a horizontal, rough surface. A string attached to the box passes over a smooth pulley and supports a 2.0 kg mass at its other end.

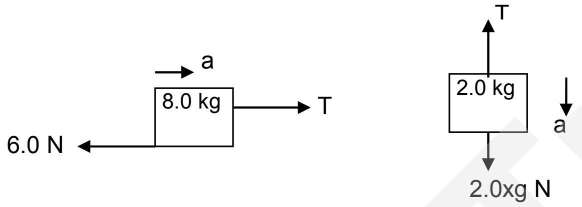


When the box is released, a friction force of 6.0 N acts on it.

What is the acceleration of the box?

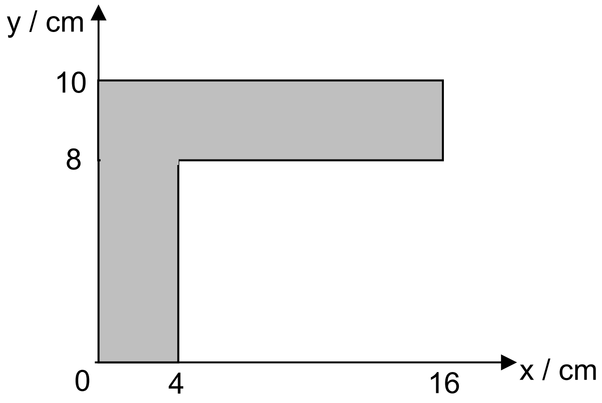
A 1.4 m s^{-2} **B** 1.7 m s^{-2} **C** 2.0 m s^{-2} **D** 2.5 m s^{-2}

Answer: A



2.0 x 9.81 – T = 2.0a ……. (1)
T – 6.0 = 8.0a ……………… (2)
From (1) & (2) a = 1.4 m s^{-2}
OR
2.0 x 9.81 – 6.0 = (2.0 + 8.0)a
a = 1.4 m s^{-2}

9 A uniform L-shape object of dimensions in centimetres is placed on a Cartesian plane as shown.

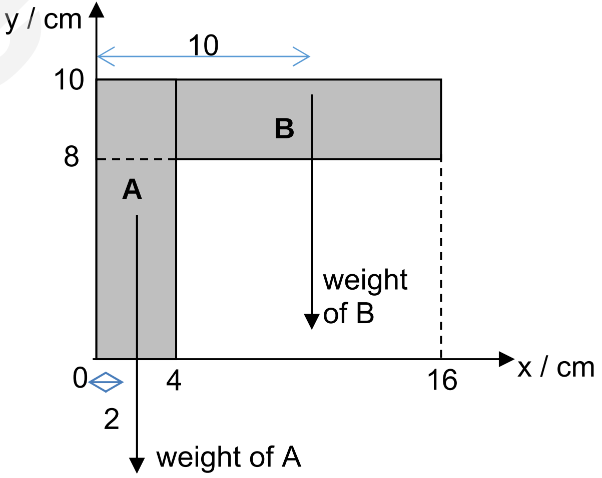


What is the location of the centre of mass of the object in the x-direction?

A 2.0 cm **B** 3.5 cm **C** 5.0 cm **D** 8.0 cm

Answer: C
Consider that the block is made of two parts A and B.
Let *t* be the thickness of the block, *ρ* be the density of the object

Consider the x-direction, taking moment about the origin (0, 0)
Moment due to weight of A + Moment due to weight of B
= Moment due to the weight of the block
$(10 \times 4)(t\,\rho\,g)(2) + (12 \times 2)(t\,\rho\,g)(10) = (10 \times 4 + 12 \times 2)\,t\,\rho\,g\,x$
$x = 5.0$ cm



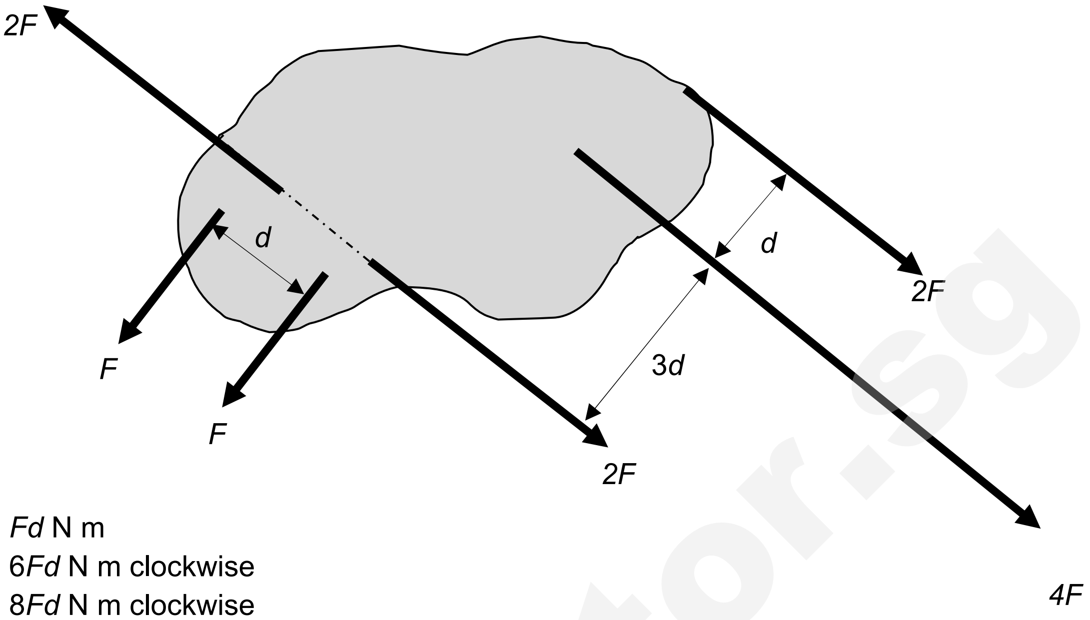
10 A spring of negligible mass has a spring constant of 1600 N m^{-1}. The spring is placed vertically on the floor. A 1.20 kg book is then dropped onto the spring from a height of 0.80 m above the top of the spring.

What is the maximum distance in which the spring will be compressed?

A 0.0117 m **B** 0.0119 m **C** 0.108 m **D** 0.116 m

Answer: D
Loss in GPE = Gain in EPE
$1.20\,(9.81)(0.80 + x) = ½(1600)x^2$
$x = 0.116$ m

11 There are many forces acting on the flat object as shown. Amongst the forces, there exists a couple. What is the torque of the couple?

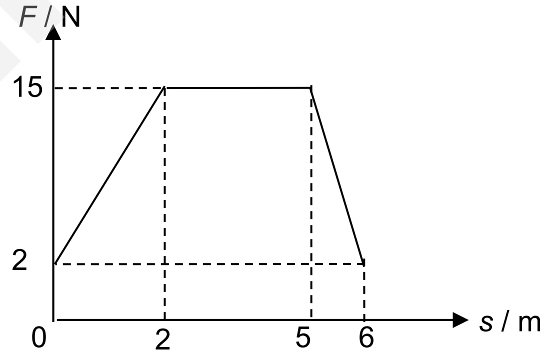


A *Fd* N m
B 6*Fd* N m clockwise
C 8*Fd* N m clockwise
D 24*Fd* N m clockwise

Answer: C
Torque of the couple
= (2*F*)(4*d*)
= 8*Fd* Nm clockwise

12 A student pushes a box from rest along a rough floor with constant friction of 2.0 N.

The graph shows the variation of the force exerted by the student on the box with displacement.



The final speed of the box after travelling 6 m is 5.0 m s^{-1}.

What is the mass of the box?

A 4.68 kg **B** 5.64 kg **C** 23.4 kg **D** 28.2 kg

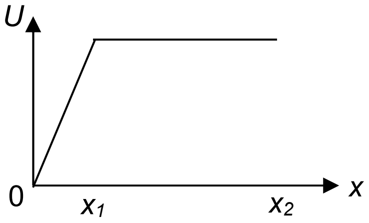
Answer: A
Using Work-energy theorem,
Net work done = Gain in KE

Work done by $F_{net} = KE_f - 0$

$$\frac{1}{2}(3+6)(13) - 2.0(6) = \frac{1}{2}m(5.0)^2 - 0$$

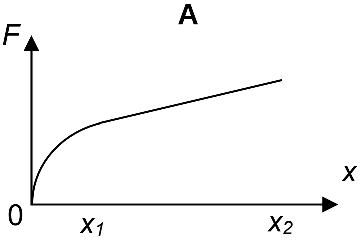
$m = 4.68$ kg

13 The graph how the potential energy U of an object varies with displacement x.

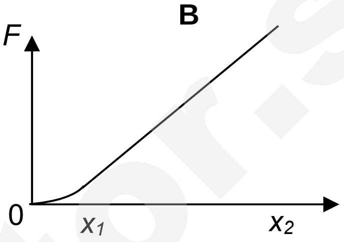


Which of the following graphs represents the variation of force acting on the object with displacement x?

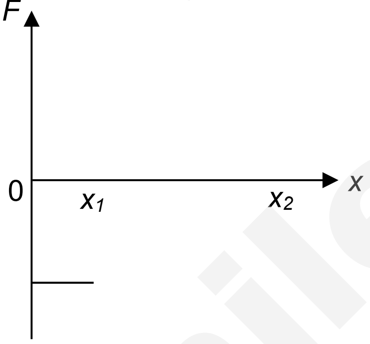
A



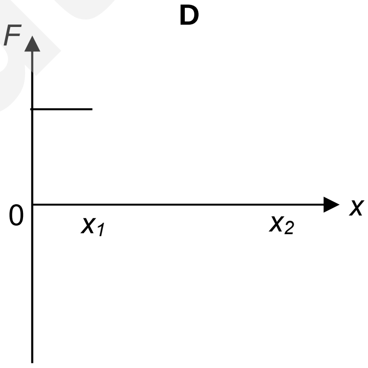
B



C

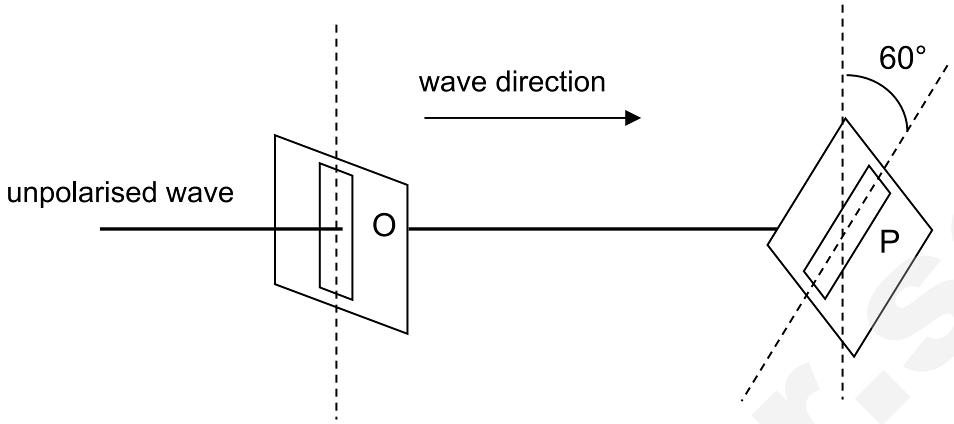


D



Answer: C
Using $F = -dU/dx$, the graph of F - x will be the negative of potential gradient.

14 An unpolarised wave passes through polariser O such that the emerging wave is plane-polarized with an intensity of 2.0 W m^{-2}. A second polariser P is placed further such that the plane-polarised wave is incident normally on it. Polariser P is rotated clockwise by an angle of 60°.

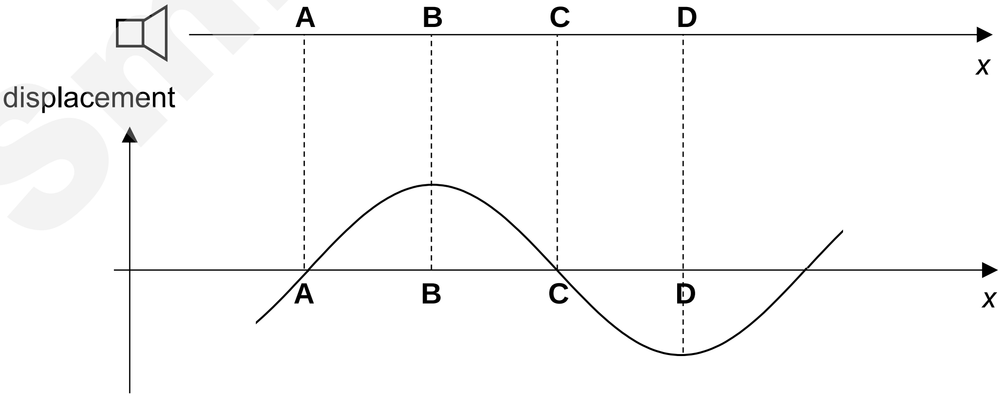


What is the intensity of the wave after passing through polariser P ?

A 0.25 W m^{-2} **B** 0.5 W m^{-2} **C** 1.0 W m^{-2} **D** 2.0 W m^{-2}

Ans : B
Using Malus' Law, $I_p = I_o \cos^2 \theta$
$= 2.0 (\cos^2 60^o) = 0.5$ W m^{-2}

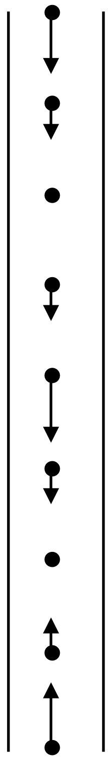
15 The figure shows a loudspeaker which emits a sound of constant frequency. The graph shows the displacements of the air particles from their undisturbed positions at one instant in time along *x*. Direction to the right is taken as positive. At which of the four points A, B, C, D is the instantaneous pressure at its minimum value?



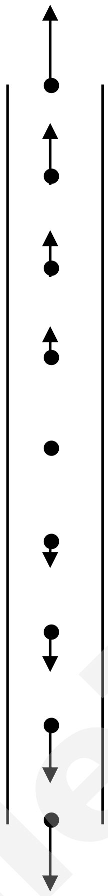
Ans : A
Particles on the left of A move to the left whereas those on the right of A move to the right, hence pressure at C is the least.

16 The arrows on the diagrams represent the movement of the air molecules in a pipe, opened at both ends, in which a stationary longitudinal wave has been set up. The length of each arrow represents the amplitude of the motion.
Which diagram shows a possible stationary wave in which there are two displacement nodes and three displacement antinodes?

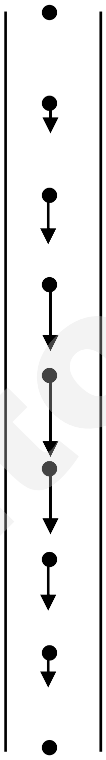
A



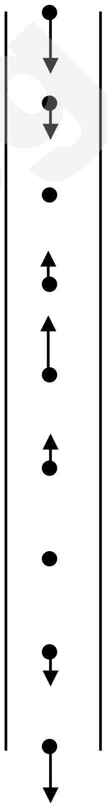
B



C



D



Answer: D

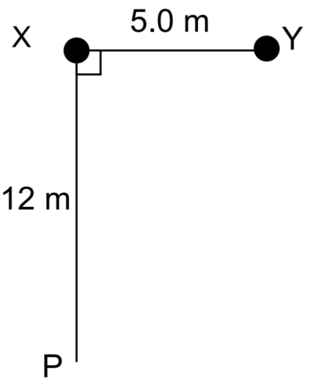
Option B does not show 2 displacement nodes.

Option C shows 2 displacement nodes at each of the ends of the open pipes which is not true for stationary waves in open-ended pipes.

For Option A (Top to bottom) – direction of oscillation does not change after the 1st node from the top, which is untrue.

For Option D – direction of oscillation is different on both sides of each node position, which is true.

17 Water waves of wavelength 2.0 m are produced by two generators X and Y, placed 5.0 m apart and operating in phase. A point P is 12 m from X as shown below.



With generator X switched off, the intensity at P due to Y alone is I_o. With generator Y switched off, the intensity at P due to X alone is $4I_o$. When both generators are switched on, what is the intensity at P?

A I_o **B** $3I_o$ **C** $5I_o$ **D** $9I_o$

Answer: A

$I \propto Á$ Thus, $A_Y = k\sqrt{I_o}$ $A_x = k\sqrt{4I_o} = 2k\sqrt{I_o}$

At P, path difference = 13 – 12 = 1 m = $\frac{1}{2}\lambda$, so destructive interference takes place.

Resultant amplitude at P, $A_{\text{total}} = A_x - A_Y = k\sqrt{I_o}$

so $I_{\text{total}} \propto A^2_{total} = I_o$

18 Which two phenomena show appropriate experimental evidence for the wave nature and the particulate nature of electromagnetic radiation?

	wave nature	particulate nature
A	photoelectric effect	diffraction
B	interference	photoelectric effect
C	interference	diffraction
D	diffraction	interference

Answer: B
Interference and diffraction show evidence for wave nature, while photoelectric effect shows evidence for particulate nature of electromagnetic radiation.

19 A generator, with output power P and output voltage V, is connected to a factory by cables of total resistance R.
What is the power input to the factory?

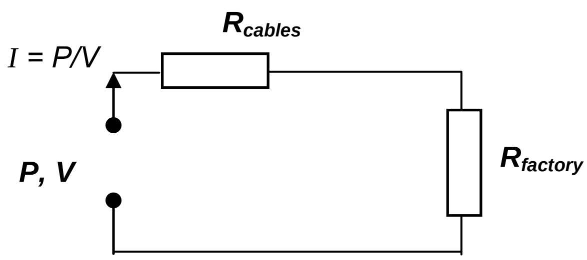
A P

B $P-\left(\frac{P}{V}\right)^2 R$

C $P-\left(\frac{P}{V}\right)^2 \frac{R}{2}$

D $\left(\frac{P}{V}\right)^2 R$

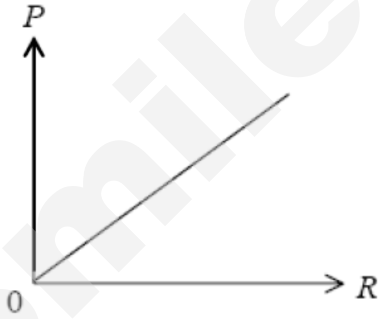
Ans: B



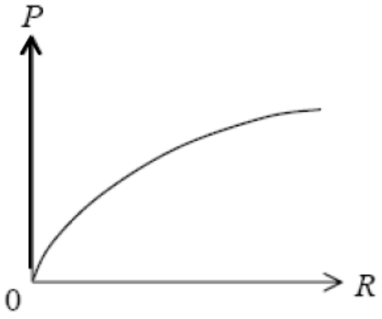
Power input to factory = P – power loss in cables
= P – I^2R_{cables}
= P – $(P/V)^2$ R

20 A d.c. supply of constant e.m.f. and internal resistance is connected to a variable resistor of resistance R. Which of the following graphs best shows how the total power P **delivered** by the supply varies with R?

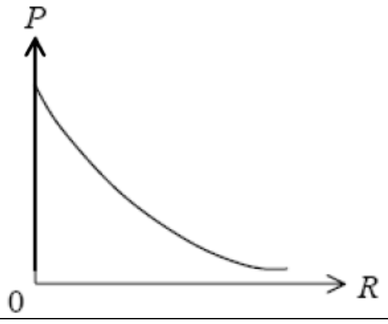
A.



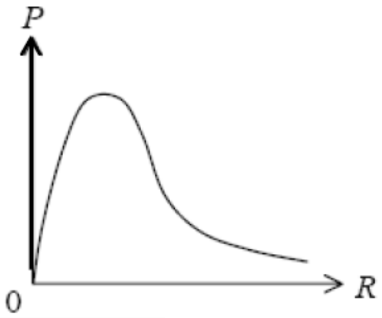
B.



C.



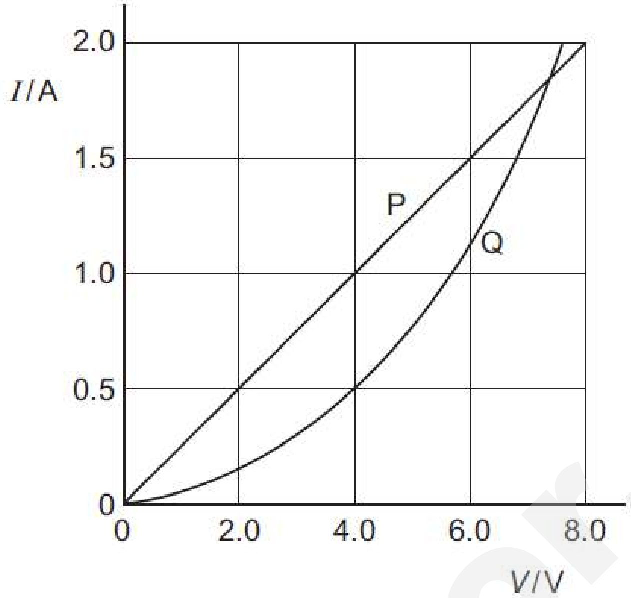
D.



Ans: C

Power delivered by supply = $E^2 / (R + r)$; with E and r as constants.
(so, when R increases, power decreases).

21 The I-V characteristics of two electrical components P and Q are shown below.



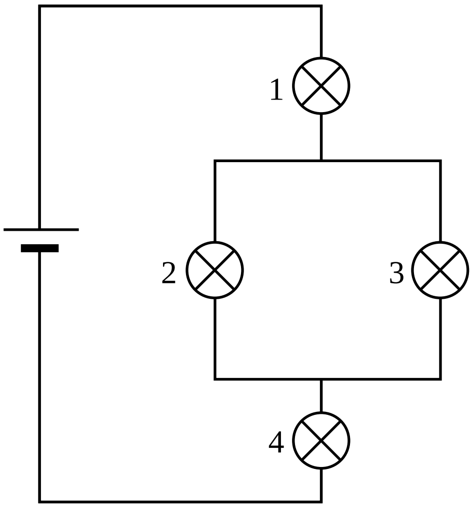
Which statement is correct?

A At 0.5 A the power dissipated in Q is double that in P.
B At 1.9 A the resistance of Q is approximately half that of P.
C The resistance of Q increases as the current in it increases.
D P is a resistor and Q is a filament lamp.

Ans: A

Ans: **A**
A. P = IV. When the current is constant 0.5 A, the potential difference at Q is double that at P.
B. At 1.9 A, the resistance (R = V/I ratio) is approximately the same.
C. Resistance of Q decreases as current in it decreases.
D. Q is a thermistor.

22 An ideal cell and four identical bulbs are connected as shown.



Bulb 3 is removed. Which of the following describes the changes in the brightness of bulbs 1, 2 and 4?

	Bulb 1	**Bulb 2**	**Bulb 4**
A	dimmer	brighter	brighter
B	dimmer	brighter	dimmer
C	brighter	dimmer	brighter
D	dimmer	dimmer	dimmer

Ans: B

With bulb 3 in parallel to bulb 2, the potential difference across bulb 2 is a smaller fraction of the cell's e.m.f as compared to that of bulbs 1 and 4.

With bulb 3 removed, the potential difference across bulb 2 increases while those of bulb 1 and bulb 4 decrease correspondingly. With fixed resistance, power dissipated increases as potential increases, hence bulbs 1 and 4 became dimmer and bulb 2 became brighter.

Alternatively,

Before bulb 3 was removed,

$$R_{total} = R + \left(\frac{1}{R} + \frac{1}{R}\right) + R = 2.5R$$

$$I_{total} = \frac{V}{2.5R} = 0.4\frac{V}{R} = I_{bulb1} = I_{bulb4}$$

$$I_{bulb2} = I_{bulb3} = 0.2\frac{V}{R}$$

After bulb 3 was removed,

$$R_{total} = R + R + R = 3R$$

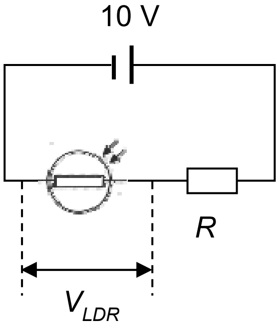
$$I_{total} = \frac{V}{3R} = 0.33\frac{V}{R} = I_{bulb1} = I_{bulb2} = I_{bulb4}$$

$\therefore I_{bulb1}$ and I_{bulb4} decreased, I_{bulb2} increased

since brightness $\propto$ power dissipated $= I^2R$

bulbs 1 and 4 became dimmer, bulb 2 became brighter

23 A light-dependent resistor (LDR) is connected in series with a fixed resistor of resistance *R* and a cell of e.m.f 10 V, as shown in the diagram below.



At a particular light intensity, resistance of the LDR is 5.3 Ω and the potential difference V_{LDR} across it is 4.5 V.

What is the value of V_{LDR} if the light intensity is increased and the resistance of the LDR drops to 3.1 Ω?

A 1.5 V **B** 2.6 V **C** 3.2 V **D** 3.5 V

Ans: C

By PDP,

When resistance of LDR is 5.3 Ω, $V_{LDR} = \frac{5.3}{5.3+R} \times 10 = 4.5$

$\Rightarrow R = 6.478\ \Omega$

When resistance of LDR is 5.3 Ω, $V_{LDR} = \frac{3.1}{6.478+3.1} \times 10 = 3.2\text{ V}$

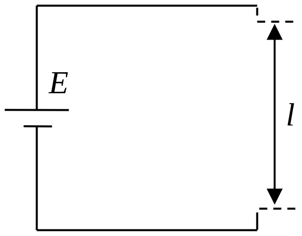
24 A mains circuit contains six similar bulbs connected in series. One of the bulbs has a broken filament. Voltmeters X and Y of infinite resistance are placed in the circuit shown below.
Which of the following voltmeter readings is correct?

	Voltmeter X	**Voltmeter Y**
A	0 V	0 V
B	0 V	240 V
C	240 V	240 V
D	240 V	0 V

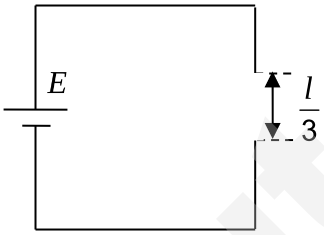
Ans: D

Due to broken bulb, current in circuit is zero. So, the potential difference across ALL bulbs *V* = *IR* is zero, EXCEPT the broken bulb (which has p.d. of 240 V).

25 A long solenoid of length l is connected to a cell with e.m.f. E and negligible internal resistance. The magnetic flux density at the centre of the solenoid is B_s.



The solenoid is subsequently cut to a length of $\frac{l}{3}$ and is reconnected to the same cell as shown below.



The magnetic flux density at the centre of a solenoid is equal to $\mu_o nI$, where n is the number of turns per unit length and I is the current through the coil.

What is the magnetic flux density at the centre of the shortened solenoid?

A $\frac{B_s}{3}$

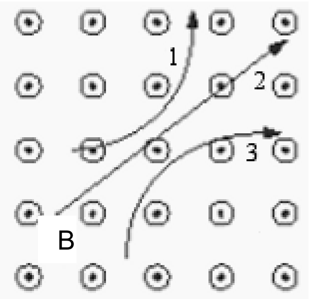
B B_s

C $3B_s$

D $6B_s$

Answer: C
Magnetic flux density α I (since μ_o and n are constant).
Reducing the solenoid length to one-third its original length will cause its resistance to correspondingly decrease to one-third its original value. Since the same battery is used, current I through the solenoid will triple.

26 Three particles travel through a region of space where the magnetic field is out of the page, as shown in the figure below.



Which statement below about their charges is correct?

A 1 is negative, 2 is neutral, and 3 is positive.

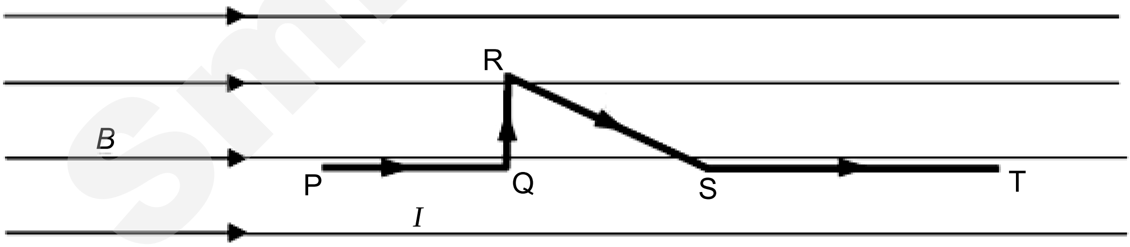
B 1 is neutral, 2 is negative, and 3 is positive.

C 1 is positive, 2 is negative, and 3 is neutral.

D 1 is positive, 2 is neutral, and 3 is negative.

Answer: A
Particle 2 is neutral since its path is straight and not affected by the magnetic field. Using Fleming's Left Hand Rule, the curved paths of the particles 1 and 3 indicates that particle 1 is negatively charged whereas particle 3 is positively charged.

27 A bent wire PQRST carrying a current I is placed in a magnetic field of flux density B as shown. QR is the shortest and ST is the longest. PQ and RS are equal in length and both are longer than QR.



The forces acting on PQ, QR, RS and ST are given by F_{PQ}, F_{QR}, F_{RS} and F_{ST} respectively.

Which of the following is true?

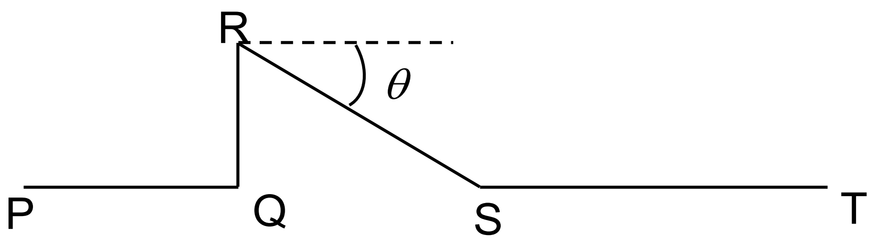
A $F_{QR} \neq F_{RS}$ and $F_{PQ} < F_{ST}$

B $F_{QR} = F_{RS}$ and $F_{PQ} = F_{ST}$

C $F_{QR} > F_{RS}$ and $F_{PQ} < F_{ST}$

D $F_{QR} < F_{RS}$ and $F_{PQ} = F_{ST}$

Answer: B



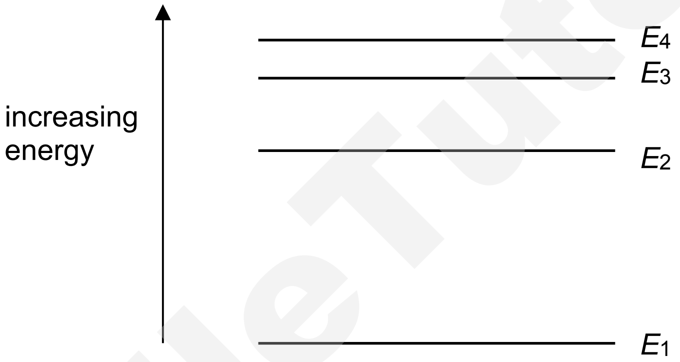
$L_{RS}\sin\theta = L_{QR}$

$F_{QR} = BI(L_{QR}) = BI(L_{RS}\sin\theta) = F_{RS}$

L_{PQ} and L_{ST} are parallel to B-field

$F_{PQ} = F_{ST} = 0$

28 Some of the energy levels of the hydrogen atom are represented in simplified form by the given diagram which has a linear scale. The emission of blue light is associated with the transition of an electron from E_4 to E_2. Which of the following transitions could be associated with the absorption of the red light ?



A E_4 to E_1

B E_3 to E_2

C E_2 to E_3

D E_1 to E_4

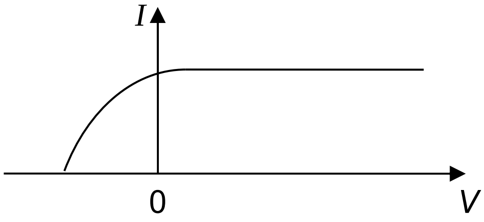
Ans : C
Absorption transition is in the direction of increasing energy.
$\Delta E = hf$
Since $f_{red} < f_{blue}$, therefore $\Delta E_{red} < \Delta E_{blue}$

29 A particle of mass *m* has kinetic energy *E*. Which of the following gives the de Broglie wavelength of the particle?

A $h\sqrt{2mE}$ **B** $\frac{\sqrt{2mE}}{h}$ **C** $\frac{h}{\sqrt{mE}}$ **D** $\frac{h}{\sqrt{2mE}}$

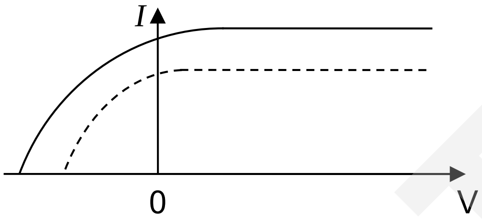
Ans: D
$E = \frac{1}{2}mv^2 = p^2/2m$
Therefore, $p = \sqrt{(2mE)}$
$\lambda = h/p = h/\sqrt{(2mE)}$

30 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photo-electrons which are collected at an adjacent electrode. For a given intensity of light, the way in which the photocurrent I depends on the potential difference V between the electrodes is as shown in the diagram below.

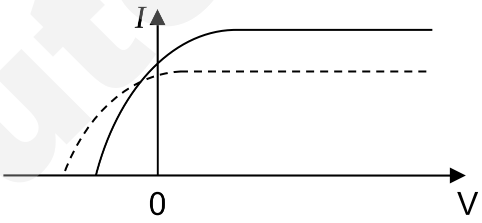


Which of the following graphs shows the result when the intensity of the light is increased? (The solid curve represents the original graph and the dotted curve represent the new graph.)

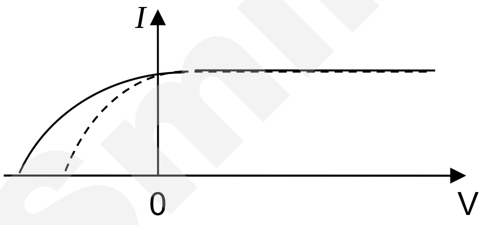
A



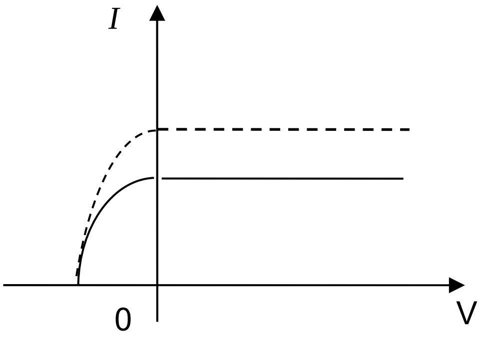
B



C



D



Ans: D
When the intensity is doubled, the rate of incidence is increased, hence the rate of emission of photoelectrons and hence photocurrent is increased. Since the frequency of light does not change, the stopping potential does not change.

SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME

CG **INDEX NO.**

PHYSICS 8866/02

Preliminary Examination **11th September 2017**
Paper 2 Structured Questions **2 hours**

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THIS INSTRUCTIONS FIRST

Write your name, civics group and index number in the spaces at the top of this page.

Write in dark blue or black pen on both sides of the paper.
You may use HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Answer **all** questions in Section A and any **two** questions in Section B.

At the end of the examination, fasten all your work securely together.
The number of marks is given in bracket [ ] at the end of each question or part question.

For Examiners' Use	
Q1	/ 8
Q2	/ 7
Q3	/ 8
Q4	/ 9
Q5	/ 8
Q6	/ 20
Q7	/ 20
Q8	/ 20
Total marks	/ 80

This document consists **23** printed pages and **1** blank page.

DATA AND FORMULAE

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + ½ at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

Section A
Answer all the questions in this Section.

1 In order to determine the value of the gravitational acceleration *g*, a student throws a ball at a speed of 15 m s^{-1} horizontally from a building.

(a) The student collects the following data for the ball when it reaches the ground.

Quantity	**Value**	**Absolute Uncertainty**
Vertical displacement	122.500 m	0.002 m
Horizontal displacement	75.000 m	0.002 m

(i) Show that the time taken to reach the ground is 5.0 s. [1]

(ii) The uncertainty of the time taken is 0.4 s.

Determine the value of *g*, with its associated uncertainty.

g = ………………….. ± ……………….. m s^{-2} [3]

(b) In the absence of air resistance, the variation of the vertical speed *v* of the ball with time *t* is shown in Fig. 1.1.

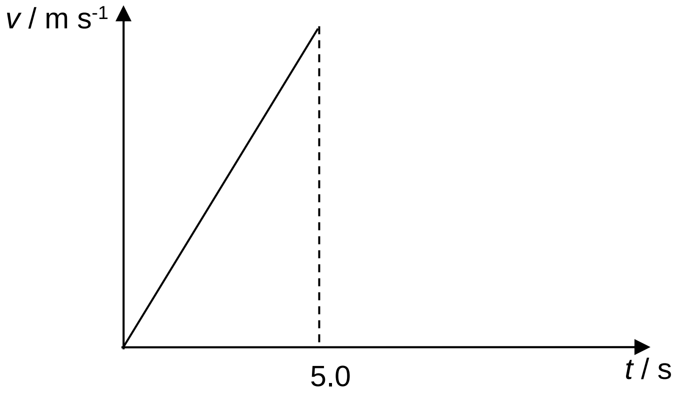


Fig. 1.1

(i) In reality, there is air resistance. Sketch the graph of variation of vertical speed with time on Fig. 1.1, and label this graph Z. [2]

(ii) Explain the shape of the graph Z.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

2 A uniform rod of weight 20 N is freely hinged to a wall at P as shown in Fig.2.1. It is held horizontal by an elastic cord made of material X of force constant 10 N cm^{-1}, attached at Q at an angle of 15˚ to the rod.

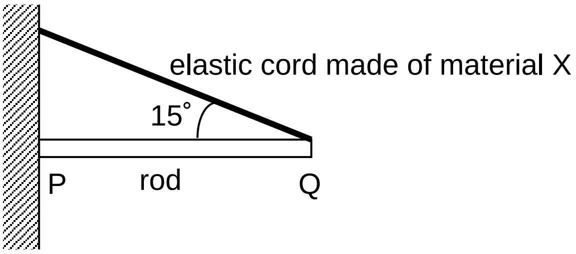


Fig.2.1

(a) Show the extension of the elastic cord is 3.86 cm. [2]

(b) Determine the magnitude of the resultant force acting at P.

magnitude of resultant force at P = …………………. N [3]

(c) The elastic cord X is now replaced by two other identical elastic cords of the same unstretched length as elastic cord X. These two elastic cords are connected in parallel. The rod PQ remains horizontal.
State and explain the value of the force constant of each of the new elastic cords.

……………………………………………………………………………………..………………

……………………………………………………………………………………..……………

……………………………………………………………………………………………...… [2]

3 Fig. 3.1 shows the cross-section of two long straight wires X and Y perpendicular to the page, placed at a distance of 3.0 cm apart. There is an electric current in both wires out of the page. The current in wires X and Y are 1.0 A and 2.0 A respectively.

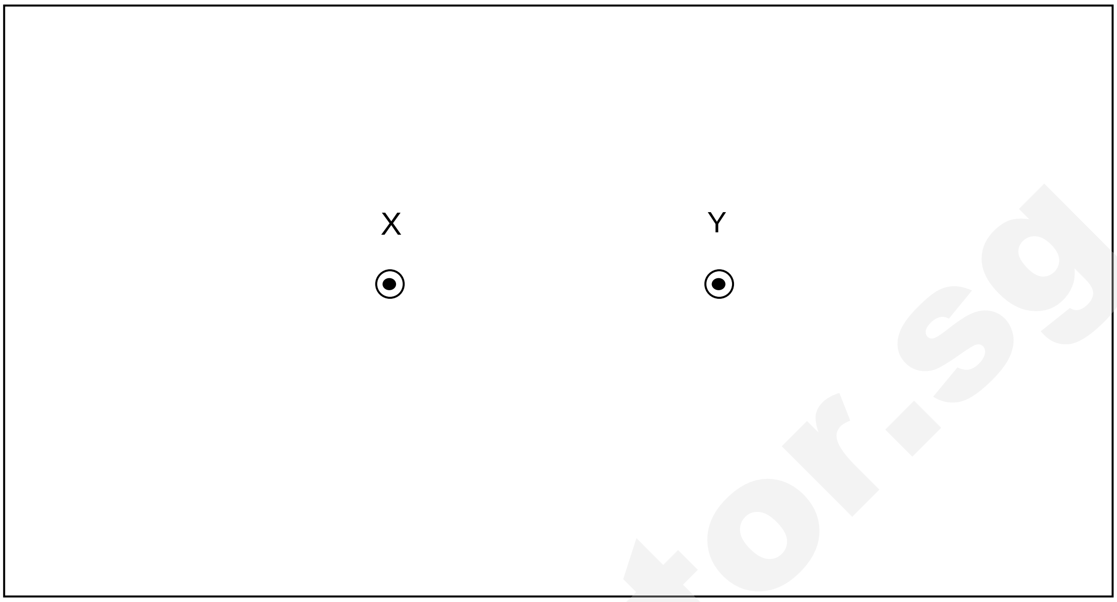


Fig. 3.1

(a) Sketch the resultant magnetic field pattern around the wires. Include direction arrows on the field lines. [3]

(b) Each wire exerts a force on the other wire. Draw one arrow on each wire to show the direction of these forces. [1]

(c) For a straight current-carrying conductor, the magnetic flux density B at a distance r from the conductor is given by the relation

$$B = \left(2.0 \times 10^{-7}\right)\frac{I}{r}$$

where I is the current flowing in the conductor.

Determine the magnetic flux density experienced by wire Y due to the current flowing in wire X.

magnetic flux density = …………………. T [2]

(d) Hence, determine the magnitude of the force per unit length between the wires.

force per unit length = …………………. N m^{-1} [2]

4 **(a)** By reference to the photoelectric effect, explain why, even when the incident light is monochromatic, the emitted electrons have a range of kinetic energies up to a maximum value.

……………………………………………………………………………………………………

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…………………………………………………………………………………………… [2]

(b) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface, and the maximum kinetic energy E_{max} of 1/λ as shown in Fig. 4.1.

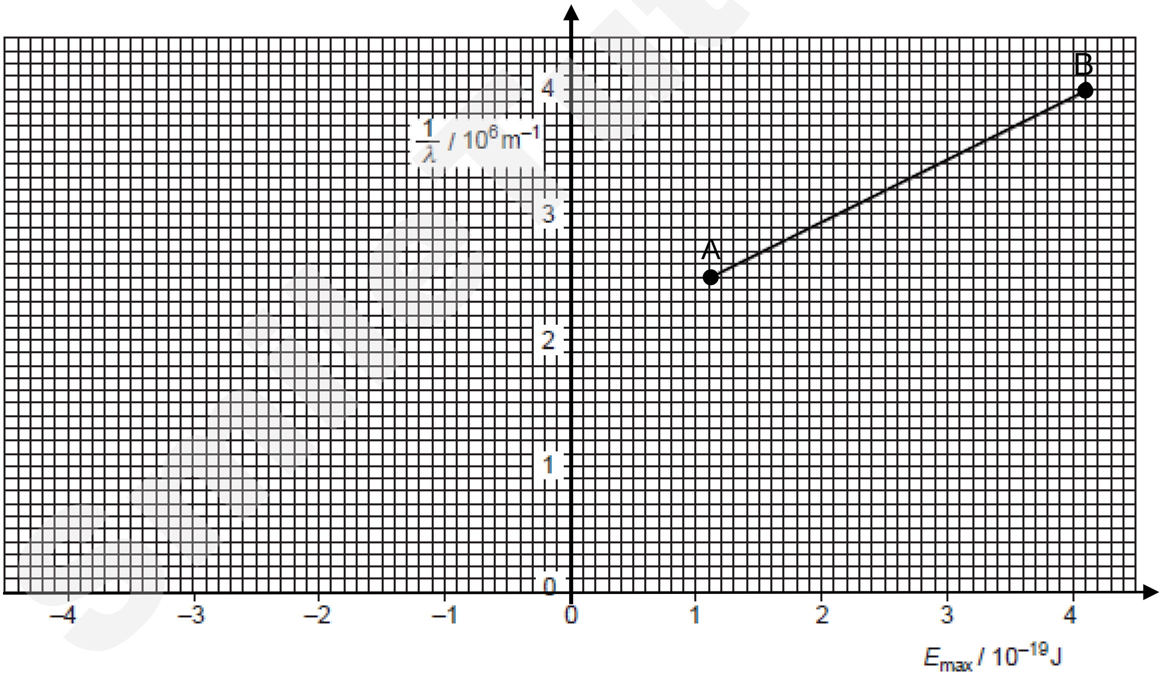

Fig. 4.1

(i) Without using the value of the Planck constant, determine the work function of the metal surface.

work function = ……………… J [2]

(ii) Using points A and B, determine the Planck constant.

Planck constant = …………………….. J s [3]

(c) White light in a beam is incident on some cool hydrogen gas as shown in Fig. 4.2.

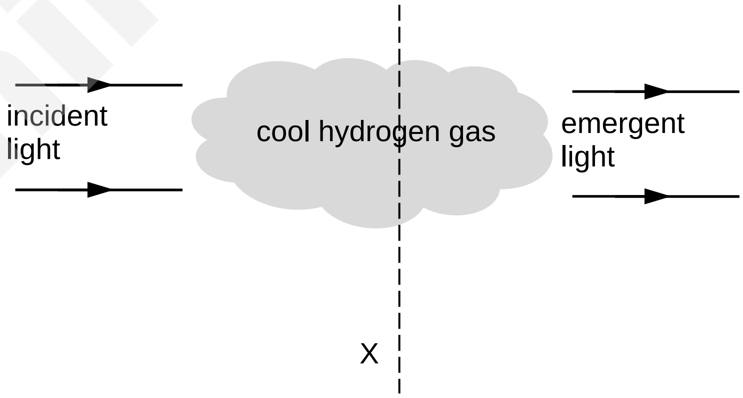

Fig. 4.2

Describe and explain the appearance of the spectrum viewed from position X.

…………………………………………………..………………………………..………………

……………………………………………………………………………………………..…..

……………………………………………………………………………………………… [2]

5 A capacitor is an electrical device which can store charges and energy. A simple parallel plate capacitor consists of two parallel conducting plates separated by an insulator, as shown in Fig. 5.1.

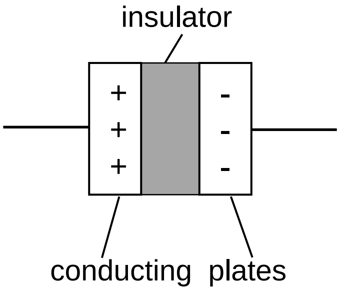

Fig. 5.1

When charged, the two plates carry opposite charges of the same magnitude. The relationship between the amount of charge stored *Q*, the potential difference *V* between the plates and the capacitance *C* is given by the equation

$$Q = CV$$

The capacitor is now charged. Fig. 5.2 shows the variation of the amount of charge *Q* with the potential difference *V* between the plates.

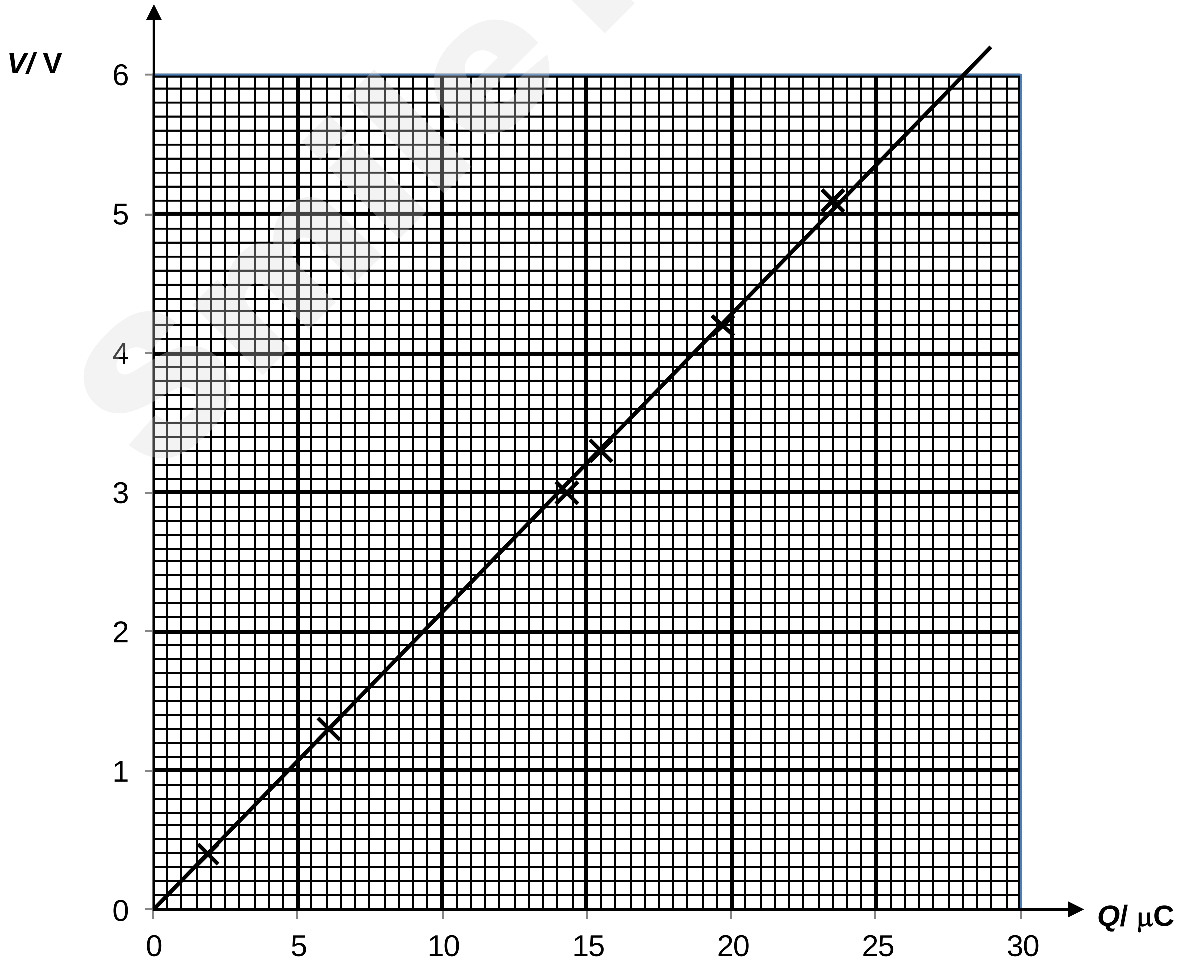

Fig. 5.2

(a) State the quantity represented by the gradient of the graph.

.... [1]

(b) The capacitor is now discharged by connecting it across a resistor of resistance *R* as shown in Fig. 5.3.

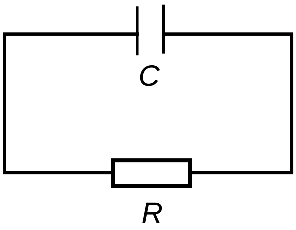

Fig. 5.3

Fig. 5.4 shows the variation with time *t* of the potential difference *V* across the resistor.

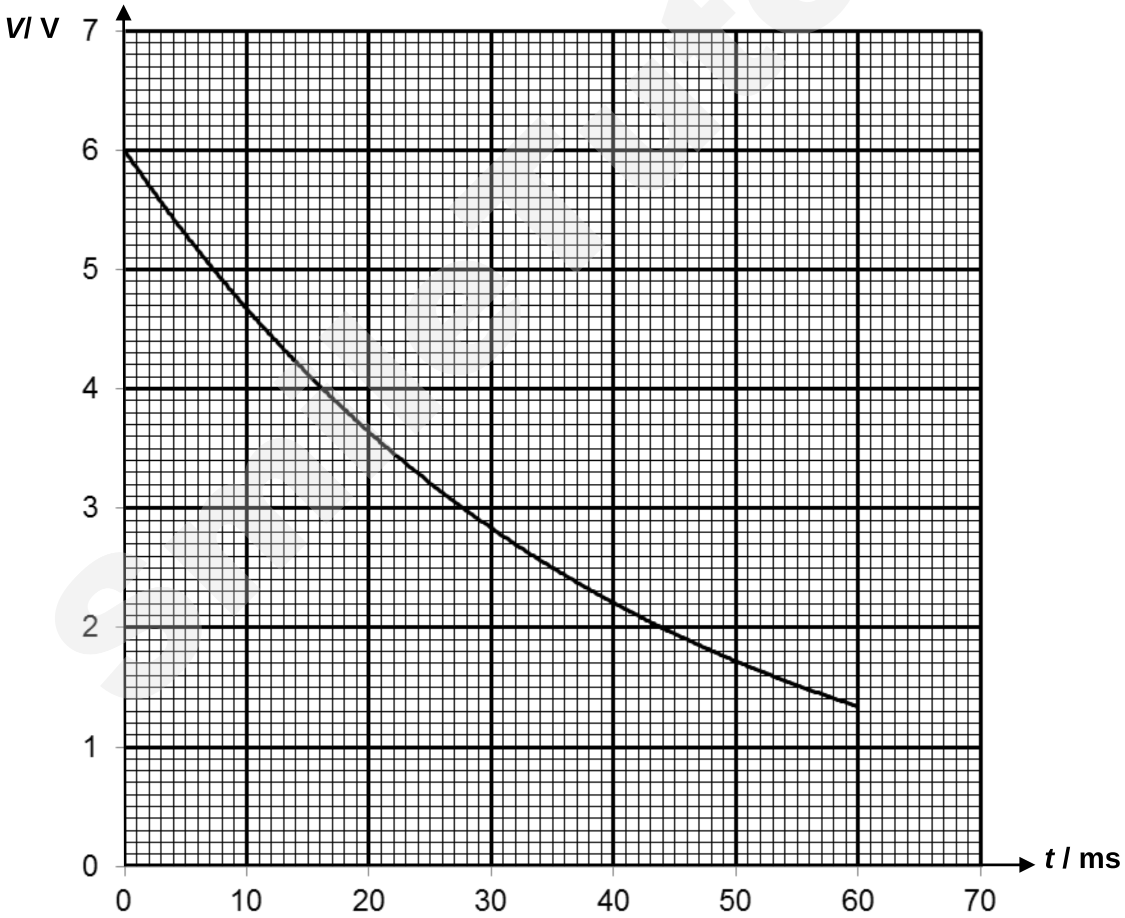

Fig. 5.4

(i) Using Fig. 5.2 and Fig. 5.4, determine the initial amount of charge stored.

charge = ... μC [2]

(ii) Hence, calculate the capacitance *C*.

capacitance = ... C V^{-1} [2]

(iii) The energy *E* stored in a capacitor is ½ CV^2.
Calculate the energy lost when the capacitor has been discharged for 45 ms.

energy lost = ... J [3]

Section B

Answer two questions from this Section.

6 **(a)** State Newton's second law of motion.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………….. [2]

(b) Two blocks, R and S, of masses 0.30 kg and 1.50 kg respectively, are connected by a string that passes over a pulley as shown in Fig. 6.1. The pulley is frictionless and the string is inelastic. The system is released from rest. Block S falls vertically before it strikes a spring that is firmly attached to the floor. The spring constant of the spring is 500 N m^{-1}.

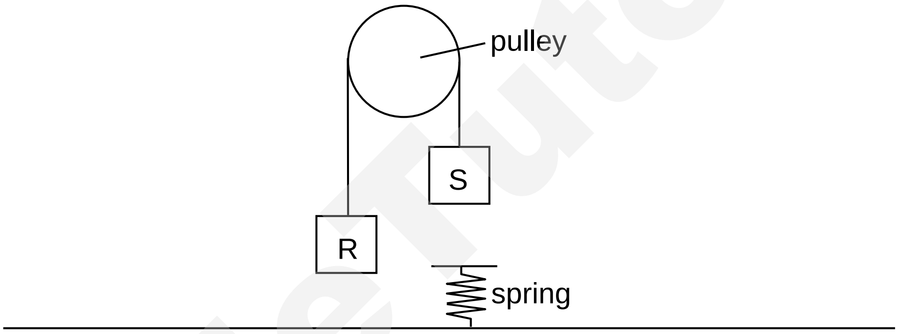

Fig. 6.1

(i) Draw the labelled free-body diagrams of Blocks R and S at the instant when the system is released from rest. [2]

(ii) Determine the magnitude of the acceleration of Block S before striking the spring.

magnitude of acceleration = ………………… m s^{-2} [3]

(iii) The acceleration of Block S decreases after it touches the spring. Block S comes to a stop after some time and the spring is observed to be compressed.

1. By considering the free body diagrams of both blocks at equilibrium, show that the maximum compression of the spring is 0.0235 m. [2]

2. Hence, explain how the maximum compression would change if a spring of smaller spring constant is used.

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

……………………………………………………………………………………… [2]

(iv) Sketch on Fig. 6.2 for Block S, the variation with the distance from the point of release of its

1. gravitational potential energy (label the graph G),

2. elastic potential energy (label the graph E),

3. kinetic energy (label the graph K). [3]

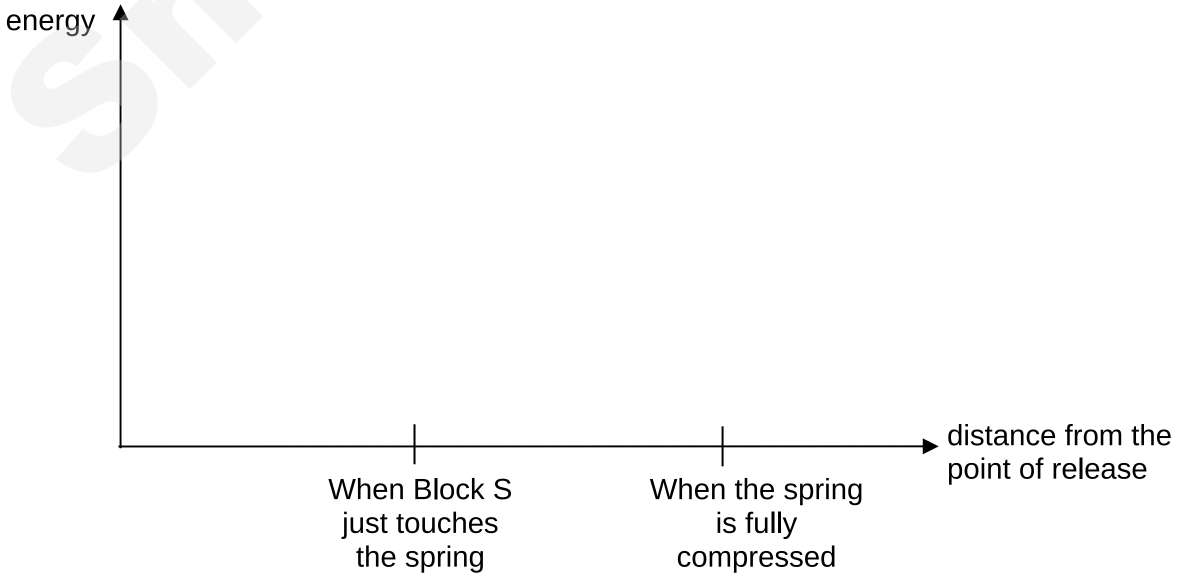

Fig. 6.2

(c) Truck X of mass 22 000 kg and moving at a speed of 3.0 m s^{-1}, catches up and collides with Truck Y moving at 1.0 m s^{-1} moving in the same direction as shown in Fig. 6.3.

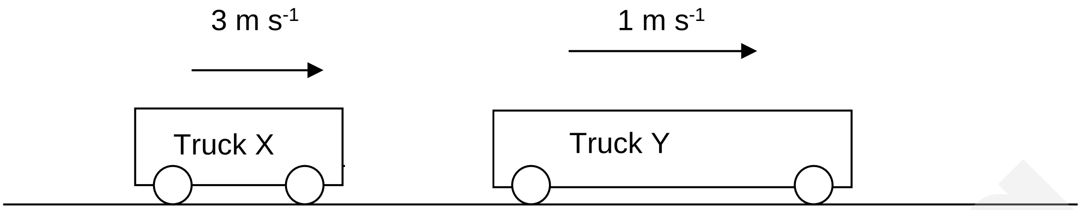

Fig. 6.3

Fig. 6.3 shows the variation of speeds *v* of the trucks with time *t* before, during and after the collision.

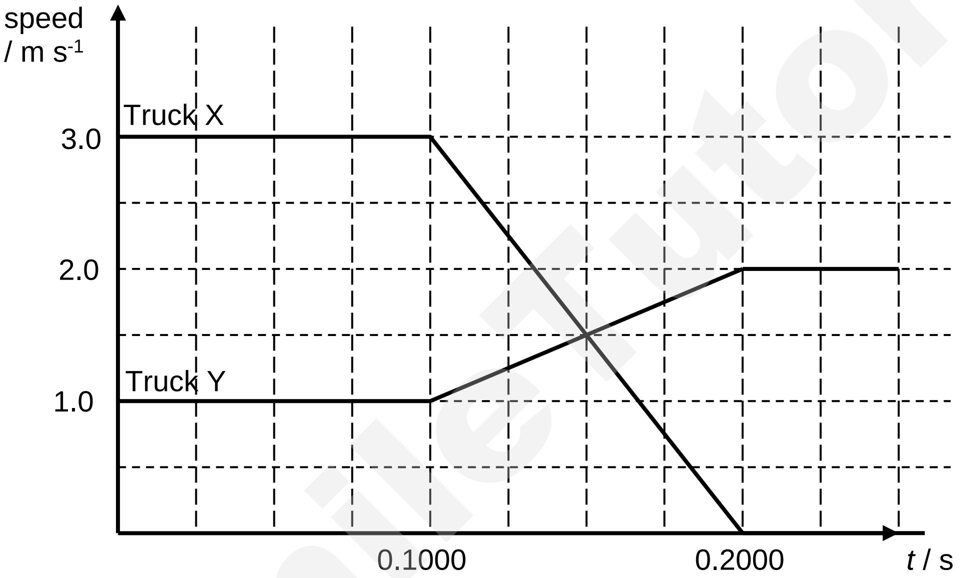

Fig. 6.3

(i) Using Fig. 6.3, show that the mass of Truck Y is 66000 kg. [2]

(ii) Show that the collision is elastic. [1]

(iii) **1.** Calculate the magnitude of the impulse exerted by Truck X on Truck Y.

magnitude of the impulse = ………………….. N s [2]

2. If the duration of collision is reduced, with the initial and final speeds of both trucks unchanged, state and explain how this affects your answer in **1**.

……………………………………………………………………………………….

……………………………………………………………………………………… [1]

7 **(a)** State what is meant by *coherent sources*.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

(b) Fig. 7.1 below shows a progressive wave displayed on a cathode ray oscilloscope (c.r.o.). Sketch on Fig. 7.1 one cycle of a wave that has a phase difference of $\frac{\pi}{2}$ radians with the progressive wave.

[2]

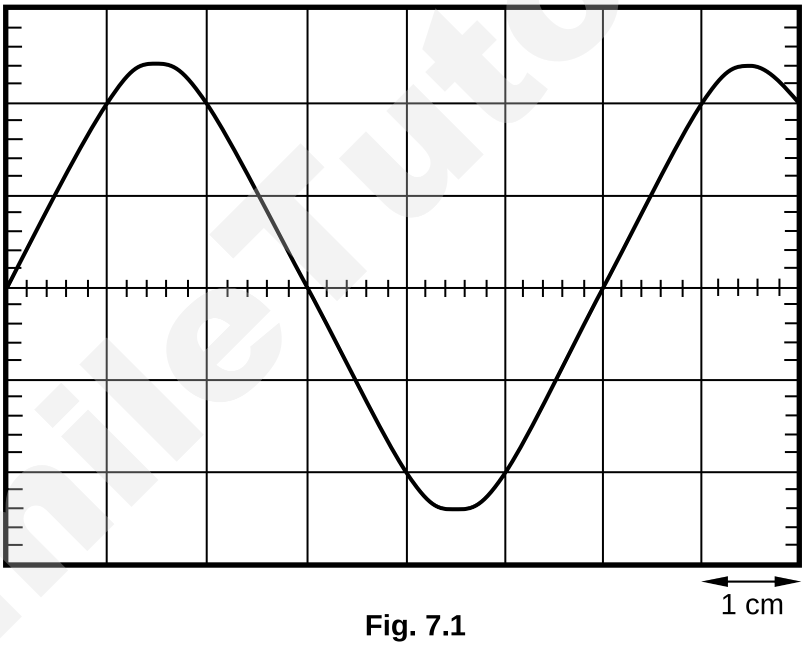

Fig. 7.1

(c) A stereo system in a large hall has two identical speakers, S_1 and S_2, placed 1.2 m apart as shown in Fig. 7.2. The amplitude of the output of each speaker is proportional to the potential difference across its terminals, which is adjusted by means of a balance control.

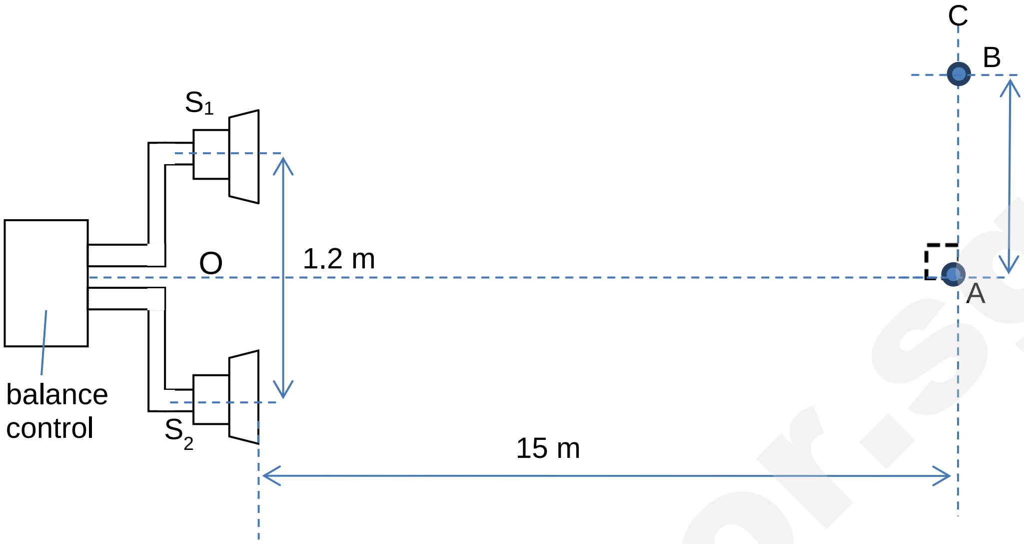

Fig. 7.2 (not to scale)

Initially, the speakers are emitting signals of frequency 1000 Hz which are in phase. The balance control is set such that the potential difference across the terminals of both speakers are the same.

Line AC is 15 m away from the speakers. An observer hears a loud sound of intensity I_{max} at A. As he moves along the line AC, 15 m away from the speakers, he observes that the intensity of the sound first falls to zero at point B, a distance *y* from A. The speed of sound in air is 330 m s^{-1}.

(i) Using Young's Double Slit formula, determine the distance between adjacent positions of loud sounds.

distance = ……………. m [3]

(ii) Hence, show that the distance *y* is 2.1 m. [1]

(iii) The balance control is now adjusted such that the amplitude of the signal from S_1 is reduced while the amplitude of the signal from S_2 is unchanged.

Suggest and explain any changes to the sound heard at B.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [2]

(iv) State the effect on the interference pattern along the line AC when the distance between the two speakers is decreased.

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

(d) Fig. 7.3 shows a string stretched between two fixed points P and Q.

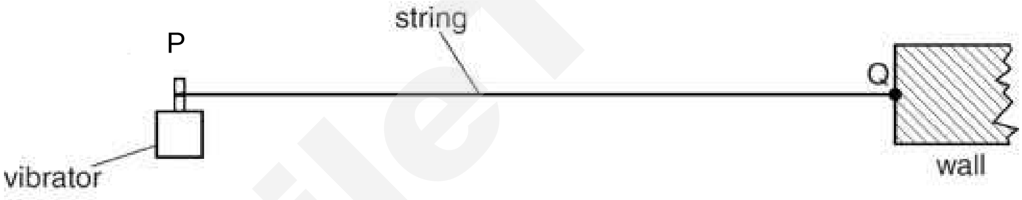

Fig. 7.3

A vibrator is attached at end P of the string. End Q is fixed to a wall. The stationary wave produced on PQ at one instant of time *t* is shown on Fig. 7.4. Each point on the string is at its maximum displacement.

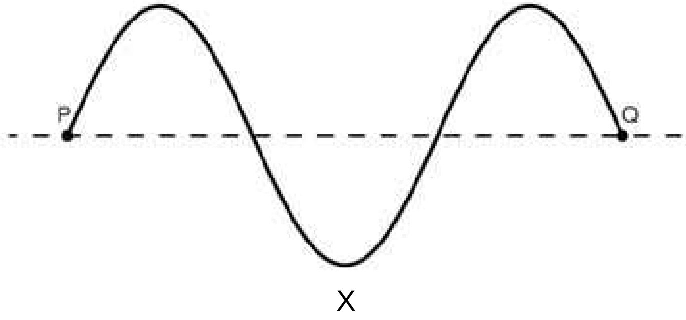

Fig. 7.4

(i) Explain how this arrangement may produce a stationary wave on the string.

....

....

....[2]

(ii) It takes 0.01 s for the point X on the string to reach the highest point of its oscillation.

Calculate the frequency of the vibrator.

frequency = ... Hz [2]

(iii) The length of PQ is 1.2 m. Determine the wavelength of the stationary wave.

wavelength = ... m [2]

(iv) Hence, show that the speed of the stationary wave is 40 m s^{-1}. [1]

(v) Draw on Fig. 7.4 the stationary wave when the frequency of the vibrator is doubled while keeping the speed of the wave constant. [2]

8 **(a)** A household electric lamp is rated as 240V, 40W. The filament lamp is made from tungsten wire of radius 5.0 × 10^{-6} m. The resistivity of tungsten at the normal operating temperature of the lamp is 7.9 × 10^{-7} Ωm.

(i) For the lamp at its normal operating condition, show that the resistance of the filament is 1440 Ω.

[1]

(ii) Calculate the length of the filament.

length = ………………………….. m [3]

(iii) Comment on your answer in **(ii)**.

…………………………..………………….…………………….……………………..……………

…………………………..………………………………………………………………….…. [2]

(b) An electric heater consists of three similar heating elements A, B, C, connected as shown in Fig. 8.1.

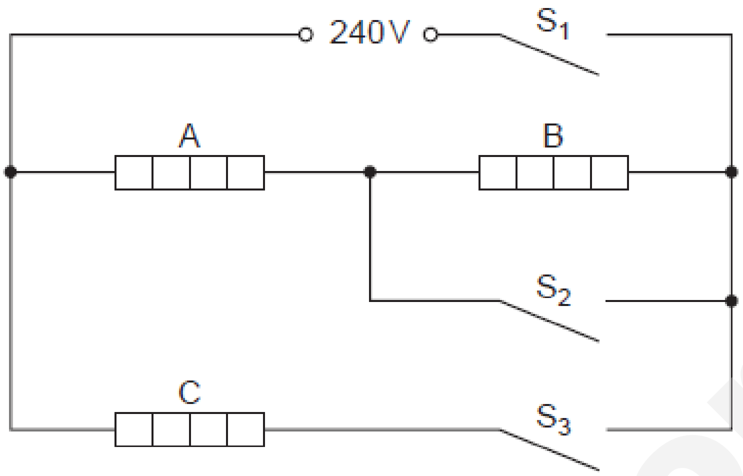

Fig. 8.1

Each heating element is rated as 1.5kW, 240V and may be assumed to have constant resistance.
The circuit is connected to a 240 V supply.

The switches S_1, S_2 and S_3 may be either open or closed.

(i) When S1, S2 and S3 are all closed, state the total power dissipation of the heater.

total power dissipation = ……………………….. kW [1]

(ii) When S1 is closed, S2 is open, and S3 is open, show that the total power dissipation of the heater is 0.75 kW. [2]

(iii) Hence, determine the total power dissipation of the heater when S1 is closed, S2 is open, and S3 is closed.

total power dissipation = ……………………….. kW [1]

(c) On Fig. 8.2, sketch the temperature characteristic of a thermistor.

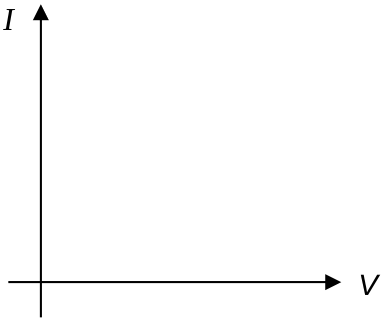

Fig. 8.2

[1]

(d) A potential divider circuit is shown in Fig. 8.3.

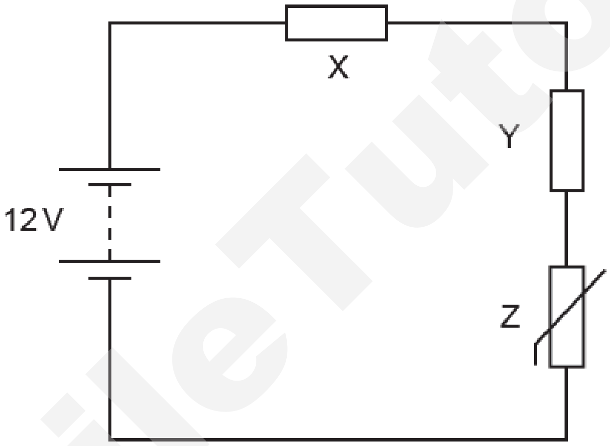

Fig. 8.3

The battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected in series with resistors X and Y and thermistor Z. The resistance of Y is 15 kΩ and the resistance of Z at a particular temperature is 3.0 kΩ. The potential difference (p.d.) across Y is 8.0 V.

(i) By reference to the circuit shown in Fig. 8.3, distinguish between the definitions of e.m.f. and p.d.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(ii) Calculate the current in the circuit.

current = ………………………….. A [2]

(iii) Calculate the resistance of X.

resistance = ………………………….. Ω [3]

(iv) The temperature of Z is decreased.
State and explain the effect of this on the potential difference across Z.

…………………………………………………………………………………………….

…………………………………………………………………………………………….

…………………………………………………………………………………………….

………………………………………………………………………………………… [2]

END OF PAPER

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SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

NAME

CG **INDEX NO.**

PHYSICS 8866/02

Preliminary Examination **11th September 2017**
Paper 2 Structured Questions **2 hours**

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THIS INSTRUCTIONS FIRST

Write your name, civics group and index number in the spaces at the top of this page.

Write in dark blue or black pen on both sides of the paper.
You may use HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Answer **all** questions in Section A and any **two** questions in Section B.

At the end of the examination, fasten all your work securely together.
The number of marks is given in bracket [ ] at the end of each question or part question.

For Examiners' Use	
Q1	/ 8
Q2	/ 7
Q3	/ 8
Q4	/ 9
Q5	/ 8
Q6	/ 20
Q7	/ 20
Q8	/ 20
Total marks	/ 80

DATA AND FORMULAE

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

acceleration of free fall, $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + ½ at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

Section A
Answer all the questions in this Section.

1 In order to determine the value of the gravitational acceleration *g*, a student throws a ball at a speed of 15 m s^{-1} horizontally from a building.

(a) The student collects the following data for the ball when it reaches the ground.

Quantity	**Value**	**Absolute Uncertainty**
Vertical displacement	122.500 m	0.002 m
Horizontal displacement	75.000 m	0.002 m

(i) Show that the time taken to reach the ground is 5.0 s. [1]

Consider the horizontal direction,

$$s_x = u_x t$$

$$t = \frac{75.0}{15} \quad \text{[M1]}$$

$$= 5.0 \text{ s}$$

(ii) The uncertainty of the time taken is 0.4 s.

Determine the value of *g*, with its associated uncertainty.

Consider the vertical direction,

$$s_y = u_y t + \frac{1}{2}gt^2 = \frac{1}{2}gt^2$$

$$g = \frac{2s_y}{t^2} = \frac{2(122.5)}{5.0^2} = 9.80 \text{ m s}^{-2} \quad \text{[M1]}$$

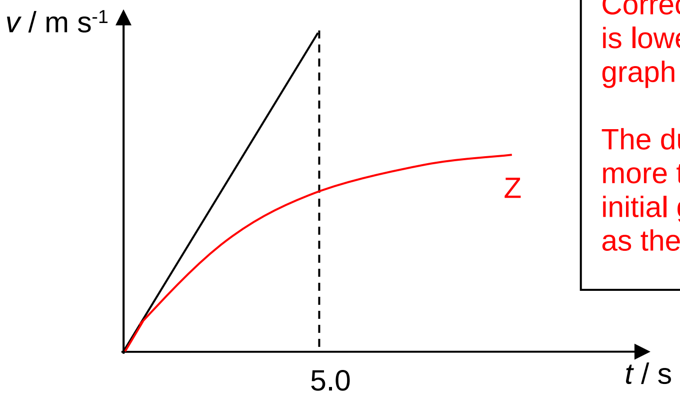
$$\frac{\Delta g}{g} = \frac{\Delta s_y}{s_y} + 2\frac{\Delta t}{t} = \frac{0.002}{122.5} + 2(\frac{0.4}{5.0}) \quad \text{[M1]}$$

$$\Delta g = 2 \text{ m s}^{-1} \text{ (1 s.f.)}$$

$$g \pm \Delta g = (10 \pm 2) \text{ m s}^{-2} \quad \text{[A1]}$$

g = ………………….. ± ……………….. m s^{-2} [3]

(b) In the absence of air resistance, the variation of the vertical speed *v* of the ball with time *t* is shown in Fig. 1.1.



Correct shape – a curve that is lower than the original graph [B1]

The duration of motion is more than 5.0 s, and the initial gradient is the same as the original graph [B1]

Fig. 1.1

(i) In reality, there is air resistance. Sketch the graph of variation of vertical speed with time on Fig. 1.1, and label this graph Z. [2]

(ii) Explain the shape of the graph Z.

As the ball falls downwards, its speed increases and therefore upward air resistance acting on it also increases. [B1]
The net force acting on the ball decreases, therefore the acceleration decreases, resulting in the gradient of graph Z being gentler than that of the original graph. [B1]

[2]

2 A uniform rod of weight 20 N is freely hinged to a wall at P as shown in Fig.2.1. It is held horizontal by an elastic cord made of material X of force constant 10 N cm^{-1}, attached at Q at an angle of 15° to the rod.

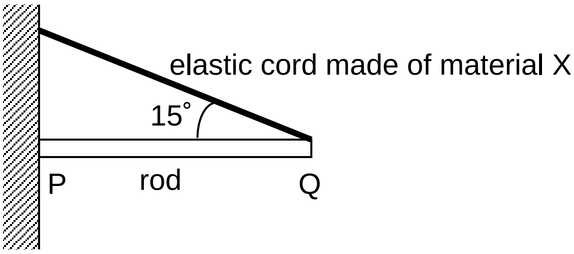


Fig.2.1

(a) Show the extension of the elastic cord is 3.86 cm. [2]

Let L be the length of the rod and x be the extension of elastic cord.
Using Principle of Moments, taking moments about point P
Sum of clockwise moment = Sum of anticlockwise moment
Or
$W(0.5L) = (T \sin 15°)L$ [B1]
$20(0.5L) = (10x \sin 15°)L$ [B1]
$x = 3.86$ cm

(b) Determine the magnitude of the resultant force acting at P.

Consider vertical forces
Taking upwards positive
$T \sin 15° + R_2 + (-W) = 0$
$38.6 \sin 15° + R_2 + (-20) = 0$ [M1]
$R_2 = 10.0$ N

Consider horizontal forces
Taking rightward positive
$R_1 + (-T \cos 15°) = 0$
$R_1 + (-38.6 \cos 15°) = 0$ [M1]
$R_1 = 37.3$ N

$R = \sqrt{R_1^2 + R_2^2} = \sqrt{10.0^2 + 37.3^2} = 38.6$ N [A1]

magnitude of resultant force at P = …………………. N [3]

(c) The elastic cord X is now replaced by two other identical elastic cords of the same unstretched length as elastic cord X. These two elastic cords are connected in parallel. The rod PQ remains horizontal.
State and explain the value of the force constant of each of the new elastic cords.

Each elastic cord experiences half of the tension as that in elastic cord X. Since the extension of each cord is the same as that of elastic cord to keep rod PQ horizontal [M1], therefore the force constant of each of the new cord is 5 N cm^{-1}. [A1]
OR
Since the elastic cords are connected in parallel, their effective force constant is same as that of elastic cord X, and the effective force constant is the sum of the force constants of the two cords [M1]. The force constant of each of the new cord is 5 N cm^{-1}. [A1]

…..
…..
..[2]

3 Fig. 3.1 shows the cross-section of two long straight wires X and Y perpendicular to the page, placed at a distance of 3.0 cm apart. There is an electric current in both wires out of the page. The current in wires X and Y are 1.0 A and 2.0 A respectively.

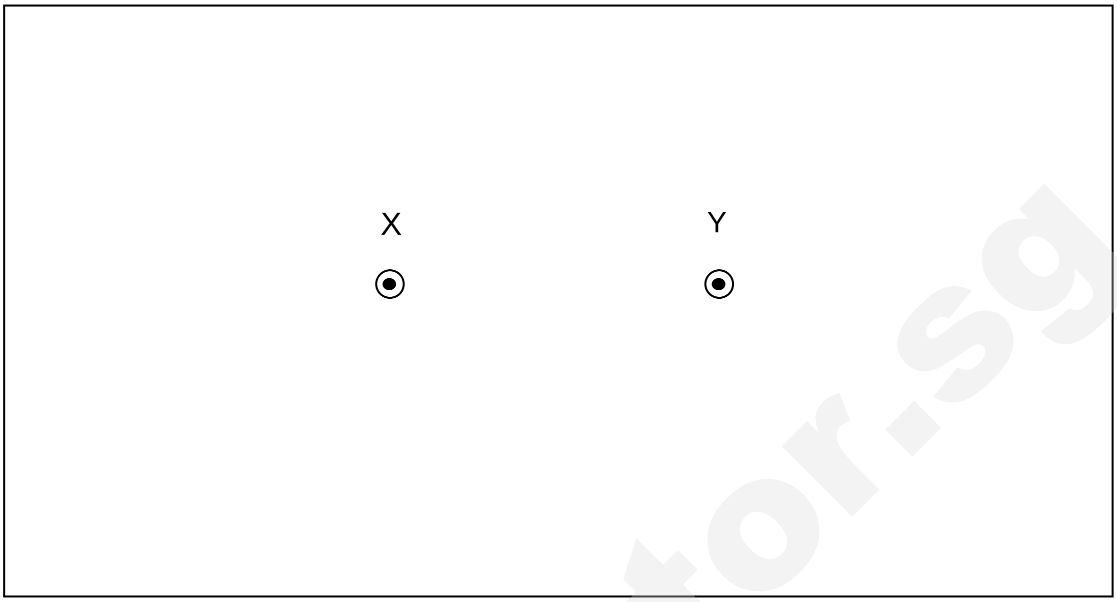


Fig. 3.1

(a) Sketch the resultant magnetic field pattern around the wires. Include direction arrows on the field lines. [3]

[B1]: Magnetic field lines are anti-clockwise.
[B1]: Magnetic field lines are closer together around Y compared to around X.
[B1]: Neutral point is closer to X than Y.

(b) Each wire exerts a force on the other wire. Draw one arrow on each wire to show the direction of these forces. [1]

[B1]: Force on X to right, force on Y to the left. Arrows should be of the same length. .

(c) For a straight current-carrying conductor, the magnetic flux density B at a distance r from the conductor is given by the relation

$$B = \left(2.0x10^{-7}\right)\frac{I}{r}$$

where I is the current flowing in the conductor.

Determine the magnetic flux density experienced by wire Y due to the current flowing in wire X.

$$B = \frac{\left(2x10^{-7}\right)\left(1.0\right)}{0.03}$$ [M1 substitution] [A1 answer]

$$= 6.67x10^{-5}T$$

magnetic flux density = …………………. T [2]

(d) Hence, determine the magnitude of the force per unit length between the wires.

$F = BIL$

$\frac{F}{L} = BI = \left(4.19x10^{-5}\right)\left(2.0\right)$ [M1 formula] [A1 substitution and answer]

$= 1.33x10^{-5}\ Nm^{-1}$

force per unit length = ………………… N m^{-1} [2]

4 (a) By reference to the photoelectric effect, explain why, even when the incident light is monochromatic, the emitted electrons have a range of kinetic energies up to a maximum value.

There is a range of kinetic energies depending on the location of the electrons with electrons that are on the surface being emitted with the maximum kinetic energy. [B1]
KE can be lower than the maximum energy because electrons that are deeper in the metal lose energy when they collide with other electrons or the lattice ions as they make their way to the surface. [B1]

……………………………………………………………………………………………

……………………………………………………………………………………………[2]

(b) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface, and the maximum kinetic energy E_{max} of 1/λ as shown in Fig. 4.1.

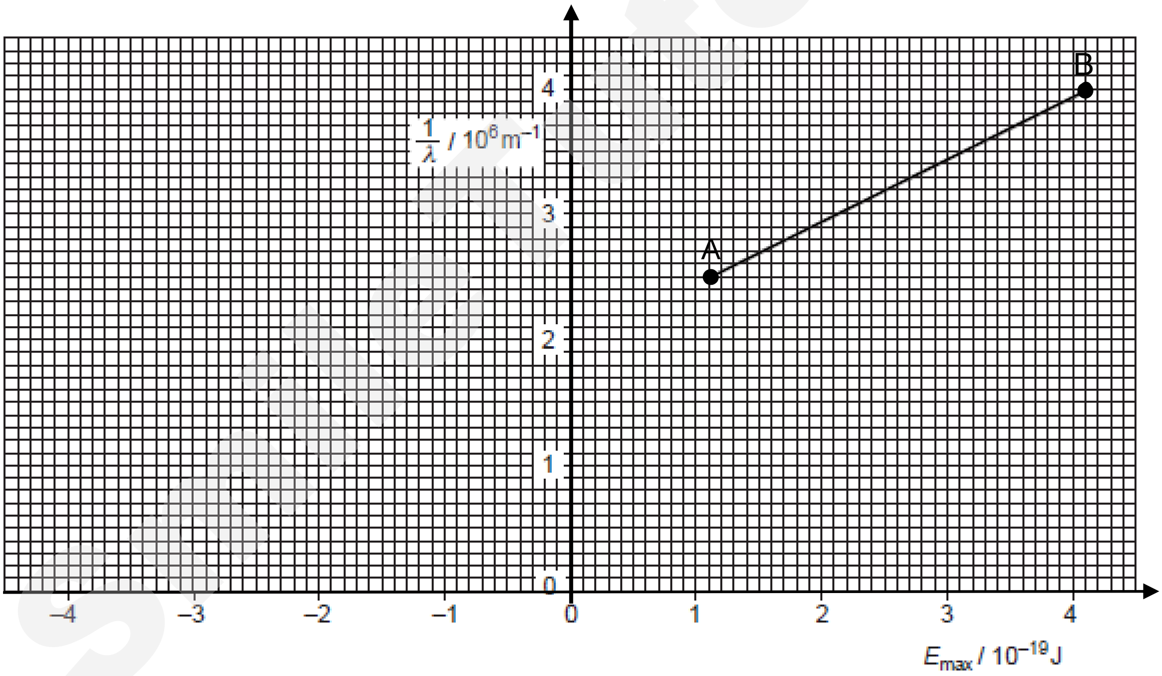


Fig. 4.1

(i) Without using the value of the Planck constant, determine the work function of the metal surface.

$hc/\lambda = \Phi + E_{max}$

$1/\lambda = \Phi/hc + E_{max}/hc$

At x-intercept, $\Phi = - E_{max}$

Either extend line to intersect on x-axis [M1]

Or form eqn of straight line to solve [M1]

$\Phi = 4.0 \times 10^{19\ J}$ (allow $\pm$ 0.2 x 10^{19} J) [A1]

work function = ……………… J [2]

(ii) Using points A and B, determine the Planck constant.

Gradient of line = 1/hc [M1]

Gradient = $\frac{(4.00-2.60)\times 10^{6}}{(4.10-1.10)\times 10^{-19}}$ = 5.00×10^{24}

Correct coordinates of points to half a square and correct calculation of gradient [M1]

h = 1/(c x gradient)

= 1/ ($3.0 \times 10^{8} \times 5.00 \times 10^{24}$)

= 6.67×10^{-34} Js [A1]

Planck constant = …………………….. J s [3]

(c) White light in a beam is incident on some cool hydrogen gas as shown in Fig. 4.2.

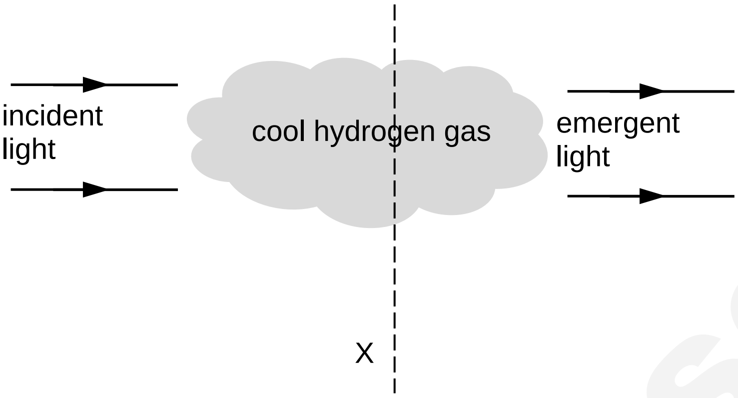


Fig. 4.2

Describe and explain the appearance of the spectrum viewed from position X.

……………………………………………………………………………………………………

[B1] Coloured lines against dark background
[B1] Spectrum exists because when the electrons in the gas de-excite to lower energy levels, the gas atoms emit photons of energies corresponding to the difference between the initial and final energy levels in all directions.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

…………………………………………………………………………………………………… [2]

5 A capacitor is an electrical device which can store charges and energy. A simple parallel plate capacitor consists of two parallel conducting plates separated by an insulator, as shown in Fig. 5.1.

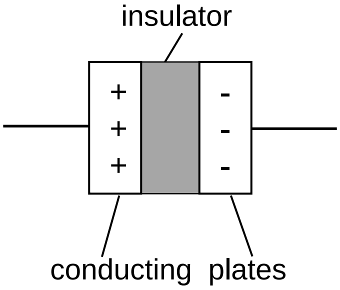


Fig. 5.1

When charged, the two plates carry opposite charges of the same magnitude. The relationship between the amount of charge stored Q, the potential difference V between the plates and the capacitance C is given by the equation

$$Q = CV$$

The capacitor is now charged. Fig. 5.2 shows the variation of the amount of charge Q with the potential difference V between the plates.

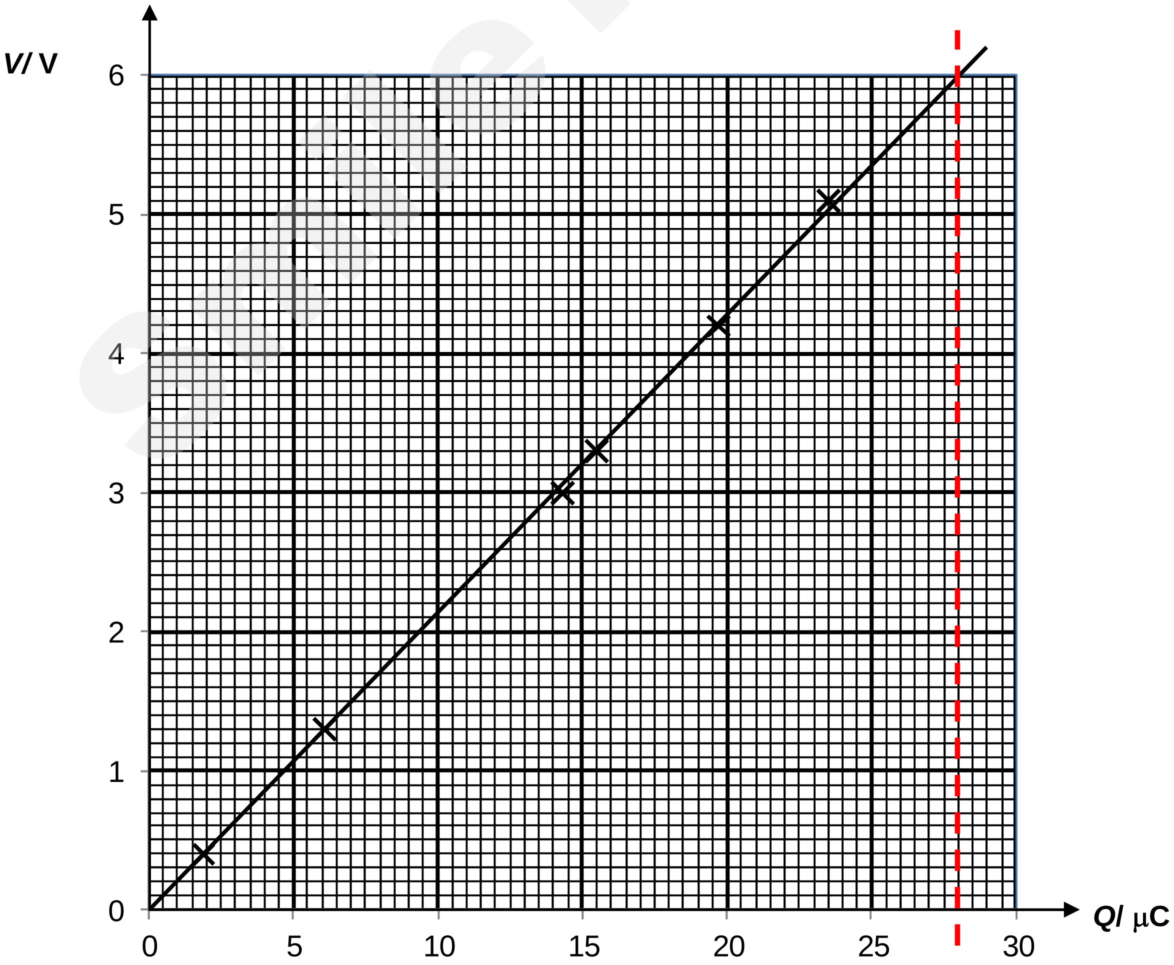


Fig. 5.2

(a) State the quantity represented by the gradient of the graph.

1/C or reciprocal of capacitance C .... [1]

(b) The capacitor is now discharged by connecting it across a resistor of resistance *R* as shown in Fig. 5.3.

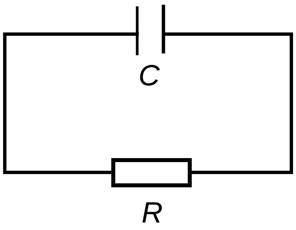


Fig. 5.3

Fig. 5.4 shows the variation with time *t* of the potential difference *V* across the resistor.

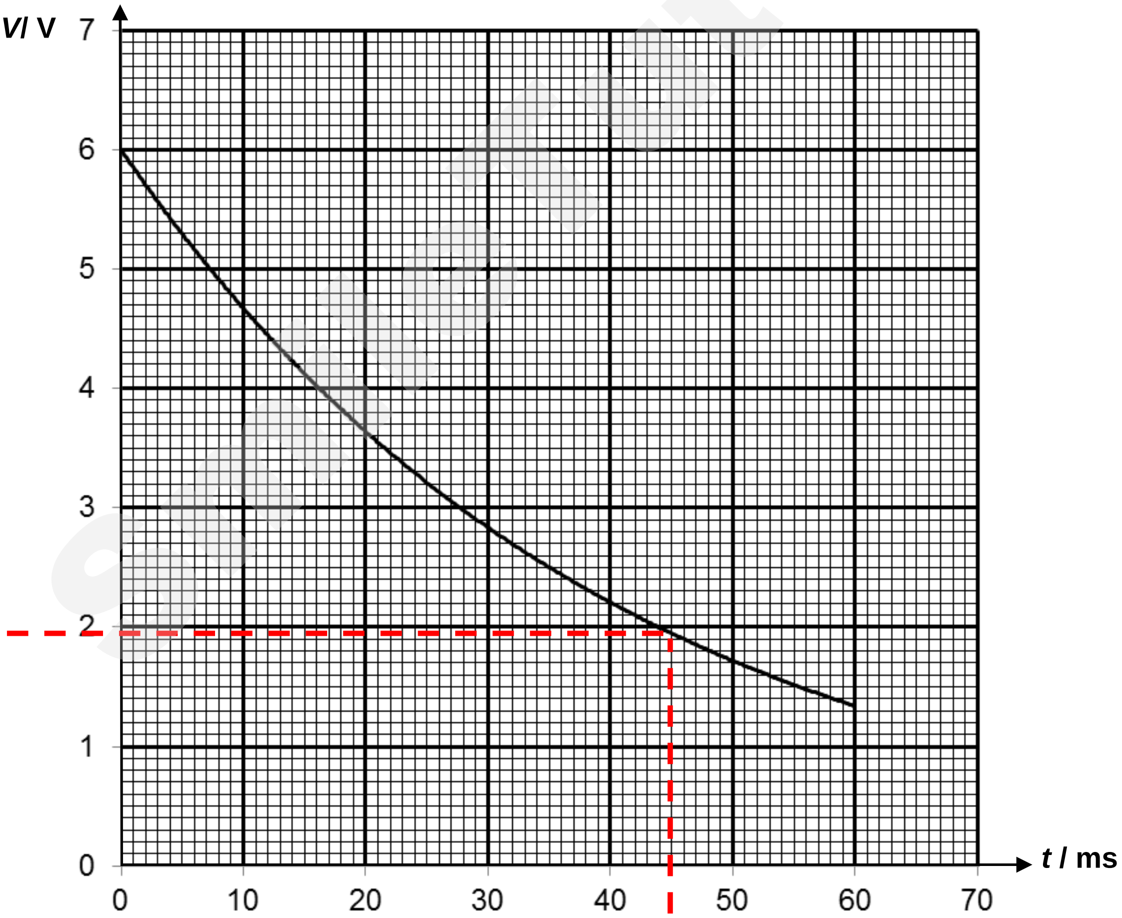


Fig. 5.4

(i) Using Fig. 5.2 and Fig. 5.4, determine the initial amount of charge stored.

From Fig 5.4, at t = 0, V = 6.00 V [M1]

From Fig 5.2, read off best fit line. At 6.00 V, Q = 28.00 μC [A1]

-1m overall for wrong d.p.

charge = ... μC [2]

(ii) Hence, calculate the capacitance *C*.

Q = CV
C = Q/V
= $28.00 \times 10^{-6} / 6.00$ [M1]
= 4.67×10^{-6} C V^{-1} [A1]

capacitance = ... C V^{-1} [2]

(iii) The energy *E* stored in a capacitor is ½ CV^2.
Calculate the energy lost when the capacitor has been discharged for 45 ms.

At 45 ms, V = 1.95 V [M1]

Energy lost = ½ C $(V_i^2 - V_f^2)$ [M1]
= ½ (4.67×10^{-6}) $(6.00^2 - 1.95^2)$
= 7.52×10^{-5} J [A1]

-1m overall for wrong d.p.

energy lost = ... J [3]

Section B

Answer two questions from this Section.

6 **(a)** State Newton's second law of motion.

Newton's 2nd Law states that the rate of change of momentum of a body is directly proportional to the resultant force acting on it [B1], and the change of momentum takes place in the direction of the resultant force. [B1]

[2]

(b) Two blocks, R and S, of masses 0.30 kg and 1.50 kg respectively, are connected by a string that passes over a pulley as shown in Fig. 6.1. The pulley is frictionless and the string is inelastic. The system is released from rest. Block S falls vertically before it strikes a spring that is firmly attached to the floor. The spring constant of the spring is 500 N m^{-1}.

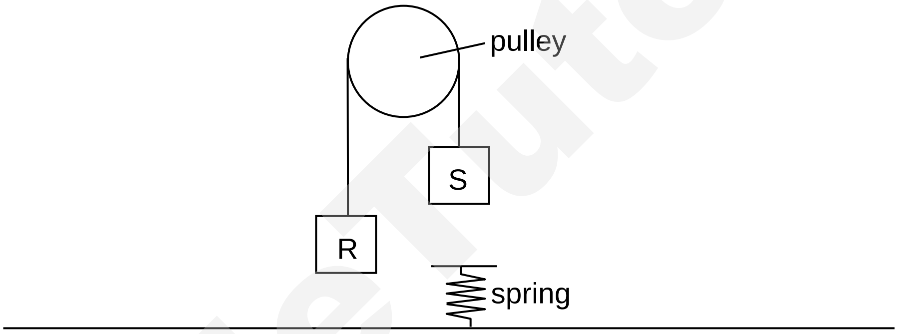
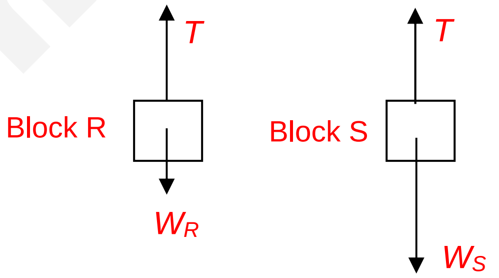


Fig. 6.1

(i) Draw the labelled free-body diagrams of Blocks R and S at the instant when the system is released from rest. [2]



Legend:
T = Tension
W_R = Weight of Block R
W_S = Weight of Block S

- T same magnitude on both [B1]
- $W_S > T > W_R$ [B1]

(ii) Determine the magnitude of acceleration of Block S before striking the spring.

Method 1
Using Newton's second law
Block R, taking upwards as positive
$T - W_R = m_R a$ (equation 1) [M1]
Block S, taking downwards as positive
$W_S - T = m_S a$ (equation 2) [M1]
Solving
$1.50(9.81) - (0.30)(9.81) = (1.50+0.30)a$
$a = 6.54$ m s^{-1} [A1]

Method 2
Using Newton's second law
Consider Blocks R and S as one system, taking downwards as positive
$W_S - W_R = (m_S + m_R)a$ [M1]
$1.50(9.81) - (0.30)(9.81) = (1.50+0.30)a$ [M1]
$a = 6.54$ m s^{-1} [A1]

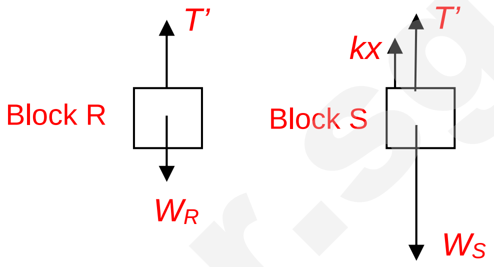
3]

(iii) The acceleration of Block S decreases after it touches the spring. Block S comes to a stop after some time and the spring is observed to be compressed.

1. By considering the free body diagrams of both blocks at equilibrium, show that the maximum compression of the spring is 0.0235 m. [2]

After Block S comes to a stop, the forces acting on Blocks R and S are in equilibrium.
$T' - W_R = 0$ (3)
$W_S - T' - kx = 0$ (4) [M1 for both]

Substitute (3) into (4),
1.50(9.81) – 0.30(9.81) – 500x = 0 [M1]
x = 0.0235 m



2. Hence, explain how the maximum compression would change if a spring of smaller spring constant is used.

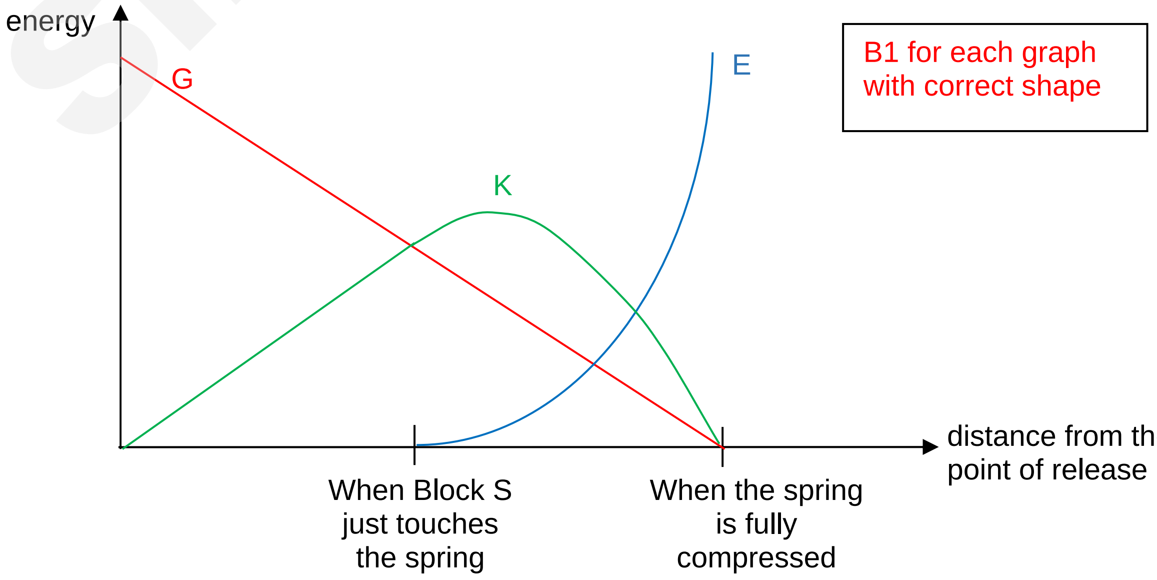
Since the <u>weights of the two blocks remain the same</u> [M1], when the spring constant decreases, the maximum compression <u>increases</u> [A1].

……………………………………………………………………………………

…………………………………………………………………………… [2]

(iv) Sketch on Fig. 6.2 for Block S, the variation with the distance from the point of release of its

1. gravitational potential energy (label the graph G),
2. elastic potential energy (label the graph E),
3. kinetic energy (label the graph K). [3]



B1 for each graph with correct shape

Fig. 6.2

(c) Truck X of mass 22 000 kg and moving at a speed of 3.0 m s^{-1}, catches up and collides with Truck Y moving at 1.0 m s^{-1} moving in the same direction as shown in Fig. 6.3.

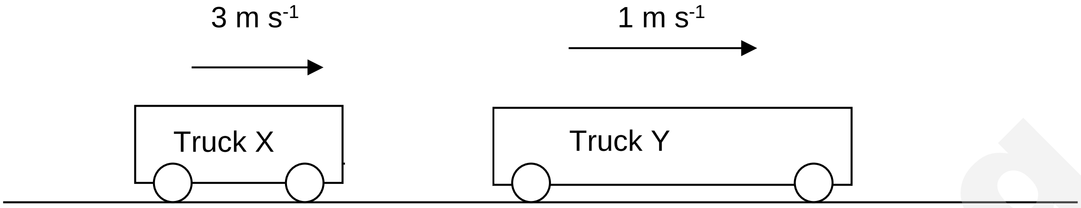


Fig. 6.3

Fig. 6.3 shows the variation of speeds *v* of the trucks with time *t* before, during and after the collision.

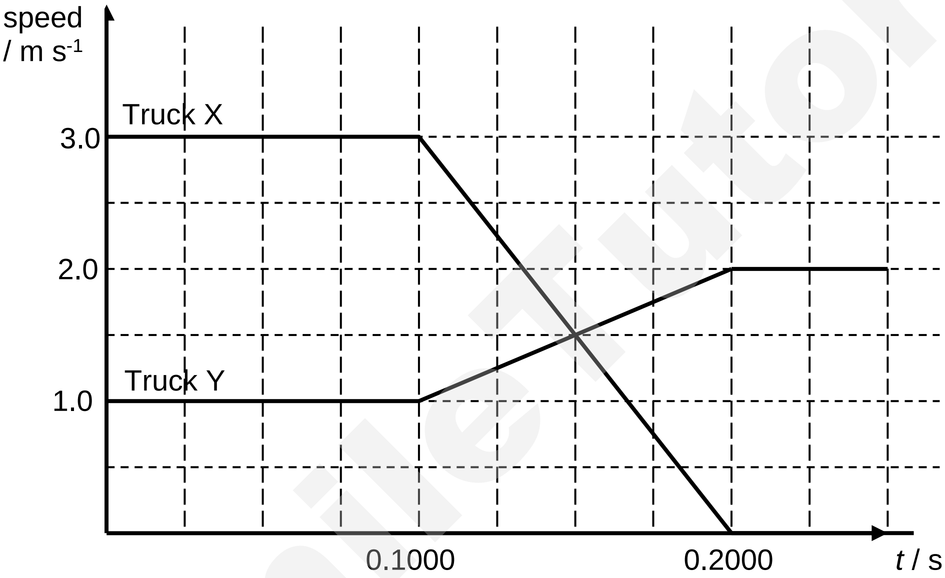


Fig. 6.3

(i) Using Fig. 6.3, show that the mass of Truck Y is 66000 kg. [2]

Using Principle of Conservation of Linear Momentum,
Total momentum before collision = Total momentum after collision
or
$m_X u_X + m_Y u_Y = m_X v_X + m_Y v_Y$ [M1]
$22000(3.00) + m_Y(1.00) = 0 + m_Y(2.00)$ [M1]
$m_Y = 66000$ kg

(ii) Show that the collision is elastic. [1]

Total kinetic energy before collision = ½ x 22000 x 3^2 + ½ x 66000 x 1^2
= 99000 + 33000
= 132 000 J
Total kinetic energy after collision = 0 + ½ x 66000 x 2^2 = 132 000 J
[M1 for both total KE before and after]

OR

Relative speed of approach = $u_X - u_Y$ = 3 - 1 = 2 m s^{-1}
Relative speed of separation = $v_Y - v_X$ = 2 – 0 = 2 m s^{-1}
[M1 for both RSA and RSS]

(iii) 1. Calculate the magnitude of the impulse exerted by Truck X on Truck Y.

Impulse
= change in momentum
= 66 000 (2 – 1) [M1]
= 66 000 N s [A1]

magnitude of the impulse = ………………… N s [2]

2. If the duration of collision is reduced, with initial and final speed of both trucks remain unchanged, state and explain how this affects your answer in **1**.

The change in momentum of Truck Y remains the same since there is no change in the initial and final speeds of both trucks.
By Impulse-momentum theorem, the impulse remains unchanged. [B1]

..

1]

7 **(a)** State what is meant by *coherent sources*.

Coherent sources are sources that emit waves with constant phase difference. [B1]
This means that the waves have the same frequency/wavelength/speed (any 2). [B1]

……………………………………………………………………………………………..….

…………………………………………………………………………………………… [2]

(b) Fig. 7.1 below shows a progressive wave displayed on a cathode ray oscilloscope (c.r.o.). Sketch on Fig. 7.1 <u>one cycle</u> of a wave that has a phase difference of $\frac{\pi}{2}$ radians with the progressive wave.

[2]

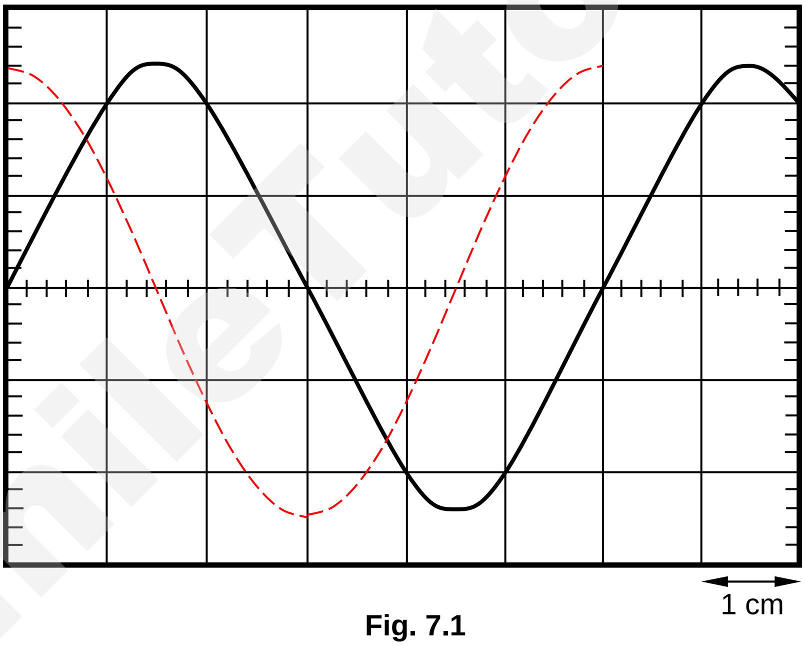


Fig. 7.1

Sinusoidal wave with same period: [M1]
Correct phase difference: [A1]

(c) A stereo system in a large hall has two identical speakers, S_1 and S_2, placed 1.2 m apart as shown in Fig. 7.2. The amplitude of the output of each speaker is proportional to the potential difference across its terminals, which is adjusted by means of a balance control.

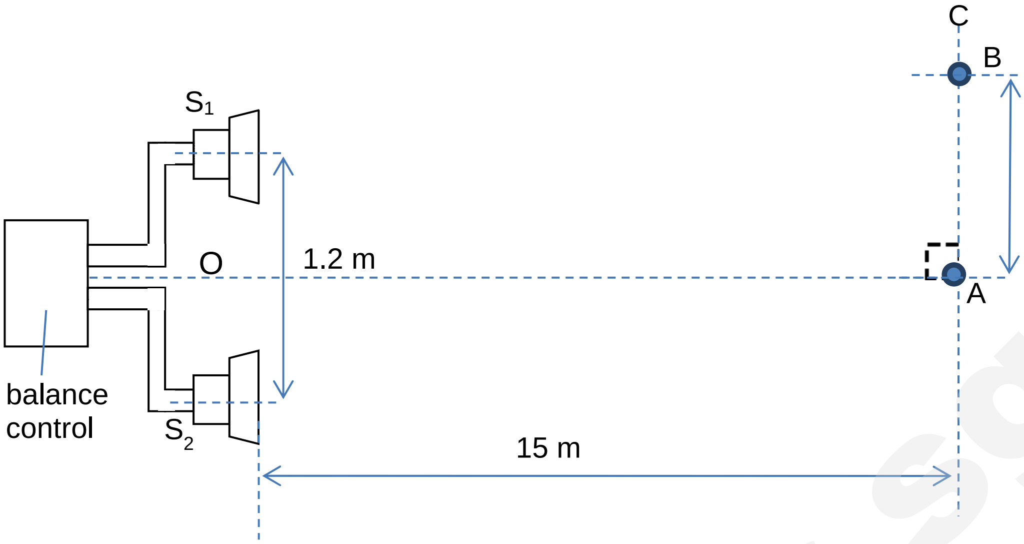


Fig. 7.2 (not to scale)

Initially, the speakers are emitting signals of frequency 1000 Hz which are in phase. The balance control is set such that the potential difference across the terminals of both speakers are the same.

Line AC is 15 m away from the speakers. An observer hears a loud sound of intensity I_{max} at A. As he moves along the line AC, 15 m away from the speakers, he observes that the intensity of the sound first falls to zero at point B, a distance *y* from A. The speed of sound in air is 330 m s^{-1}.

(i) Using Young's Double Slit formula, determine the distance between adjacent positions of loud sounds.

$\lambda = \frac{v}{f} = \frac{330}{1000} = 0.33m$ [B1]

$x = \frac{\lambda D}{a} = \frac{(0.33)(15)}{1.2}$ [M1 for formula, A1 for answer]

$= 4.2m$

distance = ……………. m [3]

(ii) Hence, show that the distance *y* is 2.1 m. [1]

y is the distance between the central maxima and the first order minima, hence it is half the distance between adjacent maxima. [B1]

Therefore, y = 4.2 / 2 = 2.1 m.

(iii) The balance control is now adjusted such that the amplitude of the signal from S_1 is reduced while the amplitude of the signal from S_2 is unchanged.

Suggest and explain any changes to the sound heard at B.

A sound is now heard at B. [B1]
This is because there is now a difference between the amplitudes of the sounds at B, resulting in incomplete destructive interference. [B1]

……………………………………………………………………………………………..….

…………………………………………………………………………………………… [2]

(iv) State the effect on the interference pattern along the line AC when the distance between the two speakers is decreased.

The distance between adjacent positions of loud and no sounds increases. [B1]

…………………………………………………………………………………………… [1]

(d) Fig. 7.3 shows a string stretched between two fixed points P and Q.

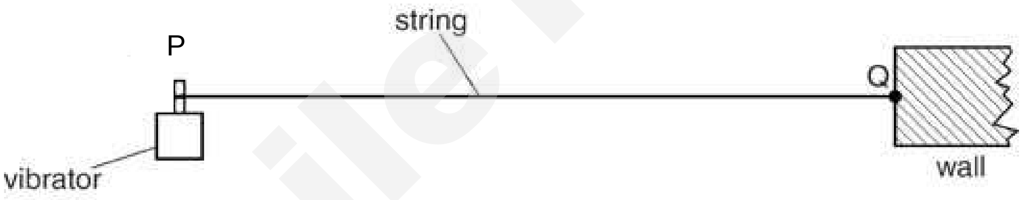


Fig. 7.3

A vibrator is attached at end P of the string. End Q is fixed to a wall. The stationary wave produced on PQ at one instant of time *t* is shown on Fig. 7.4. Each point on the string is at its maximum displacement.

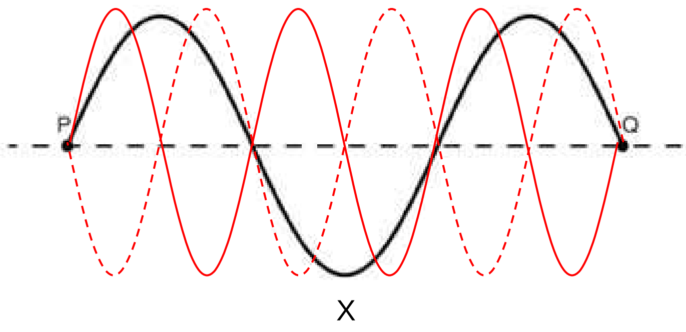


Fig. 7.4

(i) Explain how this arrangement may produce a stationary wave on the string.

The wave from P travels along string and reflects at Q [B1]. Hence the 2 waves travel in opposite directions.

The incident and reflected waves, which have the same amplitude, speed and frequency/wavelength travelling in opposite directions, interfere / superpose to form a stationary wave. [B1]

(ii) It takes 0.01 s for the point X on the string to reach the highest point of its oscillation.

Calculate the frequency of the vibrator.

$$f = \frac{1}{T}$$
$$= \frac{1}{2x0.01}$$
$$= 50Hz$$
[B1 for formula, B1 for answer]

(iii) The length of PQ is 1.2 m. Determine the wavelength of the stationary wave.

$$1.5\lambda = 1.2$$
$$\lambda = \frac{2}{3}x1.2 = 0.8m$$
[B1 for identifying wavelength as 2/3 of length of PQ, B1 for answer]

wavelength = ... m [2]

(iv) Hence, show that the speed of the stationary wave is 40 m s^{-1}. [1]

$$v = f\lambda = (50)(0.8)$$
$$= 40ms^{-1}$$
[B1 for formula and substitution]

(v) Draw on Fig. 7.4 the stationary wave when the frequency of the vibrator is doubled while keeping the speed of the wave constant. [2]

[B1]: Wavelength of 0.4 m (ie distance between adjacent nodes/antinodes is 0.2m)
[B1]: Must draw both the bolded and dotted lines to indicate that it is a stationary wave.

8 **(a)** A household electric lamp is rated as 240V, 40W. The filament lamp is made from tungsten wire of radius 5.0×10^{-6} m. The resistivity of tungsten at the normal operating temperature of the lamp is 7.9×10^{-7} Ωm.

(i) For the lamp at its normal operating condition, show that the resistance of the filament is 1440 Ω.

$P = V^2 / R$
$40 = 240^2 / R$ *[M1]*
$R = 1440\ \Omega$ [A0]

[1]

(ii) Calculate the length of the filament.

$R = \rho L / A$ [C1]
$1440 = (7.9 \times 10^{-7})\ L\ /\ [\pi(5.0 \times 10^{-6})^2]$ [M1]
$L = 0.143$ m [A1]

length = ………………………….. m [3]

(iii) Comment on your answer in **(ii)**.

The length of the filament is too long for the lamp. [B1]
So, the filament must be coiled. [B1]

…. [2]

(b) An electric heater consists of three similar heating elements A, B, C, connected as shown in Fig. 8.1.

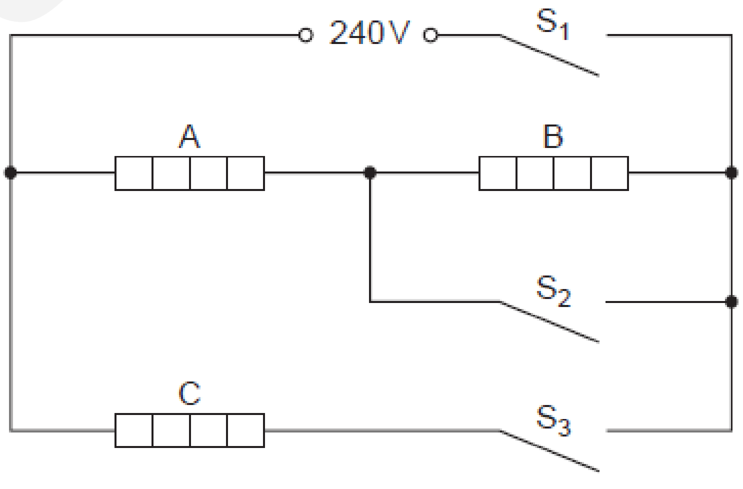


Fig. 8.1

Each heating element is rated as 1.5kW, 240V and may be assumed to have constant resistance.
The circuit is connected to a 240 V supply.

The switches S_1, S_2 and S_3 may be either open or closed.

(i) When S1, S2 and S3 are all closed, state the total power dissipation of the heater.

B is bypassed and current flows through A and C. P.d. across A and C is 240V.
So A and C dissipates 1.5 kW each, and collectively 3.0 kW.

total power dissipation = ……………………….. kW [1]

(ii) When S1 is closed, S2 is open, and S3 is open, show that the total power dissipation of the heater is 0.75 kW. [2]

Current flows through A and B, but not C. P.d. across A and B is 120V each. Since $P=V^2/R$, power is proportional to V^2 (for constant R).

$$\frac{P_{120}}{P_{240}}=\frac{V_{120}^2}{V_{240}^2}$$

$$\Rightarrow P_{120}=P_{240}\frac{V_{120}^2}{V_{240}^2}=1.5\frac{120^2}{240^2}=0.375\text{ kW} \quad \text{[M1]}$$

$$\Rightarrow P_{total}=0.375+0.375 \quad \text{[A1]}$$

$$=0.750\text{ kW (shown)}$$

(iii) Hence, determine the total power dissipation of the heater when S1 is closed, S2 is open, and S3 is closed.

Current flows through A, B and C. P.d. across A and B is 120V each, and as found in part (4) previously the power dissipated in A and B collectively is 0.75 kW.
P.d. across C is 240V, so power dissipated in C is 1.5kW.
Thus, all together, the total power dissipated in A, B and C = 0.75 + 1.5 = 2.25 kW [A1]

total power dissipation = ……………………….. kW [1]

(c) On Fig. 8.2, sketch the temperature characteristic of a thermistor.

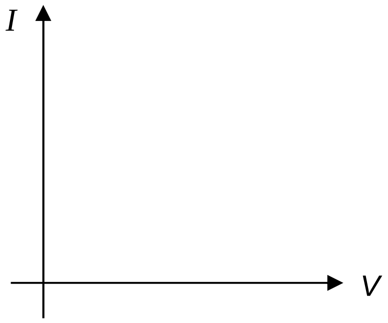
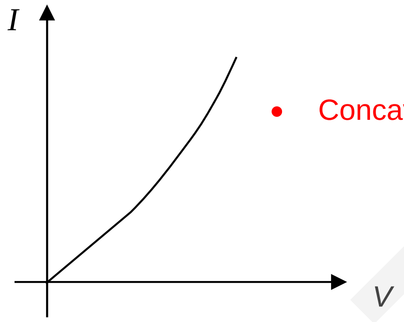


Fig. 8.2

[1]



- Concave upward [B1]

(d) A potential divider circuit is shown in Fig. 8.3.

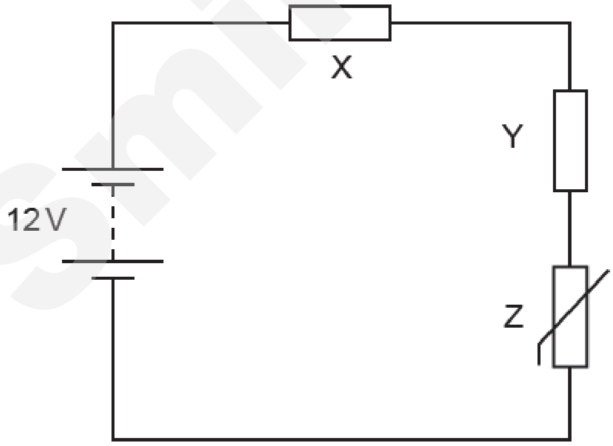


Fig. 8.3

The battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected in series with resistors X and Y and thermistor Z. The resistance of Y is 15 kΩ and the resistance of Z at a particular temperature is 3.0 kΩ. The potential difference (p.d.) across Y is 8.0 V.

(i) By reference to the circuit shown in Fig. 8.3, distinguish between the definitions of e.m.f. and p.d.

The electromotive force of a source is the electrical energy converted from other forms of energy per unit charge delivered round a complete circuit. [B1]

The potential difference between two points in a circuit is the amount of energy converted from electrical to other forms of energy per unit charge passing from one point to the other. [B1]

……………………………………………………………………………………… [2]

(ii) Calculate the current in the circuit.

$I = V/R$
$= 8/(15 \times 10^3)$ [M1]
$= 0.53 \times 10^{-3}$ A [A1]

current = ………………………….. A [2]

(iii) Calculate the resistance of X.

p.d. across X = $12 - 8.0 - (3.0 \times 10^3)(0.53 \times 10^{-3}) = 2.4$ V [M1]
$R_x = 2.4 / (0.53 \times 10^{-3})$ [M1]
$= 4.52 \times 10^3\ \Omega$ [A1]

OR

$R_{total} = 12 / (0.53 \times 10^{-3}) = 22.5 \times 10^3$ [M1]
$R_X = (22.5 - 15.0 - 3.0) \times 10^3$ [M1]
$= 4.52 \times 10^3\ \Omega$ [A1]

resistance = ………………………….. Ω [3]

(iv) The temperature of Z is decreased.
State and explain the effect of this on the potential difference across Z.

Resistance of Z increases hence current in circuit is smaller. [M1]
P.d. across X and Y decreases, hence p.d. across Z increases. [A1]

OR
By potential divider principle,
R_Z increases so $R_Z / (R_X + R_Y + R_Z)$ is larger. [M1]
Therefore p.d. across Z increases. [A1]

……………………………………………………………………………………… [2]

END OF PAPER

Class	Index Number	Name
16		

ST. ANDREW'S JUNIOR COLLEGE
JC 2 2017
Preliminary Examination Paper 1

PHYSICS, Higher 1 **8866/01**

19 Sept 2017 **1 hour**

Instructions to students:

There are **thirty** questions in this paper. Answer **all** the questions. For each question there are four possible answers **A, B, C, D.**

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet (OMS).

Each correct answer will score one mark. Double entry of choices will be considered as a wrong answer. A mark will not be deducted for a wrong answer.

This question paper consists of <u>15</u> printed pages including this page.

DATA AND FORMULAE

Data

speed of light in free space	c	=	3.00×10^{8} m s^{-1}
elementary charge	e	=	1.60×10^{-19} C
the Planck constant	h	=	6.63×10^{-34} Js
unified atomic mass constant	u	=	1.66×10^{-27} kg
rest mass of electron	m_e	=	9.11×10^{-31} kg
rest mass of proton	m_p	=	1.67×10^{-27} kg
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p\Delta V$
hydrostatic pressure	p	=	ρgh
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

1 Which of the following pairs of units are both SI base units?

A ampere, degree celsius
B ampere, kelvin
C coulomb, degree celsius
D coulomb, kelvin

2 The quantities p and q are measured with estimated errors of Δp and Δq respectively. The quantity r is related to p and q as follows:

$$r = p - 3q$$

Which of the following expression provides the best estimate of the fractional uncertainty of r?

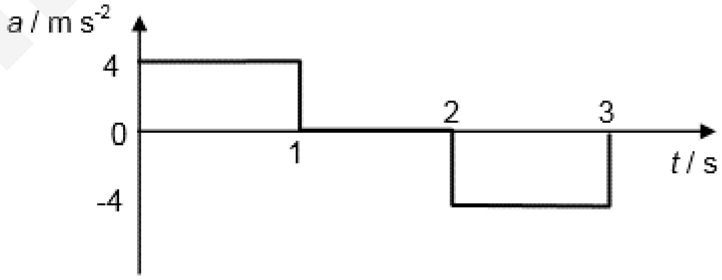
A $\frac{\Delta r}{r} = \frac{\Delta p + 3\Delta q}{p - 3q}$ **B** $\frac{\Delta r}{r} = \frac{\Delta p - 3\Delta q}{p - 3q}$

C $\frac{\Delta r}{r} = \frac{\Delta p}{p} + 3\frac{\Delta q}{q}$ **D** $\frac{\Delta r}{r} = \frac{\Delta p}{p} - 3\frac{\Delta q}{q}$

3 A car accelerates from rest at 2 m s^{-2} on a straight road and then comes to rest after applying the brakes. The total distance travelled by the car is 100 m and the overall time taken is 20 seconds. Determine the maximum velocity attained by the car.

A 5 m s^{-1} **B** 10 m s^{-1} **C** 15 m s^{-1} **D** 20 m s^{-1}

4 The graph below shows the variation with time of the acceleration of a particle. The particle is at rest at time t = 0 s. Determine the displacement of the particle after three seconds.



A 0 m **B** 8 m **C** 12 m **D** 16 m

5 A body is released from rest and falls vertically in air of constant velocity.

Which statement about the motion of the falling body is correct?

A As it accelerates, its weight decreases so that its acceleration decreases until it travels with constant velocity.

B It accelerates initially at 9.8 m s^{-2} but the drag force increases so its acceleration decreases.

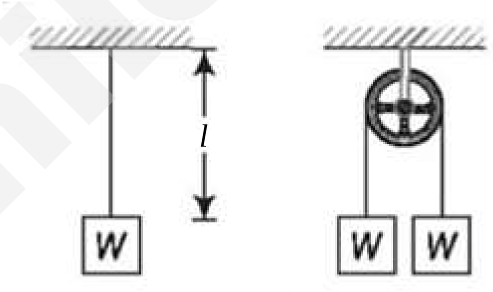
C Its velocity increases at a constant rate until its velocity becomes constant.

D The drag force of the air increases continually and eventually the velocity decreases.

6 A boy threw a ball of mass 0.2 kg vertically upwards. He applied a constant force *F* upwards on the ball as his hand moved by 0.2 m before he released the ball. The ball travelled up to a maximum height of 2.0 m from the release level. Determine the magnitude of the force *F*.

A 4.0 N **B** 16 N **C** 20 N **D** 22 N

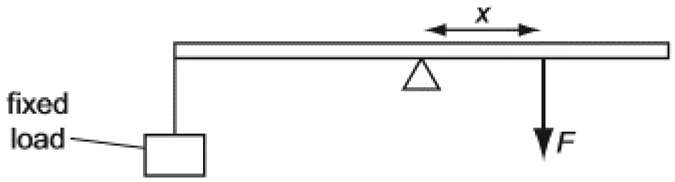
7 Two identical wires of length *l* are loaded in two different ways as shown in the figure.



The ratio of the extensions in the two cases is

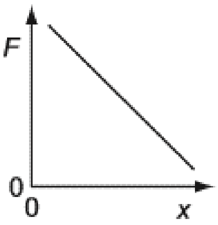
A 1 **B** 2 **C** 2.5 **D** 4

8 A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one end of the bar. To keep the bar in equilibrium, a force *F* is applied at a distance *x* from the pivot.

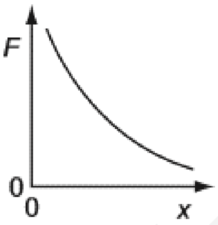


How does *F* vary with *x*?

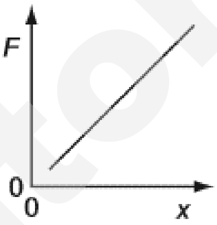
A



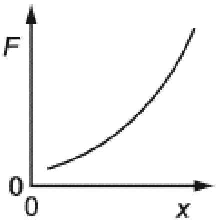
B



C



D



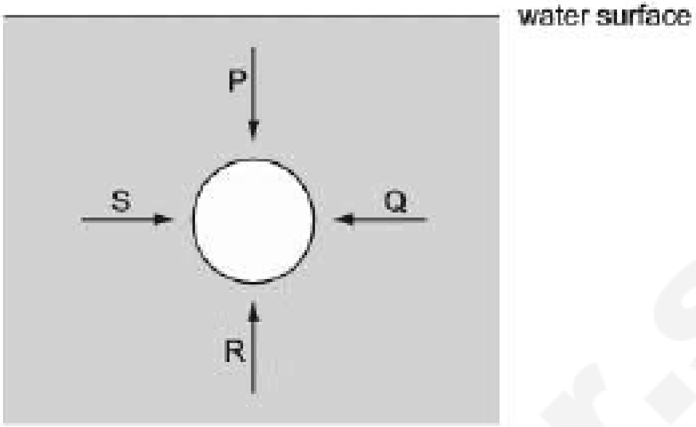
9 Two masses 1 kg and 4 kg are moving with equal kinetic energies. The ratio of their linear momenta is

A $1:\sqrt{2}$ **B** $1:2$ **C** $1:4$ **D** $1:6$

10 A freight engine pulls several train carriages of mass 200 tonnes up an inclined plane at a constant speed of 15 m s^{-1}. The engine travels a height of 1 m for every 98 m on the inclined plane. The mass of the engine is 100 tonnes and the resistive force is 20 N per tonne. What is the power exerted by the engine?

A 90 kW **B** 300 kW **C** 450 kW **D** 540 kW

11 The diagram represents a sphere under water. P, Q, R and S are forces acting on the sphere, due to the pressure of the water.



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

Which information about the magnitudes of the forces is correct?

A P < R and S = Q

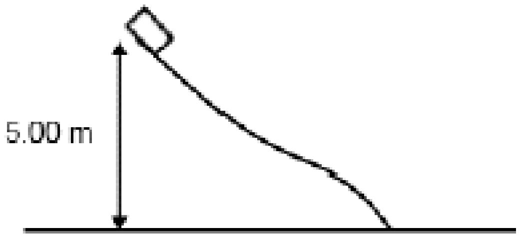
B P > R and S = Q

C P = R and S = Q and P ≠ S

D P = R and S = Q and P = S

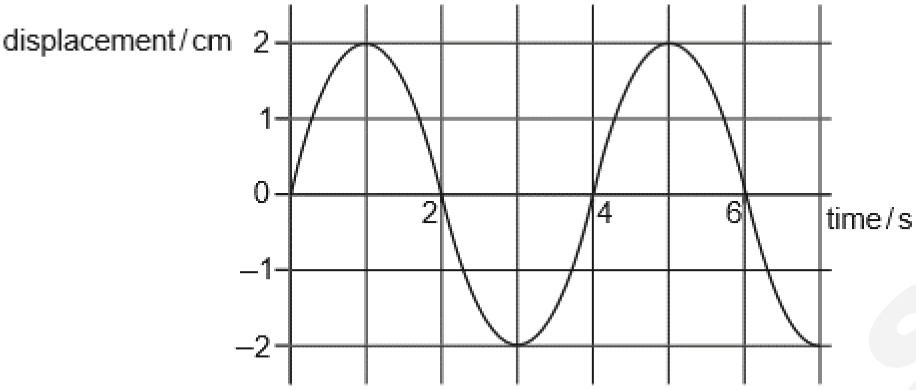
12 At a height of 5.00 m above the ground, a 50.0 kg block is released from the top of the slope with an initial speed of 2.10 m s^{-1}. It then travels a distance of 10.0 m along a curved slope to the ground. The final speed of the block at the end of the slope is only 4.90 m s^{-1} because a constant resistive force acts on it during the descent.

Determine the magnitude of the resistive force.



A 185 N **B** 196 N **C** 550 N **D** 2450 N

13 The graph shows how the displacement of a particle in a wave varies with time



Which statement is correct?

A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B The wave has an amplitude of 2 cm and must be transverse.

C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D The wave has an amplitude of 4 cm and must be transverse.

14 A vibrating tuning fork of frequency 340 Hz is placed above a vertical cylindrical tube closed at the lower end. The length of the tube is 120 cm. Water is slowly poured in until a loud sound is produced by the tube. Determine the minimum water level in the tube when this resonant sound is produced. (Assume speed of sound is 340 m s^{-1})

A 0.25 m **B** 0.45 m **C** 0.75 m **D** 0.95 m

15 In a Young's double slit experiment, the separation between the slits is 0.5 mm. The distance between the screen and slits is 1.5 m. For a monochromatic light of wavelength 500 nm, determine the distance of the 3rd minima from the central maxima.

A 0.75 mm **B** 1.50 mm **C** 2.25 mm **D** 3.75 mm

16 A beam of light consisting of two wavelengths 650 nm and 520 nm is used to obtain interference fringes in Young's double slit experiment. The distance between slits is 2 mm and between the plane of slits and screen is 120 cm. The least distance from the central maximum where the bright fringes due to both wavelengths coincide is

A 1.17 mm **B** 1.56 mm **C** 3.12 mm **D** 3.34 mm

17 Which effect provides direct experimental evidence that light is a transverse, rather than a longitudinal wave?

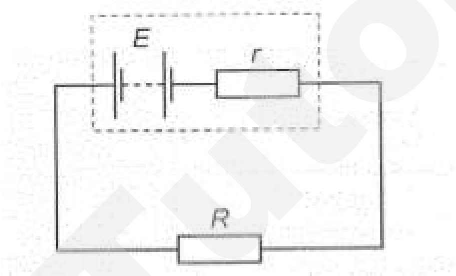
A Light can be diffracted.

B Two coherent light waves can be made to interfere.

C The intensity of light from a point source falls off inversely as the square of the distance from the source.

D Light can be polarised.

18 A battery of electromotive force (e.m.f.) *E* and internal resistance *r* is connected in series with a resistor of resistance *R* as shown.

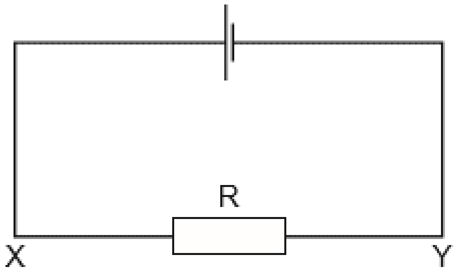


The battery transfers energy *W* at a constant rate in driving charge *Q* round the circuit in time *t*.

What is the e.m.f. *E* of the cell and the potential difference (p.d.) *V* across the external resistor?

	e.m.f. *E*	p.d. *V*
A	$\frac{W}{Q}$	RQ
B	$\frac{W}{Q}$	$R \times \frac{Q}{t}$
C	$(r + R) \times \frac{Q}{t}$	$\frac{W}{Q}$
D	$R \times \frac{Q}{t}$	$\frac{W}{Q}$

19 The current in the circuit shown is 4.8 A.



What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	3.0×10^{19} s^{-1}
B	X to Y	6.0×10^{19} s^{-1}
C	Y to X	3.0×10^{19} s^{-1}
D	Y to X	6.0×10^{19} s^{-1}

20 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate.

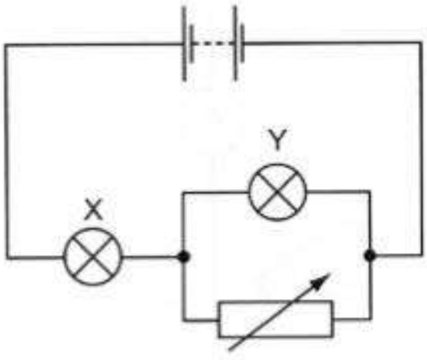
A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

The resistance of each of these wires is 0.0050 Ω per metre.

What is the minimum output e.m.f. of the power supply?

A 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

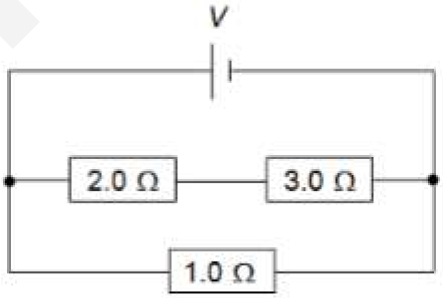
21 A circuit contains a battery, two identical lamps X and Y, and a variable resistor.



The resistance of the variable resistor is decreased. What will happen to the brightness of the lamps?

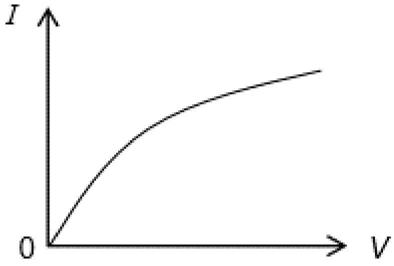
	lamp X	lamp Y
A	brighter	brighter
B	brighter	less bright
C	less bright	brighter
D	less bright	less bright

22 In the circuit below, the electromotive force of the power supply is *V*. If the power dissipated by the 2.0 Ω resistor is *P*, what is the total power supplied by the power supply?



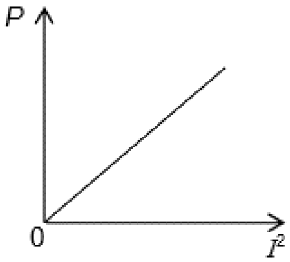
A 3*P* **B** 9*P* **C** 15*P* **D** 78*P*

23 The graph below shows the variation of the current I through a lamp with potential difference V across it.

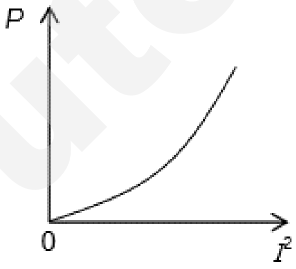


Which of the following graphs best represents the variation of power P dissipated in the same lamp, with I^2?

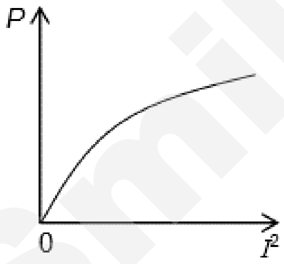
A



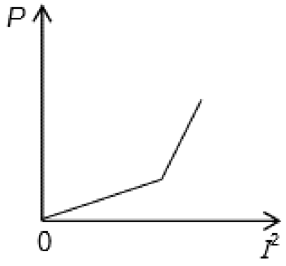
B



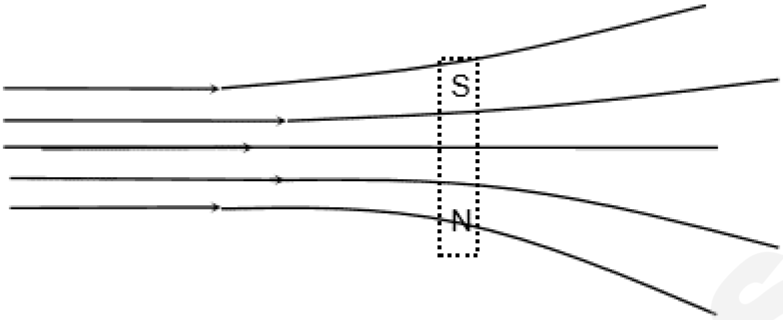
C



D



24 A bar magnet is to be placed in a non-uniform magnetic field as shown.



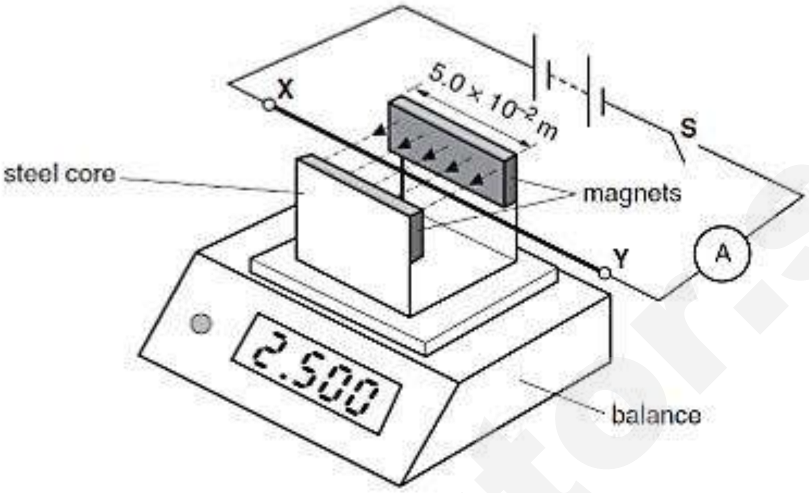
Which line of the table describes the subsequent motion of the magnet?

	rotation	movement
A	anticlockwise	To the left
B	anticlockwise	To the right
C	clockwise	To the left
D	clockwise	To the right

25 Assuming lightning strikes are vertically downwards and they consist of negative charges, in which direction would a lightning occurring at the equator be deflected by the magnetic field of the Earth?

A North **B** South **C** East D West

26 The figure below shows a rigid, straight metal rod XY placed perpendicular to a magnetic field of magnetic flux density 0.080 T. The magnetic field is produced by two magnets that are placed on a U-shaped steel core. The steel core sits on a digital balance. The weight of the steel core and magnets is 2.500 N as displayed on the balance.



When switch S is closed, the ammeter gives a reading of 4.0 A. What is the new reading on the balance?

A 2.448 N **B** 2.484 N **C** 2.500 N **D** 2.516 N

27 A blue laser beam is incident on a metallic surface, causing electrons to be ejected from the metal. If the frequency of the laser beam is increased while the intensity of the beam is held fixed,

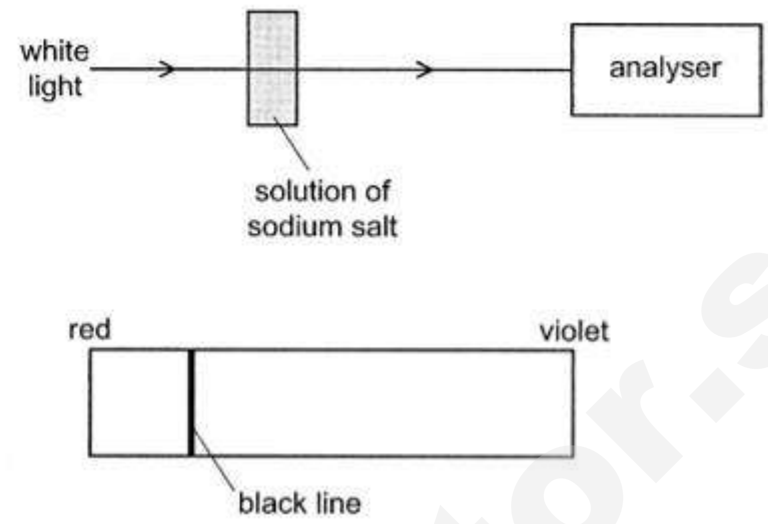
A the rate of ejected electrons will decrease and the maximum kinetic energy will increase.

B the rate of ejected electrons will remain the same but the maximum kinetic energy will increase.

C the rate of ejected electrons will increase and the maximum kinetic energy will increase.

D the rate of ejected electrons will remain the same but the maximum kinetic energy will decrease.

28 White light is passed through a solution containing a sodium salt. The light which emerges is analyzed to form a spectrum.



The spectrum consists of a continuous band of colour from red to violet, with a black line in the yellow region.

Why is the black line produced in this spectrum?

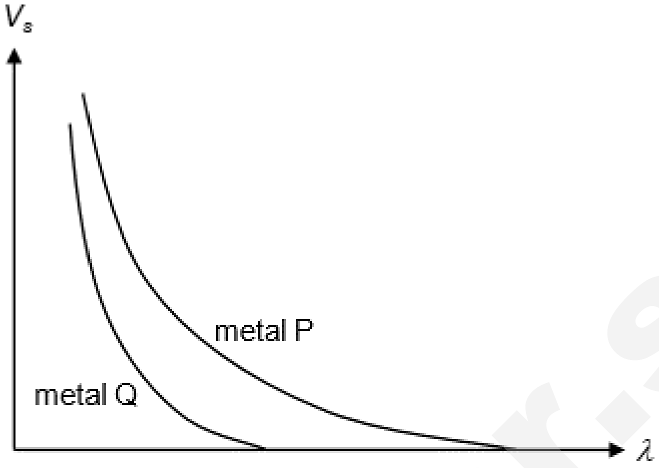
A Electrons of a particular energy are absorbed by the sodium salt.

B Electrons of a particular energy are emitted by the sodium salt.

C Photons of a particular energy are absorbed by the sodium salt.

D Photons of a particular energy are emitted by the sodium salt.

29 The figure below shows the variation of stopping potential V_s with the wavelength of the radiation λ incident on 2 different metals, P and Q.



Which of the following statements is correct?

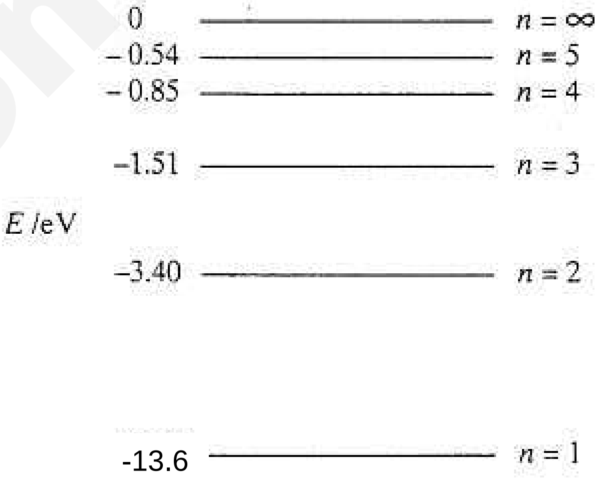
A A higher frequency light is required to produce photoelectric effect in metal Q than in P.

B The work function of metal P is higher than Q.

C The intensity of light incident on metal P is higher than that on Q.

D The gradient of the tangent to the curve gives the value of the Planck constant.

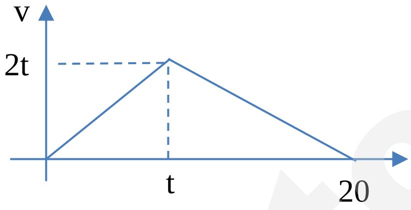
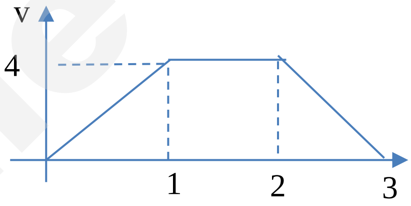
30 A hydrogen atom in its ground state is irradiated by light of wavelength 97.0 nm. Determine the number of lines present in the emission spectrum produced.



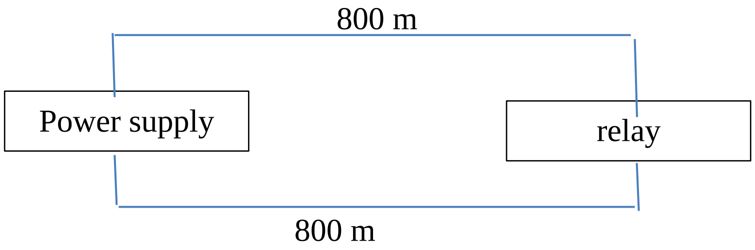
A 1 **B** 3 **C** 5 **D** 6

JC2 Preliminary Exam 2017 (H1 Physics)

Paper 1 Solutions

Qn	**Ans**	
1	B	
2	A	$\frac{\boldsymbol{\Delta r}}{\boldsymbol{r}} = \frac{\boldsymbol{\Delta(p-3q)}}{\boldsymbol{p-3q}}$ $\frac{\boldsymbol{\Delta r}}{\boldsymbol{r}} = \frac{\boldsymbol{\Delta p+3\Delta q}}{\boldsymbol{p-3q}}$
3	B	 Area under v-t graph = 0.5 x 20 x 2t = 100 t = 5s use v = u + at = 5 x 2 =10
4	B	 Area under v-t graph = 0.5 x 4 x (3+1) = 8
5	B	
6	D	Since the ball reaches max hgt of 2.0m Find the initial velocity after release from the hand $v^2 = u^2 + 2as$ $0 = u^2 + 2\ (-9.81)\ 2.0$ u = 6.26 m s^{-1} Conservation of Energy Work done by hand = ΔE = ΔGPE+ ΔKE F x 0.2 = 0.2 (9.81) 0.2+ 0.5 (0.2) 6.26^2 F = 21.6 N
7	A	
8	B	Principle of moments

		WL/2 = Fx F = const / x
9	B	Let KE be K $K = \frac{p^2}{2m}$ For 1kg : $p_1 = \sqrt{2K}$ For 4kg : $p_2 = \sqrt{2(4)K} = 2\sqrt{2K}$
10	D	$\sin\theta = \frac{1}{98}$ For constant speed Engine force: F_E = 300 x 20 (resistive force) + 300000g sin θ = 36000 N Power P = F_E v =36000 x 15 = 540000W
11	A	
12	B	Use conservation of energy F is the resistive force E (initial at top) = E (final at bottom) 50 x 9.81 x 5 + ½ x 50 x 2.10^2 = F x 10 + ½ x 50 x 4.9^2 + 0 F = 196 N
13	A	
14	B	Wavelength of sound by tuning fork λ = v/f = 340 / 340 = 1.0 m 1st Harmonic at L= λ/4 = 25 cm 2nd Harmonic at L= 3λ/4 = 75 cm 3rd Harmonic at L= 5λ/4 = 125 cm As water poured into the cylinder, 2nd harmonic is heard first Water level = 120 – 75 = 45 cm
15	D	Use Young double slit equation $\frac{x}{D} = \frac{m\lambda}{d}$ $x = \frac{2.5 \times 500 \times 10^{-9} \times 1.5}{0.5 \times 10^{-3}} = 3.75\ mm$
16	B	Find separation of fringes for each wavelength of light 650 nm : $\Delta x = \frac{\lambda D}{d} = \frac{650\times10^{-9}\times1.2}{2\times10^{-3}} = 0.39\ mm$ 520 nm : $\Delta x = \frac{\lambda D}{d} = \frac{520\times10^{-9}\times1.2}{2\times10^{-3}} = 0.312\ mm$ Consider ratio the wavelengths 650 : 520 = 5:4 The first coincident fringe will be 4th bright fringe of 650 nm and 5th bright fringe of 520 nm. Distance from central maximum = 4 x 0.39 = 1.56 mm
17	D	
18	B	
19	C	I = Ne N = 4.8/1.6 x 10^{-19}

20	C	 Resistance of wire Rw = 800 x 2 x 0.0050 Ω = 8.0 Ω Resistance of relay = V/I = 16.0/0.60 = 26.7 Ω Use potential divider theorem, $16.0 = \frac{26.7}{26.7+8} E$ $E = 20.8$ V
21	B	Parallel portion Y will reduce in equivalent resistance as variable resistance decrease. Lamp Y will decrease in PD across while X will increase in PD X will be brighter and Y will be less bright.
22	C	Use potential divider theorem to determine PD across 2.0 Ω $V_2 = 2V/5$ $P_2 = P = V_2^2 /2 = 2V^2/25$ $V_3 = 3V/5$ $P_3 = V_3^2 /3 = 3V^2/25$ $P_1 = V^2$ Total power = $2V^2/25 + 3V^2/25 + V^2 = 6V^2/5 = 6/5 \times 25P/2 = 15P$
23	B	Resistance R increases with V R also increases with I
24	A	Closer magnetic flux lines means a stronger field to the left. Flux lines pointing left to right suggests a N pole at the left. N pole of bar magnet will be repel while S pole will be attracted, therefore bar magnet will turn anticlockwise and to the left.
25	D	B-field directed northwards I directed vertically upwards since negative charges move downwards. By Fleming left hand, force is directed to left or West.
26	B	Using FLH rule, the force on XY is downwards. Since XY is fixed in place, the core magnet will be lifted upwards by N3L F =B I l = 0.08 x 4.0 x 5 x10^{-2} = 0.016 N Reading on balance 2.500-0.016 = 2.484 N
27	A	
28	C	
29	A	Einstein's eq $h f = e V_s + \phi$ $V_s = \frac{hc}{e\lambda} - \frac{\phi}{e}$

		When V_s =0 => ϕ =hc/λ $\lambda_p > \lambda_q$ $\phi_p < \phi_q$
30	D	ΔE= hc/λ = 12.8 eV Electron is promoted to n=4 from n=1 n=4 -> n=3,2,1 n=3 -> n=2,1 n=2 -> n=1 6 lines

End of solutions

Class	Index Number	Name
16		

ST. ANDREW’S JUNIOR COLLEGE
JC 2 2017
Preliminary Examination Paper 2

PHYSICS, Higher 1 **8866/02**

14 Sept 2017 **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and Civics Group on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid..

Section A
Answer **all** questions.

Section B
Answer **any two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets **[ ]** at the end of each question or part question.

For Examiner’s Use	
Paper 1	**/ 30**
Paper 2	
Section A	**/ 40**
Section B	**/ 40**
Total	**/ 110**
Percentage	**/ 100**
Grade	

This question paper consists of 24 printed pages including this page.

DATA AND FORMULAE

Data

speed of light in free space	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$
elementary charge	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{Js}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
acceleration of free fall	$g = 9.81\ \mathrm{m\ s^{-2}}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A – Answer all questions in the space provided

1 **(a)** For each of the following, tick [✓] one box to indicate whether the experimental technique would reduce random error, systematic error or neither. The first row has been completed as an example.

	Random error	**Systematic error**	**neither**
keeping your eye in line with the scale and the liquid level for a single reading of a thermometer		✓	
averaging many readings of the time taken for a ball to roll down a slope			
using a linear scale on an ammeter			
correcting for a non-zero reading when a micrometer screw gauge is close			

[2]

(b) Two of the SI base quantities are mass and time. State two other SI base quantities.

....[1]

2 **(a)** A crossbow can launch a 0.10 kg arrow at 200 m s^{-1}. The arrow accelerates from rest to 200 m s^{-1} over a distance of 0.50 m within the crossbow as it is launched.

(i) Determine the momentum of the arrow at launch.

momentum = …………………….. kg m s^{-1} [1]

(ii) Calculate the average force exerted on the arrow by the crossbow.

average force = …………………… N [2]

(b) An arbalist uses the crossbow to shoot at a circular target of diameter 20 cm at a distance of 30 m away. Assuming that the arrow is launched horizontally, with the centre of the circular target in the line of sight of the crossbow,

(i) determine how far away from the centre of the target will the arrow hit. (Ignore the effect of air resistance.)

distance from target centre = ……………………. cm [2]

(ii) Explain whether the arrow will land within the circular target.

....

....[1]

(iii) Comment on whether the approach adopted in **(i)** leads to realistic results.

....

....[2]

3 **(a)** A variable resistor is used to control the current in a circuit, as shown in Fig. 3.1.

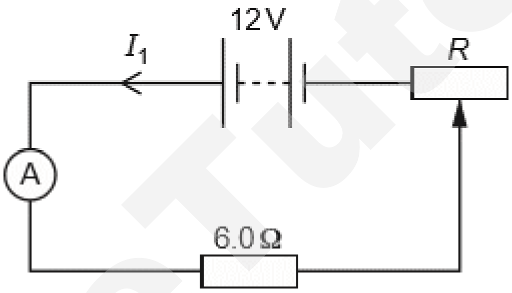


Fig. 3.1

The variable resistor is connected in series with a 12 V power supply of negligible internal resistance, an ammeter and a 6.0 Ω resistor. The resistance *R* of the variable resistor can be varied between 0 and 12 Ω.

(i) The maximum possible current in the circuit is 2.0 A. Calculate the minimum possible current.

minimum current = ... A [1]

(ii) On Fig. 3.2, sketch the variation with *R* of current I_1 in the circuit.

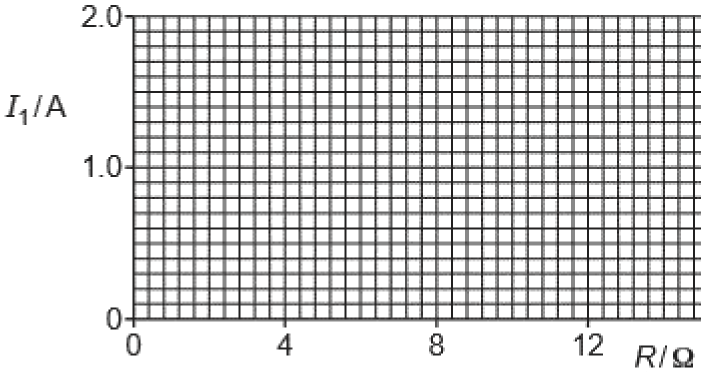


Fig 3.2

[2]

(b) The variable resistor in **(a)** is now connected as a potential divider, as shown in Fig. 3.3

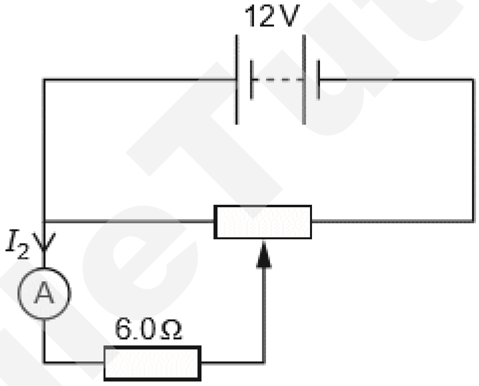


Fig 3.3

Calculate the maximum possible and minimum possible current I_2 in the ammeter.

maximum I_2 = ... A

minimum I_2 = ... A [2]

(c) **(i)** Sketch on Fig. 3.4 the I – V characteristic of a filament lamp

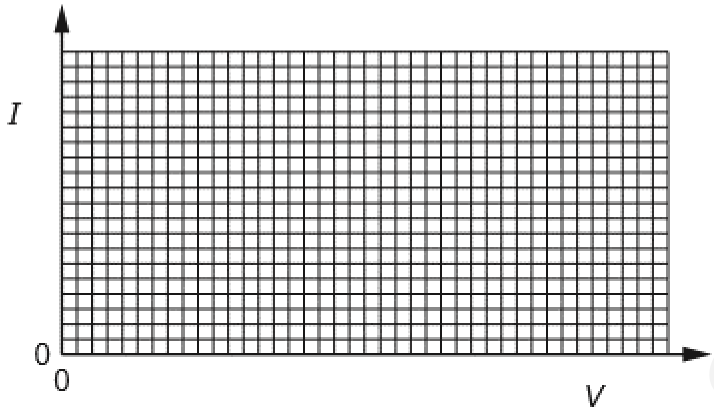


Fig 3.4

[1]

(ii) The resistor of resistance 6.0 Ω is replaced with a filament lamp in the circuits of Fig. 3.1 and Fig. 3.3.

State an advantage of using the circuit of Fig. 3.3, compared to the circuit of Fig 3.1, when using the circuits to vary the brightness of the filament lamp.

……………………………………………………………………………………

……………………………………………………………………………………[1]

4 **(a)** State what is meant by a photon.

……………………………………………………………………………………

……………………………………………………………………………………[2]

(b) Light in a beam has a continuous spectrum that lies within the visible region. The photons of light have energies ranging from 1.60 eV to 2.60 eV.

The beam passes through some hydrogen gas. It then passes through a diffraction grating and an absorption spectrum is observed.

(i) All of the light absorbed by the hydrogen is re-emitted. Explain why dark lines are still observed in the absorption spectrum.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(ii) Some of the energy levels of an electron in a hydrogen atom are illustrated in Fig. 4.1.

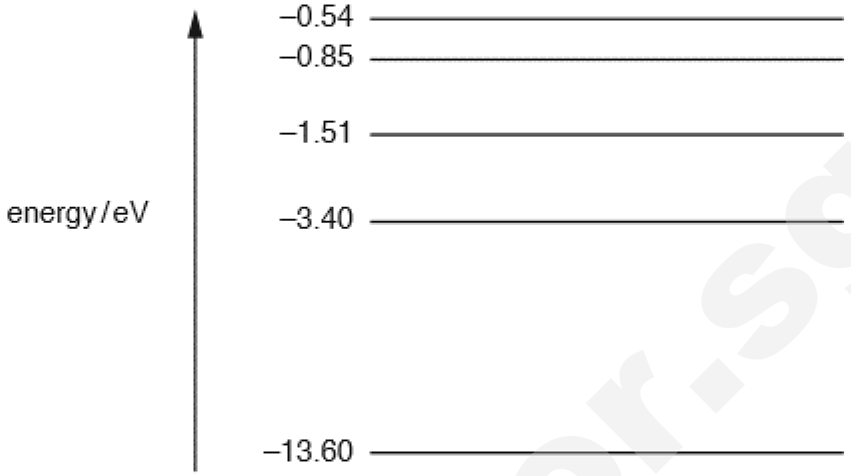


Fig 4.1 (not to scale)

The dark lines in the absorption spectrum are the result of electron transitions between energy levels.

On Fig. 4.1, draw arrows to show the initial electron transitions between energy levels that could give rise to dark lines in the absorption spectrum. [2]

(iii) Calculate the shortest wavelength of the light in the beam.

wavelength = ...m [2]

5 **(a)** A 6000 kg freight car rolls along the rails with negligible friction. The car is brought to rest by a combination of two coiled springs as shown in Fig. 5.1. Both springs obey Hooke's law. After the first spring compresses a distance of 30.0 cm, the second spring acts with the first to increase the force as additional compression occurs as shown in the graph (Fig 5.2). The car comes to rest 50.0 cm after first contacting the two-spring system.

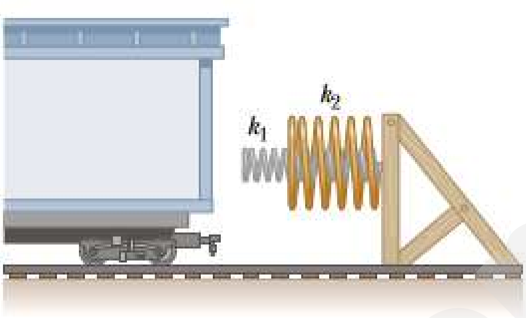


Fig 5.1

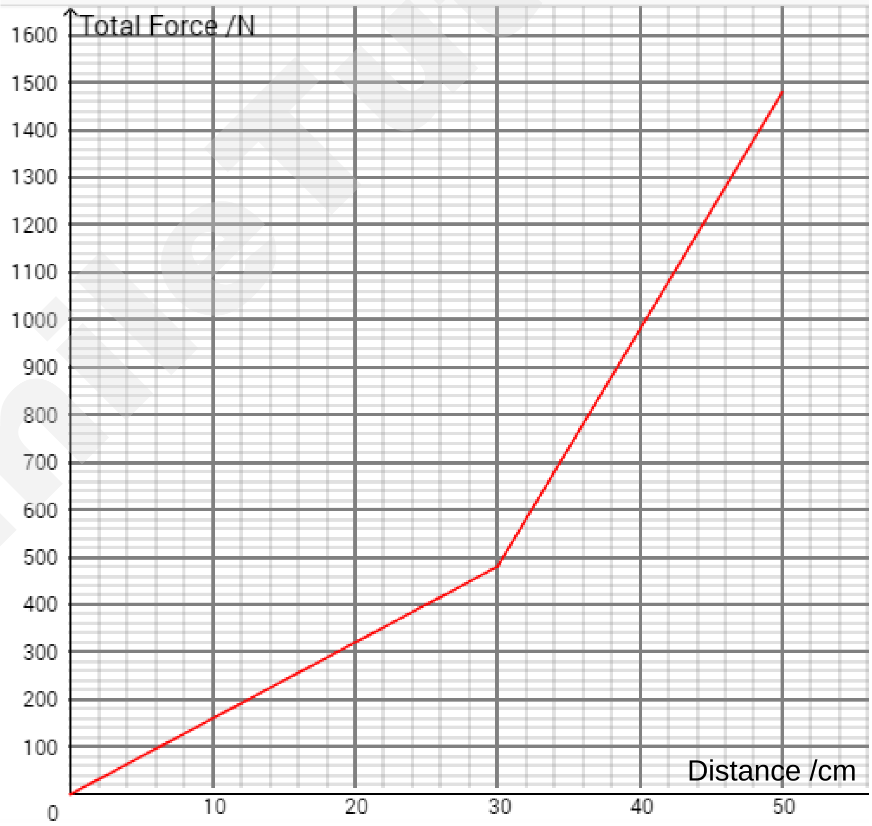


Fig. 5.2

(i) State the energy conversions that occur in the train and spring system.

……………………………………………………………………………………

……………………………………………………………………………………[1]

(ii) Use the graph to determine the magnitude of spring constant k_1.

spring constant k_1 = …………………….. N m^{-1} [2]

(iii) Calculate the magnitude of spring constant k_2.

spring constant k_2 = …………………….. N m^{-1} [3]

(iv) Hence or otherwise, determine the total elastic potential energy stored in both springs when the train first come to a stop.

total elastic potential energy = ……………………. J [2]

(v) Determine the initial velocity of the freight train just before it hits the first spring.

initial velocity = ……………………. m s^{-1} [2]

(b) A 10000 N shark is supported by a rope attached to a 4.0 m rod that can pivot at the base (Fig. 5.3). Ignore the weight of the rod.

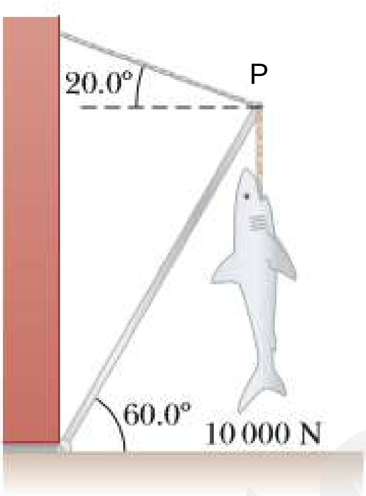


Fig. 5.3

(i) Draw and label on Fig. 5.3 the forces acting at the end of the rod at point P.

[2]

(ii) Determine the tension in the cable between the rod and the wall.

tension = ………………………… N [3]

Section B – Answer two of the questions in this section.

6 **(a)** Draw a labelled diagram of an experimental setup to demonstrate the photoelectric effect.

[3]

(b) It is found that, on exposure of a metal surface to light, either electrons are emitted immediately or they are not emitted at all.

Suggest why this observation does not support a wave theory of light.

…………………………………………………………………………………………

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………..

…………………………………………………………………………………………

……………………………………………………………………………………….[3]

(c) Data for the wavelength λ of the radiation incident on the metal surface and the maximum kinetic energy E_K of the emitted electrons are shown in Fig. 6.1.

λ/nm	$E_K/10^{-19}$ J
650 240	– 4.44

Fig. 6.1

(i) Without any calculation, suggest why no value is given for E_K for radiation of wavelength 650 nm.

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………..[1]

(ii) Use data from Fig. 6.1 to determine the work function energy of the surface.

work function energy = ... J [3]

(d) Radiation of wavelength 240 nm gives rise to a maximum photoelectric current I when the same metal surface as in **(c)** is used. The intensity of the incident radiation is maintained constant and the wavelength is now reduced.

State and explain the effect of this change on

(i) the maximum kinetic energy of the photoelectrons,

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………..[2]

(ii) the maximum photoelectric current I.

…………………………………………………………………………………………..

……………………………………………………………………………………………

……………………………………………………………………………………..[2]

(iii) Sketch a graph in Fig. 6.2 showing the relationship between the maximum kinetic energy E_K and the frequency of the incident light for the above experimental setup. Label the threshold frequency.

[2]

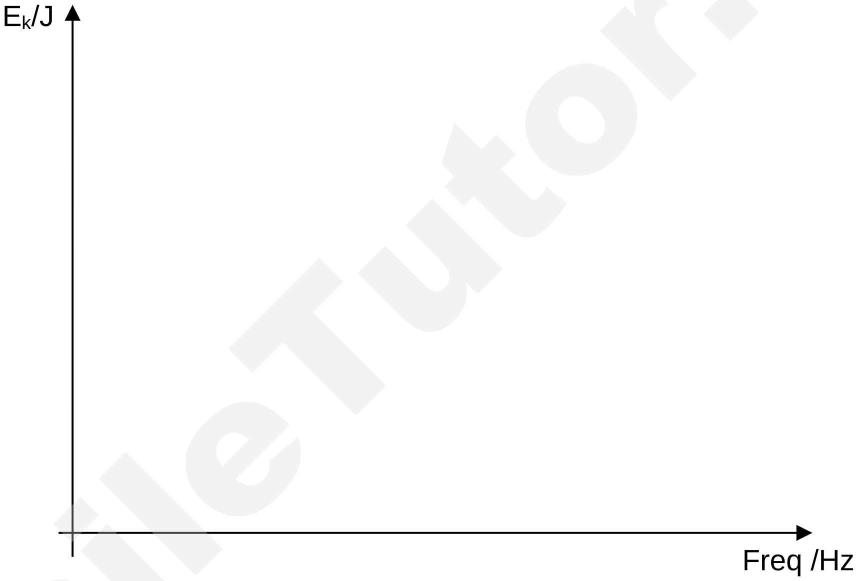


Fig. 6.2

(e) **(i)** Determine the minimum de Broglie wavelength of the electron produced in **(d)**.

de Broglie wavelength = …………………….. m [2]

(ii) Without any calculation, explain how the de Broglie wavelength will change if the wavelength of the incident radiation in (d) is reduced.

……………………………………………………………………………………..

………………………………………………………………………………………

……………………………………………………………………………………….[2]

7 **(a)** The variation with time *t* of the displacement *y* of a wave X, as it passes a point P, is shown in Fig. 7.1.

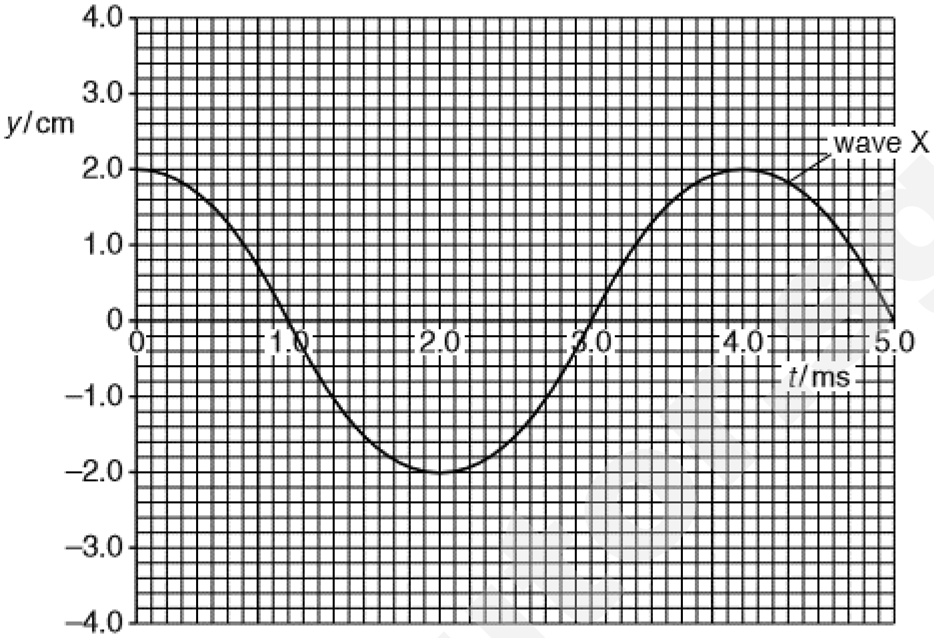


Fig. 7.1

.

The intensity of wave X is I.

(i) Use Fig. 7.1 to determine the frequency of wave X.

frequency = ... Hz [2]

(ii) A second wave Z with the same frequency as wave X also passes point P. Wave Z has intensity $2I$. The phase difference between the two waves is 90°.

On Fig. 7.1, sketch the variation with time t of the displacement y of wave Z.

Show your working.

[3]

(b) Fig. 7.2 shows the light intensity on a screen behind a double slit. The slit separation is 0.2 mm and the wavelength of the monochromatic light source is 600 nm.

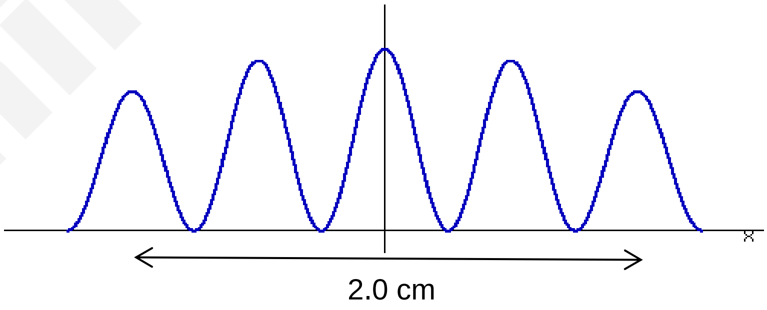


Fig. 7.2

(i) Determine the distance between the screen and the double slit.

screen distance = …………………………… m [2]

(ii) Now the distance from the screen to the double slits is increased. Draw the new light intensity graph relative to the earlier graph on Fig. 7.3.

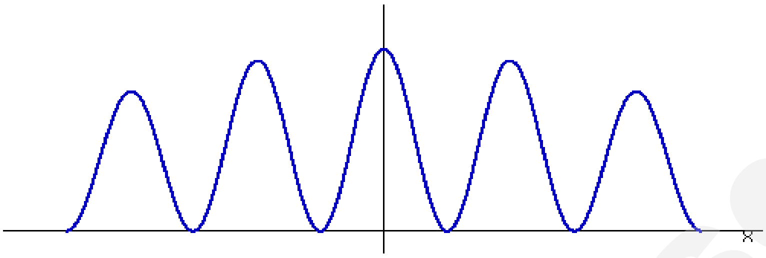


Fig. 7.3

[2]

(iii) One of the slits is now covered up. Draw the new shape of the light intensity graph on Fig. 7.4.

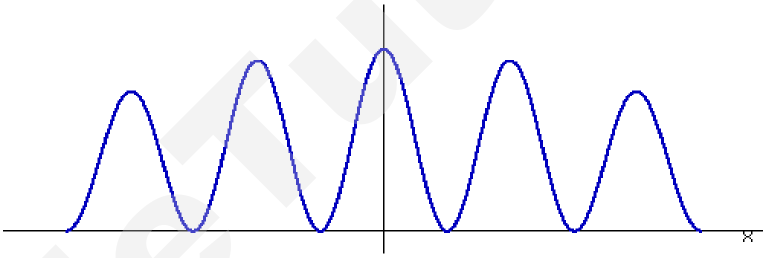


Fig. 7.4

[1]

(iv) Blue light is now shone on the double slits. Draw the new shape of the light intensity graph on Fig. 7.5. Suggest a value for the wavelength of blue light.

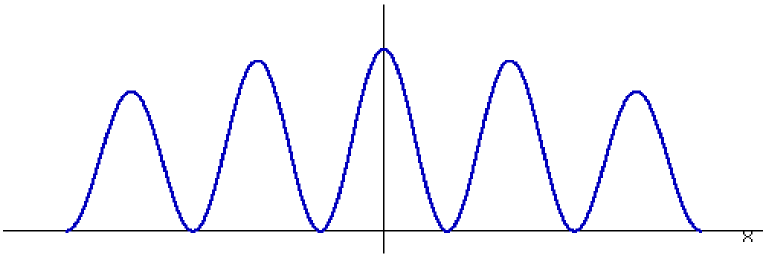


Fig. 7.5

wavelength = ……………………………… nm [3]

(c) The eardrum, which transmits vibrations to the sensory organs of your ear, lies at the end of the ear canal. As Fig. 7.6 shows, the ear canal in adults is about 2.5 cm in length

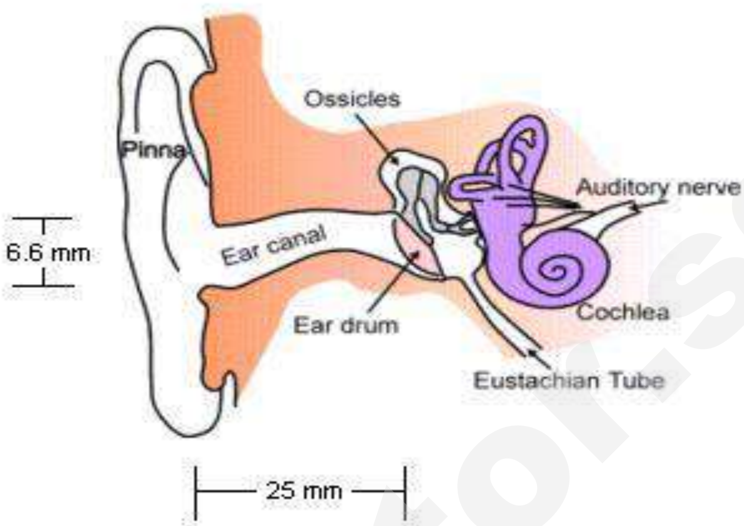


Fig. 7.6

(i) Draw and label in Fig. 7.6, the fundamental frequency of the eardrum. [1]

(ii) The human ear can hear sounds between 20 Hz and 20 kHz.

Determine the frequencies of the standing waves that can occur in the ear canal that is in the range of human hearing. Assume the speed of sound to be 340 m s^{-1}.

resonant frequencies =……………………………………………..Hz [4]

(iii) State and explain the effect on the ear when sounds of such frequencies are produced near the ear.

………………………………………………………………………………………

………………………………………………………………………………………..[2]

8 **(a)** A uniform magnetic field has constant flux density B. A straight wire of fixed length carries a current I at an angle θ to the magnetic field, as shown in Fig. 8.1.

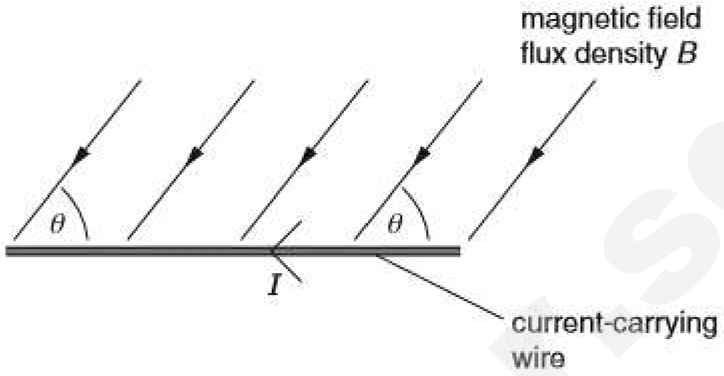


Fig. 8.1

(i) The current I in the wire is changed, keeping the angle θ constant. On Fig. 8.2, sketch a graph to show the variation with current I of the force F on the wire.

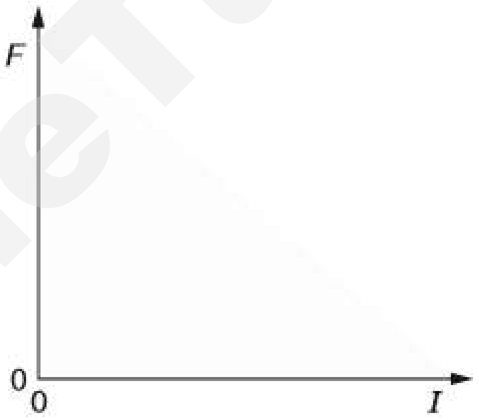


Fig. 8.2

[2]

(ii) The angle θ between the wire and the magnetic field is now varied. The current I is kept constant. On Fig. 8.3, sketch a graph to show the variation with angle θ of the force F on the wire.

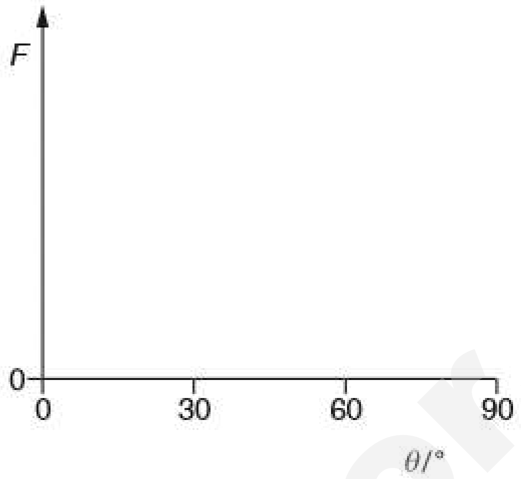


Fig. 8.3

[3]

(b) A uniform magnetic field is directed at right-angles to the rectangular surface PQRS of a slice of a conducting material, as shown in Fig. 8.4.

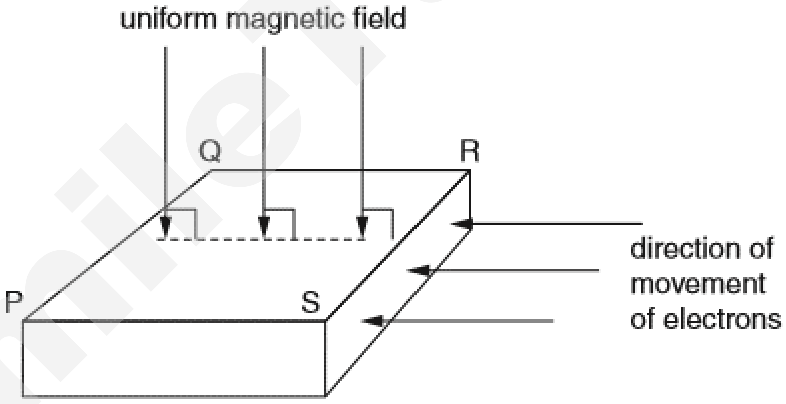


Fig. 8.4

Electrons, moving towards the side SR, enter the slice of conducting material. The electrons enter the slice at right-angles to side SR.

(i) Explain why, initially, the electrons do not travel in straight lines across the slice from side SR to side PQ.

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………….[2]

(ii) Explain to which side, PS or QR, the electrons tend to move.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………[2]

(c) Two long straight vertical wires X and Y pass through a horizontal card, as shown in Fig. 8.5.

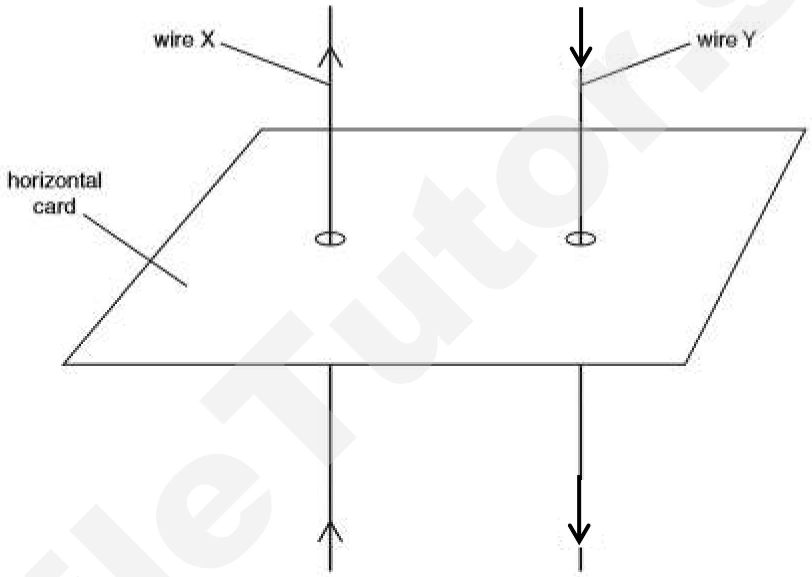


Fig. 8.5

The current in wire X and Y is in the upward and downward direction respectively.

The top view of the card, seen by looking vertically downwards at the card, is shown in Fig. 8.6.

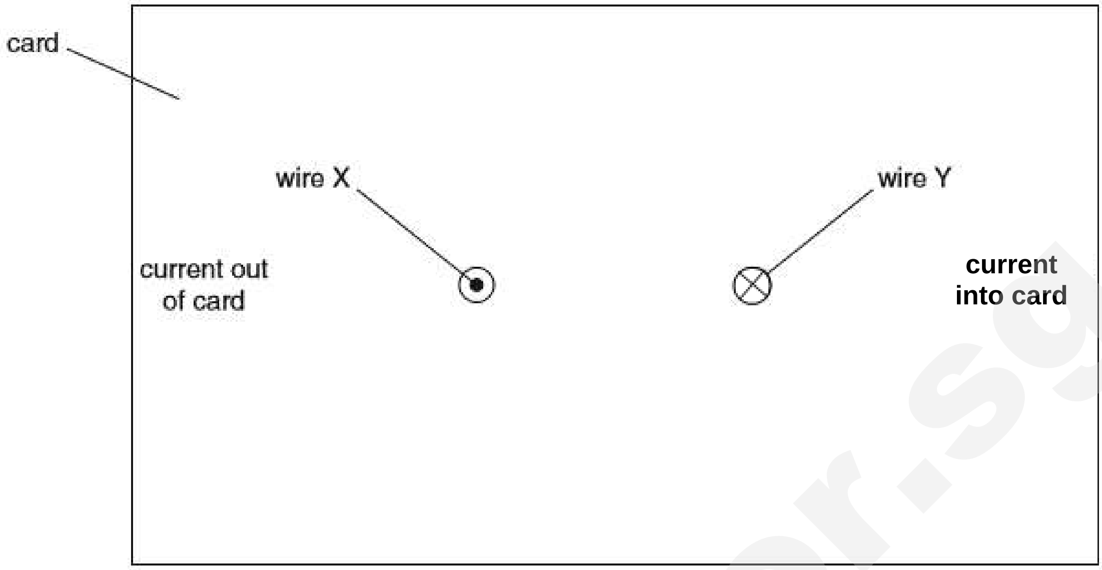


Fig. 8.6 (not to scale)

(i) On Fig. 8.6,

(1) draw four field lines to represent the pattern of the magnetic field around wire X due solely to the current in wire X, [2]

(2) draw an arrow to show the direction of the force on wire Y due to the magnetic field of wire X. [1]

(ii) The magnetic flux density *B* at a distance x from a long straight wire due to a current I in the wire is given by the expression

$$B = \frac{\mu_o I}{2\pi x}$$

where μ_o is the permeability of free space. ($\mu_o = 4\pi \times 10^{-7}$ H m^{-1})

The current in wire X is 5.0 A and that in wire Y is 7.0 A. The separation of the wires is 2.5 cm.

(1) Calculate the force per unit length on wire Y due to the current in wire X.

force per unit length = ... N m^{-1} [3]

(2) The currents in the wires are not equal.

State and explain whether the forces on the two wires are equal in magnitude.

……………………………………………………………………………

…………………………………………………………………………[2]

(iii) An external magnetic field *B* now acts from left to right and perpendicular to the two wires.

(1) Draw the resultant magnetic field lines due to the interaction of the external magnetic field and the magnetic field of the wires on Fig. 8.7. [2]

(2) Draw an arrow on wire X and on wire Y to indicate the resultant force due to the external magnetic field B. [1]

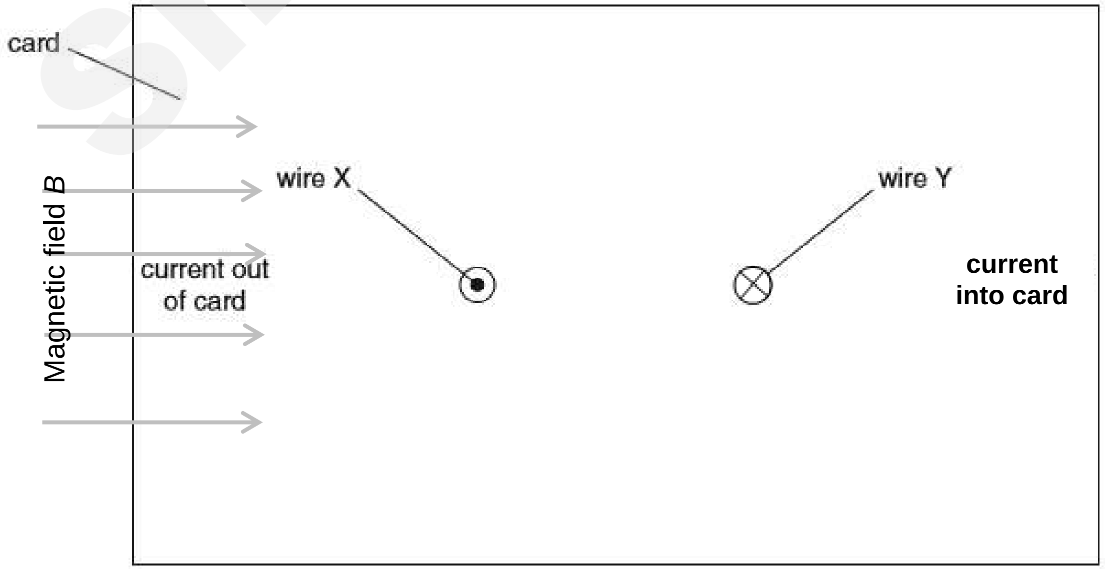
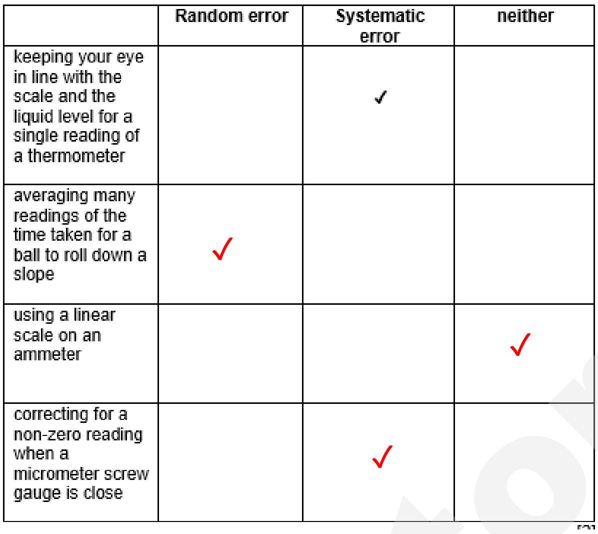


Fig. 8.7 (not to scale)

JC2 H1 Physics Prelims 2017 Solutions

<table>
<tr><th>Qn</th><th></th><th>Marks</th></tr>
<tr><td>**1(a)**</td><td>

<table>
<tr><th></th><th>Random error</th><th>Systematic error</th><th>neither</th></tr>
<tr><td>keeping your eye in line with the scale and the liquid level for a single reading of a thermometer</td><td></td><td>✓</td><td></td></tr>
<tr><td>averaging many readings of the time taken for a ball to roll down a slope</td><td>✓</td><td></td><td></td></tr>
<tr><td>using a linear scale on an ammeter</td><td></td><td></td><td>✓</td></tr>
<tr><td>correcting for a non-zero reading when a micrometer screw gauge is close</td><td></td><td>✓</td><td></td></tr>
</table>
All correct 2m
2 correct 1m</td><td>2</td></tr>
<tr><td>**1(b)**</td><td>Length, electric current, thermodynamic temperature, amount of substance
Any 2 for 1m</td><td>1</td></tr>
<tr><td>**2(a)(i)**</td><td>$p = mv$
$= 0.1 \times 200 = 20$ kg m s^{-1}</td><td>1</td></tr>
<tr><td>**2(a)(ii)**</td><td>Find avg acceleraton
using $v^2 = u^2 + 2as$
$200^2 = 0 + 2a(0.5)$
$a = 40000$ m s^{-2}
$F = ma = 0.1 \times 40000$
$= 4000$ N
Or find time *t* that force is being applied using s= ½ (u+v)t
Then use F t = Δp</td><td>

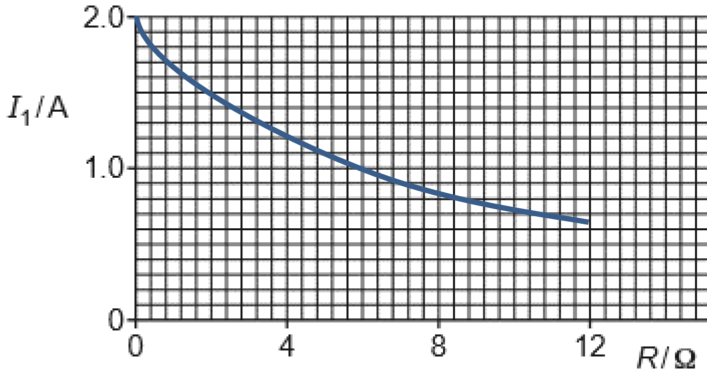
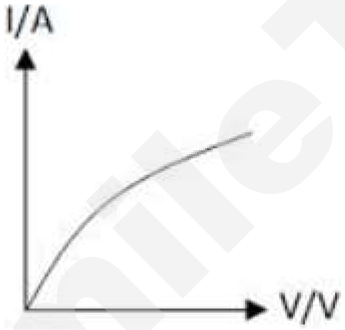
1

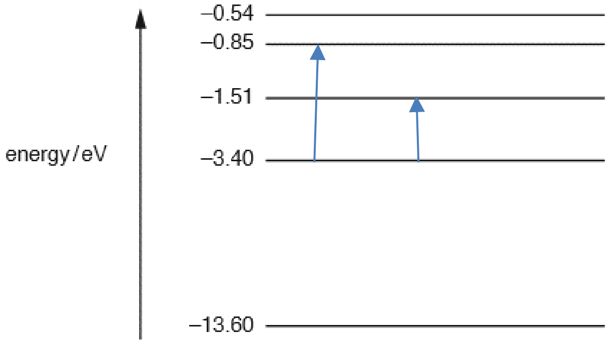
1</td></tr>
<tr><td>**2(b)(i)**</td><td>Find t to travel horizontal distance
30 = 200 t
t = 0.15 s
vertical distance downwards from centre of target
$s = ½ g t^2$
$= 0.5 (9.81)0.15^2 = 0.11$m =11 cm</td><td>

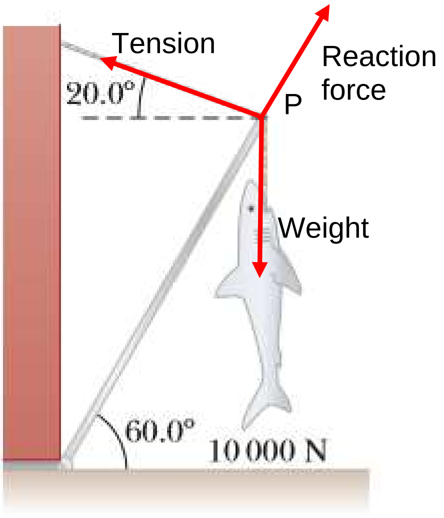
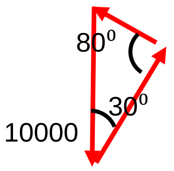
1

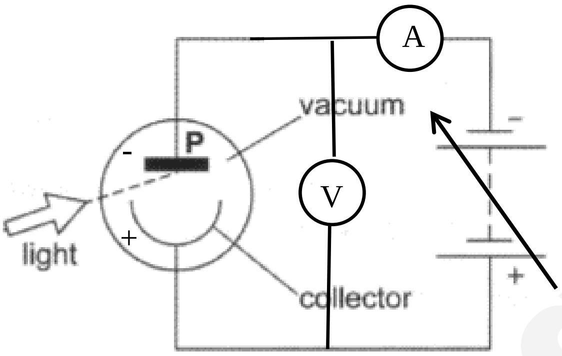
1</td></tr>
<tr><td>**2b(ii)**</td><td>No, since 11cm > 10cm (radius of target)</td><td>1</td></tr>
<tr><td>**2b(iii)**</td><td>Ignoring air resistance is not very realistic for arrow
As it is light, the air resistance in the forward direction can be significant</td><td>1
1
(8)</td></tr>
<tr><td>**3a(i)**</td><td>CIE s11 qp 21 Q5
I = 12 / (6 + 12)
minimum current = 0.67 A</td><td>

1</td></tr>
</table>

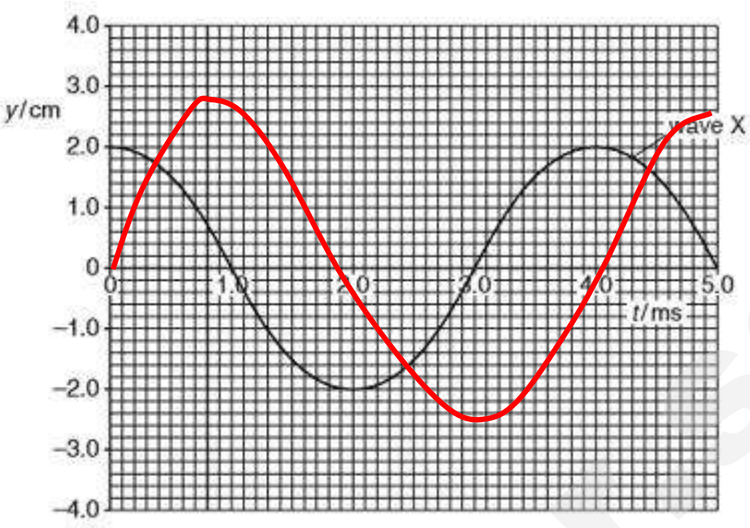
3a(ii)	 Fig 3.2 correct start and finish points M1 correct shape for curve with decreasing gradient A1	2
3b	When R=0 Ω I_2 = 0 A When R = 12 Ω I_2 = 2 A	1 1
3c(i)	 Correct shape and starting point 1m	1
3c(ii)	full range of current / p.d. possible or currents / p.d. down to zero or brightness ranging from off to full brightness	1 (7)
4a	CIE m17 qp 42 Q10 Discrete packet / quantum of energy of electromagnetic radiation	1 1
4b(i)	light is re-emitted in all directions / only part of the re-emitted light is in the direction of the beam	1

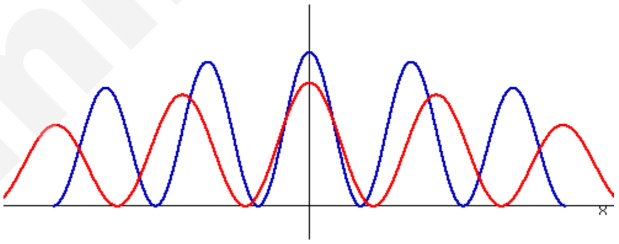
4b(ii)	 2 arrows as shown and pointing upwards. 1m each	2
4b(iii)	E = hc /λ 2.60 × 1.60 × 10^{-19} = (6.63 × 10^{-34} × 3.00 × 10^{8}) / λ λ = 4.8 × 10^{-7} m	 1 1 (7)
5a(i)	Kinetic energy in the moving train is converted to elastic potential energy in the two springs	1
5a(ii)	Read off from graph x = 0.3m F = 480 N Since the first spring obeys hooke's law 480 = k (0.3) k=1600 N m^{-1}	 1 1
5a(iii)	Reading off graph x=50cm F=1480 N F= k_1 (0.5) + k_2 (0.2) 1480 = 1600 (0.5) + 0.2 k_2 680 = 0.2 k_2 k_2 =3400 N m^{-1}	 1 1 1
5a(iv)	Area under graph E = ½ (0.3)(480) + ½ (0.2)(480+1480) = 268 J Or E = EPE(spring k1)+ EPE(spring k2) = ½ (1600) 0.5^2 + ½ (3400) 0.2^2 =268 J	 1 1
5a(v)	ΔKE = ΔEPE ½ (6000) v^2 = 268 v = 0.299 m s^{-1}	1 1

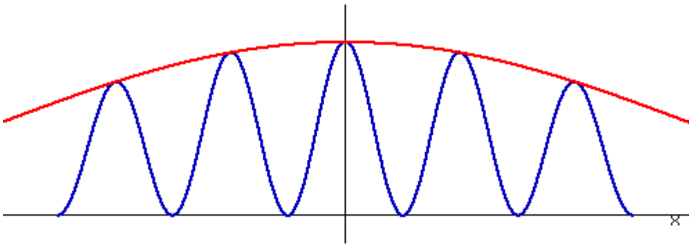
5b(i)	 1 m for 3 forces 1 m for labels	2
5b(ii)	 1 m for vector triangle use sine rule $\frac{10000}{\sin 80} = \frac{T}{\sin 30}$ T = 5080 N	1 1 1 (15)
6a	CIE s11 qp 41 Q7	3

	 Metal plate P (-), Collector (+) Light source Low pressure or evacuated discharge tube or photocell Power source ammeter, voltmeter All items present get 3m Deduct 1m for every 2 omitted items	
6b	for a wave, electron can 'collect' energy continuously [1m] for a wave, electron will always be emitted / electron will be emitted at all frequencies [1m] after a sufficiently long delay [1m]	3
6c(i)	wavelength is longer than threshold wavelength or frequency is below the threshold frequency or photon energy is less than work function	1
6c(ii)	$hc / \lambda = E_{MAX} + \phi$ $(6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (240 \times 10^{-9}) = \phi + 4.44 \times 10^{-19}$ $\phi = 3.8 \times 10^{-19}$ J	1 1 1
6d(i)	photon energy increases as $E = hc/\lambda$ so (maximum) kinetic energy of photoelectrons is larger	1 1
6d(ii)	Intensity $= \frac{nhf}{tA} = \frac{nhc}{tA\lambda}$ For constant intensity, and wavelength decreases, number of incident photons per unit time decrease. Less electrons are emitted so (maximum) photoelectric current decreases	1 1

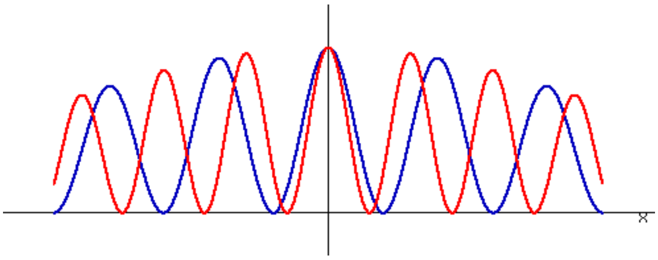
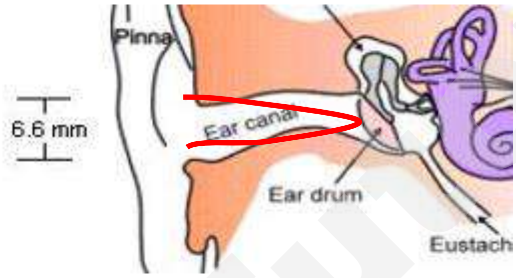
6d(iii)	 Correct shape 1m Correct label Threshold freq, 1m	2
6e(i)	Minimum De Broglie wavelength $\lambda = \frac{h}{p}$ $E = \frac{p^2}{2m}$ $\lambda = \frac{h}{\sqrt{2mE}}$ E = 4.44×10^{-19} J m = 9.11×10^{-31} kg λ =7.4×10^{-10} m	1 1
6e(ii)	As wavelength of incident radiation is reduced, the KE_{max} of the photoelectron will increase. Since E increase, the minimum de Broglie wavelength will decrease.	1 1 (20)
7a(i)	CIE s16 qp 21 Q5 Read from graph T = 4 ms f = 1/T = 1/0.004 = 250 Hz	1 1

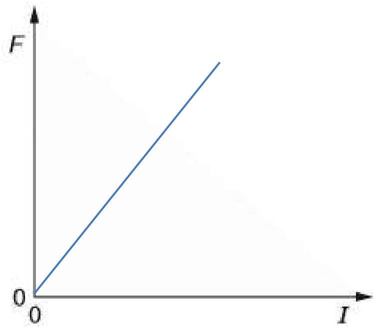
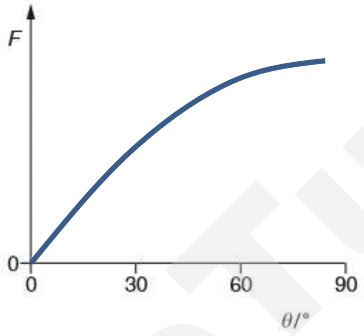
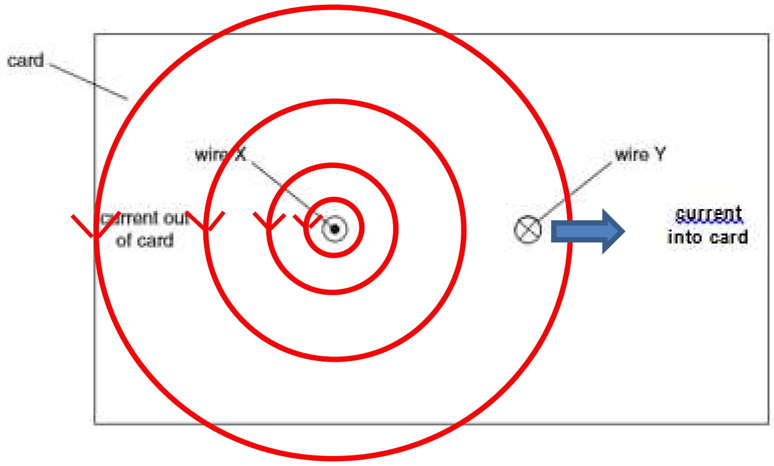
<table>
<tr><td>7a(ii)</td><td>

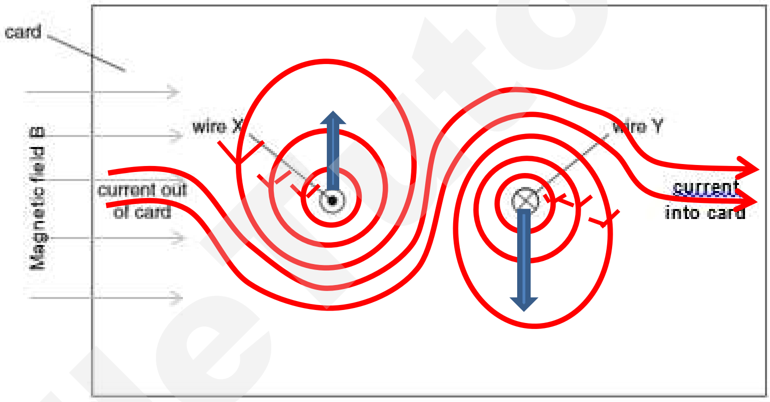
intensity ∝ (amplitude)^2 and amplitude = 2.8 (2.83) (cm)
curve with same period and with amplitude 2.8 cm
curve shifted 1.0 ms to left or to right of wave X</td><td>1
1
1</td></tr>
<tr><td>7b(i)</td><td>Use Young double slit equation for light
$\frac{\Delta x}{D} = \frac{\lambda}{d}$
$\Delta x = 2.0/4 = 0.5$ cm
$\frac{0.5 \times 10^{-2}}{D} = \frac{600 \times 10^{-9}}{0.2 \times 10^{-3}}$
D = 1.67 m</td><td>1
1</td></tr>
<tr><td>7b(ii)</td><td>

Decrease in intensity
Fringe separation is further apart</td><td>2</td></tr>
<tr><td>7b(iii)</td><td>

Replaced by one single bright fringe</td><td>1</td></tr>
</table>

7b(iv)	 Fringe separation is smaller 1m Intensity remain the same 1m Blue wavelength = 400 nm 1m	3
7c(i)	 Wavelength/4	1
7c(ii)	Length of ear canal L=λ/4 (fundamental) Fundamental freq $f_1 = v/\lambda = v/4L$ $f_1 = 340/(4 \times 25 \times 10^{-3})$ $= 3400$ Hz 3rd Harmonic $f_3 = 3 \times 3400 = 10200$ Hz 5th Harmonic $f_5 = 5 \times 3400 = 17000$ Hz Only 1st, 3rd, and 5th harmonics are within the hearing range higher harmonics are not in the range.	1 1 1 1
7c(iii)	Incoming sounds at these frequencies produce resonance condition in the ear canal, give rise to large amplitudes of the oscillation, resulting in an increased sensitivity to these frequencies.	1 1 (20)
	CIE s10 qp 43 Q8+ w09 qp 42 Q5	

8a(i)	 straight line with positive gradient 1m through origin 1m	2
8a(ii)	 maximum force shown at θ = 90° 1m zero force shown at θ = 0° 1m reasonable curve with F about ½ max at 30° 1m	3
8b(i)	force on electron due to magnetic field 1m force on electron normal to magnetic field and direction of electron 1m	2
8b(ii)	quote / mention of (Fleming's) left hand rule 1m electron moves towards QR 1m	2
8c(i)(1), (2)		2 1

	concentric circles, anticlockwise (minimum 3 circles) 1m separation of lines increases with distance from wire 1m direction to the right of Y	
8c(ii)(1)	flux density at wire Y = $(4\pi \times 10^{-7} \times 5.0) / (2\pi \times 2.5 \times 10^{-2})$ $= 4.0 \times 10^{-5}$ T force per unit length = $BI = 4.0 \times 10^{-5} \times 7.0$ $= 2.8 \times 10^{-4}$ N	 1 1 1
8c(ii)(2)	force depends on product of the currents in the two wires so equal *or* (isolated system so) Newton's 3rd law applies so equal	1 1
8c(iii)(1) (2)	 Anticlockwise circles around X, and clockwise circles around Y 1m External field lines following the anticlockwise flow about X and then following the clockwise flow about Y. 1m Magnetic force at X is upward and downward at Y. 1m	3 (20)

TEMASEK JUNIOR COLLEGE

2017 Preliminary Examination
Higher 1

PHYSICS

8866/01

Paper 1 Multiple Choice

18 September 2017
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and Civics group on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **14** printed pages.

[Turn over

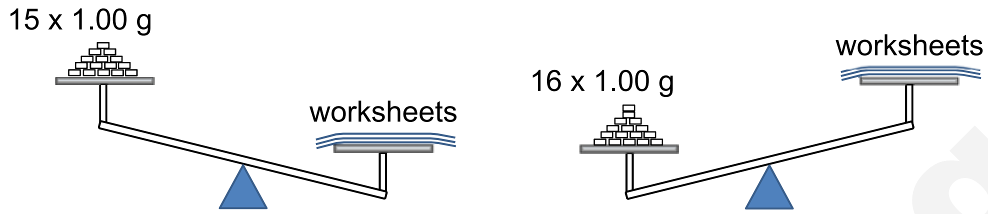
Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p\,\Delta V$
hydrostatic pressure	p	=	ρgh
resistors in series	R	=	$R_1 + R_2 + ...$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + ...$

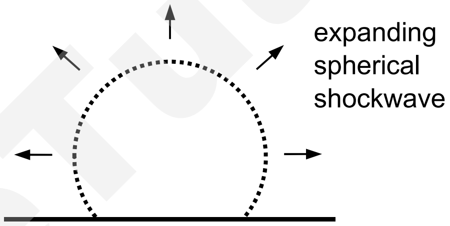
1 A Physics student measures the mass of his Measurement tutorial worksheets using a simple balance and some standard masses, each of 1.00 ± 0.02 g. He finds that 15 masses are not quite enough for balance but 16 masses are just too much.



What is an appropriate value, with its associated uncertainty, for the mass of the worksheets?

A 15.50 ± 0.02 g **B** 15.5 ± 0.3 g **C** 15.5 ± 0.5 g **D** 15.5 ± 0.8 g

2 The detonation of an atomic bomb results in a shockwave that reflects off the ground, propagating outwards as shown.



The radius R of the shockwave at time t after the explosion is related to the energy E that is released and the density ρ of the surrounding medium as follows:

$$R = \left(\frac{Et^2}{\rho}\right)^{\frac{1}{x}}$$

where x is a constant.

What is the value of x?

A $-\frac{1}{5}$ **B** –1 **C** 4 **D** 5

3 A man is running on a horizontal road towards the north at 8 km h^{-1} in the rain. He sees the rain drops falling vertically as he runs. He increases his speed to 16 km h^{-1} and finds that the rain drops now make an angle of 30° with the vertical.

What is the velocity of the rain drops?

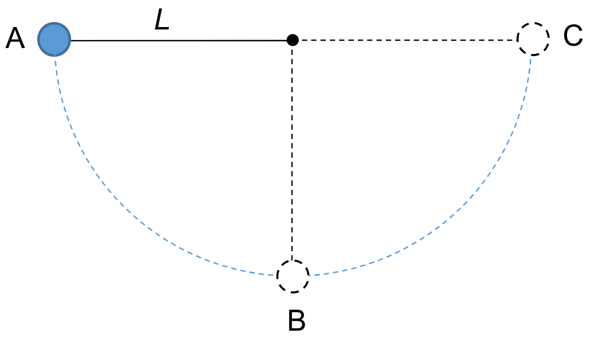
A 16 km h^{-1}, 30° with the vertical, downwards and northwards

B 16 km h^{-1}, 30° with the vertical, downwards and southwards

C 32 km h^{-1}, 30° with the vertical, downwards and northwards

D 32 km h^{-1}, 30° with the vertical, downwards and southwards

4 A pendulum of length L is released from A and swings to C where it comes to rest momentarily as shown. It follows a circular path and has maximum velocity at B.



What is the average velocity of the pendulum bob as it moves from A to C, if the time taken is T?

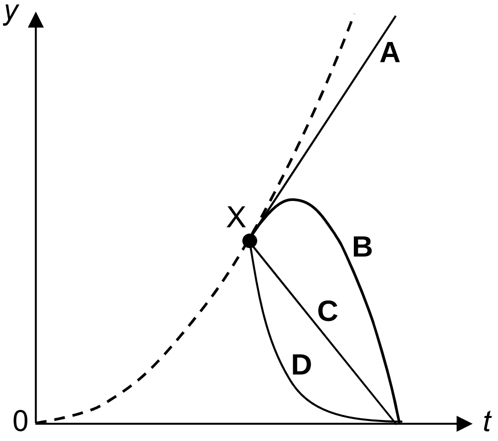
A 0 **B** $\frac{\sqrt{2gL}}{2}$ **C** $\frac{2L}{T}$ **D** $\frac{\pi L}{T}$

5 Water drops fall from rest at regular intervals from a tap which is 5.00 m above the ground. The third drop is leaving the tap at the instant the first drop reaches the ground.

How far above the ground is the second drop at that instant?

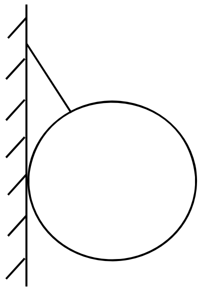
A 1.25 m **B** 2.50 m **C** 2.78 m **D** 3.75 m

6 A toy rocket is moving upward with constant acceleration. The dashed curve in the figure shows the height y of the rocket from the ground with respect to time t. At the instant indicated by the point X, a tail fin of the rocket breaks loose and drops from the rocket.



Ignoring air resistance, which of the curves labelled **A** to **D** best represents the position of the tail fin with respect to t?

7 The diagram shows a uniform sphere of weight *W* attached to a smooth wall by a string of length equal to its radius.

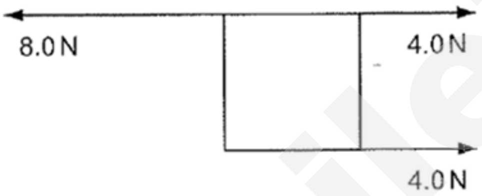


What is the tension in the string?

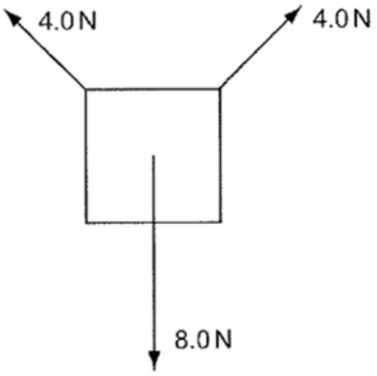
A $2\,W$ **B** $2\sqrt{3}\,W$ **C** $\frac{2W}{\sqrt{3}}$ **D** $\frac{W}{2}$

8 Which vector diagram showing three forces acting on a body will produce equilibrium?

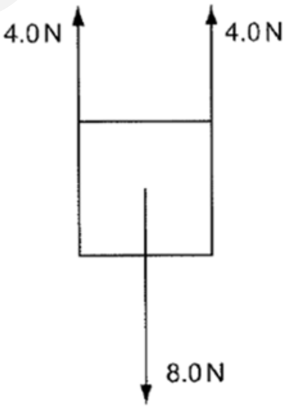
A



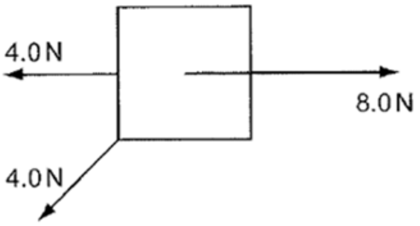
B



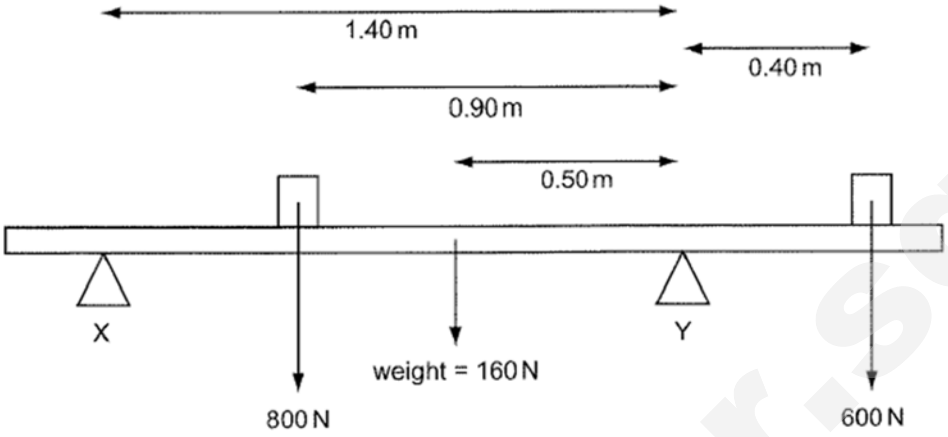
C



D



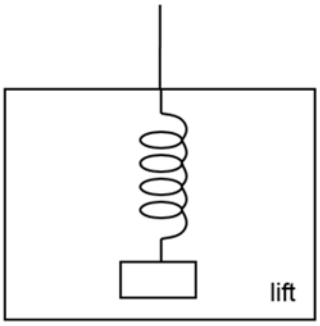
9 A beam of weight 160 N is supported at X and Y. Loadings on the beam and dimensions are shown in the diagram below.



What are the forces exerted by supports X and Y?

	Force due to X	Force due to Y
A	400 N	1960 N
B	400 N	1160 N
C	570 N	9970 N
D	740 N	820 N

10 A light spring of natural length 25.0 cm is suspended from the ceiling of a lift. A mass is hung from the end of the spring, as shown in the figure below.



When the lift is moving downwards at a constant speed, the length of the spring is 50.0 cm. The lift then slows down with a constant acceleration of 2.0 m s^{-2}.

Which of the following is correct? (Take g = 10.0 m s^{-2}.)

A The spring shortens by a length of 5.0 cm.

B The spring lengthens by a length of 5.0 cm.

C The spring shortens by a length of 10.0 cm.

D The spring lengthens by a length of 10.0 cm.

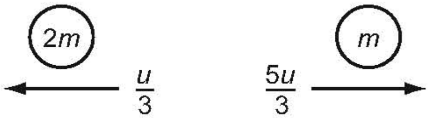
11 The diagram shows two spherical masses approaching each other head-on at an equal speed u. One has mass 2*m* and the other has mass *m*.

Which diagram represents the situation after an elastic collision?

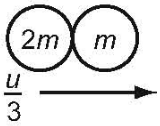
A

B

C



D

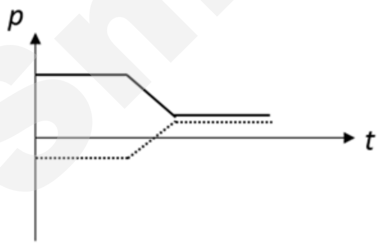


the spheres stick together

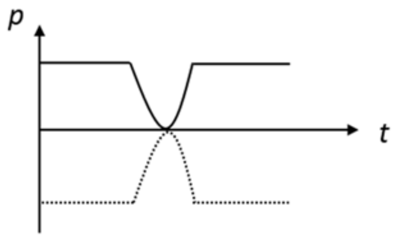
12 Two vehicles, not necessarily of the same mass or momentum, approach one another with constant velocities along a linear air track and make a head-on collision. The graphs below show the momentum of each vehicle against time for the period just before the collision until just after it.

Which of the following graphs is **not** possible?

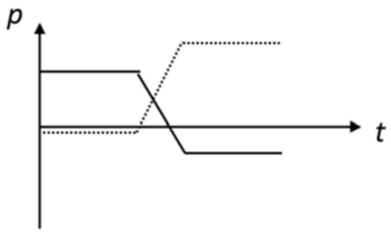
A



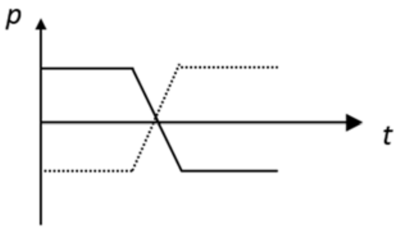
B



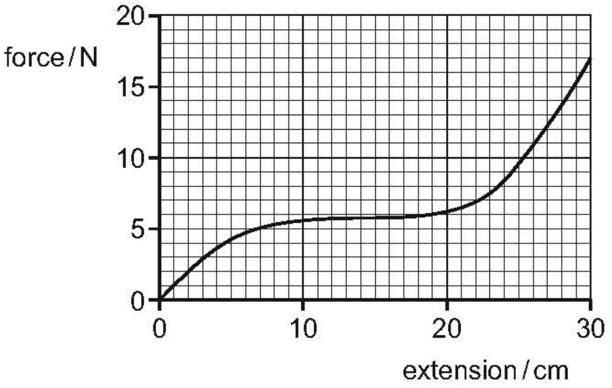
C



D



13 A rubber band is stretched by hanging weights on it and the force-extension graph is plotted from the results.



What is the best estimate of the strain energy stored in the rubber band when it is extended 30 cm?

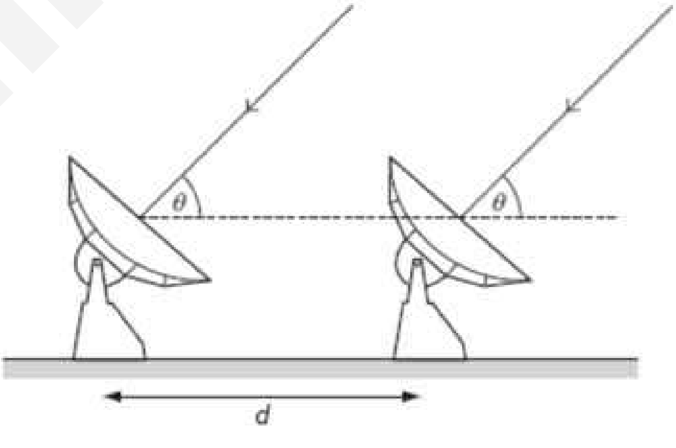
A 2.0 J **B** 2.6 J **C** 5.1 J **D** 200 J

14 A crane lifting a container out of the hold of a ship is working at a rate of 670 kW. The container has a mass of 40 tonnes and is rising with a constant speed of 1.3 m s^{-1}.
(1 tonne = 1000 kg)

What is the efficiency of the arrangement?

A 0.078% **B** 7.8% **C** 59% **D** 76%

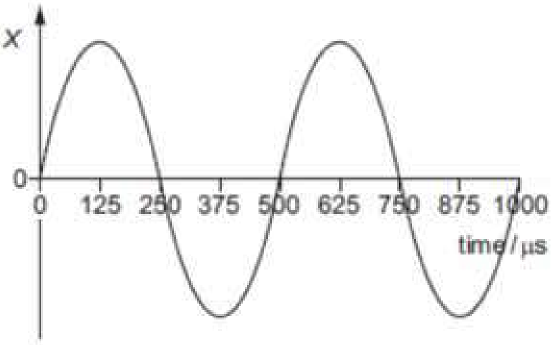
15 Two radio telescopes separated by a distance *d* detect parallel waves of wavelength λ from the same distant radio source.



What is the correct expression for the path difference between the waves received at the telescopes?

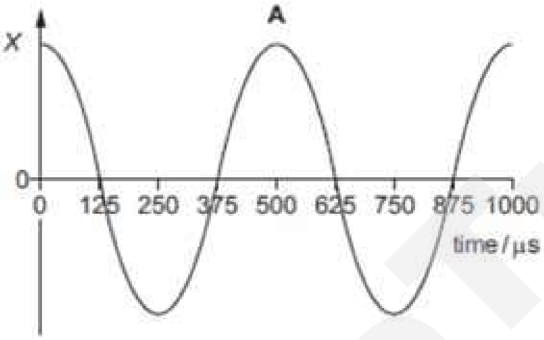
A $d\sin\theta$ **B** $d\cos\theta$ **C** $\dfrac{d\sin\theta}{\lambda}$ **D** $\dfrac{d\cos\theta}{\lambda}$

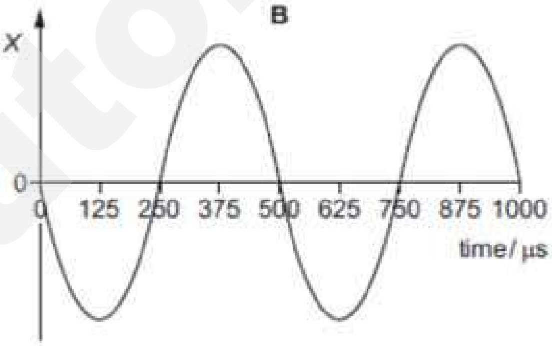
16 The graph shows the variation with time of the displacement X of a gas molecule as a continuous sound wave passes through a gas.

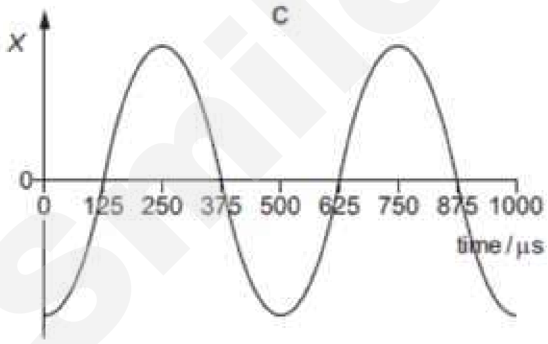


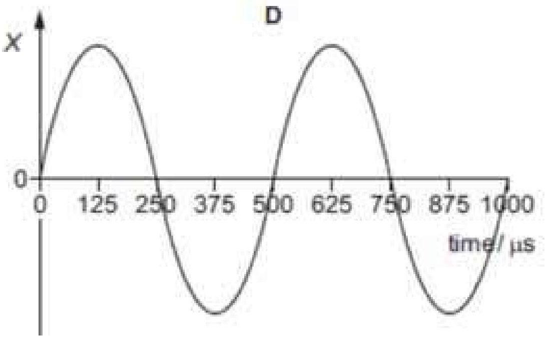
The velocity of sound in the gas is 330 m s^{-1}. All the graphs below have the same zero time as the graph above.

What is the displacement-time graph for a molecule that is a distance of 0.289 m further away from the source of the sound?







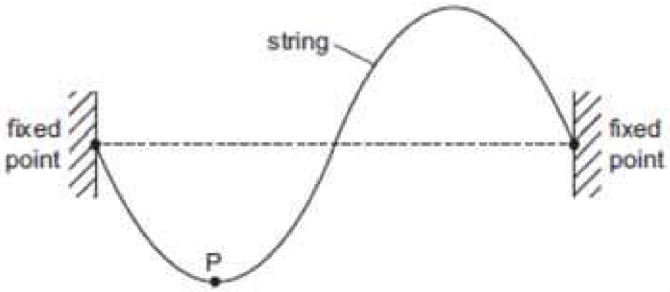


17 A plane wave of amplitude *A* is incident on a surface of area *S* placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is *E*.
The amplitude of the wave is increased to 2*A* and the area of the surface is reduced to ½*S*.

How much energy per unit time reaches this smaller surface?

A 4*E* **B** 2*E* **C** *E* **D** ½ *E*

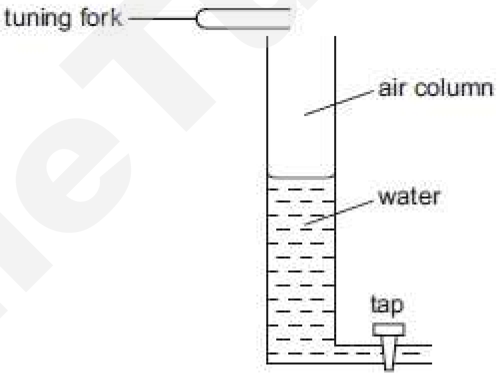
18 A stationary wave is formed on a stretched string. The diagram illustrates the string at an instant of time when the displacement of the string is at its maximum.



The frequency of the wave is 250 Hz. Point P on the string has a vertical displacement of –1.0 mm. What will be the vertical displacement of the point P after a time of 5 ms?

A –0.5 mm **B** zero **C** + 0.5 mm **D** + 1.0 mm

19 The diagram shows an experiment to produce a stationary wave in an air column. A tuning fork, placed above the column, vibrates and produces a sound wave. The length of the air column can be varied by altering the volume of the water in the tube.



The tube is filled and then water is allowed to run out of it. The first two stationary waves occur when the air column lengths are 0.14 m and 0.42 m.

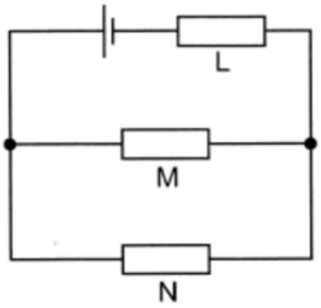
What is the wavelength of the sound wave?

A 0.14 m **B** 0.28 m **C** 0.42 m **D** 0.56 m

20 What is the **definition** of resistance?

A It is the ratio of the voltage to the current.
B It is the gradient of the graph of potential difference against current.
C It is the voltage required for a current of one ampere.
D It is the product of the resistivity of the material and the length of the wire divided by its area of cross-section.

21 In the circuit shown, a battery supplies a current of 0.025 A for 80 s. During this time it produces 18 J of electrical energy while resistor M receives 11 J and resistor N receives 4.0 J.



What is the e.m.f. of the battery and its internal resistance L?

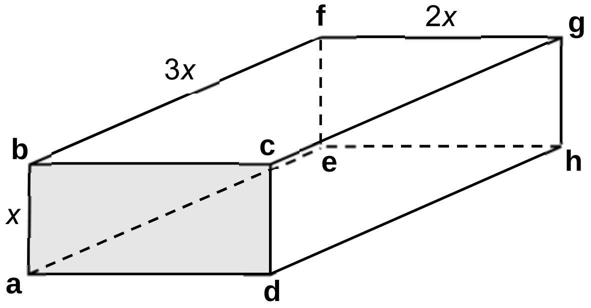
	e.m.f. of battery / V	internal resistance L of battery / Ω
A	1.5	60
B	9.0	60
C	9.0	360
D	16.5	360

22 The filament of a 240 V, 100 W electric lamp heats up from room temperature to its operating temperature. As it heats up, its resistance increases by a factor of 16.

What is the resistance of this lamp at room temperature?

A 36 Ω **B** 580 Ω **C** 1.5 kΩ **D** 9.2 kΩ

23 The diagram shows a rectangular block with dimensions x, $2x$ and $3x$. Electrical contact can be made to the block between opposite pairs of surfaces (for example, between surface **abcd** and surface **efgh**).



Between which two surfaces would the maximum electrical resistance be obtained?

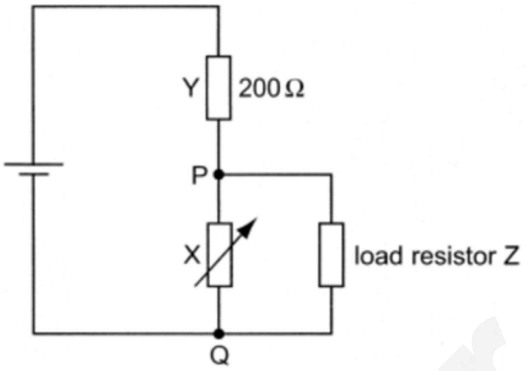
A the surfaces **bcgf** and **adhe**

B the surfaces **abcd** and **efgh**

C the surfaces **abfe** and **dcgh**

D the resistance is the same whichever pair of surfaces is used

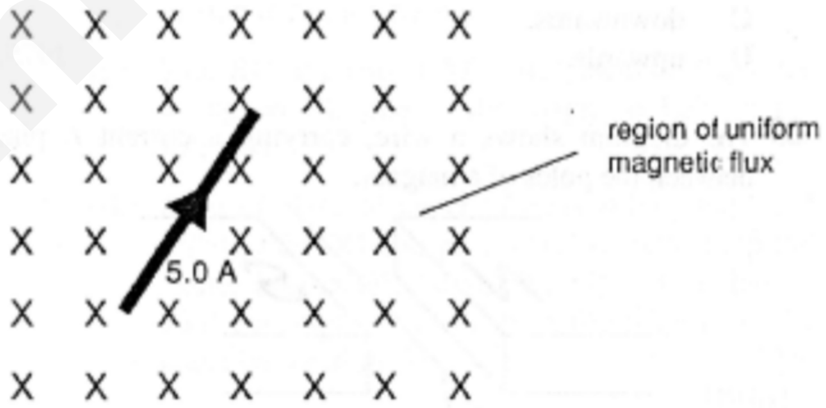
24 The circuit below consists of a 12 V battery of negligible resistance, a fixed resistor Y of resistance 200 Ω and a variable resistor X whose resistance can be changed between 100 Ω and 1200 Ω. The circuit is used to provide a variable voltage across terminals P and Q.



What range of potential differences can be obtained across the load resistor Z when its value is 400 Ω?

	maximum p.d. / V	minimum p.d. / V
A	7.2	3.4
B	10.3	4.0
C	10.7	8.6
D	12.0	8.0

25 A wire of length 3.0 cm is placed in the plane of this page while a uniform magnetic field of flux density 0.040 T acts perpendicularly into this page. The wire carries a current of 5.0 A.



What is the magnitude of the force which the field exerts on the wire?

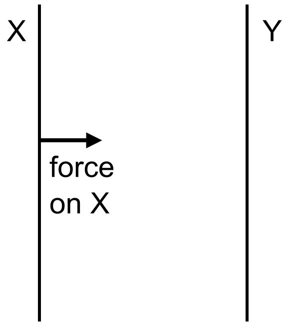
A less than 0.0060 N

B 0.0060 N

C greater than 0.0060 N but less than 0.60 N

D 0.60 N

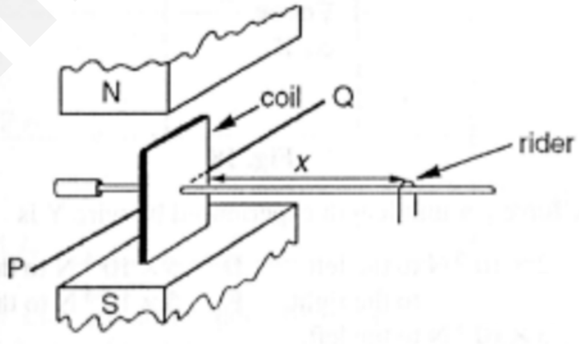
26 Two long parallel vertical wires X and Y carry currents of 3 A and 5 A respectively. The current in wire X flows upward and the force per unit length experienced by wire X is 3×10^{-5} N m^{-1} to the right as shown below.



What is the direction of the current in wire Y and the force per unit length experienced by wire Y?

	direction of current	force per unit length / N m^{-1}
A	upward	3×10^{-5}
B	downward	3×10^{-5}
C	upward	5×10^{-5}
D	downward	5×10^{-5}

27 A small square coil of *N* turns has sides of length *L* and is mounted so that it can pivot freely about a horizontal axis PQ, parallel to one pair of sides of the coil, through its centre, as shown below.



The coil is situated between the poles of a magnet which produces a uniform magnetic field of flux density *B*. The coil is maintained in a vertical plane by moving a rider of weight *W* along a horizontal beam attached to the coil. When a current *I* flows through the coil, equilibrium is restored by placing the rider a distance *x* along the beam from the coil.

Which of the following gives the correct expression for the distance *x*?

A $\dfrac{W}{BINL^2}$ **B** $\dfrac{W}{BINL}$ **C** $\dfrac{BINL}{W}$ **D** $\dfrac{BINL^2}{W}$

28 Which of the following statements on photoelectric effect is **not** an evidence for particulate nature of light?

A Emission of electrons happens as soon as light shines on metal.

B Increasing intensity of light increases rate at which electrons leave metal.

C Maximum speed of emitted electrons is dependent on the frequency of incident light.

D A minimum threshold frequency of light is needed.

29 The world's first interplanetary solar sail spacecraft, called IKAROS, works on the principle that photons reflected from the sail, of area *A*, undergo a change of momentum and, by Newton's Third Law, exert a forward force on the sail.

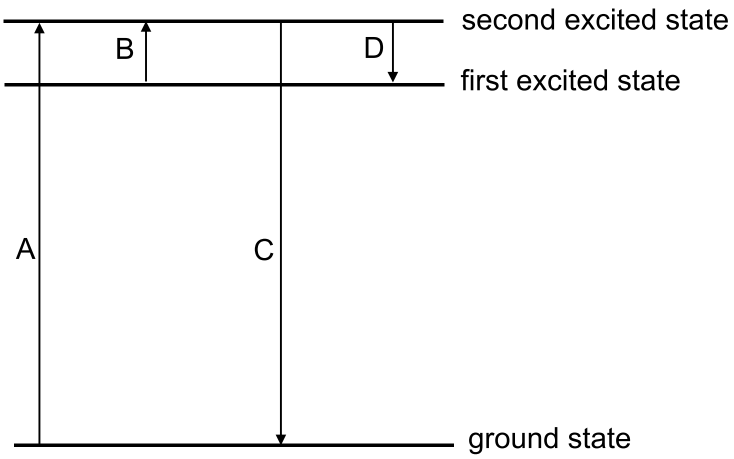
A beam of light of frequency *f* and intensity *I*, traveling at speed *c*, is reflected at right angles to a solar sail.

What is the force exerted on the sail?

A $\frac{IA}{hf}$ **B** $\frac{2hf}{c}$ **C** $\frac{I}{c}$ **D** $\frac{2IA}{c}$

30 The diagram below shows some possible electron transitions between three principal energy levels in the hydrogen atom.

Which transition is associated with the absorption of a photon of the longest wavelength?



2017 TJC H1 Physics Prelim Paper 1 Solutions

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D	**D**	**A**	**C**	**D**	**B**	**C**	**C**	**B**	**B**	**C**	**B**	**A**	**D**	**B**
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
A	**B**	**B**	**D**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**D**	**B**	**D**	**B**

1 **D** M_{min} = 15 x (0.98 g) = 14.7 g

M_{max} = 16 x (1.02 g) = 16.3 g

$\langle M \rangle$ = 15.5 g

$\Delta M = (M_{max} - M_{min})/2$ = 0.8 g

Thus $M = 15.5 \pm 0.8$ g

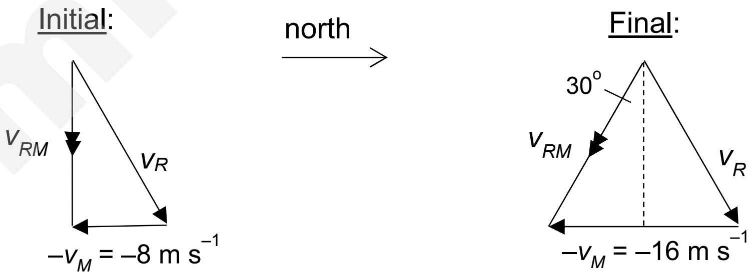
2 **D**

$$[R]^x = \left[\frac{Et^2}{\rho}\right]$$

$$\text{m}^x = \frac{(\text{kg}\,(\text{m}\,\text{s}^{-1})^2)(\text{s}^2)}{(\text{kg}\,\text{m}^{-3})} = \text{m}^5$$

$x = 5$

3 **A** Relative velocity v_{RM} of rain with respect to man is $v_{RM} = v_R - v_M$, a vector subtraction. v_R is the velocity of the rain (which stays the same) and v_M is the velocity of the man.



4 **C** Average velocity = (change in displacement) /(time taken)
= (AC) /(T) = $2L/T$

5 **D** Let T be the time interval between the drops falling from the tap. The first drop takes $2T$ (from $t = 0$ to $t = 2T$) to fall 5.00 m to ground, thus we have:

$$5.00 = ½\, g(2T)^2$$

The 2nd drop would have fallen in a time of T (from $t = T$ to $t = 2T$) a distance

$$y = ½\, g(T)^2$$

Solving, y = 1.25 m. Thus distance of 2nd drop from ground = 5.00 – 1.25 = 3.75 m

6 **B** At X when the tail fin breaks off, its initial velocity is the same as the rocket. Thus the gradients of the *s-t* graphs for both the rocket and the tail fin must be the same at X. Thereafter, the motion of the tail fin would be that of a vertical projectile.

7 **C** Angle that the string makes with vertical is 30°.

$$Cos30^o = \frac{W}{T} = \frac{\sqrt{3}}{2} => T = \frac{2W}{\sqrt{3}}$$

8 **C** For equilibrium, net force = 0, net torque about any axis = 0.
Only C satisfy these two conditions.

9 **B** Take moment about the support X,
$0.5(800) + 0.9(160) + 1.80(600) = F_Y(1.40) => F_Y = 1160N.$
$F_X + F_Y = 800 + 160 + 600 = 1560$ N. Thus $F_X = 400$ N

10 **B** Constant velocity downwards gives:
↑+: $T - mg = 0 \Rightarrow ke_o - mg = 0 \;\Rightarrow ke_o = mg$ …..(1)

Slowing down, velocity downwards ⇒ acceleration points upwards:
↑+: $T_1 - mg = ma \Rightarrow ke_1 - ke_o = ma \Rightarrow k(e_1 - e_o) = ma$ …..(2)

$$(2)/(1) \Rightarrow \frac{(e_1 - e_o)}{e_o} = \frac{a}{g} \Rightarrow (e_1 - e_o) = \frac{e_o a}{g} = \frac{(50.0-25.0)(2.0)}{10.0} = 5.0\,\text{cm}$$

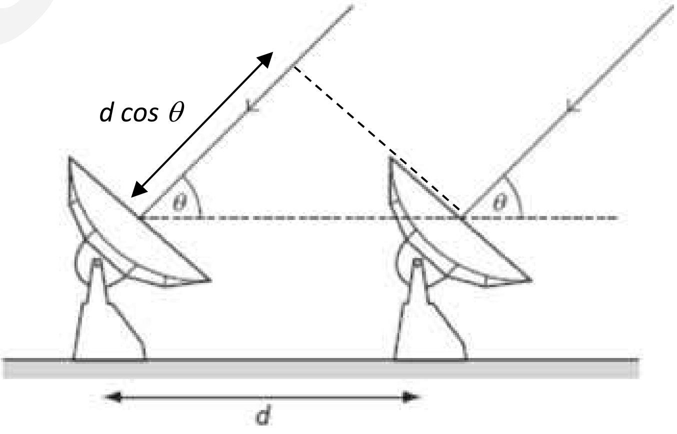
11 **C** *For head on elastic collision, relative speed of approach = relative speed of separation,*
The relative speed of approach = u – (– u) = 2u.
For answer C: relative speed of separation = 5u/3– (– u/3) = 2u.
The other options do not give relative speed of separation of 2 u.

12 **B** Answer B is not possible as the two vehicles that came to a stop at the same time cannot continue their motion again with their individual same initial momentum as that would imply the trucks had passed through each other.

13 **A** EPE = area under the force-extension graph ≈ area of triangle= ½ (0.30)13 = 2.0

14 **D** $\eta = \frac{P_o}{P_i} = \frac{mgh/t}{P_i} = \frac{mgv}{P_i} = ... = 76\%$

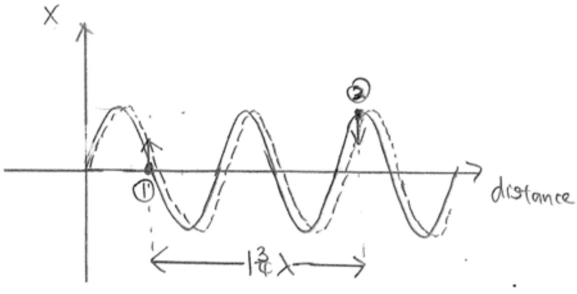
15 **B**



16 **A** $v = f\lambda$

$$v = \frac{\lambda}{T} \Rightarrow \lambda = 330(500 \times 10^{-6}) = 0.165\,\text{m}$$

A distance of 0.289 m ⇒ 0.289/0.165 = 1 ¾ λ further away from source



17 **B**

$$P = \frac{Energy}{time} = IS \ \alpha \ A^2S$$

$$\frac{P'}{P} = \left(\frac{A'}{A}\right)^2 \left(\frac{S'}{S}\right)$$

$$\frac{P'}{E} = \left(\frac{2A}{A}\right)^2 \left(\frac{\frac{1}{2}S}{S}\right)$$

$$P' = 2E$$

18 **B** *T = 1/f = 1/250 = 4 ms*
∴after 5 ms = 1.25 cycles

19 **D** Distance between 2 consecutive resonant positions = $\lambda/2$
$(0.42 - 0.14) = \lambda/2$
$\lambda = 0.56$ *m*

20 **A**

21 **B** Energy produced by cell = ε I t = *18 J*
ε *x 0.025 x 80 =18* ⇒ ε *= 9.0 V*

Energy dissipated in the cell = I^2r t = *18 – 11 – 4 = 3 J*
0.025^2 x r *x 80 = 3*
r = *60* Ω

22 **A** Let *R* be the resistance of the lamp at room temperature.
$P = V^2 / (16R)$
$100 = 240^2 / (16R) \Rightarrow R = 36\ \Omega$

23 **B** $R = \rho L / A$
For maximum resistance, *L* should be maximum and *A* should be minimum.

24 **A** *When* R_X *= 1200 Ω, effective resistance across PQ = 300 Ω.*
p.d. across PQ = 300/500 × 12 = 7.2 V.

When R_X *= 100 Ω, effective resistance across PQ = 80 Ω.*
p.d. across PQ = 80/280 × 12 = 3.4 V.

25 **B** F = BIL sin θ
= 0.040 × 5.0 × 3.0 × 10^{-2} sin 90^o = 0.0060 N

26 **A** *Applying Newton's third law, force on Y is towards X. Force per unit length experienced by Y is the same as that experienced by X and current in Y flows in the same direction as that in X.*

27 **D** *Taking moments about axis PQ,*
clockwise moment = *anticlockwise moment due to magnetic force* F
due to W *acting on the pair of sides parallel to axis PQ*
$Wx = FL$
$= (BILN)\,L$
$x = BINL^2/W$

28 **B**

29 **D** momentum of photon = $h/\lambda = hf/c$
change in momentum on rebound from sail = 2 hf/c
Intensity $I = nhf/A$ where n = number of photons incident per unit time
force = total rate of change of momentum = $n \times 2\,hf/c = IA/hf \times 2\,hf/c = 2\,IA/c$

30 **B** For absorption of a photon to take place, the energy transition is from a lower energy level to a higher energy level. For absorption of a photon with highest wavelength, the difference between the 2 energy levels is the smallest. i.e. $\Delta E = \dfrac{hc}{\lambda}$

TEMASEK JUNIOR COLLEGE

2017 Preliminary Examination
Higher 1

CANDIDATE NAME

CIVICS GROUP

INDEX NUMBER

PHYSICS

8866/02

Paper 2 Structured Questions

12 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Civics group, index number and name in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

You are advised to spend about one hour on each section.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **21** printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$p \Delta V$
hydrostatic pressure	p	=	ρgh
resistors in series	R	=	$R_1 + R_2 + ...$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + ...$

Section A

Answer **all** the questions in the spaces provided.

1 To investigate how well a basketball can bounce after hitting a hard surface, a student drops the basketball from a fixed height h_1 and measures the rebound height h_2. The experimental setup is shown in Fig. 1.1.

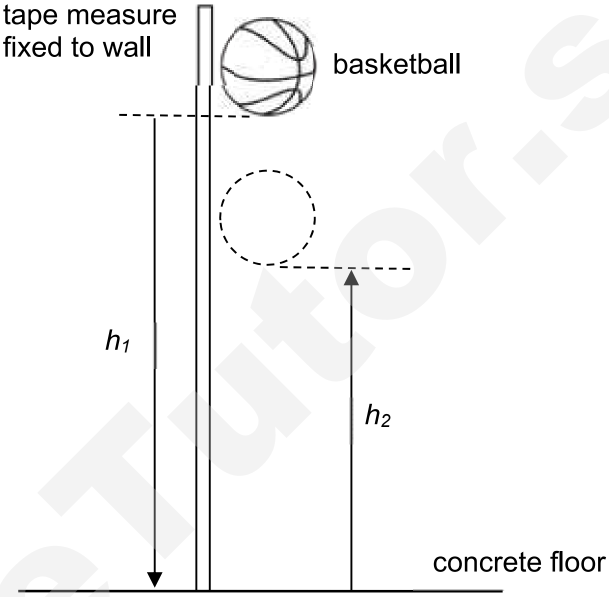


Fig. 1.1

Theory suggests that h_1 and h_2 are related by the expression

$$h_2 = e^2 h_1$$

where e is a constant known as the *coefficient of restitution*.

The following results are obtained by the student:

$h_1 = 200 \pm 1$ cm
$h_2 = 135 \pm 5$ cm

(a) Suggest why the uncertainty for h_2 is larger than that for h_1.

....

....

.... [1]

(b) **(i)** Calculate the value of e.

e = ... [1]

(ii) Calculate the actual uncertainty in e.

actual uncertainty in e = ... [2]

(iii) State the value of e and its actual uncertainty to the appropriate number of significant figures.

e = ... ± .... [1]

(c) The student decides to obtain further sets of readings for different h_1 and h_2. A graph of h_2 against h_1 is plotted, as shown in Fig. 1.2. From the graph, the gradient of the best-fit line is determined and the value of e^2 and hence e is obtained.

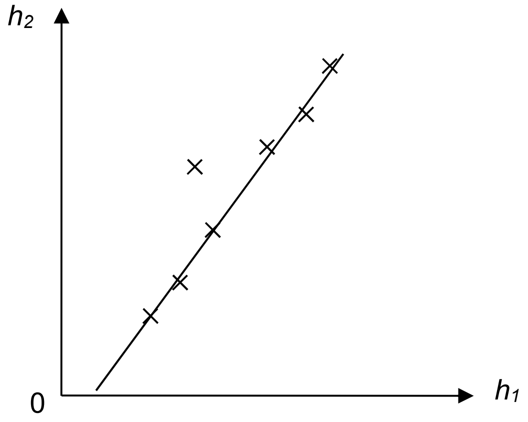


Fig. 1.2

Suggest two advantages that plotting this graph might provide, compared to just using a single set of data for h_1 and h_2 to compute e.

1. ....

....

2. ....

....

[2]

2 A train passenger is running at a maximum velocity of 3.0 m s^{-1} to catch a train. At time t = 0 s, when the passenger is at a distance d from the nearest entrance of the train, the train starts from rest with a constant acceleration of 0.30 m s^{-2} away from the passenger. The passenger just catches the train to jump into the nearest entrance.

(a) Fig. 2.1 shows the variation with time t of the displacement of the nearest entrance of the train.

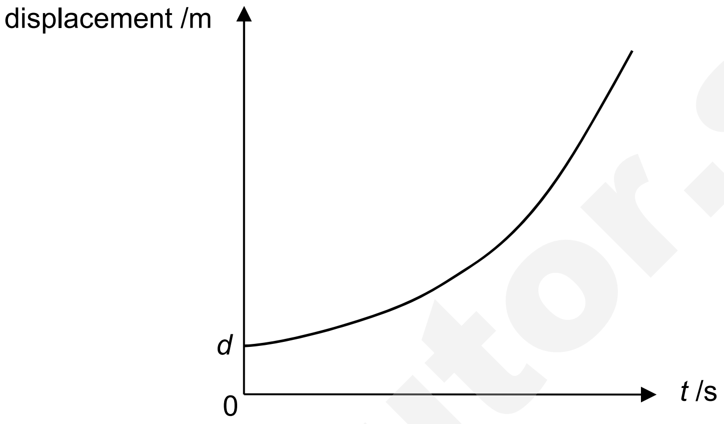


Fig. 2.1

Sketch on Fig. 2.1 a line showing the variation with time t of the displacement of the passenger. Label the line P. [1]

(b) Determine how long it will take the passenger to catch the train.

time = ... s [3]

(c) Hence calculate the distance d.

d = ... m [3]

3 Fig. 3.1 shows an arrangement which can be used to determine the speed of sound in air.

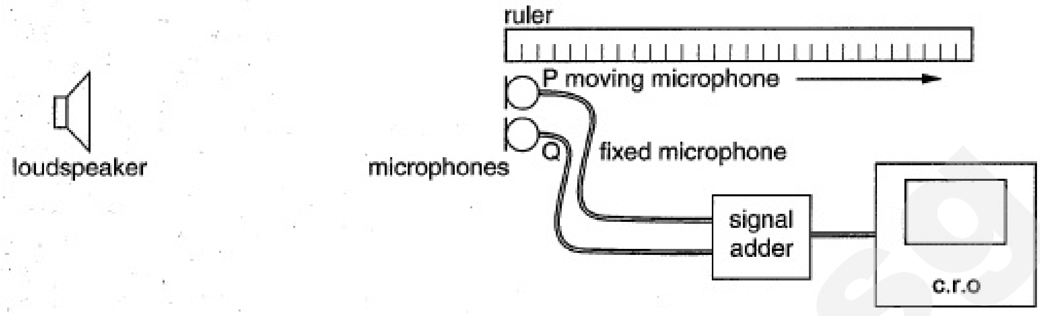


Fig. 3.1

The loudspeaker emits a sinusoidal sound wave. The electrical signals from the two microphones P and Q are added together in the electronic "signal adder" and the resultant signal is displayed on the cathode-ray oscilloscope (c.r.o.) screen. This process may be regarded as equivalent to the superposition of the waves.

Microphone Q is **fixed** and microphone P is **slowly moved** back along the edge of the ruler.

(a) Fig. 3.2 shows the appearance of the trace on the c.r.o. when both microphones are at the left hand end of the ruler, that is, the same distance from the loudspeaker.

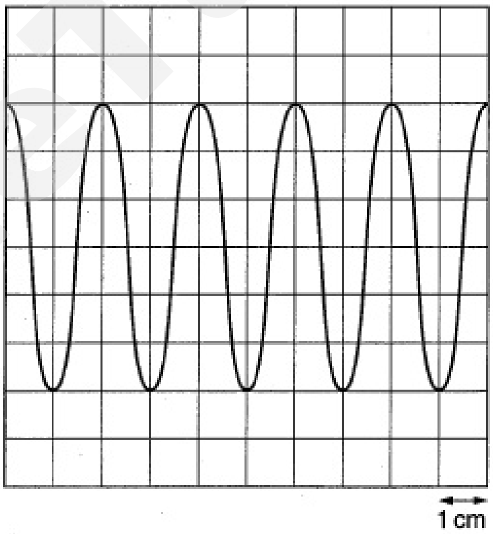


Fig. 3.2

The time-base setting of the c.r.o is 0.2 ms cm^{-1}. Determine the frequency of the sound wave.

frequency = ... Hz [2]

(b) As P is moved slowly along the edge of the ruler, the amplitude of the trace is seen to decrease, then increase, then decrease and so on.
Explain

(i) why the amplitude is a maximum when P and Q are at the left hand of the ruler,

....

....

.... [2]

(ii) why the amplitude of the trace varies.

....

....

.... [2]

(c) The first minimum of the amplitude occurs when P is at a distance of 6.8 cm from the left hand end of the ruler. Determine

(i) the wavelength of the sound.

wavelength = ... m [2]

(ii) the speed of the sound in air.

speed = ... m s^{-1} [1]

4 **(a)** **(i)** A force acts on a long, straight copper wire carrying a current I at an angle θ to a uniform magnetic field of flux density *B*.
Write down the expression for the force per unit length of the wire in terms of *B*, I and θ.

force per unit length of wire = ... [1]

(ii) Hence define the *tesla*.

....

....

.... [1]

(b) Fig. 4.1 shows a moving-coil loudspeaker.

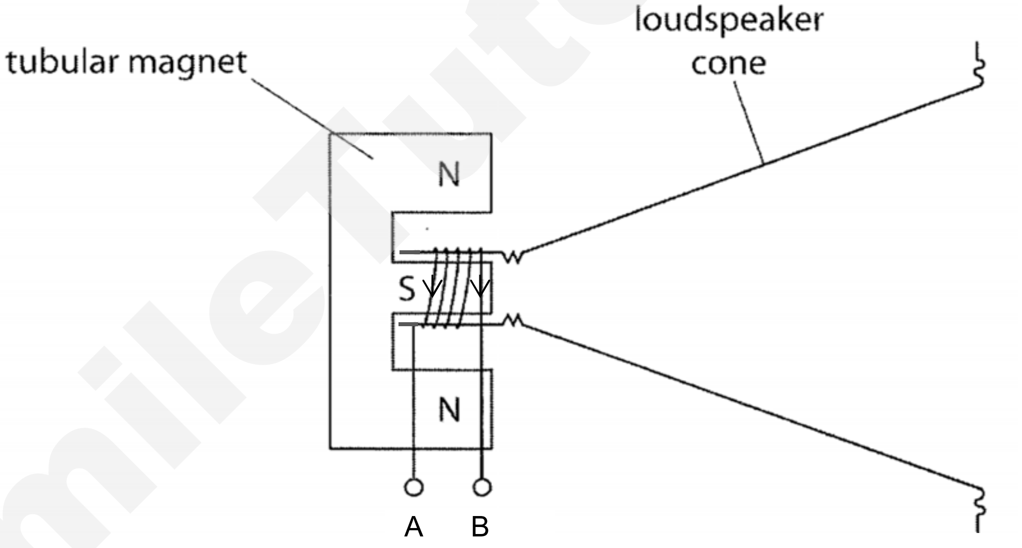


Fig. 4.1

The tubular magnet provides a radial magnetic field between the poles. A coil of copper wire surrounds the south pole of the tubular magnet. A current of 25 mA is passed through the coil from terminal A to terminal B. Each turn of the copper wire experiences a constant magnetic field of flux density 28 mT. The copper coil has a mean diameter of 16.4 mm and 250 turns.

(i) State and explain the direction of the force experienced by the coil of wire.

....

....

....

.... [2]

(ii) Calculate the force experienced by the coil of wire.

force = ... N [3]

5 According to some scientists, battery-powered cars offer many advantages over petrol driven cars. Rechargeable lead batteries are the most common type of batteries used in cars. The data below shows some properties of petrol, of a particular lead-acid battery and of a typical car.

Petrol
density = 700 kg m^{-3}
chemical energy available = 45 MJ kg^{-1}

Typical lead-acid battery
energy available when fully charged = 2.8 MJ
mass = 20 kg
e.m.f. = 12 V

Car
volume of petrol tank = 4.0×10^{-2} m^3
efficiency of transfer of chemical energy of petrol to kinetic energy of car = 25 %
drag force at 30 m s^{-1} = 580 N

(a) Calculate the chemical energy available from a full tank of petrol.

energy = ... MJ [2]

(b) A fully-charged car battery delivers a constant current of 8.0 A. Calculate the time in hours before the battery needs to be charged again.

time = ... h [2]

(c) **(i)** Calculate the total mass of lead-acid batteries needed to provide the same energy as a full tank of petrol.

mass = ... kg [1]

(ii) Suggest how your answer to **(i)** may affect the performance of a battery-powered car.

....

.... [1]

(d) Calculate the total distance in km travelled by the car on a full tank of petrol when traveling at a constant speed of 30 m s^{-1} on a level road.

distance = ... km [2]

(e) The drag force on the car is directly proportional to the square of its speed. Show that a reduction of speed by 20% can lead to a power saving of almost 50%.

Section B

Answer **two** questions from this section.

6 A group of students built a catapult to test its capability as a launcher. In one of their test launches, a ball was successfully projected over a 5.0 m wall. The ball was released 1.0 m above the ground with an initial velocity *u* at an angle θ to the horizontal. At the highest part of the trajectory, the ball managed to just go over the wall with a horizontal speed of 10 m s^{-1}. Assume that air resistance is negligible.

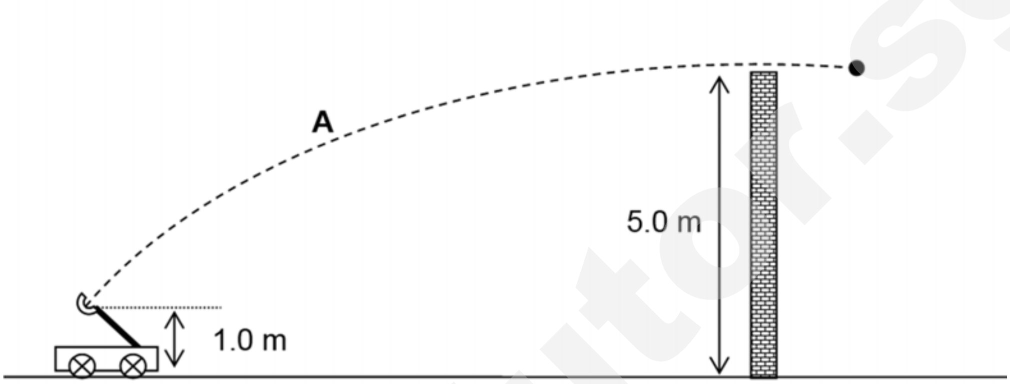


Fig. 6.1

(a) Describe the shape of the trajectory (labelled A) of the ball.

....

.... [1]

(b) Calculate

(i) the vertical component of the initial velocity *u*,

vertical component of *u* = ... m s^{-1} [2]

(ii) the angle θ of projection,

θ = ... ° [2]

(iii) the time taken for the ball to reach top of the wall, and

time taken = ... s [2]

(iv) the horizontal distance between the wall and the point of projection.

horizontal distance = ... m [2]

(c) If air resistance was significant, sketch the path of the trajectory on Fig. 6.1 and label it B. State two differences between trajectories A and B.

....

....

.... [3]

(d) The estimated normal contact force acting on the ball upon hitting the floor is shown in Fig. 6.2. Assume that the floor is frictionless.

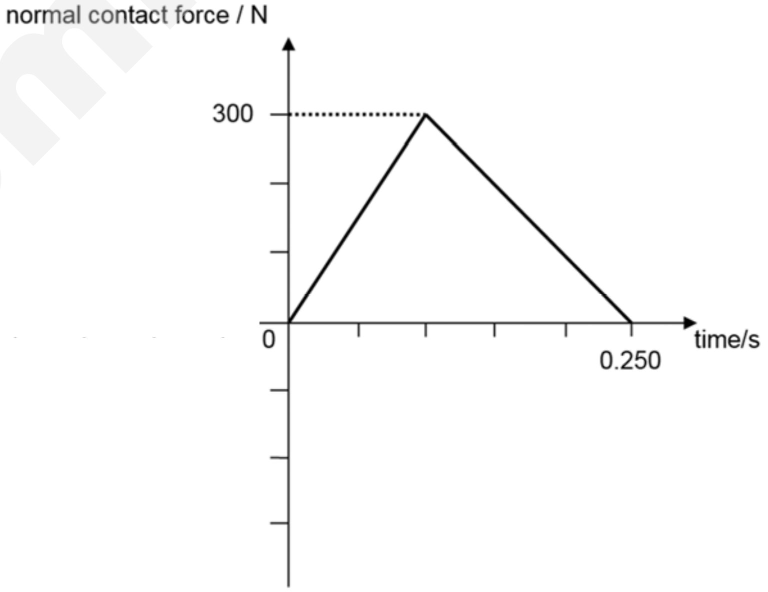


Fig. 6.2

(i) Sketch on Fig.6.2 the normal contact force exerted by the ball on the floor. [1]

(ii) Define *impulse*.

....

.... [1]

(iii) Determine the impulse delivered to the ball in the vertical direction.

vertical component of impulse = ... N s [2]

(iv) Hence find the average normal contact force acting on the ball.

average normal contact force = ... N [2]

(v) Describe the energy changes during the collision of the ball with the floor.

....

....

....

....

.... [2]

7 **(a)** **(i)** Explain why some solids are electrical conductors while some are insulators.

....

.... [1]

(ii) Describe how electrical conduction occurs in a metal.

....

....

.... [2]

(b) A certain electric hotplate, designed to operate on a 250 V supply, has two coils of nichrome wire of resistivity $9.8 \times 10^{-7}\ \Omega$ m. Each coil consists of 16 m of wire of cross-sectional area 0.20 mm^2.

For one of the coils, calculate

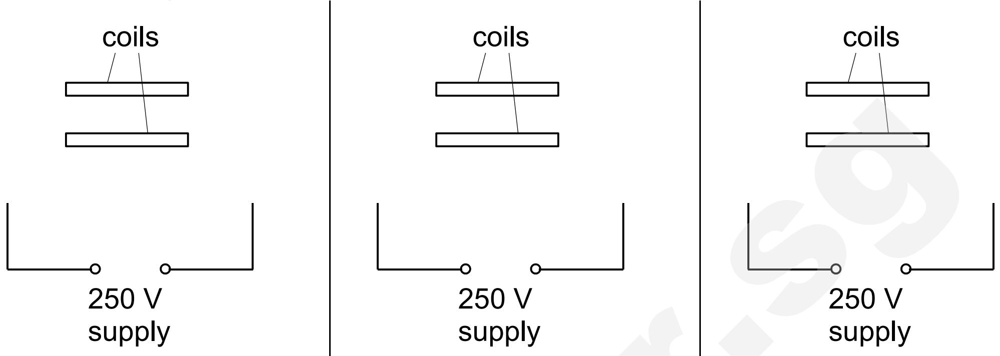
(i) its resistance,

resistance = ... Ω [2]

(ii) the power dissipated when a 250 V supply is connected across the coil, assuming its resistance does not change with temperature.

power dissipated = ... W [2]

(c) Complete the circuits in Fig. 7.1 to show how the coils in **(b)** may be arranged so that the hotplate may be made to operate at three different powers. In each case calculate the power rating.



power rating = _______ W | power rating = _______ W | power rating = _______ W

Fig. 7.1 [5]

(d) The hotplate in **(b)** is connected to the 250 V supply by means of cable of resistance 3.0 Ω.

(i) Calculate the power loss in the connecting cable when the hotplate is being used on its **middle power rating** in **(c)**.

power loss = ______________ W [3]

(ii) Comment qualitatively on any change in power loss in the cable when the hotplate is operating at each of its other power ratings in **(c)**.

[3]

(e) Different connecting cables are available for use with the hotplate in **(b)**. The maximum safe current which can be used in any one of the cables is 1 A or 3 A or 6 A or 12 A. State which is the most appropriate cable to use and briefly explain one possible danger of using cable with a lower maximum safe current.

....

....

....

.... [2]

8 **(a)** By reference to the photoelectric effect, explain

(i) what is meant by *work function energy*,

....

....

.... [2]

(ii) why, even when the incident light is monochromatic, the emitted electrons have a range of kinetic energy up to a maximum value.

....

....

.... [2]

(b) Electromagnetic radiation of frequency *f* is incident on a metal surface. The variation with frequency *f* of the maximum kinetic energy E_{MAX} of electrons emitted from the surface is shown in Fig. 8.1.

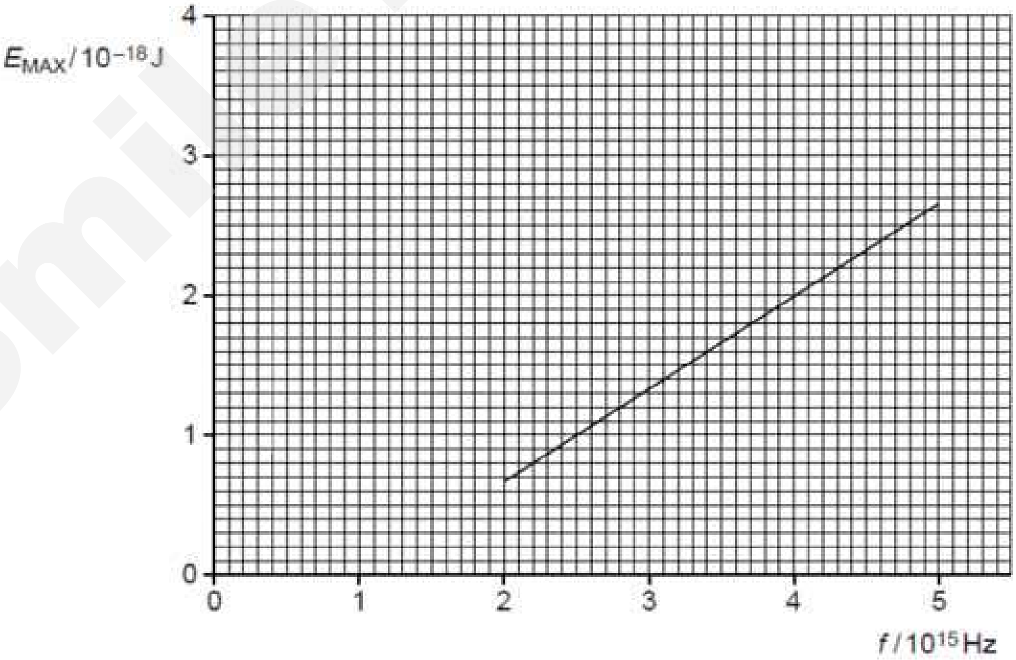


Fig. 8.1

(i) Use Fig. 8.1 to determine the work function energy of the metal surface.

work function energy = ... J [3]

(ii) A second metal has a greater work function energy than that in **(i)**.
On Fig. 8.1, draw a line to show the variation with *f* of E_{MAX} for this metal. [2]

(iii) Explain why the graphs in **(i)** and **(ii)** do not depend on the intensity of the incident radiation.

....

....

.... [2]

(c) **(i)** State what is meant by the *de Broglie wavelength*.

....

.... [1]

(ii) An electron is accelerated in a vacuum from rest through a potential difference of 850 V. Calculate the de Broglie wavelength of this electron.

wavelength = ... m [4]

(iii) Describe an experiment to demonstrate the wave nature of electrons.
You may draw a diagram if you wish.

....

....

....

....

....

....

.... [4]

Solutions to TJC 2017 H1 Physics Prelim Paper 2

1 **(a)** The basketball started at rest at the height of h_1, thus the uncertainty for its position when measuring h_1 is small. B1

It is however <u>difficult to determine when the ball has come to rest</u> on its rebound, thus <u>the final position of the ball</u> and hence the height h_2 has a larger uncertainty.

-Other possible suggestion: <u>ball might not bounce perpendicularly to floor</u>, thus the <u>measured rebound height might not be accurate, and has a larger uncertainty</u>.

-note that the measurement of h_2 involves the determination of <u>2 position readings, that at the start and also the maximum height position</u>. h_2 is also required to be <u>perpendicular to the ground</u>. Thus any factor that affects the reading of the 2 positions, or affects the perpendicular bounce of the ball would add to the uncertainty.

(b) **(i)**

$$e = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{135}{200}} = 0.822$$ A1

(ii)

$$\frac{\Delta e}{e} = \frac{1}{2}(\frac{\Delta h_2}{h_2} + \frac{\Delta h_1}{h_1})$$ C1

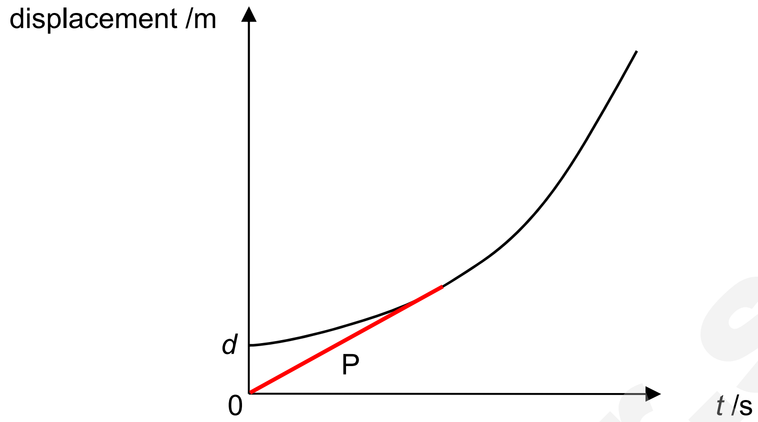
$$\Delta e = \frac{1}{2}(\frac{5}{135} + \frac{1}{200})(0.822) = 0.02$$ A1

(iii) $e = 0.82 \pm 0.02$ A1

(c) Any 2 of the following points: B2

- The graph provides a confirmation of the linear relationship between h_1 and h_2.
- The best-fit line reduces the effects of random errors in the reading of each data point.
- The graph uncovers outlying data points, which could then be further investigated.
- The graph did not pass through the origin, as predicted by the given equation. This could indicate the presence of systematic error in the experiment.

2 **(a)**



B1

P is a straight line just touching the bottom of the displacement-time graph of the train. The straight line should not extend beyond the point of contact as the passenger would have boarded the train.

(b) When the passenger 'just' catches the train, $v_P = v_T$ C1
$3.0 = (0) + (0.30)t$ C1
$t = 10$ s A1

(c) $s_P = d + s_T$ C1
$(3.0)(10) = d + [(0)(10) + ½\,(0.30)(10)^2]$ C1
$d = 15$ m A1

3 **(a)** One cycle is represented by 2 cm.
Thus period = 2 x 0.2 x 10^{-3} = 4.0 x 10^{-4} s C1
f = 1/T = 1/4.0 x 10^{-4} = 2500 Hz A1

(b)(i) P and Q are the same distance from speaker, thus the sound waves arrive in phase/zero path difference. B1
Constructive interference occurs. B1

(b)(ii) As P is moved, the path difference changes. B1
Minima when P moves odd number of ½ λs, and maxima if P moves whole number of λs. B1
OR Phase difference of waves arriving at P and Q changes; minima when waves meet out of phase & maxima when waves meet in phase)

(c)(i) First minimum corresponds to ½ λ path difference. C1
Wavelength = 2 x 6.8 = 13.6 cm = 0.136 m A1

(c)(ii) v = fλ = 2500 (0.136) = 340 ms^{-1} A1

4 **(a)** **(i)** force per unit length of wire = $B\,I\,\sin\theta$ A1

(ii) The tesla is the uniform magnetic flux density which, acting normally to a long straight wire carrying a current of 1 A, causes a force per unit length of 1 N m^{-1} to act on the wire. B1

(b) **(i)** consider top part of coil: I in wire flows out of page and B points down.
or consider bottom part of coil: I in wire flows into page and B points up. M1
(From Fleming's left-hand rule) force on coil points to the right. A1

(ii) $F = B\,I\,L\,(\sin\theta) \times N$
$= 28 \times 10^{-3} \times 25 \times 10^{-3} \times (\pi \times 16.4 \times 10^{-3}) \times 250$ C2
$= 9.0 \times 10^{-3}$ N (2 or 3 s.f.) A1

5 **(a)** Chemical energy = density x volume x 45 MJ kg^{-1} C1
= 700 (4.0 x 10^{-2}) (45) = 1260 MJ A1

(b) $E = Pt$ C1

$$t = \frac{E}{P} = \frac{E}{IV}$$

$$= \frac{2.8 \times 10^6}{(8.0)(12)}\text{ s}$$

$$= \frac{2.8 \times 10^6}{(8.0)(12)(60 \times 60)}$$ A1

$= 8.1$ hours

(c)(i) $mass = \dfrac{1260}{2.8} \times 20 = 9000$ kg A1

(ii) The total mass of the car becomes very large. Thus the acceleration of the car will be small and it will take a longer time for it to attain its required speed. B1

(d) To travel at constant speed of 30 m s^{-1} $\Rightarrow F_{\text{drive}} = f_{\text{drag}} = 580$ N C1
Kinetic energy of the car is used to do work against drag forces.
$\therefore$ KE = $f \times d$
$0.25(1260 \times 10^6) = 580 \times d$ A1
$d = 5.43 \times 10^5$ m = 543 km

(e) $f_{\text{drag}} = kv^2$
$P = F_{\text{drive}} \times v = f_{\text{drag}} \times v = (kv^2)v = kv^3$ C1

$$\frac{P'}{P} = \left(\frac{v'}{v}\right)^3 = \left(\frac{0.80v}{v}\right)^3 = 0.512$$ M1

$\therefore$ power savings = (1- 0.512) P = 0.488 P or 48.8 % A0

6 **(a)** *Shape of the trajectory is parabolic* B1

(b) **(i)** ↑+ $v_Y{}^2 = u_Y{}^2 + 2gS$ C1

$=> 0 = u_Y{}^2 + 2(-9.81)(5.0 - 1.0)$ A1

$=> u_Y = 8.86 \text{ m s}^{-1}$

(ii) $\tan\theta = \dfrac{u_Y}{u_X} = \dfrac{8.86}{10}$ C1

A1

$=> \theta = 41.5^o$

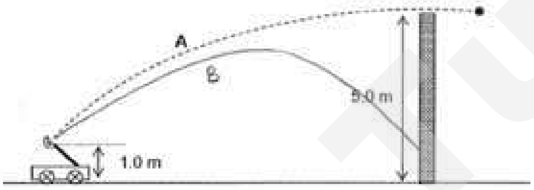
(iii) ↑+ $0 = u_Y + gt = 8.86 + (-9.81)t$ C1

$=> t = 0.903 \text{ s}$ A1

(iv) $->+ \quad s_X = u_X t$ C1

$= 10(0.903) = 9.03 \text{ m}$ A1

(c)



B1

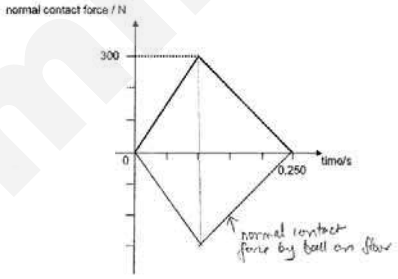
B1

B1

*Compared to **A, B** has shorter range.*

*Peak for **B** occurs earlier and is of lower height*

(d) **(i)**



B1

(ii) Impulse is the product of the force acting on a body and the time interval during which the force is exerted. (It is given by the area under the force–time graph.) A1

(iii) Impulse = area under *F* - *t* graph C1

$= \frac{1}{2}(0.250)300 = 37.5 \text{ N s}$ A1

(iv) *<F>t = impulse* C1

<F>0.250 = 37.5 => <F> = 150 N A1

(v) During collision, KE of the ball is converted into sound energy, thermal energy and elastic PE as the ball deforms. A2

Part of the elastic PE is returned to the ball as KE on rebound.

7 **(a)** **(i)** Electrical conductors contain abundant charge carriers (eg. free electrons in a metal) whereas insulators have no charge carriers. B1

(ii) Electrical conduction in a metal arises due to the flow of free electrons through a lattice of fixed positive ions. M1 A1

(b) **(i)**

$$R = \frac{\rho L}{A} = \frac{9.8 \times 10^{-7} \times 16}{0.20 \times 10^{-6}}$$ C1

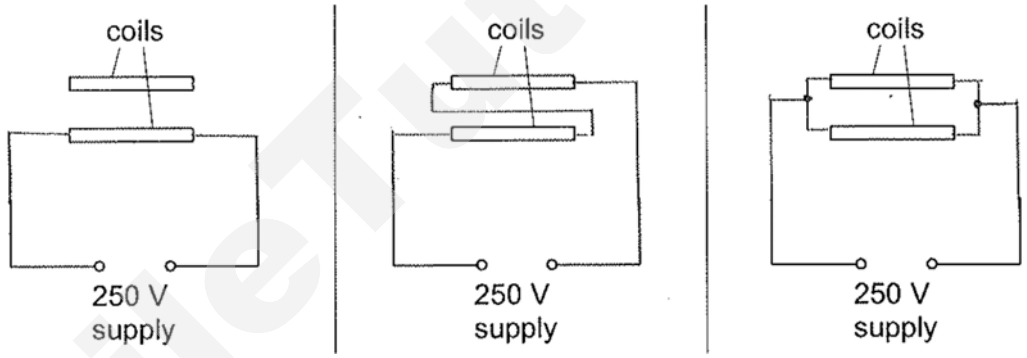
$= 78.4\ \Omega$ A1

(ii)

$$P = \frac{V^2}{R} = \frac{250^2}{78.4}$$ C1

$= 797$ W A1

(c)



power rating = 797 W	power rating = 399 W	power rating = 1590 W

B1 - each correct circuit diagram
A1 - correct power rating for series
A1 - correct power rating for parallel arrangement
-1 mark if power rating for one coil is not given

(d) **(i)**

$$P_{\text{loss}} = I^2 r = \left(\frac{250}{78.4 + 3.0}\right)^2 \text{ X } 3.0$$ C2

$= 28.3$ W A1

(ii) When the coils are in series, the total resistance of both coils doubles and so the current from the supply decreases. M1
When the coils are in parallel, the total resistance of both coils halves and so the current from the supply increases. M1
Hence the power loss decreases in the series arrangement but increases in the parallel arrangement. A1

(e) Most appropriate cable – 6 A B1
If a cable with a lower maximum safe current is used, then for two of the arrangements of the coils, the current in the circuit would exceed this value. B1
The cable will overheat and might cause a fire.

8 **(a)** **(i)** minimum photon energy B1
to remove an electron from the metal surface B1

(ii) Either maximum kinetic energy = photon energy – work function energy B1
Or electron has maximum kinetic energy when ejected from surface

Electrons within metal require energy to bring them to surface and so have lower energies than maximum KE. B1

(b) **(i)** threshold frequency = 1.00×10^{15} Hz (allow ± 0.05×10^{15} Hz) C1

work function energy = hf_0
$= 6.63 \times 10^{-34} \times 1.00 \times 10^{15}$ C1
$= 6.63 \times 10^{-19}$ J A1
(allow alternative approaches based on use of coordinates of points on the line)

(ii) straight line with same gradient M1
displaced to right A1

(iii) For the same incident frequency,
intensity determines number of photons arriving per unit time and B1
therefore it affects number of electrons emitted per unit time B1
(not maximum kinetic energy of electrons).

(c) **(i)** Either wavelength (of a wave) associated with a particle that is moving B1
Or wavelength (of a wave) associated with a particle having momentum *p* given by $\lambda = h/p$ where *h* is the Planck's constant.

(ii) energy of electron = $850 \times 1.60 \times 10^{-19}$ M1
$= 1.36 \times 10^{-16}$ J

energy = $p^2 / 2m$ or $p = mv$ and $KE = ½\, mv^2$ M1
momentum = $\sqrt{(1.36 \times 10^{-16} \times 2 \times 9.11 \times 10^{-31})}$
$= 1.57 \times 10^{-23}$ N s

$\lambda = h / p$ C1
wavelength = $(6.63 \times 10^{-34}) / (1.57 \times 10^{-23})$
$= 4.2 \times 10^{-11}$ m A1

(iii) description (and diagram) showing:
electron beam in a vacuum incident on thin metal target / carbon film B1
fluorescent screen B1
pattern of concentric rings observed M1

pattern similar to diffraction pattern observed with visible light. A1

VICTORIA JUNIOR COLLEGE

2017 JC2 PRELIMINARY EXAMINATIONS

PHYSICS
Higher 1

Paper 1 Multiple Choice

Additional Materials: Multiple Choice Answer Sheet

8866/01
21 Sep 2017
THURSDAY
2 pm to 3 pm
1 Hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, CT group and index number on the Multiple Choice Answer Sheet provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers A B C and D.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

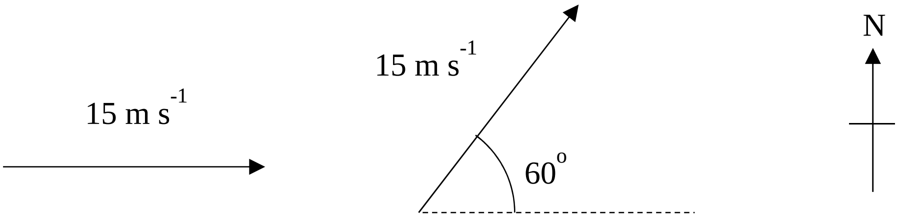
Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + (½)\, at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$

1 A car is initially travelling with a velocity of 15 m s^{-1} eastwards. At a later time, its velocity is 15 m s^{-1}, 60^{o} north of east. The change of velocity of the car is



A zero

B 26 m s^{-1} , 30^{o} north of east

C 15 m s^{-1} , 60^{o} north of west

D 13 m s^{-1} , northwards

2 Express the *tesla* in base units.

A kg m s^{-2} A^{-1}

B kg m^{2} s^{-2} A^{-1}

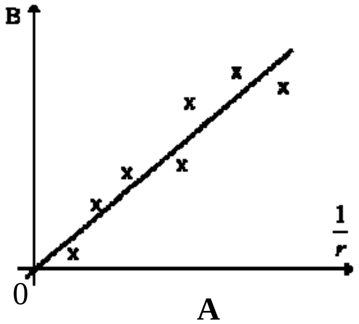
C kg s^{-2} A^{-1}

D kg m s^{-2}

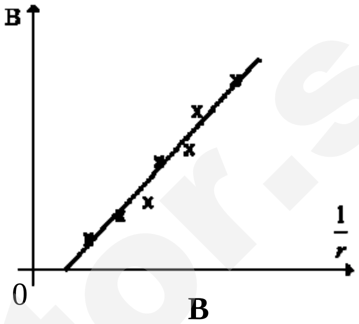
3 The radius of a solid sphere is measured to be (7.50 ± 0.03) cm and its mass is measured to be (1.65 ± 0.02) kg. Determine the density of the sphere in kg m^{-3} and its associated uncertainty.

	density / kg m^{-3}	uncertainty / kg m^{-3}
A	9.3×10^{-4}	0.2×10^{-4}
B	933.71	0.02
C	934	2
D	930	20

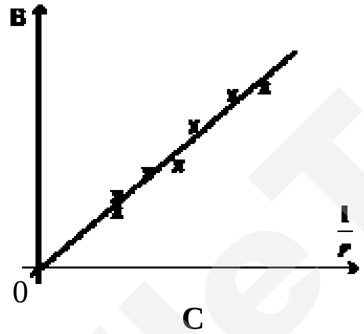
4 The magnetic flux density at a point r from a straight, long wire carrying current I is given by $B = \dfrac{\mu_0 I}{2\pi\, r}$ where μ_0 is a constant known as the permeability of free space. Experiments were carried out to determine the magnetic flux density for different values of r. Which of the following graphs shows that the data collected are inaccurate but precise?



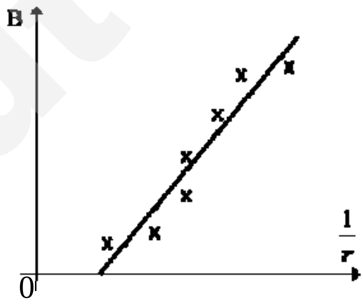
A



B



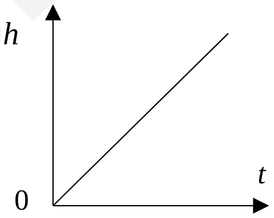
C



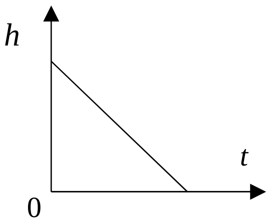
D

5 A brick falls vertically downwards from a tall building. Which of the following curves represents the variation with time t of its height h above the ground if air resistance is negligible?

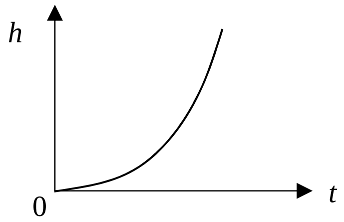
A



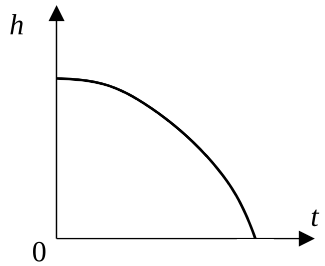
B



C



D



6 A body is thrown vertically upwards in a medium in which the drag force cannot be neglected. If the times of flight for the upward motion t_u and the downward motion t_d (to return to the same level) are compared, then

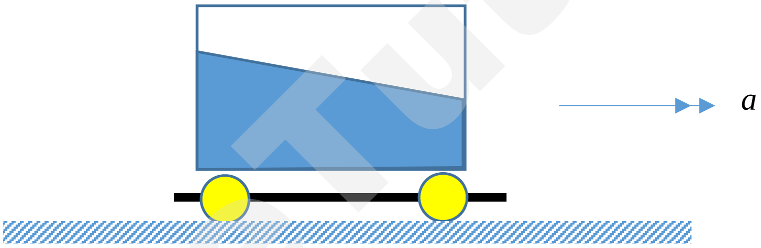
A $t_d > t_u$.

B $t_d < t_u$.

C $t_d = t_u$.

D it cannot be determined which will be larger.

7 An aquarium partly filled with water accelerates along a level surface as shown below. The water surface makes an angle θ with respect to the horizontal. If the aquarium's acceleration is a while that due to gravity is g, deduce which of the following equations is correct. (Hint: consider forces acting on a single molecule at the water surface)



A $a = g \tan \theta$ **B** $a = g \sin \theta$ **C** $a = g \cos \theta$ **D** $a = g \cot \theta$

8 Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.

The spheres have a head-on **elastic** collision. Which statement is correct?

A The sum of the momenta before impact is $2mv$.

B The kinetic energies before impact are zero.

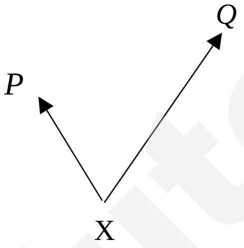
C The sum of the kinetic energies after impact is mv^2.

D The spheres stick together on

9 A spring obeying Hooke's Law has an unstretched length of 50 mm and a spring constant of 500 N m^{-1}. What is the energy stored in the spring when its overall length is 70 mm?

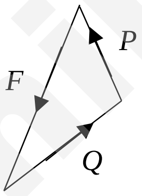
A 0.100 J **B** 0.600 J **C** 1.23 J **D** 100 kJ

10 Two forces *P* and *Q* act at a point X as shown in the vector diagram below.

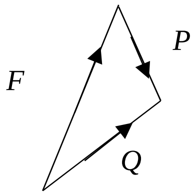


In which of the following diagrams does the vector *F* represent the force which must be applied at X to maintain equilibrium?

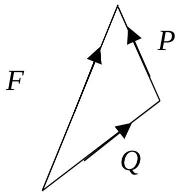
A



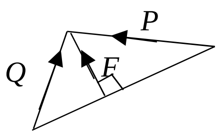
B



C



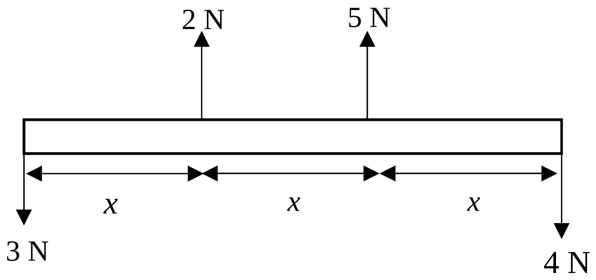
D



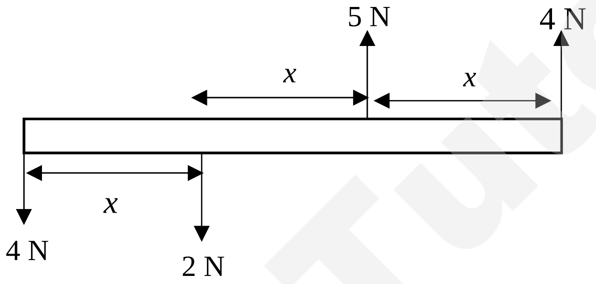
11 The force diagrams show all the forces acting on a beam of length 3*x*.

Which force system causes only rotational motion of the beam without any linear movement?

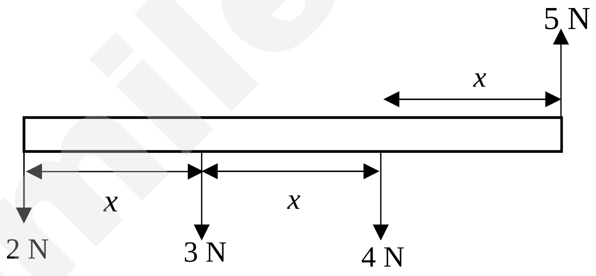
A



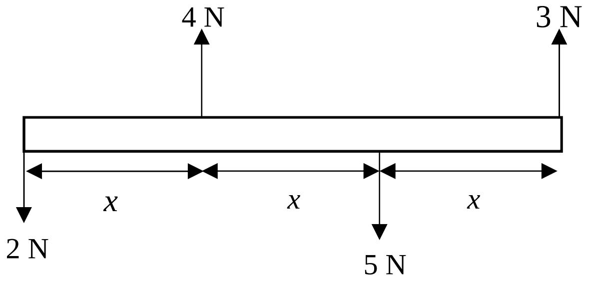
B



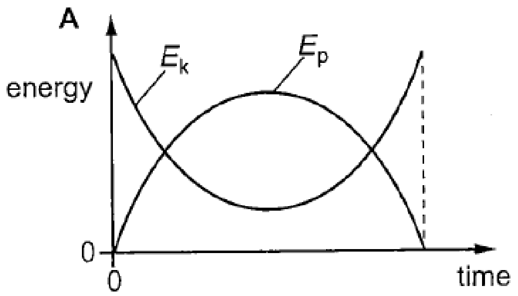
C

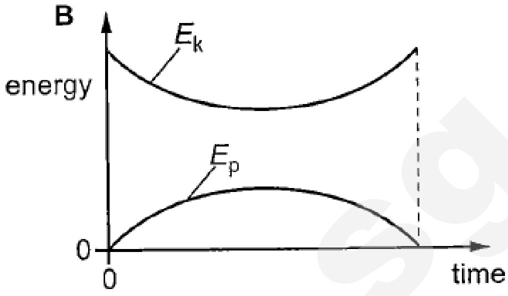


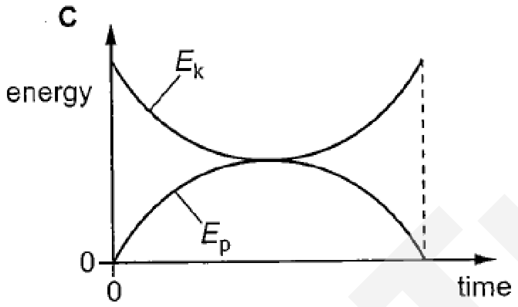
D

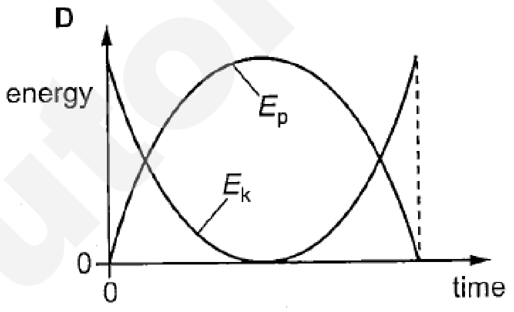


12 A soccer ball is kicked at an angle of 60° above the horizontal. Which graph shows how the kinetic energy E_k and the gravitational potential energy E_p of the ball vary from the time of impact until just before it reaches the ground? Ignore effects of air resistance.

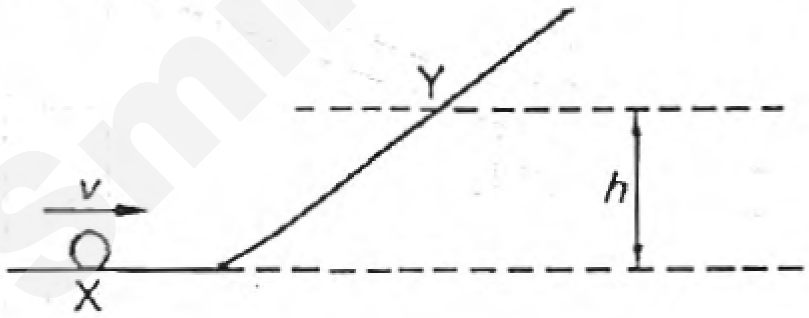








13 An object of mass *m* passes a point X with a velocity *v* and slides up a frictionless incline to stop at a point Y which is at a height *h* above X.



A second object of mass ½ *m* passes X with a velocity of ½ *v*. To what height will it rise?

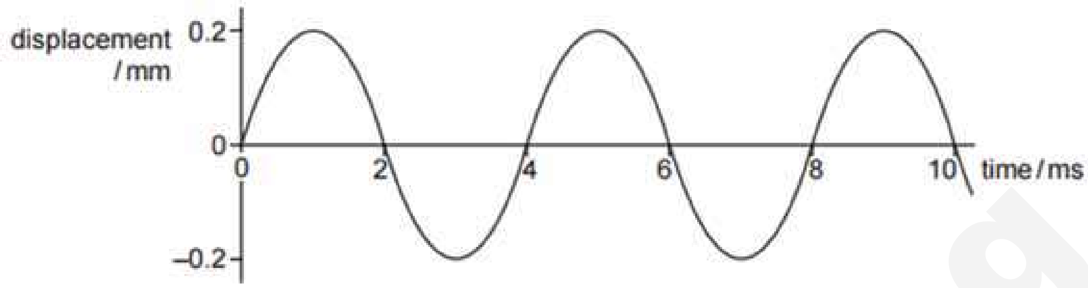
A *h*

B 0.707 *h*

C ½ *h*

D ¼ *h*

14 A sound wave moves through air. The variation with time of the displacement of an air particle due to this wave is shown in the graph below.



Which statement about the sound wave is correct?

A The frequency of the wave is 500 Hz.

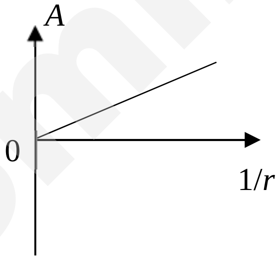
B The graph shows that sound is a transverse wave.

C The intensity of the wave will be doubled if its amplitude is increased to 0.4 mm.

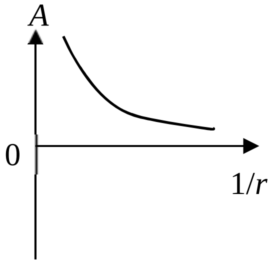
D The wavelength of the sound wave is about 1.32 m.

15 A point source of sound emits waves equally in all directions. Which graph shows the variation with 1/*r* of the amplitude *A* of the sound, where *r* is the distance from the source?

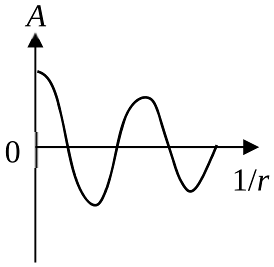
A



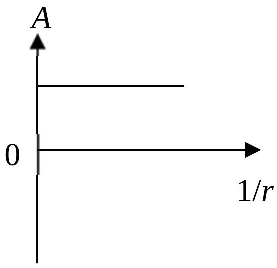
B



C



D



16 If the wavelength of water waves is λ, which of the following slit widths gives the most diffraction?

A 1.5λ **B** 3λ **C** 5λ **D** 10λ

17 Which of the following statements concerning standing waves below is **false**?

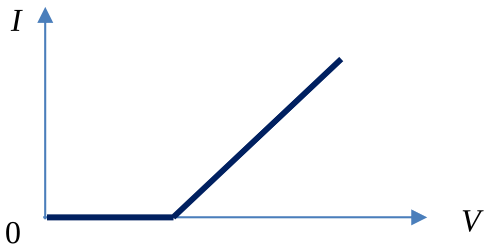
A They can be formed when microwaves of a fixed frequency from a source are directed at a reflector that reflects the waves back to the source.

B They have certain frequencies only when they are set up in a taut string fixed at its two ends.

C They can be formed when a loudspeaker generating sound at a fixed frequency is directed at a reflector that reflects the waves back to the source.

D They can be formed by tuning forks when they are placed in turn over a certain closed tube, regardless of their frequencies.

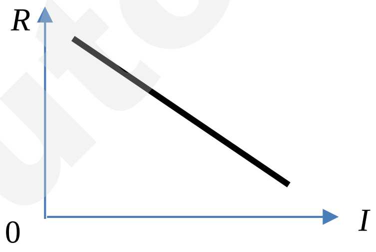
18 The diagram shows the relation between the current *I* in a certain conductor and the potential difference *V* across it.



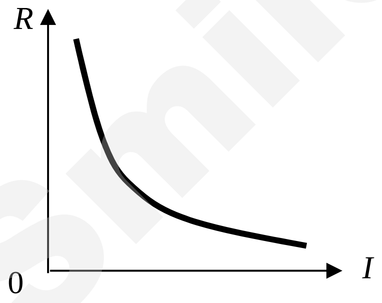
Which graph shows the correct relation between its resistance *R* and current *I*?

A

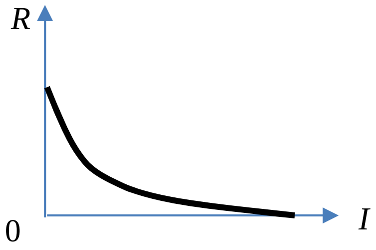
B



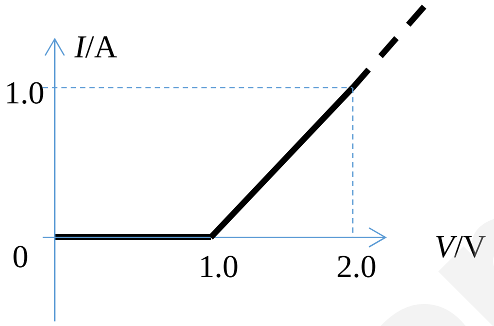
C



D

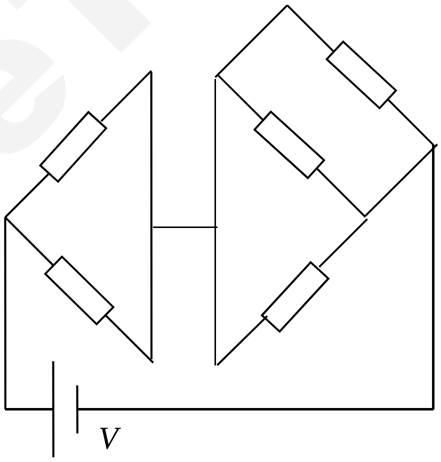


19 The graph below shows part of the I-V characteristic of a resistor when a potential difference is applied across it from 0 to 2.0 V. The characteristic remains continuous and linear as shown by the short dotted line until the potential difference across it reaches 6.0 V. What is its resistance when a potential difference of 3.0 V is applied across it?



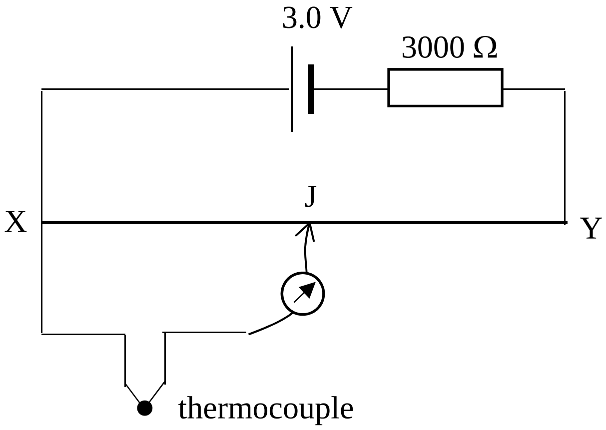
A 1.0 Ω **B** 1.5 Ω **C** 1.8 Ω **D** 2.0 Ω

20 The diagram below shows five identical resistors each of resistance R. What is the total power dissipated by the resistors?



A $V^2/(2R)$ **B** $5V^2/(6R)$ **C** V^2/R **D** $6V^2/(5R)$

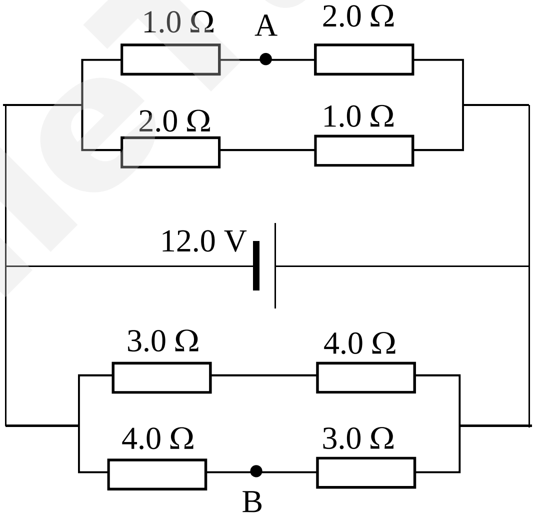
21



A thermocouple is connected across a potentiometer, and the jockey is slid along the metre bridge wire XY until balance point is reached. The balance length XJ is 80.1 cm. If the resistance of the bridge wire is 2.00 Ω, what is the e.m.f. of the thermocouple?

A 0.82 mV **B** 1.6 mV **C** 2.2 mV **D** 9.7 mV

22



What is the p.d. between points A and B in this circuit?

A 1.2 V **B** 2.9 V **C** 4.8 V **D** 6.6 V

23 A linear conductor with current I_1 is placed along the axis of a solenoid, which carries current I_2.The magnetic force acting on the conductor is:

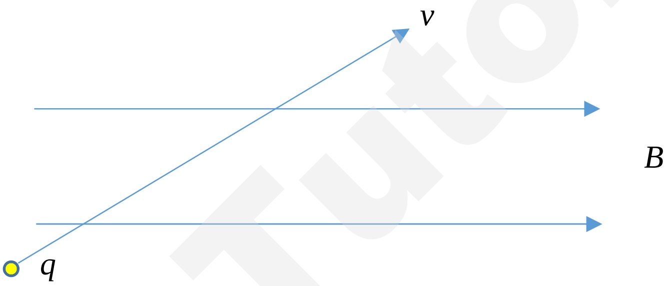
A zero;

B directly proportional to the product of currents I_1 and I_2, and inversely proportional to the radius of the solenoid;

C directly proportional to the product of currents I_1 and I_2, and inversely proportional to the square of the radius of the solenoid;

D directly proportional to the product of current I_1 ,current I_2, and the area of the solenoid

24



A positive ion of charge *q* is moving with a velocity *v* at an angle with respect to a uniform magnetic field of flux density *B* as shown in the figure. The ion experiences a magnetic force

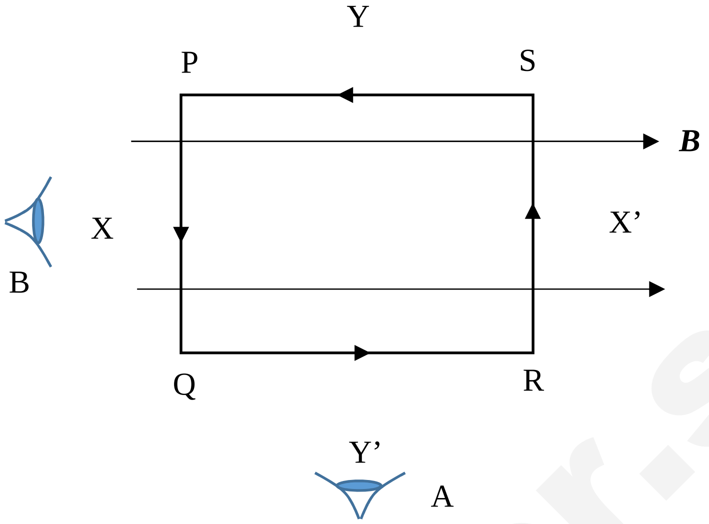
A directed out of the plane of the paper

B directed into the plane of the paper

C directed in the plane of the paper perpendicular to the magnetic field

D directed in the plane of the paper parallel to the magnetic field

25



A rectangular coil carries a constant current that flows counter-clockwise in the coil. The coil is in the plane of the paper. A constant magnetic field is directed left to right in the plane of the coil. Which of the following is correct?

A When viewed from position A, the coil will rotate clockwise about axis YY'

B When viewed from position A, the coil will rotate counter-clockwise about axis YY'

C When viewed from position B, the coil will rotate clockwise about axis XX'

D When viewed from position B, the coil will rotate counter-clockwise about axis XX'

26 A photon of light enters a block of glass after travelling through a vacuum. The energy of the photon on entering the glass block

A increases because its associated wavelength decreases

B decreases because the speed of radiation decreases

C stays the same because the speed of the radiation and the associated wavelength increase by the same factor

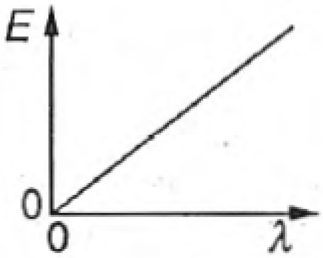
D stays the same because the frequency of the radiation does not change

27 Photons of energy 3.5×10^{-19} J fall on the cathode of a photocell. The current through the cell is just reduced to zero by applying a stopping potential of 0.25 V.
What is the work function energy of the cathode?

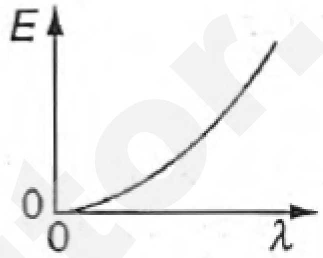
A 2.9×10^{-19} J **B** 3.1×10^{-19} J **C** 3.5×10^{-19} J **D** 3.9×10^{-19} J

28 Which graph shows how the energy *E* of a photon of light is related to its wavelength λ?

A

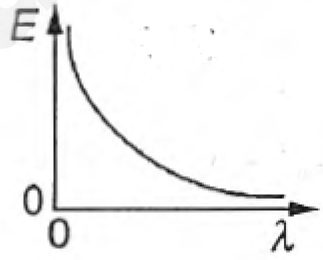


B



C

D



29 A hypothetical atom has three energy levels: the ground level and 2.00 eV and 3.00 eV above the ground level. A gas of these atoms was heated. Which of the following wavelengths of the emission spectral lines would not be detected?

A 414 nm **B** 622 nm **C** 1034 nm **D** 1240 nm

30 What is the de Broglie wavelength of a particle of mass *m* and kinetic energy *E*?

A $h\sqrt{(2mE)}$ **B** $\frac{\sqrt{(2mE)}}{h}$ **C** $\frac{h}{\sqrt{(2mE)}}$ **D** $\frac{h}{\sqrt{(mE)}}$

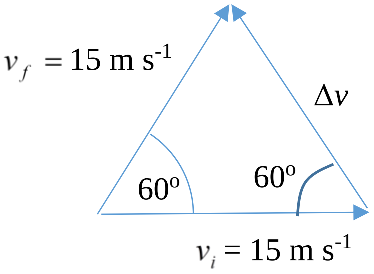
******* END *******

VICTORIA JUNIOR COLLEGE

SUGGESTED SOLUTIONS TO 2017 PHYSICS PRELIM EXAMS 8866 P1

1. Change in velocity

$\Delta\vec{v} = \vec{v}_f - \vec{v}_i$ or $\vec{v}_f = \Delta\vec{v} + \vec{v}_i$. Hence



which shows an equilateral triangle, and Δv is 15 m s^{-1} , 60° north of west

Ans: C

2. Consider a straight metallic rod of length L carrying a constant current I and placed in a magnetic field of flux density B perpendicular to the field. Then $F = BIL$ or $B = \dfrac{F}{IL}$. The SI unit for B is the tesla (T). In base unit form, the tesla is equivalent to

$$\frac{\text{kg m s}^{-2}}{\text{A m}} = \text{kg s}^{-2}\ \text{A}^{-1}$$

Ans: C

3. Density = mass/ volume

$$\rho = \frac{m}{\frac{4}{3}\pi r^3} = \frac{1.65}{\left(\frac{4}{3}\pi r^3\right)} = \frac{1.65}{\left(\frac{4}{3}\pi(0.075)^3\right)}$$

$= 933.71$ kg m^{-3}.

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta r}{r} = \frac{0.02}{1.65} + 3\frac{0.03}{7.50} = 0.02412$$

$$\Delta\rho = 0.02412\rho = 0.02412 \times 933.71 = 22.5$$

$$\approx 20\ \text{(1s.f.)}$$

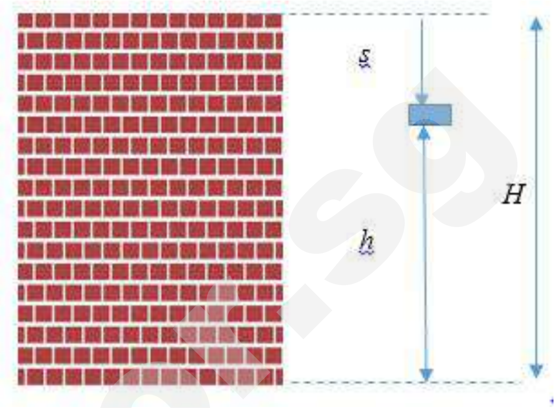
Hence $\rho = (930 \pm 20)$ kg m^{-3}.

Ans: D

4. Graph B is inaccurate because the line does not pass through the origin. It is precise because the points are close to the best fit line.

Ans: B

5.



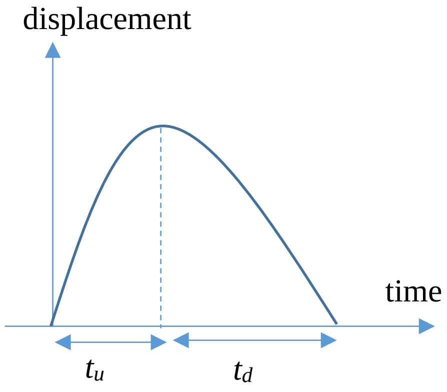
Using "$s = ut + \frac{1}{2}at^2$", we have

$$H - h = \frac{1}{2}gt^2 \text{ or } h = H - \frac{1}{2}gt^2$$

h decreases as t increases, and gradient increases as t increases.

Ans: D

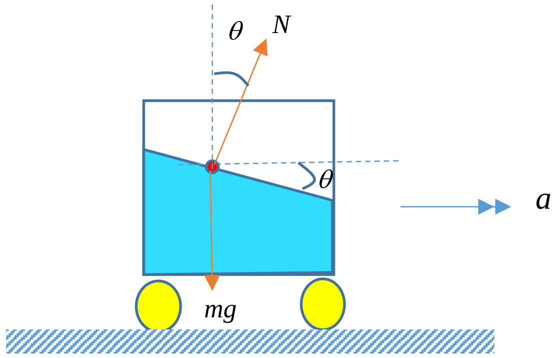
6.



The displacement-time graph for the motion of the object is shown above. It can be seen that the time taken for the object to reach its highest point is shorter than that for it to return to its starting point.

Ans: A

7.



Forces acting on a molecule of mass *m* on the surface of the water are the weight *mg* and the normal reaction *N*.

For vertical equilibrium, $N\cos\theta = mg\ldots(1)$

For horizontal acceleration to the right,

$N\sin\theta = ma\ldots.(2)$

$\frac{(2)}{(1)}$ gives $\tan\theta = \frac{a}{g}$

Ans: A

8. An elastic collision corresponds to one where the total kinetic energy of colliding particles is conserved before and after the collision. Since the total KE before the collision is $2\text{x}\frac{1}{2}mv^2 = mv^2$ before the collision, it will be mv^2 after the collision.

Ans: C

9. Stored energy = ½ $k\,e^2$
= ½ (500) $(0.020)^2$ = 0.100 J

Ans: A

10. Three planar forces in equilibrium must form a closed triangle when the forces are joined head to tail relative to one another.

Ans: A

11. In option A, there are no translational and rotational equilibrium. In option B, there is no translational equilibrium and there is linear motion. Similarly, in option C, there is no translational equilibrium and so there is linear motion. In option D, there is translational equilibrium but no rotational equilibrium (e.g. take moments about the left end of the beam). Hence the beam will not have linear motion but have only rotational motion.

Ans: D

12. When kicked at 60°, the soccer ball will still have a velocity at its highest point, hence D is not the answer. At the highest point, the velocity is

$v = v_0\cos 60^0 = \frac{v_0}{2}$. Hence the final E_k must be $E_k = \frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{mv_0{}^2}{4}\right)$ which is ¼ of the initial E_k. Hence answer is A.

Ans: A

13.

From conservation of energy,

loss of KE = gain in GPE

$$\frac{1}{2}mv^2 = mgh,$$

$$h = \frac{v^2}{2g}$$

When velocity is halved, the height reached will be a quarter of the original height reached.

Ans: D

14. Period T = 4 ms, $f = 1/T$ = 250 Hz, $v = f\lambda$,

Estimating the speed of sound in air to be 330 m s^{-1}, 330 = 250λ

λ = 1.32 m.

Ans: D

15. $I = kA^2 = P/(4\pi r^2)$, or $A\,\alpha\,1/r$

Ans: A

16. When the size of the opening in a barrier is small compared to the wavelength of the wave, more diffraction occurs.

Ans: A

17. Only tuning forks of certain frequencies can cause resonance in the closed tube. Hence standing waves can only be formed at certain frequencies that match the natural frequency of the air column in the tube.

Ans: D

18. When the current is zero, it is equivalent to saying resistance is infinitely big.
An imaginary line drawn from the origin of the *IV* graph to the line where current increases with p.d. *V* shows the gradient of the imaginary line increasing progressively as *V* increases. But the gradient of the imaginary line is the inverse of resistance. Hence resistance decreases as p.d. *V* increases.

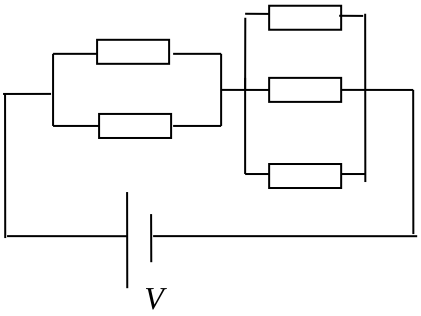
Ans: C

19. Using $y = mx + c$,
or $I = mV + c$.
Take $I = 1.0$ A, then $V = 2.0$ V.
$m = 1$, $c = -1$, hence for the linear part
$I = V - 1$
When $V = 3.0$ V, $I = 2.0$ A,
$R = V/I = 1.5\ \Omega$

Ans: B

20.

Redrawing the circuit,



Effective resistance = $R/2 + R/3$
= $5R/6$
Power dissipated = $6V^2/(5R)$

Ans: D

21. At balance point,

e.m.f. of thermocouple = p.d. across XJ

$$= \frac{R_{XJ}}{R_{XY} + 3000} \times E$$

$$= \frac{\frac{80.1}{100} \times 2.00}{2.00 + 3000} \times 3.0$$

= 0.00160 V = 1.60 mV

Ans: B

22. P.d. across top 1.0 Ω resistor is

$$V_{OA} = \frac{1.0}{1.0+2.0} \times 12.0 = 4.0 \text{ V}$$

p.d. across bottom 4.0 Ω resistor is

$$V_{OB} = \frac{4.0}{4.0+3.0} \times 12.0 = 6.9 \text{ V}$$

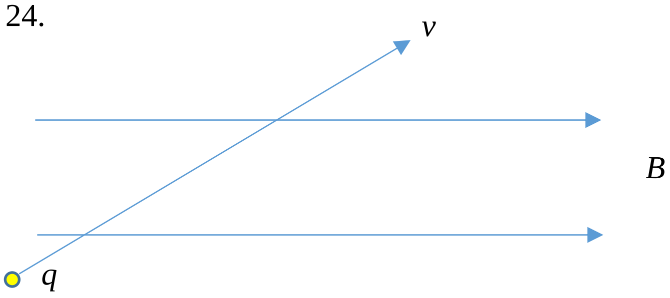
∴ p.d. between A and B = 6.9 – 4.0 = **2.9 V**.

Ans: B

23. The magnetic force acting on the conductor is zero because the magnetic field due to the current in the solenoid is either parallel or anti-parallel to the current in the linear conductor.

Ans: A

24.

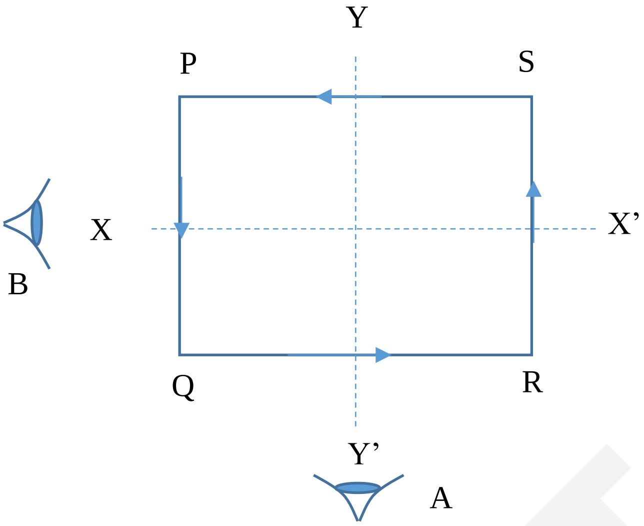


First, resolve *v* to obtain the component perpendicular to *B*.

By FLHR, this force is directed into the plane of the paper.

Ans: B

25.



With the magnetic field directed left to right in the plane of the paper, arm PQ will experience a force up out of the plane of the paper. Arm RS will experience a force down into the plane of the paper. Arms SP and QR will not experience any force.

Looking from A, the coil will rotate clockwise about axis YY'.

Ans: A

26. Since $E = hf$, and since frequency stays the same within the glass block, the energy stays the same.

Ans: D

27. 0.25 eV = 4.0×10^{-20} J

$$hf = \phi + eV$$

$$\phi = hf - eV = 3.5\times10^{-19} - 4.0\times10^{-20} \text{ J}$$

$$= 3.1\times10^{-19} \text{ J}$$

Ans: B

28. Since $E = hc/\lambda$, as λ gets bigger, E should become smaller.

Ans: D

29. Using $\Delta E = hc/\lambda$, and $\lambda = hc/\Delta E$, and substituting ΔE of 1,2,3 eV, we find the corresponding λ to be

$$\lambda = hc/\Delta E = \frac{6.63\times10^{-34}\times3\times10^{8}}{1\times1.6\times10^{-19}}$$

=1240 nm (from 3.00 eV level to 2.00 eV level)

$$\lambda = hc/\Delta E = \frac{6.63\times10^{-34}\times3\times10^{8}}{2\times1.6\times10^{-19}}$$

= 622 nm (from 2.00 eV level to ground)

$$\lambda = hc/\Delta E = \frac{6.63\times10^{-34}\times3\times10^{8}}{3\times1.6\times10^{-19}}$$

= 414 nm (from 3.00 eV level to ground)

Ans: C

30. Using $\lambda = \frac{h}{p}$ and since

$$E = \frac{p^2}{2m},\ p = \sqrt{2mE}$$

Combining the 2 equations, we have

$$\lambda = \frac{h}{\sqrt{2mE}}$$

Ans: C

********** END **********

Name : ________________________________ CT group : _________

VICTORIA JUNIOR COLLEGE
2017 JC2 PRELIMINARY EXAMINATIONS

PHYSICS **8866/02**

Higher 1 **18 Sep 2017**

MONDAY

Paper 2 Structured Questions

2 pm – 4 pm

Candidates answer on the Question Paper

2 Hours

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and CT group at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
Section B	
7	
8	
9	
Total (max. 80):	

This document consists of a total of **21** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron,	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton,	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall,	$g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + (\frac{1}{2})\, at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho g h$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** the questions in this section.

1 A student throws a ball from point A to a friend at point B. The path of the ball is shown in **Fig. 1**.

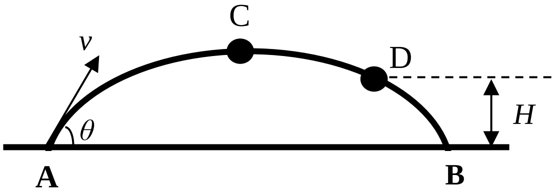


Fig. 1

The points A and B are on the same horizontal level. Air resistance is negligible.

(a) The ball is thrown from A with velocity v at an angle θ above the horizontal.

(i) Express the speed, v_c of the ball at C, the highest point on its path of motion in terms of v and θ.

[1]

(ii) Point D is at height H above the horizontal AB. Express the speed, v_D of the ball at D, in terms of v and H. Show the steps clearly.

[2]

(b) If air resistance cannot be neglected, sketch the path of the ball in **Fig. 1.**

[2]

2 A non-uniform bar XY makes an angle of 60° with a horizontal surface, as shown in **Fig. 2**.

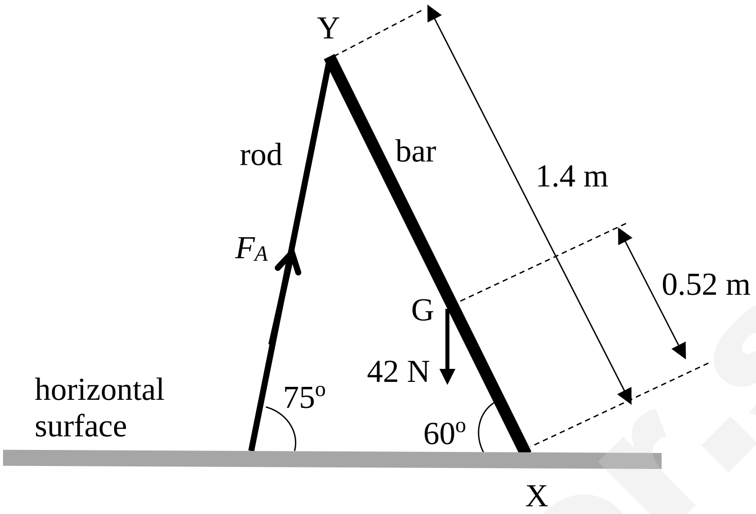


Fig. 2

The bar is hinged at X and is supported by a rod of negligible mass at Y. The force F_A produced by the rod at Y acts at an angle of 75° to the horizontal.

The bar has a length of 1.4 m and a weight of 42 N.

The centre of gravity G of the bar is 0.52 m from X.

(a) Use the Principle of Moments to find the magnitude of the force F_A.

Force F_A = ………………….. N [2]

(b) A force F_X acts on the bar at X.

(i) Explain why a force is required to act on the bar at X to keep the bar in equilibrium.

………………………………………………………………..…………………

………………………………………………………………..…………………

………………………………………………………………..…………………

………………………………………………………………..…………. [2]

(ii) Draw an arrow to represent the force F_X in **Fig. 2**. [1]

3 The Prius is a hybrid car that runs on both petrol and electricity. It has a mass of 1300 kg.

(a) Calculate the kinetic energy of a Prius that is moving at a speed of 16.7 m s^{-1}.

Kinetic energy = ……………… J [1]

(b) The power P required to overcome external forces opposing the motion of the Prius is given by the expression,

$$P = 240v + 0.98v^3 .$$

(i) Calculate the magnitude of the external forces opposing the motion of the car when it is moving at a constant speed of 16.7 m s^{-1}.

Resistive force = ……………………… N [2]

(ii) Hence or otherwise, calculate the work done in overcoming the forces in **(b)(i)** during a time of 3.0 minutes.

Work done = ………………… J [2]

4 **(a)**

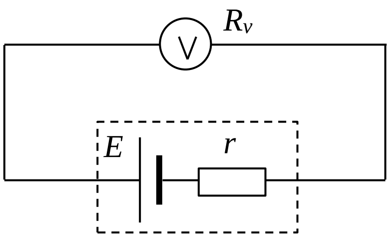


Fig. 4.1

A voltmeter is connected across the terminals of a cell of e.m.f. $E = 2.0$ V and internal resistance r (see **Fig. 4.1**). If the resistance of the voltmeter is R_v, write down an expression for the voltmeter's reading. Express your answer in terms of R_v, r and E.

[1]

(b) If $r = 0.10\ \Omega$, determine the minimum resistance that the voltmeter must have for its reading to be within 0.1 % of the e.m.f. E.

Minimum resistance needed = ………………… Ω [2]

(c)

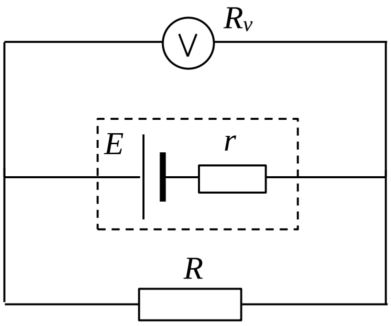


Fig. 4.2

The cell is now connected across a resistor R (see **Fig. 4.2**).
Derive an expression for the reading of the voltmeter. Express your answer in terms of R_v, r, R and E.

[2]

5 A metal wire L = 10 m long lies east-west on a wooden table. The density D and resistivity ρ of the metal of the wire are 1.0×10^4 kg m^{-3} and 2.0×10^{-8} Ω m respectively. The wire has a radius of cross-section 0.457 mm. The horizontal component of the earth's magnetic field B is 1.8×10^{-5} T.
A p.d. is applied to the ends of the wire.

(a) Draw a diagram to show the directions of current, magnetic field and magnetic force acting on the wire.

[1]

(b) Calculate the resistance of the wire.

Resistance = ………………….. Ω [2]

(c) Determine the minimum potential difference that would have to be applied to the ends of the wire in order to make the wire rise from the surface of the table.

Minimum p.d. = …………………….. V [2]

6

Sphere A

Fig. 6.1

Two spheres approach each other along a line joining their centres, as illustrated in **Fig. 6.1**.
When they collide, the forces acting on spheres A and B are F_A and F_B respectively.
The forces act for time t_A on sphere A and time t_B on sphere B.

(a) State the relationship between

(i) F_A and F_B , taking into consideration their directions. For the sign convention, take the rightward direction as positive.

.... [1]

(ii) t_A and t_B.

.... [1]

(b) Use your answers in **(a)** to show that the change in momentum of sphere A is equal in magnitude and *opposite in direction* to the change in momentum of sphere B.

[2]

(c) For the spheres in **(b)**, the variation with time of the momentum of sphere A before, during and after the collision with sphere B is shown in **Fig. 6.2**. The momentum of sphere B before the collision is also shown in **Fig. 6.2**.

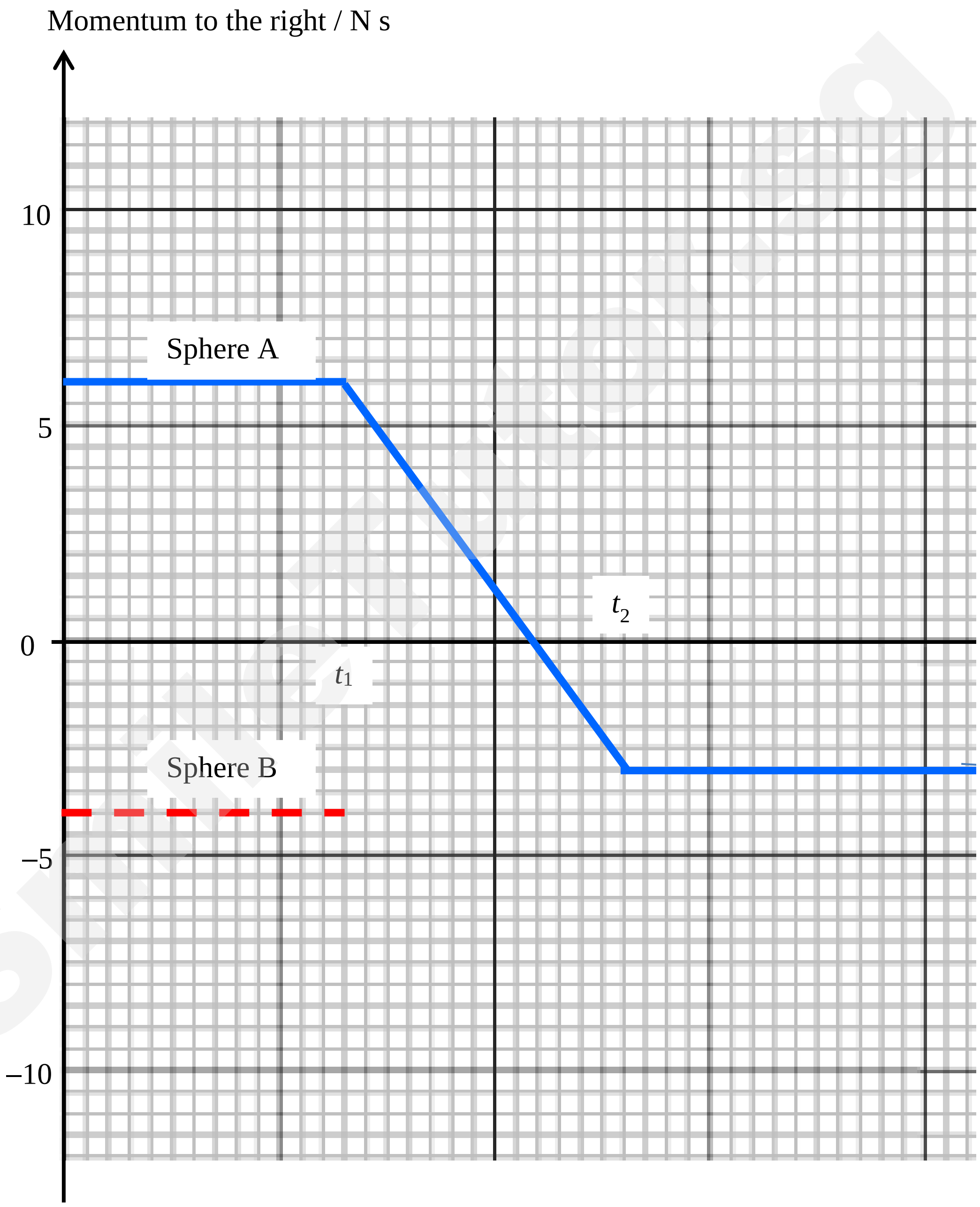


Fig. 6.2

(i) Using the result from (b), calculate the momentum of sphere B after its collision with sphere A.

Momentum = ……………….. kg m s^{-1} [2]

(ii) Complete **Fig. 6.2** to show the variation with time of the momentum of sphere B during and after the collision with sphere A.

[2]

(d) The initial velocity u_A is 3.0 m s^{-1}. Calculate the mass of sphere A and its final velocity v_A.

Mass = ……………….. kg [1]

v_A= ………………………. m s^{-1} [1]

(e) Calculate the ratio of the final to initial velocities $\frac{v_B}{u_B}$ of sphere B.

$\frac{v_B}{u_B} =$ ………………… [2]

(f) The mass of sphere B is 1.0 kg. Determine quantitatively whether the collision is elastic or inelastic.

[3]

Section B

Answer two of the questions from this section.

7 (a) Bob has a mass of 71 kg. He stands on a spring scale in an elevator. The spring balance reads in newtons. Starting from rest, the elevator ascends with constant acceleration, attaining its maximum speed of 1.2 m s^{-1} in 0.80 s. It travels with this constant speed for the next 2.0 seconds. The elevator then undergoes a uniform deceleration for 1.9 s and comes to rest.

(i) Draw a labelled velocity-time graph for Bob's motion.

[2]

(ii) Draw a corresponding labelled graph to show how the readings of the spring balance varies with time for the whole of Bob's motion. Show your calculations.

[4]

(b) Bob steps into the elevator to go to the ground floor. For some reason, the elevator malfunctions and plunges suddenly.

(i) Explain, using Newton's Laws, why (apart from fear) Bob feels lighter while the elevator is plunging towards the ground floor.

....

....

....

....

.... [2]

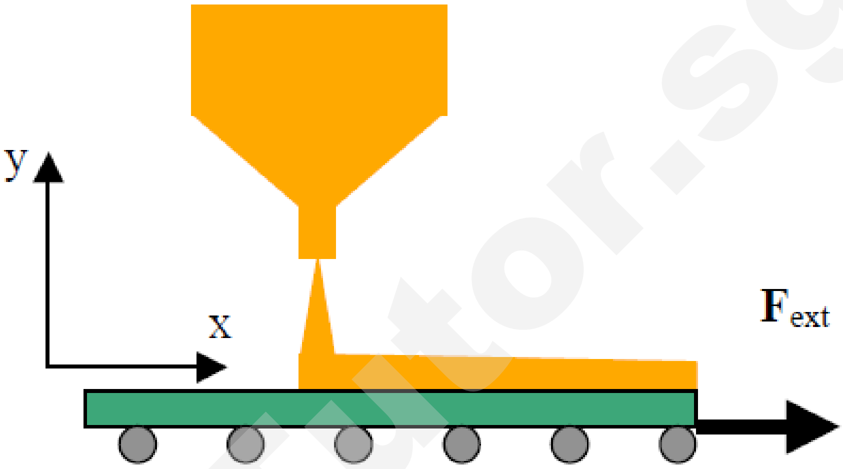
(ii) Bob reasons that if the elevator cables had been cut, he would effectively be weightless. Explain using Newton's Laws.

…………………………………………………………………………………

…………………………………………………………………………………

……………………………………………………………………………….. [2]

(c)



Sand from a stationary hopper falls onto a moving conveyor belt at a rate of 5.00 kg s^{-1} as shown above. The conveyor belt is supported by frictionless rollers and moves at a constant speed of 0.75 m s^{-1} under the action of a constant horizontal external force $\boldsymbol{F}_{ext}$ supplied by the motor that drives the belt.
Calculate:

(i) the force of friction exerted by the belt on the sand;

Frictional force = ……………….. N [2]

(ii) the external force $\boldsymbol{F}_{ext}$, giving your reason.

F_{ext} = ………………… N [2]

(iii) the power due to $\boldsymbol{F}_{ext}$;

Power = …………………….. W [2]

(iv) the rate of change of kinetic energy of the sand due to the change in its horizontal motion;

Rate = …………………… W [2]

Compare and analyse the answers to **(c)(iii)** and **(c)(iv)**.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

………………………………………………………………………….. [2]

8 **(a)** The speed of the wave set up in a vibrating string is given by

$$v = \sqrt{\frac{T}{\mu}}$$

where T is the tension in the string, and μ is the mass per unit length of the string. On a particular piano note, the mass per unit length of the string is 0.030 kg m^{-1} and the tension in it is 275 N. The string is 0.87 m long and it vibrates at a frequency of 55 Hz.

(i) Show using base units that the equation above is homogeneous.

[2]

(ii) Calculate the speed of the wave in the vibrating string.

Speed = ……………… m s^{-1} [2]

(iii) Calculate the wavelength of the stationary wave.

Wavelength = …………………… m [2]

(iv) Sketch a diagram of the stationary wave formed and label the length of the string.

[1]

(v) If the speed of sound in air is 340 m s^{-1}, calculate the wavelength of the sound when this note is heard.

Wavelength = …………………… m [1]

(vi) Explain why sound is characterized by its frequency rather than its wavelength.

……………………………………………………………………..………………

……………………………………………………………………..………………

……………………………………………………………………..……….. [2]

(b) A pipe is open at both ends, while another is closed at one end. Two **consecutive** resonances corresponding to stationary waves are heard at 264 Hz and 440 Hz for one of the pipes.

(i) By drawing the 3 lowest modes of oscillation in the pipe open at one end, show that

$$\left(\frac{2n-1}{4}\right)\lambda = L$$

where n = 1, 2, 3, …

[3]

(ii) By drawing the 3 lowest modes of oscillation in the pipe open at both ends, derive an expression involving n, λ and L.

[3]

(iii) Determine whether the pipe open at both ends can produce the two resonances of 264 Hz and 440 Hz.

[4]

9 **(a)** In a photoelectric emission experiment, ultra-violet radiation, of wavelength 254 nm and of intensity of 210 W m^{-2}, was incident on a silver surface in an evacuated tube, so that an area of 12 mm^2 was illuminated.

A photocurrent of 4.8×10^{-10} A was measured.

(i) Calculate the rate of incidence of photons on the silver surface.

Rate of incidence = ………………. s^{-1} [3]

(ii) Calculate the rate of emission of electrons.

Rate of emission = …………….. s^{-1} [2]

(iii) The photoelectric quantum yield is defined as the ratio of

$$\frac{\text{number of photoelectrons emitted per second}}{\text{number of photons incident per second}},$$

1 Calculate the quantum yield of this silver surface at the wavelength of 254 nm.

Quantum yield = …………………. [1]

2 Suggest two reasons why this value is expected to be much less than one.

………………………………………………………………….…………

………………………………………………………………….…………

…………………………………………………………………..…. [2]

(iv) When the experiment was repeated with visible radiation, no photoelectrons were emitted. Explain this observation.

……………………………………………………………….………..……

……………………………………………………………….………..……

…………………………………………………………………...…. [2]

(b) **Fig. 9.1** shows the setup for another experiment on the photoelectric effect. X and Y are electrodes made of different metals and placed in an evacuated chamber.

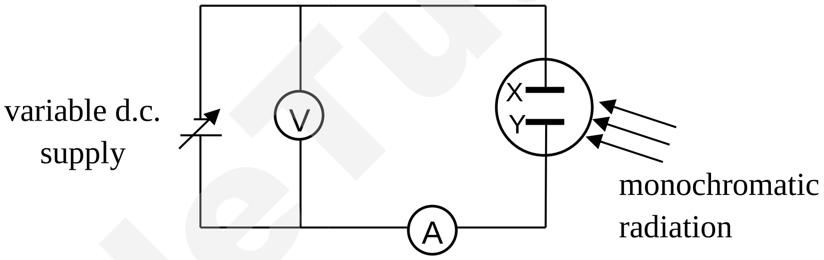


Fig. 9.1

X and Y were both illuminated by monochromatic radiation and the photocurrent *I* was measured as the potential difference across them was varied. When the wavelength of the light was λ_1, the *I-V* characteristic was as shown in **Fig. 9.2.**

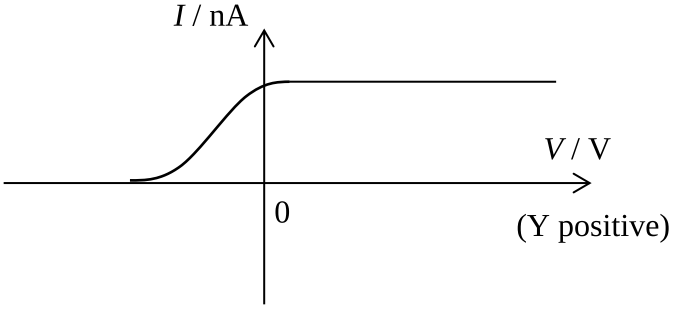


Fig. 9.2

When the wavelength of the light was λ_2, the *I-V* characteristic is as shown in **Fig. 9.3.**

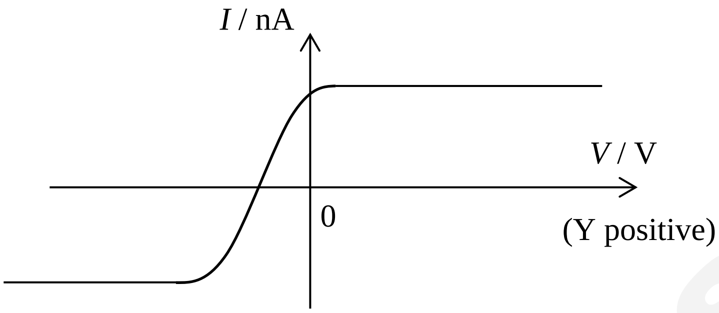


Fig. 9.3

(i) State and explain which wavelength, λ_1 or λ_2, is shorter.

………………………………………………………………………………..

……………………………………………………………………………….

…………………………………………………………………………….…. [2]

(ii) State and explain which electrode, X or Y, has the higher work function energy.

……………………………………………………………………………….

……………………………………………………………………………….

…………………………………………………………………..…..…. [1]

(c) The energy diagram in **Fig. 9.4** shows a simplified representation of the four lowest energy levels of the outermost electron in the sodium atom.

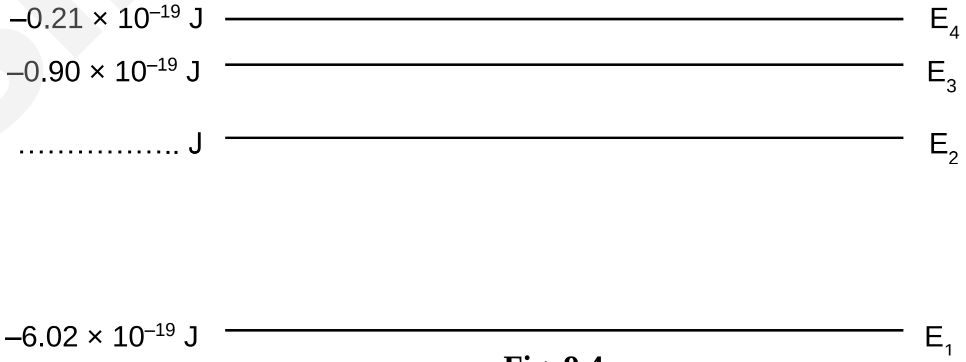


Fig. 9.4

(i) When the electron in the sodium atom transits from energy level E_4 to E_2, a photon of wavelength 820 nm is produced. Complete **Fig. 9.4** with the value of energy level E_2. [1]

(ii) In the emission line spectrum in **Fig. 9.5**, the photons produced from the transitions E_4 to E_2 and E_3 to E_2 are shown. Without further calculation, sketch and label the emission lines for **all the transitions to E_1**. [2]

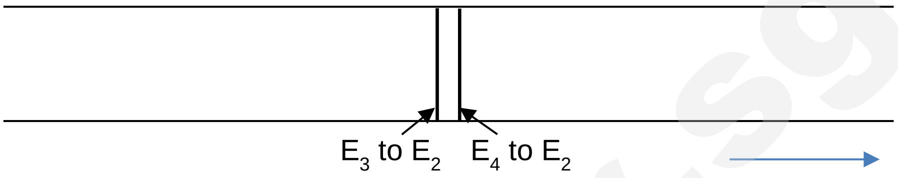


Fig. 9.5

Increasing frequency

(iii) State, with explanation, the possible upward transitions that can take place for a cool sodium atom that is initially in the ground state when it is bombarded with the following:

1 a photon of energy 5.21×10^{-19} J,

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

2 an electron with a kinetic energy of 5.9×10^{-19} J.

……………………………………………………………………………

……………………………………………………………………………

…………………………………………………………………………… [2]

****** END ********

VICTORIA JUNIOR COLLEGE

SUGGESTED SOLUTIONS TO 2017 PHYSICS PRELIM EXAMS 8866 H1P2

Section A

Q1(a)(i) $\boldsymbol{v_c = v\cos\theta}$

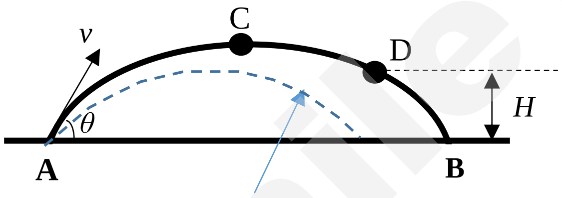
1(a)(ii) From conservation of energy, loss of KE from A to D = gain in GPE

$$\frac{1}{2}mv^2 - \frac{1}{2}mv_D{}^2 = mgH$$

$$\boldsymbol{v_D = \sqrt{v^2 - 2gH}}$$

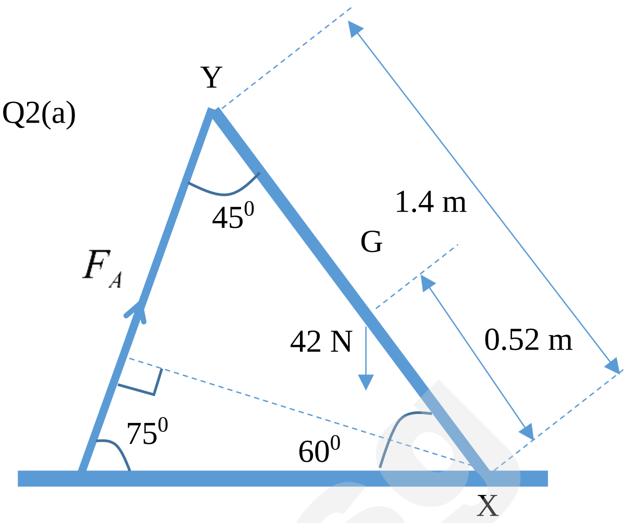
1(a)(iii)

The dotted path is when resistance is significant.



Path where air resistance is significant

Q2(a)



Taking moments about X,

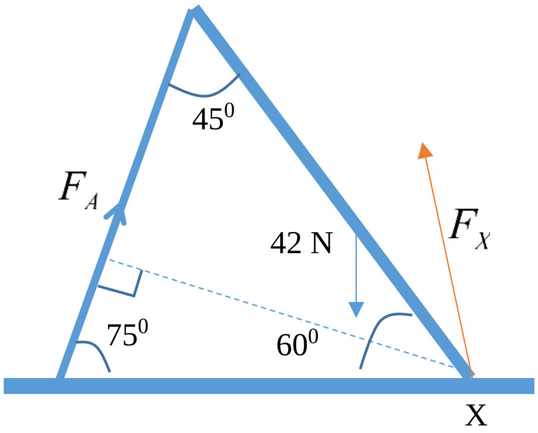
Sum of clockwise moments = sum of anti-clockwise moments

$(F_A)(1.4 \sin 45^0) = 42\ [0.52 \cos 60^0]$

F_A = **11 N**

2b(i) For translational equilibrium, the resultant force acting on the bar must be zero.

A force at X is required to balance the horizontal component of the force F_A.



Q3(a) $KE = \frac{1}{2}mv^2 = 0.5 \times 1300 \times (16.7)^2$

$= \mathbf{1.81 \times 10^5\ J}$

3(b)(i) Let total external forces opposing motion of car be *R*. Then driving force *F* =*R* since velocity is constant.

$$P = Fv = (240 + 0.98v^2) \times v$$

$$R = 240 + 0.98v^2 = 240 + 0.98(16.7)^2$$

= **513 N**

3(b)(ii) Work done = Force x Distance
= *R* x velocity x time

= 513 x 16.7 x (3x 60) = $\mathbf{1.54 \times 10^6}$ **J**

Q4(a) p.d. across voltmeter is

$$\boldsymbol{V = \frac{R_v}{R_v + r}E}$$

4(b) If the voltmeter reading is within 0.1 % of the e.m.f.,

$$\frac{E - V}{E} \leq 0.001$$

$$1 - \frac{V}{E} \leq 0.001 \text{ or } 1 - \frac{R_v}{R_v + r} \leq 0.001$$

$$\therefore \frac{r}{R_v + r} \leq 0.001$$

$$\therefore 1000r \leq R_v + r$$

$$\therefore R_v \geq 999r = 999 \times 0.10 = 99.9$$

$$\therefore R_{v(min)} = \mathbf{99.9\ \Omega}$$

4(c) The voltmeter and the resistor *R* form a parallel load resistance that the cell is connected across.

The equivalent resistance of the voltmeter and resistor *R* in parallel is:

$$R_{\parallel} = \frac{R_v \times R}{R_v + R}$$

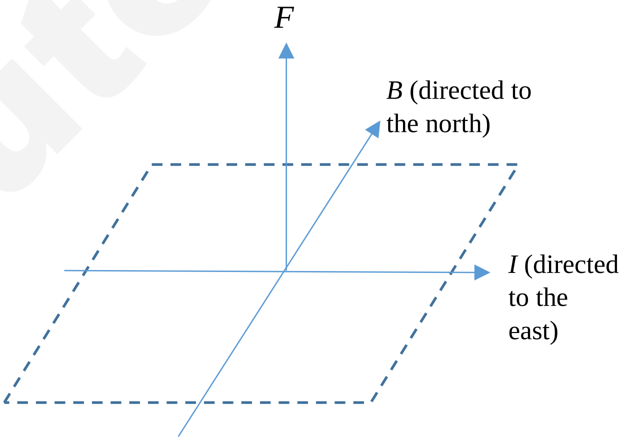
By the voltage divider rule, the voltmeter reading is

$$V = \frac{R_{\parallel}}{R_{\parallel} + r} \times E$$

$$V = \frac{\frac{R_v \times R}{R_v + R}}{\frac{R_v \times R}{R_v + R} + r} \times E$$

$$\boldsymbol{V = \frac{R_v R}{R_v R + r R_v + r R} \times E}$$

Q5(a)



5(b) $R = \rho \dfrac{L}{\pi r^2}$

$$= \frac{(2.0\text{x}10^{-8})(10)}{\pi(0.457\text{x}10^{-3})^2} \approx \mathbf{0.305\ \Omega \approx 0.31\ \Omega}$$

5(c) To cause the wire to rise from the table, $BIL \geq mg$ or $B\left(\dfrac{V}{R}\right)L \geq D(\pi r^2 L)g$

Or $V_{\min} = \dfrac{D\pi r^2 gR}{B}$

$$= \frac{(1.0\text{x}10^4)\pi(0.457\text{x}10^{-3})^2(9.81)(0.305)}{1.8\text{x}10^{-5}}$$

$\approx$**1.09 x 10^3 V**

Q6(a)(i) $\boldsymbol{F_B} = -\boldsymbol{F_A}$

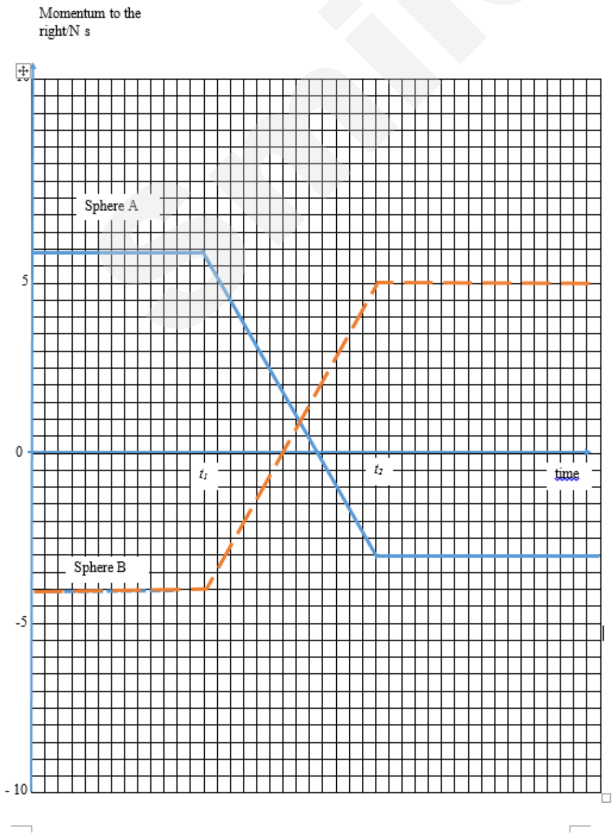
6(a)(ii) $\boldsymbol{t_B} = \boldsymbol{t_A}$

6(b) Let Δp_A and Δp_B be change in momentum for A and B respectively.
By the impulse-momentum theorem, impulse = change in momentum of a body.

Impulse on A = $F_A t_A = \Delta p_A$
Impulse on B = $F_B t_B = \Delta p_B$
Since $F_A = -F_B$, we have
$F_A t_A = -F_B t_B$ or $\boldsymbol{\Delta p_A = -\Delta p_B}$

6(c)(i) Taking right as positive, change in momentum of A is
Δp_A = -3.0 -6.0 = -9.0 kg m s^{-1}
Let final momemtum of sphere B be $p_{B(f)}$.
$p_{B(f)} - (-4.0) = 9.0$ since $\Delta p_A = -\Delta p_B$
Hence $p_{B(f)}$ = **5.0 kg m s^{-1}**

6(c)(ii)



6(d) From the graph, the initial and final momenta of sphere A are 6.0 kg m s^{-1} and -3.0 kg m s^{-1} respectively.
Since initial velocity $u_A = 3.0\,\text{m s}^{-1}$, the mass of sphere A is $m_A = \dfrac{6.0}{3.0}$ =**2.0 kg**

Final velocity is $= -\dfrac{3.0}{2.0}$ = **- 1.5 m s^{-1}**

6(e) $\dfrac{p_{B(f)}}{p_{B(i)}} = \dfrac{v_B}{u_B}$

$\therefore \dfrac{v_B}{u_B} = \dfrac{5.0}{-4.0}$ = **-1.25**

6(f) Given $m_B = 1.0\,\text{kg}$,
Now kinetic energy
$K = \dfrac{1}{2}mv^2 = \dfrac{m^2v^2}{2m} = \dfrac{p^2}{2m}$
Total initial KE is $K_i = \dfrac{6.0^2}{2(2)} + \dfrac{(-4.0)^2}{2(1)}$
= 17 J

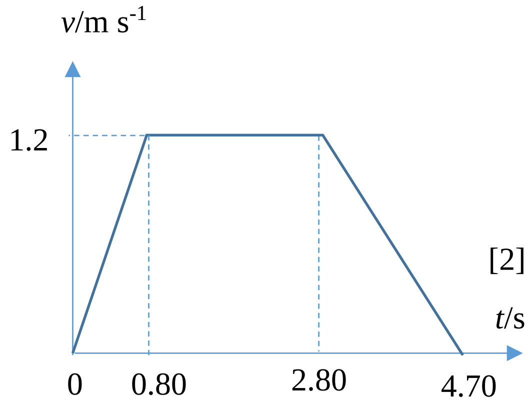
Total final KE is $K_f = \dfrac{(-3.0)^2}{2(2)} + \dfrac{(5.0)^2}{2(1)}$

≈14.8 J

Since there has been a loss of total KE, the collision is **inelastic.**

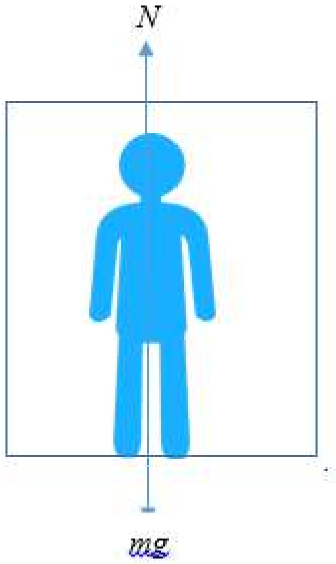
Section B

Q7(a)(i)



[2]

7(a)(ii) When Bob is at rest or moving at constant velocity, the spring balance will just read his actual weight $W = mg$ $= 71 \text{x} 9.81 = 697$ N.



When accelerating while ascending, using N2L, $N - mg = ma$ where N = normal reaction exerted by floor on Bob and

$$a = \frac{1.2-0}{0.80-0} = 1.5 \text{ m s}^{-2}$$

Hence $N = 71\text{x}9.81 + 71\text{x}(1.5)$

≈ 803 N

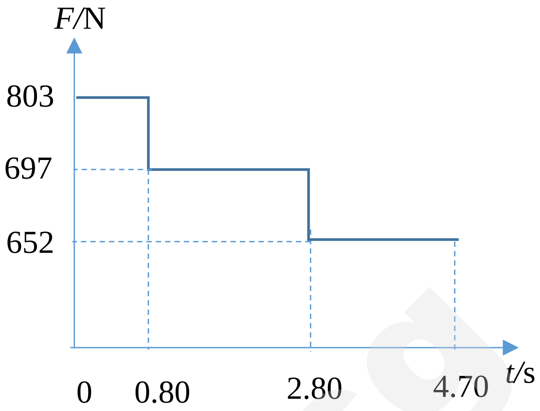
By N3L, this is also the force which Ah Beng exerts on the floor of the elevator, or his effective weight.

When decelerating while still ascending,

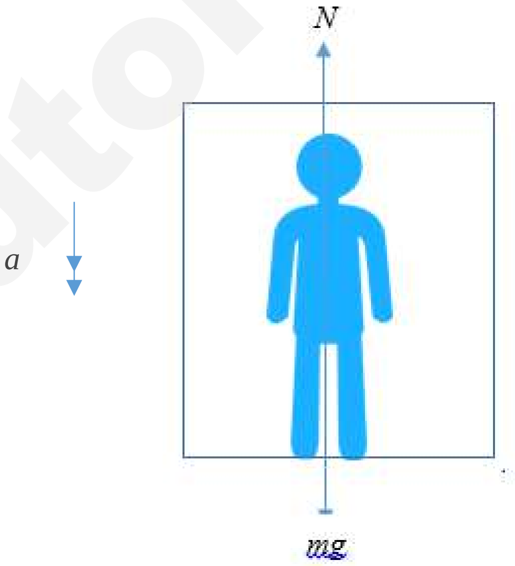
$$a = \frac{0-1.2}{4.70-2.80} \approx -0.632 \text{ m s}^{-2}$$

Hence $N = 71\text{x}9.81 - 71\text{x}0.632$

≈ 652 N



7(b)(i)



By Newtons' Second Law, $mg - N = ma$.

Hence $N = mg - ma$

Hence, Bob feels lighter as the floor pushes against him with a force smaller than his weight.

7(b)(ii) Here $a = g$ (free fall).

From $N = mg - ma$, $N = 0$. As the floor is not pushing against Bob with any force, it means Bob is weightless.

7(c)(i) When the sand impacts on the conveyor belt, it has zero initial horizontal velocity. Friction drags the sand particles along the surface of the conveyor belt, causing the sand to attain a final horizontal velocity of v = 0.75 m s^{-1}. Hence

From N2L, $f = ma = \frac{m(v-0)}{t}$

= (5.00)(0.75) = **3.75 N**

7(c)(ii) The external force is opposed by the force exerted on the conveyor belt by the sand particles.

By Newton's 3rd Law, this force is numerically 3.75 N**. Hence F_{ext} = 3.75 N**

7(c)(iii) Power due to F_{ext} is $P = F_{ext}\, v$

= 3.75 (0.75) ≈ **2.81 J s^{-1}**

7(c)(iv) Rate of change of kinetic energy is

$$\frac{dK}{dt} = \frac{d}{dt}\left(\frac{1}{2}mv^2\right) = \frac{1}{2}v^2\left(\frac{dm}{dt}\right)$$

$= \frac{1}{2}(0.75^2)(5.00) \approx$ **1.41 J s^{-1}**

The rate of change of kinetic energy of the sand is half of the power due to F_{ext}.

Half of the work done by the external force is due to work done to overcome friction between the sand and the conveyor belt.

8(a)(i) $v = (T/\mu)^{1/2}$

Let BU stand for base units.

LHS BU = m s^{-1}

RHS BU = $\left(\frac{\text{kg m s}^{-2}}{\text{kg m}^{-1}}\right)^{\frac{1}{2}} = \text{m s}^{-1}$

Since BU on both sides of the equation sign are the same, the equation is homogeneous.

8(a)(ii) v = (275/0.030)$^{1/2}$

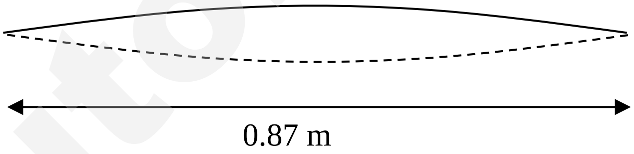
= **95.7 m s^{-1}**

8(a)(iii) $v = f\lambda$

λ = 95.7/55

= **1.74 m**

8(a)(iv)



8(a)(v) $v = f\lambda$

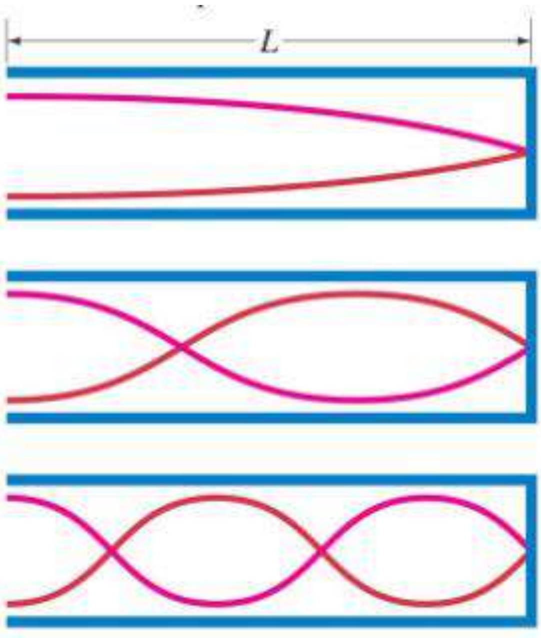
λ = 340/55

= 6.2 m

8(a)(vi) The frequency that is heard by the ear is the same as the vibration of the string.

The wavelength of the stationary wave in the string is different from the wavelength of the sound heard at a particular frequency, i.e. wavelength is affected by the medium the wave travels in.

8(b)(i)

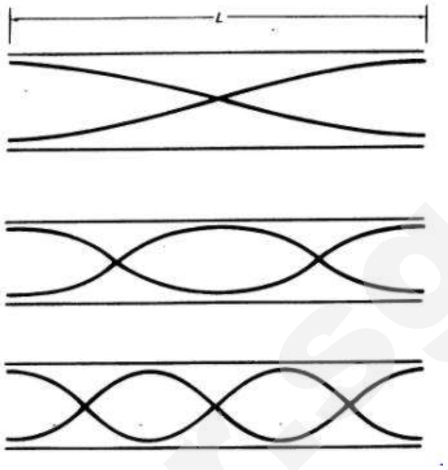


The three modes of oscillation correspond to $\frac{1}{4}\lambda = L, \frac{3}{4}\lambda = L$ and $\frac{5}{4}\lambda = L$

Hence the modes of oscillation can be represented by $\left(\frac{2n-1}{4}\right)\lambda = L$

where n =1,2,3

8(b)(ii)



Here the modes of oscillation correspond to $\frac{\lambda}{2} = L, \ \frac{2\lambda}{\lambda} = L$ and $\frac{3\lambda}{2} = L$

Hence $\frac{n\lambda}{2} = L$ where $n = 1,2,3,\ldots.$

8(b)(iii) For a pipe of length L that is open at both ends,
$n\lambda /2 = L$
where n = 1, 2, 3,….

Let n be the integer corresponding to the 264 Hz resonance, and v be the speed of sound.
$nv/[2(264)] = L$

Let n +1 be the integer corresponding to the 440 Hz.
$(n + 1)v/[2(440)] = L$

Solving, n = 1.5, which is not an integer.

Hence the pipe open at both ends cannot produce the two resonances of 264 Hz and 440 Hz.

Q9(a)(i) Intensity $= \frac{power}{area}$

$$= \frac{E}{t} \times \frac{1}{area} = \frac{nhf}{t \times area}$$

hence, $\frac{n}{t} = \frac{Int \times area}{hf} = \frac{Int \times area}{hc/\lambda}$

$$= \frac{210 \times 12 \times 10^{-6}}{6.63 \times 10^{-34} \times 3 \times 10^{8} \div (254 \times 10^{-9})} \text{ s}^{-1}$$

$$= \mathbf{3.22 \times 10^{15} s^{-1}}$$

9(a)(ii)

$I = \frac{Q}{t} = \frac{ne}{t}$, hence $\frac{n}{t} = \frac{I}{e}$

$$\frac{n}{t} = \frac{4.8 \times 10^{-10}}{1.6 \times 10^{-19}} = \mathbf{3.0 \times 10^{9} s^{-1}}$$

9(a)(iii)1.

$$\frac{\text{number of photoelectrons emitted per second}}{\text{number of photons incident per second}}$$

$$= \frac{3.0 \times 10^{9}}{3.22 \times 10^{15}}$$

$$= \mathbf{9.32 \times 10^{-7}}$$

9(a)(iii)2. Some of the incident radiation may interact with entire atoms causing them to vibrate more vigorously.

Incident light may also be reflected away from the metal surface and thus cannot interact with and eject electrons.

[Accept : The atom is mostly empty space. The chance of a photon-electron interaction is extremely small.]

9(a)(iv) Visible radiation has a wavelength longer than that of ultra-violet radiation.

This wavelength is apparently longer than the threshold wavelength of the metal, and so no photoelectric emission can occur.

9(b)(i) When λ_1 alone is used, only electrode X emits photoelectrons, whereas when λ_2 is used, both electrodes X and Y emit photoelectrons.

Hence λ_2 must be more energetic and λ_2 is therefore shorter than λ_1.

9(b)(ii) Since electrode X emits photoelectrons more easily than electrode Y, the work function of X is smaller than that of Y.

9(c)(i) Using $E = hc/\lambda$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{(820 \times 10^{-9})} = 2.43 \times 10^{-19} \text{ J} \quad ,$$

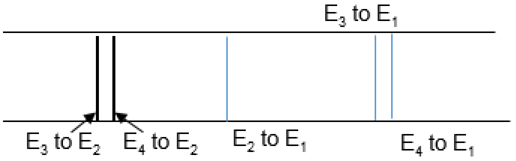
$$E_4 - E_2 = 2.43\text{x}10^{-19}$$

Hence the energy level E_2 =

$$(-0.21 \times 10^{-19}) - 2.43 \times 10^{-19}$$

$$= \mathbf{-2.64 \times 10^{-19}} \text{ J}$$

9(c)(ii)



9(c)(iii)1. No transitions occur.

The atom is unable to absorb the photon and undergo excitation. The photon energy does not match exactly the difference in energy levels between E$_1$ and the other energy levels.

9(c)(iii)2.

Transition E_1 to E_2, energy required
= -2.64 x 10^{-19} - (-6.02 x 10^{-19})
= 3.38 x 10^{-19} J
E_1 to E_3, energy required = 5.12 x 10^{-19} J
E_1 to E_4, energy required = 5.81 x 10^{-19} J

All the above transitions are possible because the incoming electron has energy 5.9 x 10^{-19} J which is bigger than energies required for the above-mentioned transitions.

******** END *******

Candidate's name ……………………………….…………. CTG …………..……

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS 2017

PHYSICS **8866/1**

HIGHER 1 **15th September 2017**

1 hour

Paper 1 Multiple Choice

Additional Material:
Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name and CTG on the Optical Mark Sheet in the spaces provided.
Shade your NRIC in the space provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D.**

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet.

Read the instructions on the Optical Mark Sheet carefully.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho g h$
resistors in series,	$R = R_1 + R_2 + \ldots\ldots\ldots\ldots$
resistors in parallel,	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$

1 The intensity of a beam is defined as the energy delivered per unit area per unit time.

What is the base unit of intensity?

A kg m^2 s^{-3} **B** kg m s^{-3} **C** kg s^{-2} **D** kg s^{-3}

2 Errors in measurement may be either systematic or random.

Which of the following involves random error?

A Not accounting for zero error on a moving-coil voltmeter.

B Using a stopwatch to determine the time to complete a race.

C Using the outer diameter of the beaker when calculating the volume of water in the beaker.

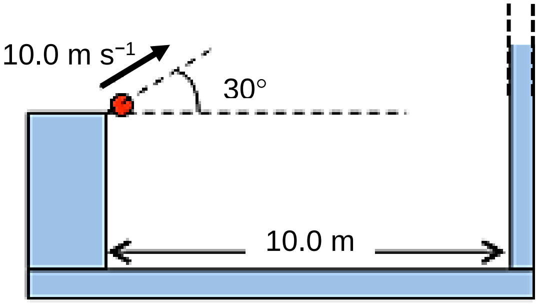
D Using the value of g as 10 m s^{-2} when calculating weight from mass.

3 Car A and car B were having a race along a straight line towards the finishing line. Car A was moving at a speed of 40 m s^{-1} and car B was moving at a speed of 50 m s^{-1} when car B overtook car A. After 1.0 s of reaction time, car A accelerated to 55 m s^{-1} uniformly in another 1.0 s. Car A then moved at that constant speed.

What is the total time taken for car A to catch up with car B? Assume that car B maintained a constant velocity throughout?

A 1.3 s **B** 2.2 s **C** 4.5 s **D** 17.5 s

4 A tennis ball is projected with an initial speed of 10.0 m s^{-1} at an angle of 30° from the horizontal towards a vertical wall 10.0 m away.



What is the speed of the ball when it hits the wall?

A 6.3 m s^{-1} **B** 10.7 m s^{-1} **C** 12.0 m s^{-1} **D** 18.5 m s^{-1}

5 Which of the following statements is true?

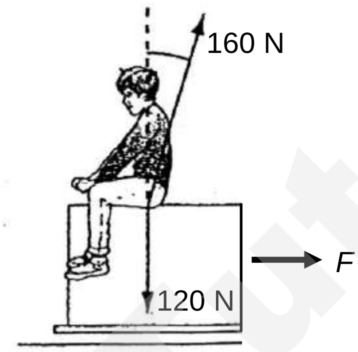
A When an object is thrown upwards, its acceleration at the highest point is zero.

B When an object is in motion, its velocity and acceleration are always in the same direction.

C When the velocity of an object is zero, its acceleration can be non−zero.

D When the acceleration of an object is non-zero, its speed must be changing.

6 A child is sitting on a moving cart which is pulled towards the right by a constant force *F*.



The resultant force that the cart exerts on the child is 160 N and the weight of the child is 120 N.

What is the acceleration of the child?

A 0.88 m s^{-2}

B 3.3 m s^{-2}

C 8.7 m s^{-2}

D 84 m s^{-2}

7 A constant mass undergoes uniform non-zero acceleration.

Which of the following is a correct statement about the momentum of the mass?

A It increases uniformly with respect to time.

B It is increasing at a decreasing rate with respect to time.

C It is increasing at an increasing rate with respect to time.

D It is constant but non-zero.

8 A ball falls vertically and bounces on the ground. The following statements describe the forces acting while the ball is in contact with the ground.

Which statement is correct?

A The force that the ball exerts on the ground is always equal to the weight of ball.

B The force that the ball exerts on the ground is always equal in magnitude and opposite in direction to the force ground exerts on ball.

C The force that the ball exerts on the ground is always greater than the weight of ball.

D The weight of ball is always equal and opposite to the force that the ground exerts on ball.

9 The spring suspension system of a car obeys Hookes' law. The following data is provided:

mass of passengers = 450 kg

mass of car and passengers = 2000 kg

difference in height of car when passengers alight = 0.100 m

What is the spring constant of the spring suspension system?

A 4.50×10^{3} N m^{-1}

B 1.55×10^{4} N m^{-1}

C 4.41×10^{4} N m^{-1}

D 1.52×10^{5} N m^{-1}

10 What is not true of two forces that give rise to a couple?

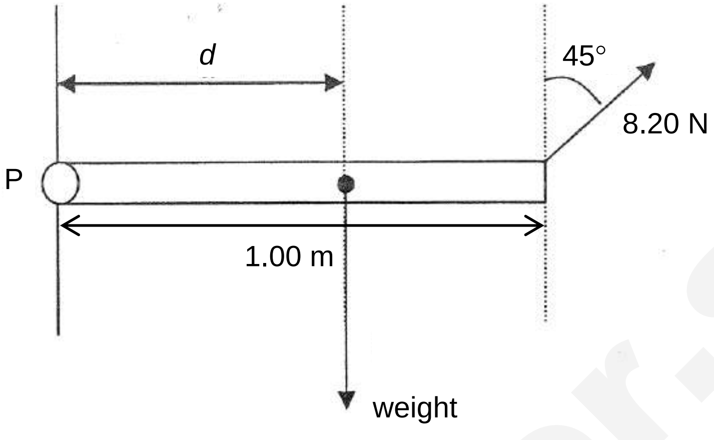
A They act in opposite directions.

B They both act at the same point.

C They both act on the same body.

D They both have the same magnitude.

11 A 1.00 m non-uniform rod of weight 10.0 N is freely hinged to a wall at pivot P. A force of 8.20 N acts on the other end of the rod such that the rod remains horizontal. The centre of gravity of the rod is at a distance *d* from P.



What is the value of *d*?

A 0.180 m **B** 0.420 m **C** 0.580 m **D** 0.820 m

12 The driving force *F* of a car of mass *m* causes the car to accelerate. In a time *t*, it travels a distance *s* and its speed increases from *u* to *v*.

What is the useful work done by the car engine?

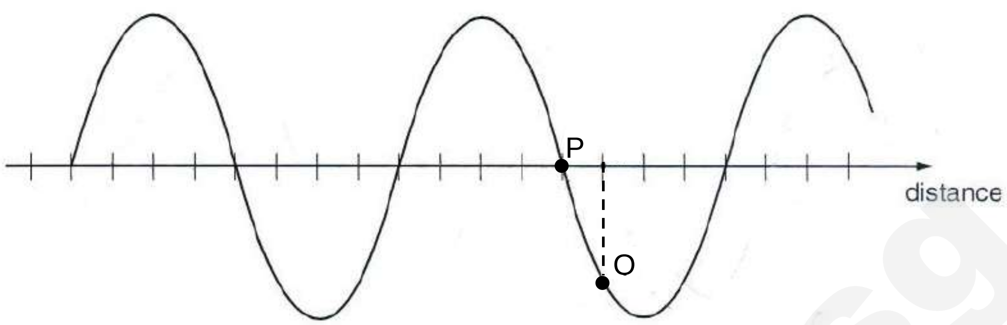
A Ft **B** $\frac{Fs}{t}$ **C** m(v − u) **D** $\frac{m(v^2 - u^2)}{2}$

13 A car of mass 1.2×10^3 kg travels along a horizontal road at a speed of 10 m s^{-1}. It then accelerates at 0.20 m s^{-2}. At the time it begins to accelerate, the total resistive force acting on the car is 160 N.

What total output power is developed by the car as it begins the acceleration?

A 0.80 kW **B** 1.6 kW **C** 2.4 kW **D** 4.0 kW

14 The diagram shows a transverse wave at a particular instant. The wave is travelling to the right. The frequency of the wave is 12.5 Hz.

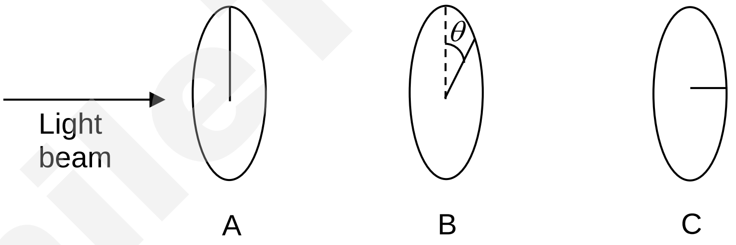


At the instant shown, the displacement of particle P is zero.

What is the shortest time to elapse before the displacement of particle Q is zero?

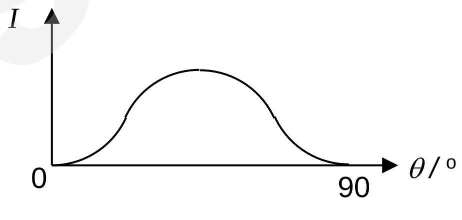
A 0.010 s **B** 0.030 s **C** 0.080 s **D** 0.10 s

15 Three polarisers are placed facing one another. The axis of polarisation of polariser A is vertical, of B is at an angle of θ from the vertical, and of C is horizontal. A light beam is shone at A, as shown.

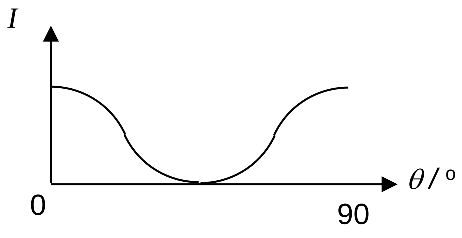


Which of the following graphs shows how the intensity I of the emergent light beyond C will vary with θ?

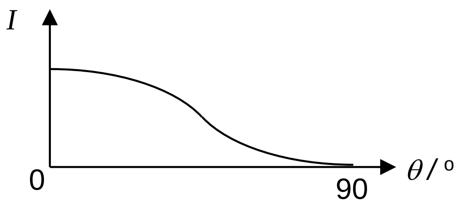
A



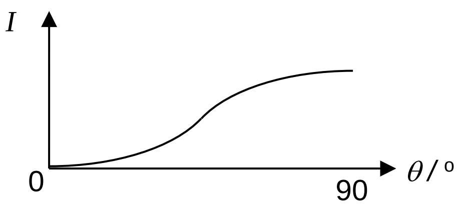
B



C



D



16 In a double-slit experiment, the slit separation is 2.0 mm, and two wavelengths of light, 750 nm and 900 nm, illuminate the slits. A screen is placed 2.0 m from the slits.

What is the minimum distance from the central maximum on the screen that a maximum from one pattern coincide with the maximum from the other?

A 1.5 mm **B** 3.0 mm **C** 4.5 mm **D** 6.0 mm

17 Two coherent wave-trains of monochromatic light arrives at a point on a screen.

Which one of the following statements must be true?

A They are in phase.

B They have a constant phase difference.

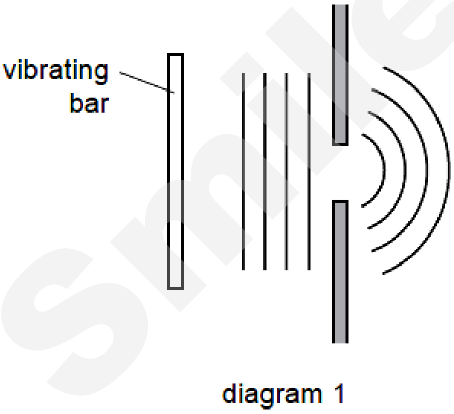
C They interfere constructively.

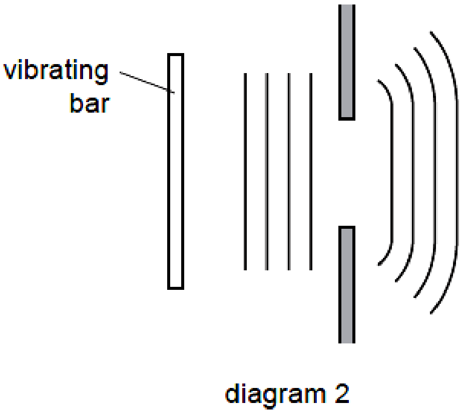
D They interfere destructively.

18 Diagram 1 shows a ripple tank experiment in which plane waves are diffracted through a narrow slit in a metal sheet.

Diagram 2 shows the same tank with a slit of greater width.

In each case, the pattern of waves incident on the slit and the emergent pattern are shown.





Which of the following changes would cause the waves in diagram 2 to diffract more and produce an emergent pattern closer to that shown in diagram 1?

A Increase the speed of the waves by making the water in the tank deeper

B Increase the frequency of vibration of the bar

C Reduce the amplitude of vibration of the bar

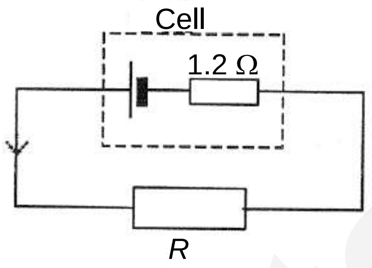
D Reduce the length of the vibrating bar

19 Aluminium and copper cylindrical rods are designed to have the same length and the same resistance. The resistivity of copper is half that of aluminium and its density is three times that of aluminium.

What is the ratio of the mass of the copper rod to the mass of aluminium rod?

A 0.167 **B** 0.667 **C** 1.50 **D** 6.00

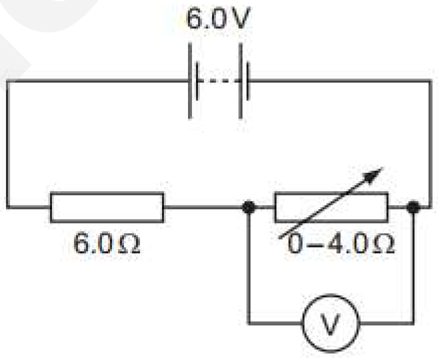
20 A cell with internal resistance of 1.2 Ω is connected to a load of resistance *R* of 4.8 Ω.



What is the ratio of power dissipated in *R* to the total power supplied by the e.m.f. source?

A 0.20 **B** 0.25 **C** 0.80 **D** 4.0

21 An ideal 6.0 V e.m.f source is connected in series with a 6.0 Ω resistor and a variable resistor. The resistance of the variable resistor is varied between 0 Ω and 4.0 Ω.



What is the range of the voltmeter reading?

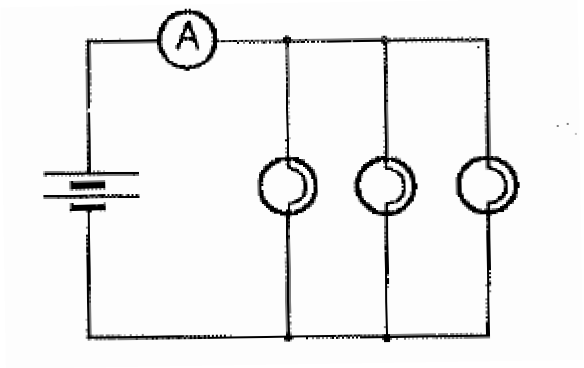
A 0 V to 2.4 V

B 0 V to 3.6 V

C 2.4 V to 6.0 V

D 3.6 V to 6.0 V

22 Three similar light bulbs are connected to a constant voltage d.c. supply of negligible internal resistance. Each bulb operates at normal brightness and the ideal ammeter register a steady current.

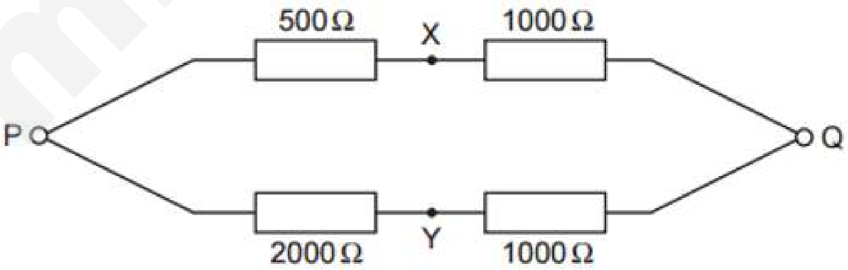


The filament of one of the bulbs breaks.

What happens to the ammeter reading and the brightness of the remaining bulbs?

	ammeter reading	bulb brightness
A	increases	increases
B	increases	remains unchanged
C	decreases	decreases
D	decreases	remains unchanged

23 A potential difference of 6.0 V is applied between P and Q.

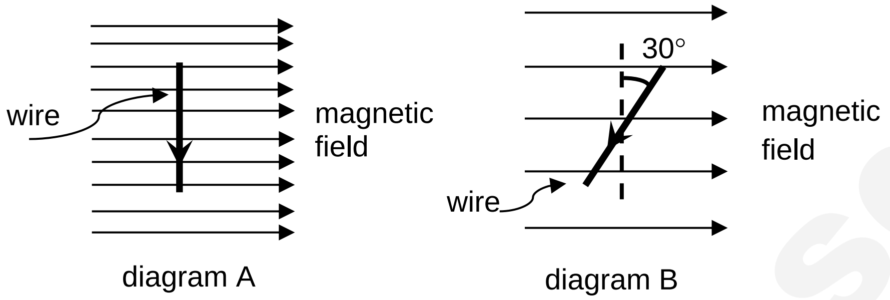


What is the potential difference between X and Y?

A 0 V **B** 2 V **C** 4 V **D** 6 V

24 A straight current-carrying wire lies at right angles to a horizontal magnetic field as shown in daigram A. The field exerts a force of 8.0 mN on the wire.

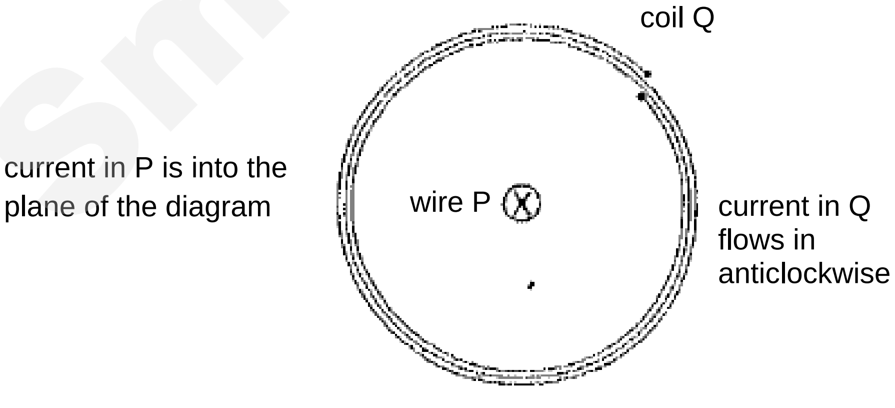
The wire is now rotated, in its horizontal plane, through 30° and the flux density in the magnetic field is halved, as shown in diagram B.



What is the direction and magnitude of the force acting on the wire?

	direction	magnitude
A	into the plane	2.0 mN
B	out of the plane	2.0 mN
C	into the plane	3.5 mN
D	out of the plane	3.5 mN

25 A long straight wire P is placed along the axis of a flat circular coil Q. The wire and the coil each carry a current as shown.



What can be deduced about the force acting on each part of Q due to current in P?

A There is no force in any direction.

B The force is towards P.

C The force is away from P.

D The force is perpendicular to the plane of the diagram.

26 Light falling on a metal surface causes electrons to be emitted from the metal surface.

As the intensity of the light is increased, but keeping its wavelength the same, which of the following statement is correct?

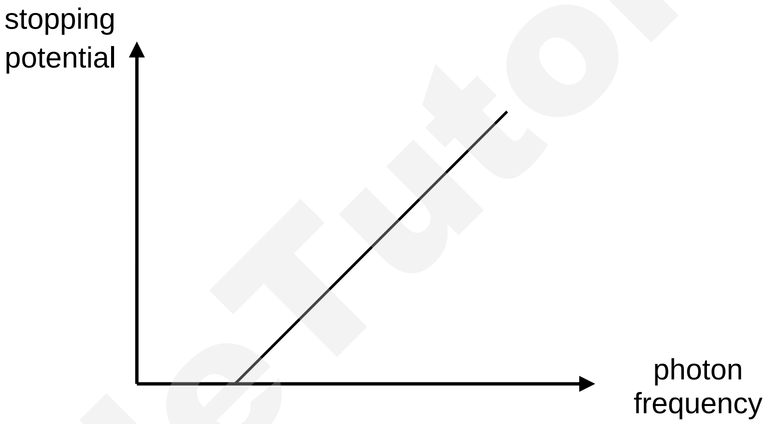
A The maximum speed of the emitted electrons increases.

B The rate of emission of electrons increases.

C The work function of the metal increases.

D The rate of emission of electrons remains constant.

27 The graph shows how the stopping potential of emitted electrons is dependent on the frequency of the incoming photon for a certain metal surface.



What changes, if any, would occur to the graph when the metal is changed to one with a larger work function?

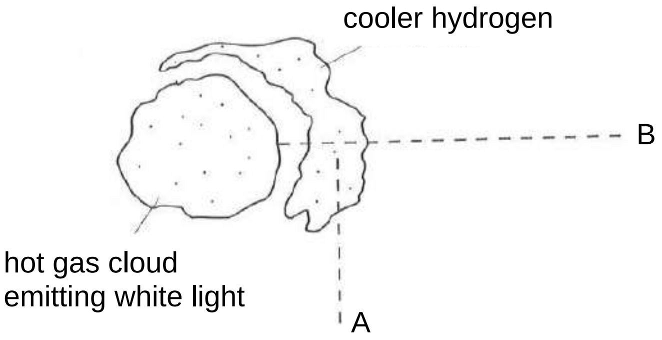
	gradient	x-intercept
A	higher	lower
B	lower	lower
C	same	higher
D	same	lower

28 Particle X has a de Broglie wavelength λ. Particle Y has the same mass but twice the kinetic energy of particle X.

What is the de Broglie wavelength of particle Y?

A 2λ **B** $\lambda\sqrt{2}$ **C** $\frac{\lambda}{2}$ **D** $\frac{\lambda}{\sqrt{2}}$

29 The diagram shows a cooler region of hydrogen gas surrounding a hot gas cloud emitting white light.



Which of the following describes the type of spectrum observed at point A and B?

	point A	point B
A	continuous	emission
B	emission	absorption
C	absorption	emission
D	continuous	absorption

30 The diagram below represents the energy levels for an electron in a certain atom.

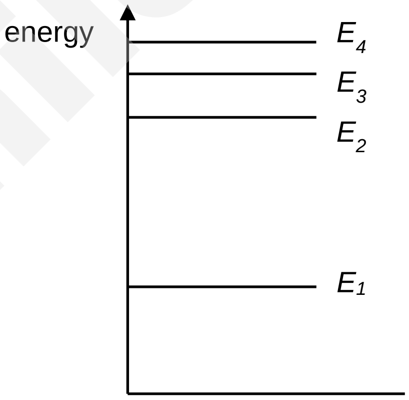


diagram is drawn to scale

The transition from E_3 to E_1 produces a blue line.

Which transition could give rise to a violet line?

A E_4 to E_3

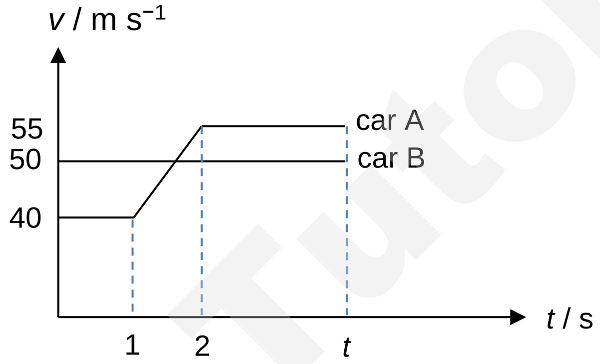
B E_4 to E_1

C E_3 to E_2

D E_2 to E_1

--- End of paper ---

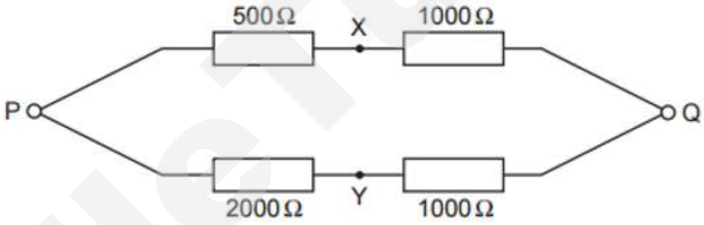
2017 8866 JC2 H1 Physics Prelim Paper 1 Solutions

S/N	Answer	Explanation
1	**D**	Intensity = Power/Area = Energy/(Time × Area) [Intensity] = [Energy]/([Time] × [Area]) = ([Force] ×[displacement]/ ([Time] × [Area]) = (kg m s^{-2} × m)/(s × m^2) = kg s^{-3}
2	**B**	Human reaction time when using a stopwatch is a random error.
3	**C**	 For car A to catch up with car B, the distance travelled by both cars will be the same. $50t = (40\times1) + ½ (40+55)(1) + 55(t – 2)$ $t = 4.5$ s Incorrect answers Option D: If students did some careless mistakes $50t = (40\times1) + ½ (40+55)(1) + 55(t)$ $t = 17.5$ s Option B: did not understand the use of relative speed Distance travelled by B in 2s = 50 × 2 = 100 m Distance travelled by A in first second = 40(1) Distance travelled by A in second second = 40(1) + ½ (55-40)$(1)^2$ =47.5 m Distance between A & B = 100 – (40 + 47.5) = 12.5 m Time taken to catch up by A = 12.5 / 55 = 0.23 s (failed to see that the relative speed between A & B is 5 m s^{-1}, hence should use 12.5 / 5 = 2.5 s Total time = 2 + 0.23 = 2.2 s Option A: did not understand the question Distance travelled by B = $50t$ Distance travelled by A = $ut + ½ (at)^2$ $= 40t + ½ (55-40)t^2$ $50t = 40t + ½ (55-40)t^2$ $t = 1.3$ s

4	**B**	Horizontally, $s = ut$ $t = 10 / 10\cos30 = 1.155$ s vertically, $v_y = 10\sin30 - 9.81(1.155) = -6.33$ m s^{-1} final speed = $((10\cos30)^2 + (6.33)^2)^{0.5}$ = 10.7 m s^{-1} Incorrect answers Option A : value belongs to v_y only Option C : incorrect resolution $t = 10 / 10\sin30 = 2$ s $v_y = 10\cos30 - 9.81(2) = -10.96$ m s^{-1} final speed = $((10\sin30)^2 + (10.96)^2)^{0.5}$ = 12.0 m s^{-1} Option D : incorrect sign convention $v_y = 10\sin30 + 9.81(1.155) = -16.33$ m s^{-1} final speed = $((10\cos30)^2 + (16.33)^2)^{0.5}$ = 18.5 m s^{-1}
5	**C**	Option C: Example a ball being thrown vertically upwards, at the highest point, the velocity is zero but the acceleration is 9.81 m s^{-2} downwards. Incorrect answers Option A: When an object is thrown upwards, its acceleration at the highest point is 9.81 m s^{-2} downwards. Option B: An object which is slowing down, its velocity and acceleration are in opposite directions. Option D: An object in uniform circular motion has a centripetal acceleration, only the direction of the velocity is changing and its speed is not changing.
6	**C**	Vertically: $\Sigma F_y = 0$ $N - W = 0$ $N = W = 120$ N $R = \sqrt{N^2 + f^2}$ $160 = \sqrt{120^2 + f^2}$ $120^2 + f^2 = 25600$ $f = 105.83$ N Horizontally: $\Sigma F_x = m\ a_x$ $f = (W/g)\ a_x$ $105.83 = (120/9.81)\ a_x$ $a_x = 8.7$ m s^{-2}

7	**A**	$p = m v$ $p = m (u + a t)$ $p = (m a) t + m u$ Given m, a & u are constants, Plotting a graph of p against t will yield a straight line graph (of linear trend) with gradient = m a = constant & y-intercept = mu gradient = dp/dt = m a = constant p is increasing uniformly with respect to t.
8	**B**	By Newton’s Third Law: The two forces indicated in choice B is action reaction pair. The force exerted by the ground will vary during the collision with the ground. It is not a constant force and will not always be greater or equal to the weight of the ball.
9	**C**	By Hookes’ Law: $F = k x$ $k = \Delta F/\Delta x = W_{passengers}/0.10$ $= (450)(9.81)/0.10$ $= 4.41 \times 10^4 \text{ N m}^{-1}$
10	**B**	For a couple, the line of action of the two forces must not coincide. Hence, both forces cannot act at the same point.
11	**C**	Clockwise Moment as positive: $\Sigma T_P = 0$ $W d - (F \cos 45°)(L) = 0$ $(10.0)(d) - (8.20 \cos 45°)(1.00) = 0$ $d = 0.580$ m
12	**D**	Useful work done by the car engine = gain kinetic energy of the car $= ½ mv^2 - ½ mu^2$ $= \frac{m(v^2 - u^2)}{2}$
13	**D**	$\sum F = ma$ $F_{driving} - F_{resistive} = 1200 (0.20)$ $F_{driving} = 400$ N $P = F v$ $= 400 (10)$ $= 4000$ W
14	**A**	Phase difference between PQ = $2\pi/8.0$ Time = $T / 8.0 = 1/(8.0)f = 1/(8.0 \text{ x}12.5) = 0.010$ s

15	**A**	When $\theta = 0^o$, the light will pass through A, be vertically polarised, and pass through B. But it will be blocked by C. Final intensity = 0. When $\theta = 90^o$, the light will pass through A, be vertically polarised, and be blocked by B. Final intensity = 0. When $0^o<\theta<90^o$, the vertically polarised light after passing through A will have a component parallel to B. This component will pass through B. The resultant light will then be polarised parallel to B. Then when it reaches C, the horizontal component of the light will pass through C. Final intensity is non-zero.
16	**C**	$\lambda = ax / D$ $x_1 = \frac{\lambda_1(D)}{a}$ $\quad x_2 = \frac{\lambda_2(D)}{a}$ For them to coincide, $n_1\lambda_1 = n_2\lambda_2$ where n is the order of the bright fringes Ratio of $n_1 / n_2 = 900 / 750$ The smallest n_1 such that both n_1 and n_2 are integers is 6. Therefore, Smallest distance is $6x_1 = 6 (750 \times 10^{-9})(2.0) / (2.0 \times 10^{-3})$ $= 4.5 \times 10^{-3}$ m
17	**B**	Coherence = constant phase difference.
18	**A**	Option A : $v = f\lambda$ By increasing v, λ will be larger, f being constant. The larger λ will be more comparable to the slit width and hence the diffraction will be more significant. Incorrect answers Option B: Increasing the f will reduce the λ, v being constant. Option C & D: It will not change anything
19	**C**	$R = \rho L/A$ $A = \rho L/R$ --- (1) $D = M/V = M/LA$ ⇨ $M = DLA$ --- (2) Substitute (1) into (2): $M = D\rho L^2/R$ M α D ρ (L & R = constant) $M_C/M_A = (D_C/D_A) \times (\rho_C/\rho_A)$ $M_C/M_A = (3D_A/D_A) \times (0.5\ \rho_A/\rho_A)$ $= 3 \times 0.5$ $= 1.50$

20	**C**	$P_1 = I^2 R$ --- (1) $P_2 = E I = (V + I r) I$ $= V I + I^2 r$ $= (I R) I + I^2 r$ $= I^2 (R + r)$ --- (2) (1)/(2): $P_1/P_2 = R/(R + r) = 4.8/(4.8 + 1.2) = 0.80$
21	**A**	P.d across variable resistor (R=0) = 0 V P.d across variable resistor (R= 4) = (4/4+6)(6) =2.4 V
22	**D**	Suppose each bulb resistance is R. The initial combined resistance is R/3. Current through each bulb is E/R, ammeter reading is 3(E/R) Power of each bulb is E^2/R After one bulb breaks, The combined resistance is R/2. Current through each bulb is E/R, ammeter reading is 2(E/R) Power of each bulb is E^2/R
23	**B**	 Using potential divider rule, Vxp = (500/1500) (6) = 2 V Vyp = (2000/3000) (6) = 4 V Vxy = 4-2 = 2 V
24	**D**	Using FLHR, the force is out of the plane $F = (B/2)IL \cos 30^o = 4.0 \cos 30^o = 3.5$ mN
25	**A**	Consider any one point on Q, the B-field due to P is in anti-clockwise direction. B_p is always anti-parallel to current of Q.
26	**B**	Since wavelength remains the same, photon energy remains constant and KE remains constant. Rate of incidence photons increases and rate of emission of electrons increases.

27	**C**	Using photoelectric equation, $hf = \phi + eV_s$ Rearranging the equation gives $\underline{V_s = \frac{hf}{e} - \frac{\phi}{e}}$ Hence a graph of V_s against f will give a straight line where the gradient is $\underline{\frac{h}{e}}$ x-intercept = $\frac{\phi}{e}$
28	**D**	Let KE = E =$\frac{p^2}{2m}$ KE of x = E= $\frac{px^2}{2m}$ KE of y = 2E = $\frac{py^2}{2m}$ $\frac{p_x}{p_y} = \frac{1}{\sqrt{2}}$ Since λ = $\frac{h}{p}$, hence $\frac{\lambda_y}{\lambda_x} = \frac{p_x}{p_y}$ Hence $\lambda_y = \frac{1}{\sqrt{2}}\lambda$
29	**B**	Point A : Dark background with coloured lines, Emission spectrum Point B : coloured background with dark lines, Absorption
30	**B**	E_3 to E_1 is blue ROYGBIV Violet line, the energy difference must be greater than blue, hence only E_4 to E_1 is possible.

Candidate's name ………………………………..………… CTG ……….…….

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS 2017

PHYSICS
8866/2
HIGHER 1

25th August 2017

2 hours

Paper 2 Structured Questions

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces provided on this cover page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

Write your answers in the spaces provided on the question paper.
For numerical answers, **all** working should be shown clearly.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Paper 1 (27.3%)	
	/30
Paper 2 (72.7%)	
Section A	
1	**/5**
2	**/10**
3	**/4**
4	**/8**
5	**/8**
6	**/5**
Section B	
7	**/20**
8	**/20**
9	**/20**
Penalty	
	/ 80
Overall Percentage (%)	

This question paper consists of 24 printed pages.

Data

speed of light in free space, $c = 3.00 \times 10^{8}$ m s^{-1}

elementary charge, $e = 1.60 \times 10^{-19}$ C

the Planck constant, $h = 6.63 \times 10^{-34}$ J s

unified atomic mass constant, $u = 1.66 \times 10^{-27}$ kg

rest mass of electron, $m_e = 9.11 \times 10^{-31}$ kg

rest mass of proton, $m_p = 1.67 \times 10^{-27}$ kg

Acceleration of free fall $g = 9.81$ m s^{-2}

Formulae

uniformly accelerated motion, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

work done on/by a gas, $W = p\Delta V$

hydrostatic pressure, $p = \rho g h$

resistors in series, $R = R_1 + R_2 + \ldots\ldots\ldots$

Resistors in parallel, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots..$

Section A

Answer **all** the questions in the spaces provided.

1 **(a)** The density of the material of a rectangular block was determined by measuring the mass and linear dimensions of the block. The table shows the results obtained, together with their absolute uncertainties.

- mass = (25.0 ± 0.1) g
- length = (5.00 ± 0.01) cm
- breadth = (2.00 ± 0.01) cm
- height = (1.00 ± 0.01) cm

Express the density of the block ρ, with its associated absolute uncertainty of $\Delta\rho$.

$\Delta\rho$ = ………….. ± …………… g cm^{-3} [4]

(b) Estimate the kinetic energy of a typical car cruising along the expressway in Singapore.

kinetic energy = ………………….. J [1]

2 A stone is projected with a speed of 5.0 m s^{-1} from a cliff on a faraway planet. It travels from point A, through point B and to point D as shown in Fig. 2.1.

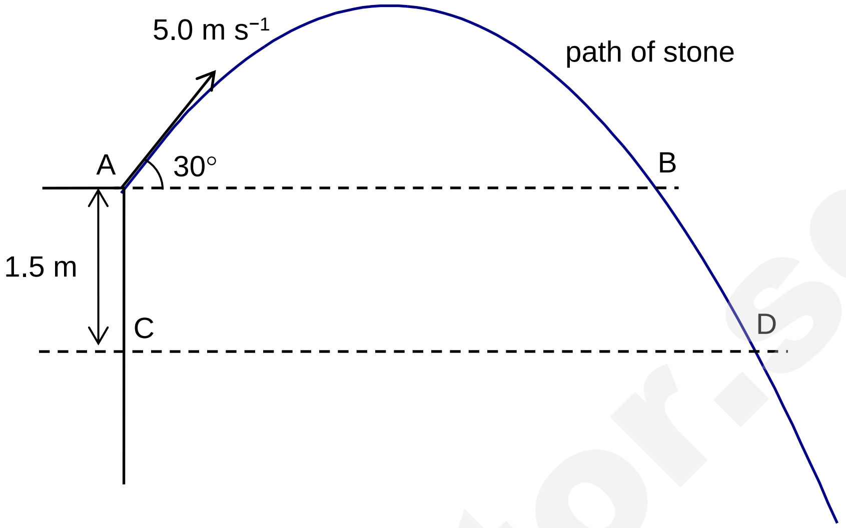


Fig. 2.1

Fig. 2.2 shows the variation of the stone's vertical velocity *v* with time *t*.

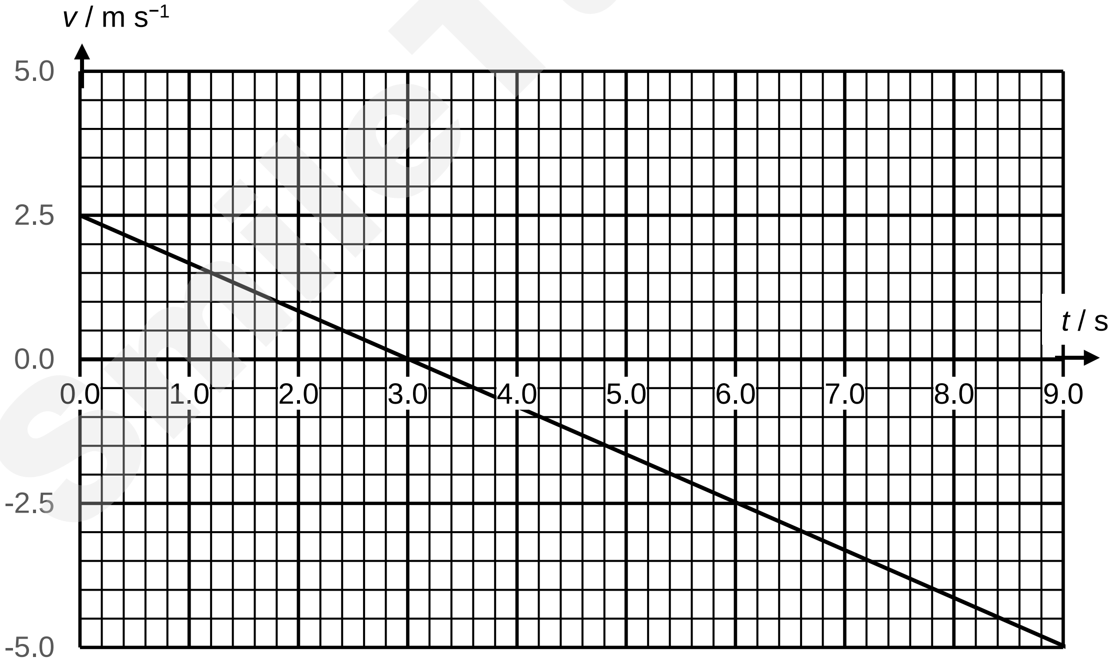


Fig. 2.2

(a) Determine the acceleration in the vertical direction.

acceleration = ………………….. m s^{-2} [1]

(b) Determine the vertical velocity of the stone at point D.

speed = ………………….. m s^{-1} [2]

(c) Shade on Fig. 2.2, the area corresponding to the vertical displacement between point B and D. [2]

(d) Mark on the line with ' **X** ' in Fig. 2.2, the instant when the stone is moving 45° to the horizontal axis. Explain how you derived your answer clearly in the space provided below.

[3]

(e) Sketch in Fig. 2.2, the variation of the stone's vertical velocity with time when the effect of air resistance is not negligible. [2]

3 A 60 kg skier start from rest at A and glides down a smooth slope. The dimensions of the slope and the skier's motion are illustrated in Fig. 3.1. The skier passes through point B before launching himself off the cliff at point C.

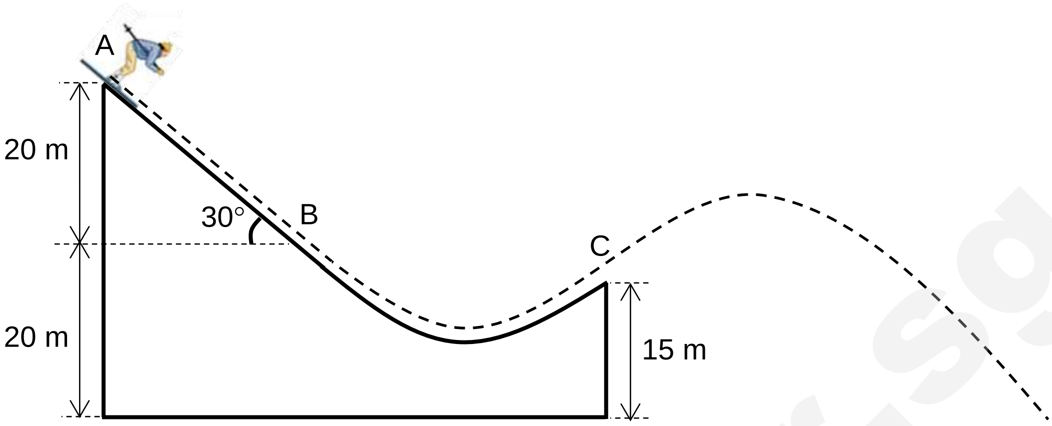


Fig. 3.1

(a) Determine the work done by the weight of the skier from point A to B.

work done = ………………….. J [2]

(b) Determine the speed of the skier at point C.

speed = ………………….. m s^{-1} [2]

4 **(a)** The I–V characteristic graph of a given tungsten filament lamp is shown in Fig. 4.1.

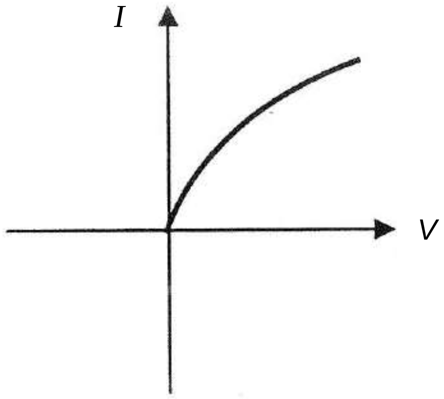


Fig. 4.1

With the aid of a labelled diagram, describe how the I–V characteristic graph can be obtained.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [4]

(b) A high potential difference is applied between the electrodes of a gas discharge tube so that the gas is ionised (both electrons and positive charged particles are present).The gas carries a current of 8.16 mA and the number of electrons passing any point in the gas per unit time is 2.58×10^{16} s^{-1}.

(i) Calculate the current due to the electrons.

current = …………………..A [2]

(ii) If the charge on each positively charged particle is 3.2×10^{-19} C, what is the number of positively charged particles passing any point in the gas per unit time?

number per unit time = ………………….. s^{-1} [2]

5 A photocell may be used to demonstrate the photoelectric effect. Fig. 5.1 shows a photocell connected to a circuit.

The photocell consists of two metal plates E and C. The metal plate E is sensitive to electromagnetic radiation. The metal plate C is a collector plate. A sensitive ammeter measures the photoelectric current.

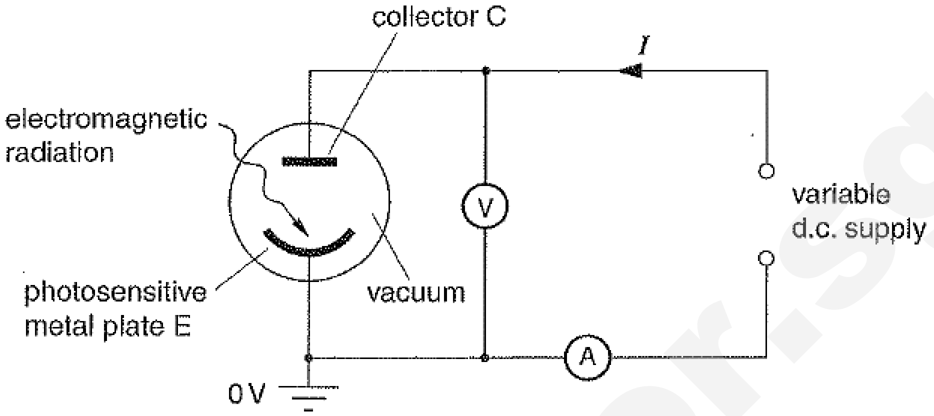


Fig. 5.1

Fig. 5.2 shows the variation with potential difference *V* of the photoelectric current *I* for radiation of a particular intensity.

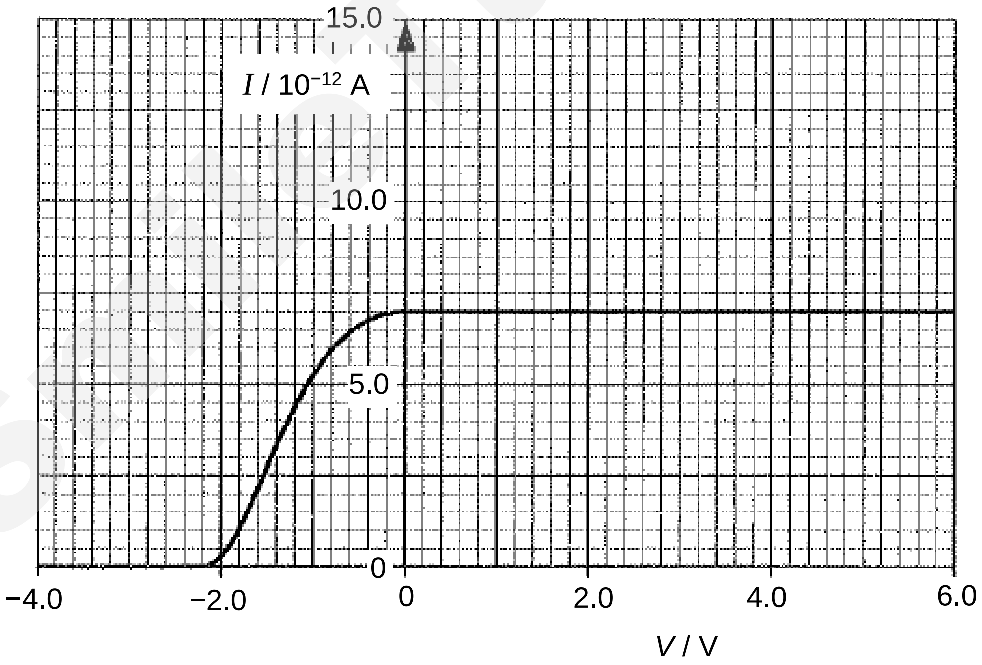


Fig. 5.2

(a) Explain what is meant by *photoelectric effect*.

....

....

.... [2]

(b) Explain why the photoelectric current decreases and eventually becomes zero when the potential difference becomes negative.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………… [2]

(c) Use Fig. 5.2 to show that the maximum speed of the photoelectrons is 8.8×10^5 m s^{-1}.

[2]

(d) The intensity of the electromagnetic radiation is doubled but the frequency is kept constant. On Fig. 5.2, sketch a graph to show the new I-V characteristic. [2]

6 In Fig. 6.1, a fluorescent tube is filled with mercury vapour at low pressure. After mercury atoms have been excited they emit photons. The emitted photons have energy corresponding to ultra-violet in the electromagnetic spectrum.

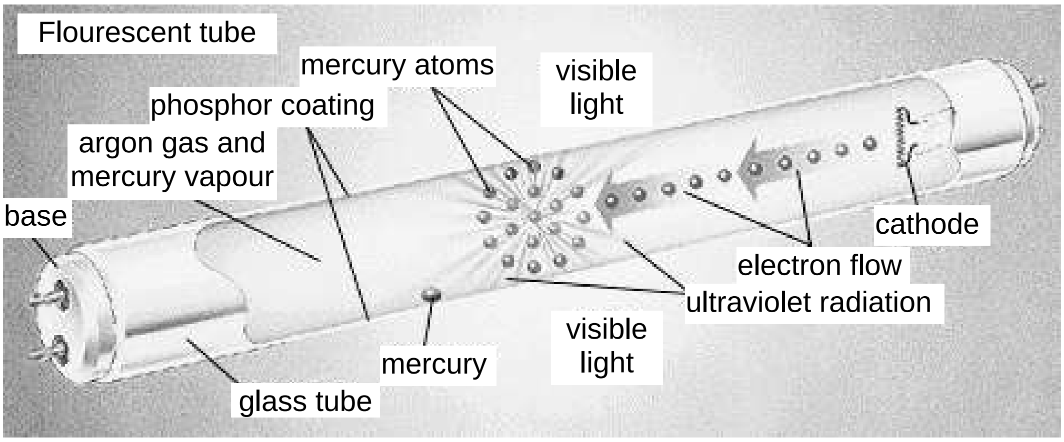


Fig. 6.1

Explain

(a) what is meant by an *excited* mercury atom;

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(b) how the mercury atoms in the fluorescent tube become excited;

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(c) why the excited mercury atoms emit photons of specific frequencies; and

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(d) how the phosphor coating on the inside of a fluorescent tube emits visible light.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

Section B

Answer any **two** questions from this section in the spaces provided.

7 **(a)** Explain what is meant by *progressive* wave.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) To study the attenuation of radio wave signal by air, a radio wave detector is placed at a distance *x* away from a radio wave point source. The intensity I is noted at different distances and variation of I with *x* is shown in Fig. 7.1.

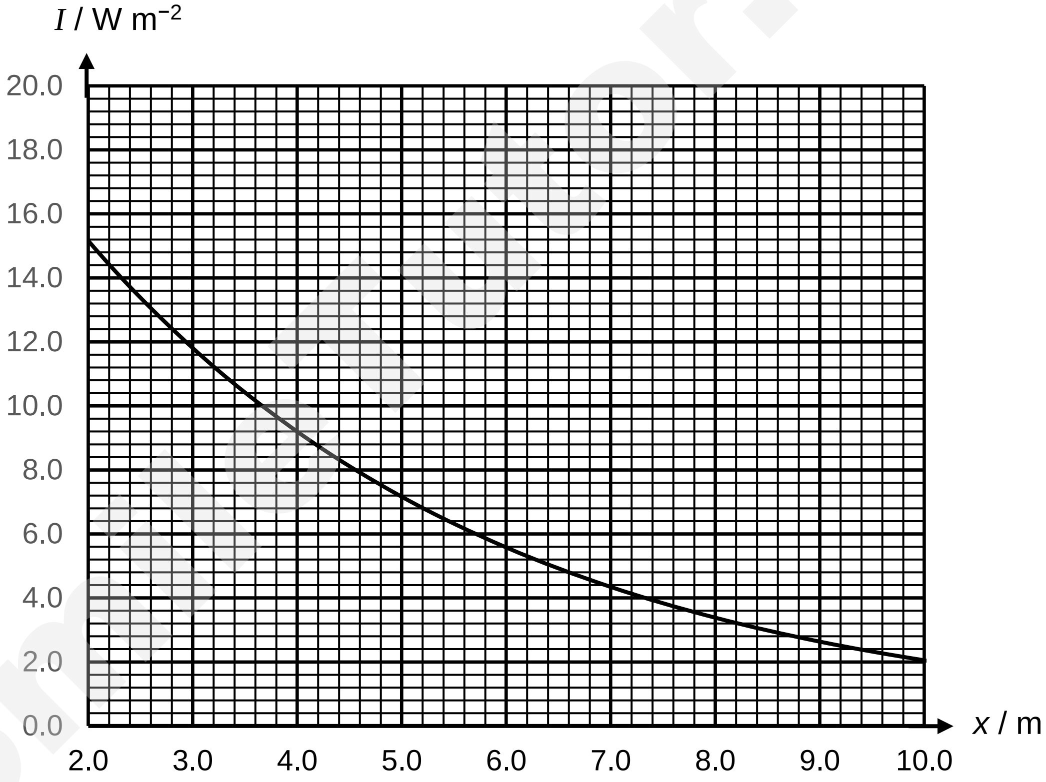


Fig. 7.1

Using Fig. 7.1,

(i) describe how the intensity I varies with the distance *x*,

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………... [2]

(ii) determine the ratio

$$\frac{\text{amplitude at } x = 4.0\text{ m}}{\text{amplitude at } x = 7.0\text{ m}}.$$

ratio = ………………….. [3]

(c) The shape of the curve in Fig. 7.1 suggests that the decrease of the intensity I with range in air x could be exponential. A graph of ln (I / W m^{-2}) against x is plotted to test the relationship as shown in Fig. 7.2.

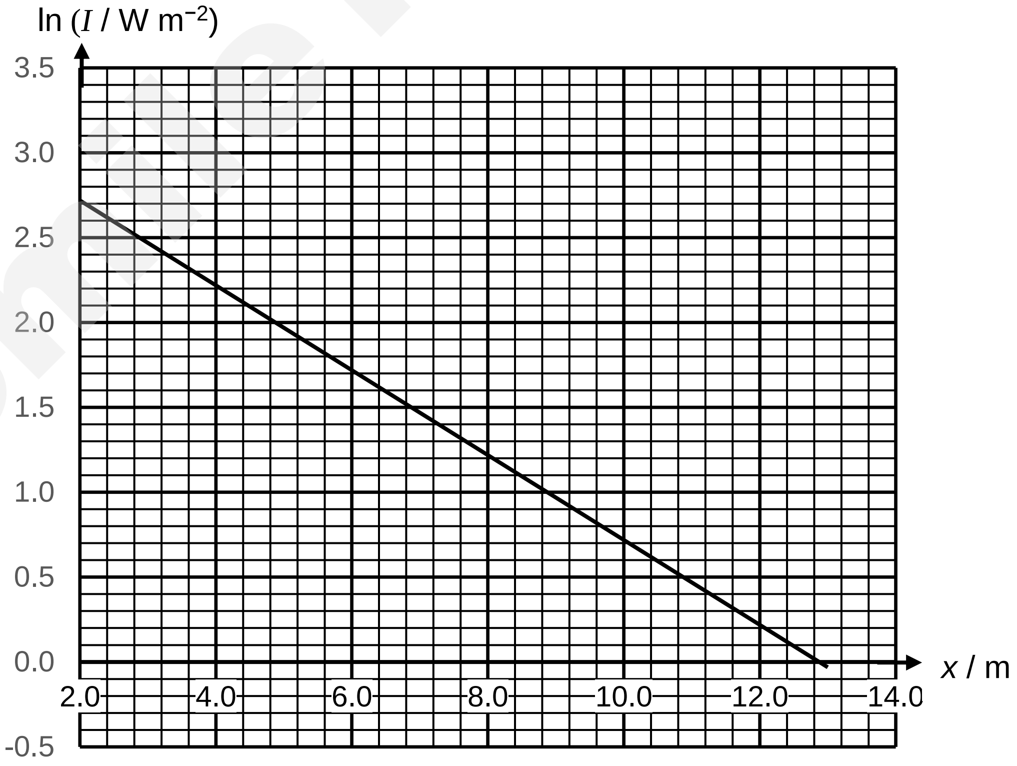


Fig. 7.2

(i) Determine the gradient of the graph in Fig. 7.2.

gradient = ………………….. [1]

(ii) It is suggested that the exponential relationship between I and x is in the form

$$I = I_0 e^{-kx}$$

where I_0 is the intensity at x = 0 and k is a constant.

Using Fig. 7.2, explain whether the above exponential relationship is true.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………... [2]

(d) A string, tied to a sinusoidal oscillator at P and running over a support at Q, is stretched by a block of mass m as shown in Fig. 7.3. The amplitude of the motion at P is small enough for that point to be considered a node. A node also exists at Q.

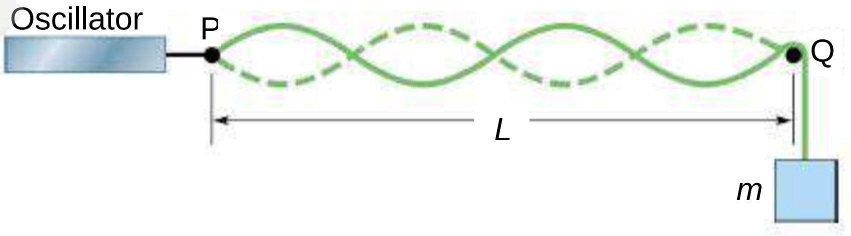


Fig. 7.3

(i) Explain how stationary waves are formed along the string.

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………...

…………………………………………………………………………………... [2]

(ii) In terms of phase change, explain why a node is formed at Q.

………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………... [2]

(iii) The frequency of the oscillator is set at 120 Hz. A stationary wave is formed when the length *L* is 1.20 m. The maximum amplitude of the antinode is 0.80 cm. The length is slowly increased and the stationary wave disappears. The stationary wave is again formed when *L* is increased by 0.30 m.

1. Determine the velocity of the wave in the string.

velocity = ………………….. m s^{-1} [2]

2. Point X is at one of the antinodes when *L* is 1.50 m. Point Y is at a distance $\lambda/8$ away from point X, where λ is the wavelength of the wave. Determine the phase difference between the two points.

phase difference = ………………….. rad [1]

(e) A signal from source S is emitted through two separate speakers as shown in Fig. 7.4.

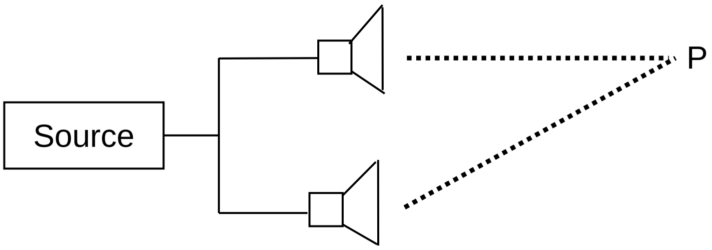


Fig. 7.4

The sound waves from the speakers reach a point P by two paths which differ in length by 1.4 m. When the frequency of the sound is gradually increased, the resultant intensity at P goes through a series of maxima and minima. A maximum occurs when the frequency is 1000 Hz and the next maximum occurs at 1200 Hz.

Determine the speed of the sound wave.

speed of sound wave = ………………….. m s^{-1} [3]

8 **(a)** Explain what is meant by *electromotive force of a source* and *potential difference between two points of a circuit*.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

(b) The circuit in Fig. 8.1 consists of three fixed resistors, each of which has a safe power rating of 0.80 W.

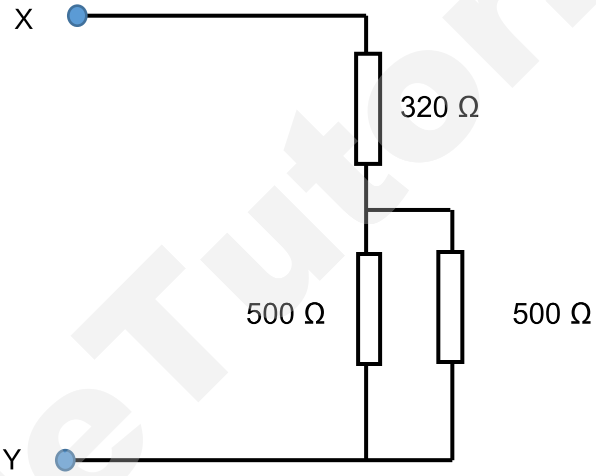


Fig. 8.1

Determine the maximum potential difference that can be applied between X and Y without damage to any of the resistor.

maximum potential difference = …………………….V [4]

(c) A car battery is used to power up four lamps as shown in Fig. 6.2. The resistance of each lamp should be 180 Ω when it is working under normal conditions.

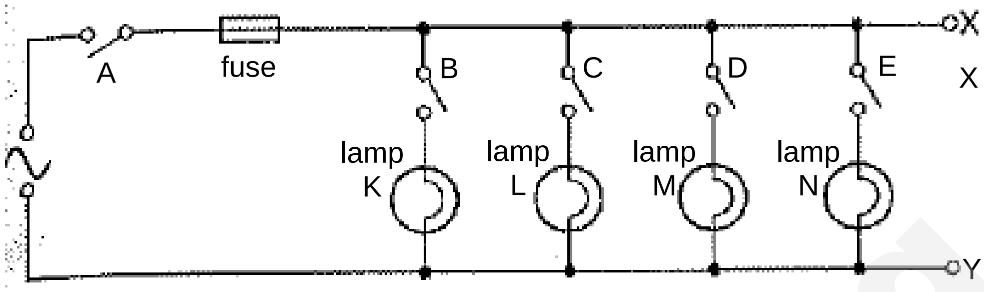


Fig. 8.2

A fault is discovered in the circuit, so switch A is open and the fuse is removed for safety. An electrician uses a resistance meter, an equipment which can be used to measure the effective resistance across any two points in a circuit, to check the lamps. He connected the resistance meter between the points X and Y and the readings obtained for different switch positions are shown in **Fig. 8.3**.

Switches					
A	B	C	D	E	Resistance meter reading/Ω
open	open	open	open	open	14 000 000
open	open	open	open	closed	180
open	open	open	closed	closed	90
open	open	closed	closed	closed	60
open	closed	closed	closed	closed	0.2

Fig. 8.3

(i) Based on the readings in Fig. 8.3, explain which lamp is faulty in the circuit. Show your workings clearly.

faulty lamp = ……………………… [2]

(ii) Suggest what could have happened to the faulty lamp.

………………………………………………………………………………………...

………………………………………………………………………………………... [1]

(iii) Suggest why there is still a reading of 14 MΩ on the resistance meter when all the switches are open.

………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………... [1]

(d) A simple D.C. motor works on the principle of converting electrical energy to mechanical energy in the form of rotation.

A small rectangular coil ABCD contains 150 turns of wire. The sides AB and BC of the coil are lengths of 4.5 cm and 2.8 cm respectively, as shown in Fig. 8.4

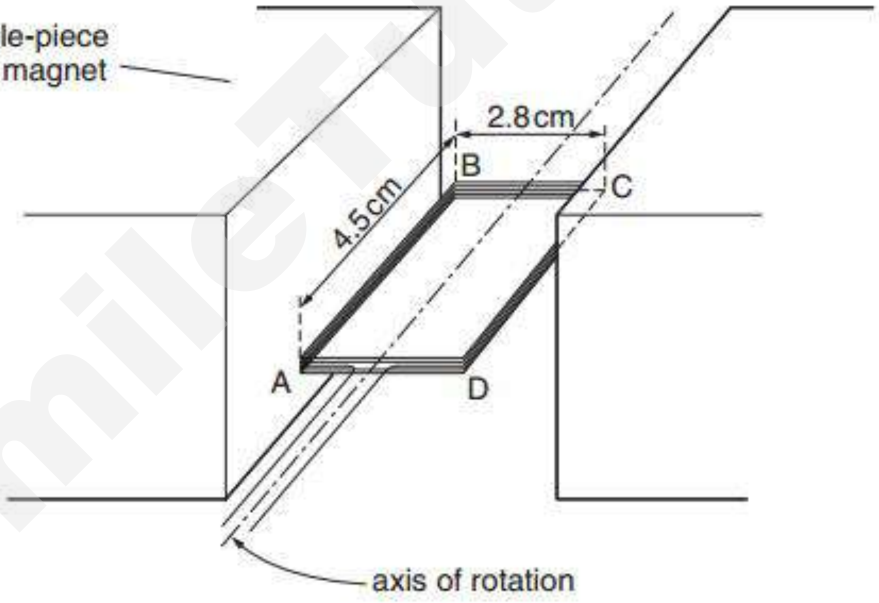


Fig. 8.4

The coil is held between the poles of a large magnet so that the coil can rotate about an axis through its centre.

The magnet produces a uniform magnetic field of flux density *B* between its poles. When a current of 185 mA is passed through the coils, it causes the coil to rotate.

(i) Define magnetic flux density.

………………………………………………………………………………………...

………………………………………………………………………………………...

………………………………………………………………………………………... [1]

(ii) For the coil to achieve maximum torque, state whether the plane of the coil should be parallel to, or normal to, the direction of magnetic field.

………………………………………………………………………………….. [1]

(iii) For the coil in the position shown in Fig. 8.4, the torque produced in the coil is 2.1×10^{-3} Nm.

Calculate the magnitude of the force on

1. side AB of the coil,

force on AB = ……………………….N [2]

2. side BC of the coil.

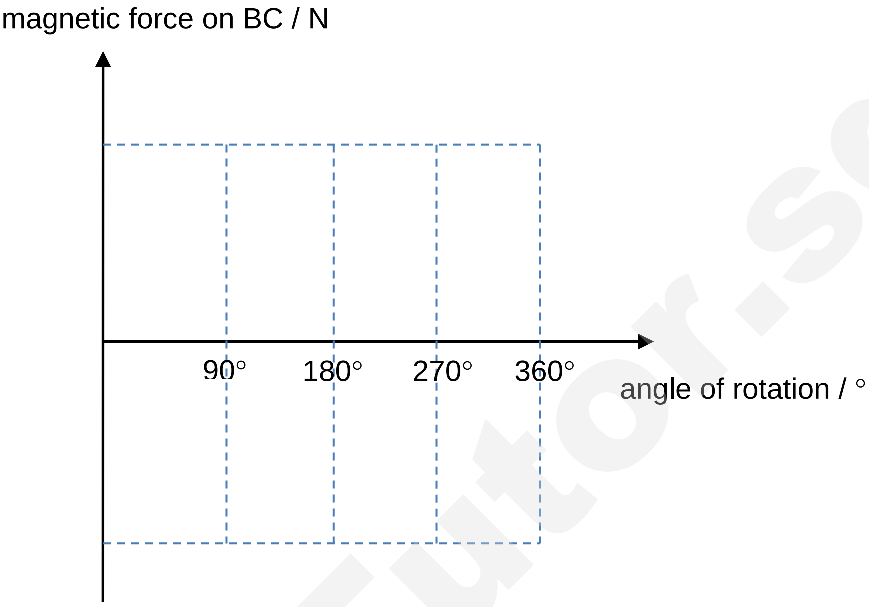
force on BC = ……………………….N [1]

(iv) Use your answer to **(iii)** to show that the magnetic flux density *B* between the poles of the magnet is 60 mT.

[2]

(v) As the coil rotates and make one complete revolution, sketch the variation of magnetic force acting on side BC with angle of rotation. (values are not required)

The angle of rotation for the coil in the position shown in Fig. 8.4 is taken to be 0°.



[1]

(vi) Show by means of a simple diagram, the relative directions of magnetic force *F*, magnetic flux density *B* and current I when the angle of rotation θ is 30°. You may make your own assumption on the current direction and direction of rotation.

[2]

9 **(a)** State the principle of conservation of momentum.

……………………………………………………………………………………………….

……………………………………………………………………………………………….

………………………………………………………………………………………………. [2]

(b) A 0.0200 kg object travelling towards the right at 8.0 m s^{-1} collides head on with another 0.0100 kg object travelling towards the right at 5.0 m s^{-1}. After collision, the 0.0200 kg object travels towards the left at 2.0 m s^{-1}.

(i) Calculate the speed of the 0.0100 kg object after collision.

speed = …………………. m s^{-1} [2]

(ii) State the direction of motion of the 0.0100 kg object after collision.

…………………………………………………………………………………......... [1]

(iii) If the impact time is 0.120 s, calculate the average force exerted on the 0.0100 kg object by the 0.0200 kg object during collision.

force = …………………. N [2]

(iv) Explain why it is not possible for both objects to stop at the same instant during the collision.

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………...

……………………………………………………………………………………... [2]

(c) Fig. 9.1 shows a wooden block B (mass = 3.0 kg) resting on another block A (mass = 5.0 kg). Both blocks are connected by a light string which goes around a fixed smooth pulley. The friction between block A and block B is 12 N. Block A is travelling at constant velocity under an applied force of 40 N along a horizontal rough ground.

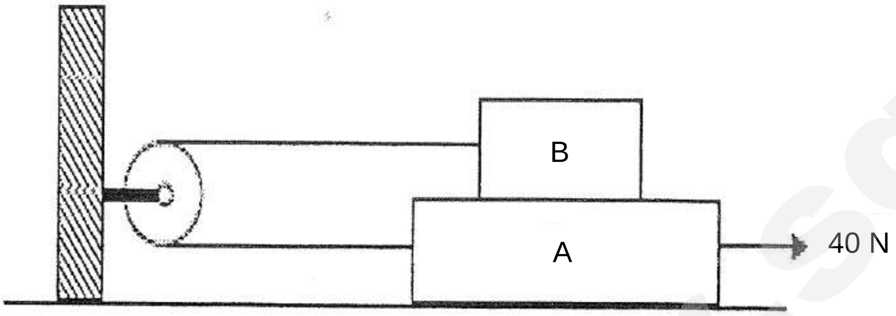


Fig. 9.1

(i) Draw a free body diagram of block A. (Name all the forces)

[3]

(ii) Draw a free body diagram of block B. (Name all the forces)

[2]

(iii) With reference to your answer in **(ii)**, calculate the force exerted on block B by the string.

force exerted on block B by string = …………………. N [1]

(iv) Hence, or otherwise, calculate the force exerted on block A by the ground.

force exerted on block A by ground = …………………. N [3]

(v) Describe the subsequent motion of block B if the string suddenly snaps, given that block B remains in contact with block A at all times.

………………………………………………………………………………...

………………………………………………………………………………...

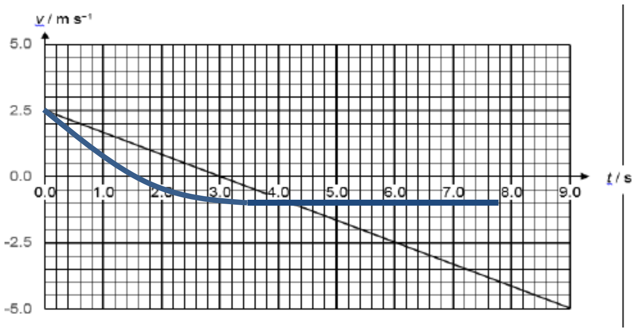
………………………………………………………………………………...

……………………………………………………………………………….. [2]
.

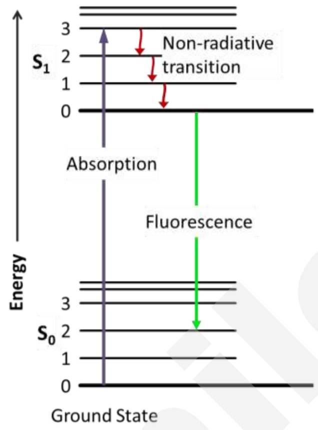
--- End of paper ---

2017 8866 JC2 H1 Physics Prelim Paper 2 Solutions

1	**(a)**	$\rho = M/V = M/(LBH) = 25.0/(5.0)(2.0)(1.0) = 2.50\ \text{g cm}^{-3}$ $\Delta\rho/\rho = \Delta M/M + \Delta L/L + \Delta B/B + \Delta H/H$ $\Delta\rho/2.50 = 0.1/25.0 + 0.01/5.00 + 0.01/2.00 + 0.01/1.00$ $\Delta\rho = 0.0525\ \text{g cm}^{-3}$ $\Delta\rho = 0.05\ \text{g cm}^{-3}$ or $0.06\ \text{g cm}^{-3}$ (1 sf) $\rho = (2.50 \pm 0.05 \text{ or } 0.06)\ \text{g cm}^{-3}$	**B1** **C1** **A1** **A1**
		Marker's comment	
	(b)	Speed must be between 70 km h^{-1} and 100 km h^{-1}. Mass of car is between 1000 kg to 2000 kg.	**A1**
		Marker's comment	
2	**(a)**	acceleration = gradient of the graph $= \frac{-2.5-2.5}{6.0-0}$ $= -0.83\ \text{m s}^{-2}$	**1**
		Marker's comment	
	(b)	$v^2 = u^2 + 2as$ $= [5.0 (\sin 30)]^2 + 2 (-0.83)(-1.5)$ $v = 2.96\ \text{m s}^{-1}$	**1** **1**
		Marker's comment	
	(c)	The area between t = 6.02 s to point where v = calculated value of (b) 1 mark for correct starting time 1 mark for the ending time which corresponds to value of (b)	**1** **1**
		Marker's comment	
	(d)	$5.0 \cos 30 = 4.33\ \text{m s}^{-1}$ For the velocity to be 45° to the horizontal, the vertical velocity must also be 4.33 m s^{-1} (t will be at 8.2 s)	**1**
		Marker's comment	

	(e)	 Correct curvature [1] Need not reach terminal velocity Max height is reached at a shorter time [1]	**1** **1**
3	**(a)**	*WD* = *F s* = 60 (9.81) (20) [1] = 1.18 × 10^4 J [1]	**1** **1**
		Marker's comment	
	(b)	By conservation of energy Loss in GPE = Gain in KE $mg(40 – 15) = ½\, m\, v^2$ [1] $9.81\ (25) = ½\ v^2$ v = 22.1 m s^{-1} [1]	**1** **1**
		Marker's comment	
4		Diagram: Cell, Variable Resistor, Filament Lamp connected in series + Ammeter connected in series to Filament Lamp Voltmeter connected in parallel to Filament Lamp Correct Circuit Diagram Symbols Procedures: By adjusting resistance of variable resistor to a specific value R, the current I flowing through filament lamp can be obtained from ammeter. The corresponding potential difference across filament lamp V can be obtained from voltmeter. Decrease or increase R to obtain another 7 sets of (V, I). Plot the I-V characteristic graph using the 8 sets of (V, I) and draw a best fit curve.	**B1** **B1** **B1** **B1**
		Marker's comment	

	(b)	$I_1 = Q_1/t$ $= [(N_1)/t] \times e$ $= (2.58 \times 10^{16})\ (1.60 \times 10^{-19})$ $= 4.13 \times 10^{-3}$ A	 **M0** **C1** **A1**
		Marker's comment	
	(c)	$I_T = I_1 + I_2$ $Q_2/t = I_T - I_1$ $[(N_2)/t] \times p = I_T - I_1$ $N_2)/t = (I_T - I_1)/p$ $= \{(8.16 - 4.13) \times 10–3\}/(3.2 \times 10^{-19})$ $= 1.26 \times 10^{16}$ s^{-1}	 **M0** **C1** **A1**
		Marker's comment	
5	**(a)**	The *photoelectric effect* is the emission of electrons from the surface of a metal when electromagnetic radiation of high enough frequency is incident on it.	**1** **1**
		Marker's comment	
	(b)	When the potential of plate C is negative, photoelectrons emitted are repelled. As the potential becomes more negative, less photoelectrons are able to reach the collector. Current will be zero when the negative potential is large enough to stop the fastest moving electron.	**1** **1**
		Marker's comment	
	(c)	From graph, stopping potential $V_s = 2.2$ V $eVs = ½\ m\ v_{max}^2$ $v_{max}^2 = 2eV_s/m_e$ $v_{max} = \sqrt{\frac{2(1.6\times10^{-19})(2.2)}{9.11\times10^{-31}}} = 8.79 \times 10^5$ m s^{-1}	**1** **1**
		Marker's comment	
	(e)	Same stopping potential, Max photocurrent at 7.0 x 2 = 14	**2**
		Marker's comment	
6	**(a)**	Electron/atom (in ground state) has transited/ moved/ jumped to a higher energy level by either absorping an photon or colliding with another atom.	**1**

		Marker's comment	
	(b)	Free electrons collide with (orbital electrons) mercury atom, hence transfering energy	**1**
		Marker's comment	
	(c)	(mercury) atoms have discrete/ specific energy levels. When electrons transit/change levels, they lose an exact/specific/discrete set of energy equal to energy difference between the two levels, leading to photons of discrete/specific energy and hence specific wavelengths/frequency.	**1** **1**
		Marker's comment	
	(d)	The coating <u>absorbs</u> photons/ UV light and re-emits photons of lower energy /longer wavelength/lower frequency.  Additional information: After an electron absorbs a high energy photon the system is excited electronically and vibrationally. The system relaxes vibrationally(non-radiative transition), and eventually fluoresces at a longer wavelength. Source: fluorescence - wikipedia	**1**
		Marker's comment	

Section B (Option Questions)

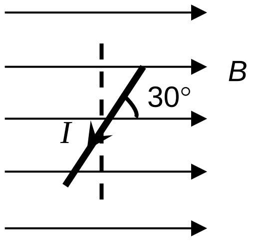
7	**(a)**		A wave is progressive when the wavefront moves [1] and energy is dissipated to the surrounding [1] along the direction of propagation.	**1** **1**
			Marker's comment	
	(b)	**(i)**	The intensity decreases [1] at a decreasing rate [1] as x increases.	**1** **1**
			Marker's comment	
		(ii)	$\frac{\text{intensity at } x=4.0\ m}{\text{intensity at } x=7.0\ m}=\frac{9.2}{4.4}$ [1 mark for reading off correctly]	**1**

			$I \alpha A^2$ [1 mark for showing this relationship] Ratio of amplitude = $(9.2/4.4)^{0.5}$ = 1.44 [1 mark for final answer]	**1** **1**
		Marker's comment		
	(c)	**(i)**	Gradient = $\dfrac{0-2.7}{12.8-2} = -0.25$	**1**
		Marker's comment		
	(c)	**(ii)**	$I = I_o e^{-kx}$ $\ln I = -kx + \ln I_o$ [1 mark for showing the linearization] Since the graph in Fig 7.2 is a straight line [1] with a non-zero y-intercept, the relationship is correct [no mark for making conclusion without any explanation]	**1** **1**
		Marker's comment		
	(d)	**(i)**	Formed due to superposition/interference of the incident wave from oscillator and reflected wave from Q. [1] The two waves have the same speed, wavelength/frequency, same amplitude and travel in opposite directions [1]	**1** **1**
		Marker's comment		
		(ii)	There is a 180°/ π radian phase change at Q [1] since it is a fixed end, Hence there is destructive interference between the incident and reflected wave, [1] since they are π radian out of phase. – this mark given only if they are able to explain about the phase change.	**1** **1**
		Marker's comment		
		(iii)	**1.** ½ λ = 0.30 m λ = 0.60 m [1] v = f λ = 120 (0.60) = 72 m s^{-1} [1]	**1** **1**
		Marker's comment		

			2.	Phase different is zero.	**1**
		Marker's comment			
	(e)		For constructive interference, Path difference = 1.4 m (fixed) $n\lambda = 1.4$ $n\left(\frac{v}{f_1}\right) = 1.4 \Rightarrow n\left(\frac{v}{1000}\right) = 1.4 \Rightarrow n = \frac{1400}{v} \quad --(1)$ $(n+1)\left(\frac{v}{f_2}\right) = 1.4 \Rightarrow (n+1)\left(\frac{v}{1200}\right) = 1.4 \quad --(2)$ Solving (1) and (2), v = 280 m s^{-1}		**1** **1** **1**
		Marker's comment			

8	**(a)**		Potential difference between two points of a circuit **is the amount of electrical energy converted per unit charge into other forms of energy** when the charge moved from one point to the other. Electromotive force of a source is defined as the **energy converted per unit charge from other forms of energy into electrical energy** when the charge is driven through the source round a complete circuit.	**1** **1**
			Marker's comment	
	(b)		Calculate safe maximum current 500 Ω : current = $\sqrt{\frac{P}{R}} = \sqrt{\frac{0.8}{500}}$ = 0.040 A 2 x 0.040 = 0.080 A 320 Ω : current = $\sqrt{\frac{0.8}{320}}$ = 0.050 A 2 marks for calculating max current for both types of resistors. The 320 Ω resistor will be damaged first. Maximum current in circuit = 0.050 A 1 mark for recognizing the maximum current or the resistor which will be damaged first. Maximum safe p.d = 0.050 (320 + 250)= 28.5 V 1 mark for determining the maximum safe potential difference.	**1** **1** **1** **1**
			Marker's comment	
	(c)	**(i)**	Lamp K. When switches B, C, D, E are closed and switch A open, the reading should be 45 Ω. But the reading measured is 0.2 Ω.	**1** **1**

			Marker's comment	
		(ii)	The lamp is short-circuited or any other possible reason which could cause the resistance of the lamp to be reduced to near zero. Do not accept that the lamp is fused because if the lamp is fused, the resistance should be infinite (open circuit).	**1**
		Marker's comment		
		(iii)	The resistance meter has its own internal resistance of 1.4 x 10^7 when operated. (This resistance is connected in parallel to the rest of circuit. Hence when the rest of the circuit to be measured has infinite resistance, the effective resistance is its own internal resistance.) Do not accept resistance meter is non-ideal or that the resistance meter can only give a maximum reading of this value. These answers are too generic. Student should explain more clearly.	**1**
		Marker's comment		
	(d)	**(i)**	The magnetic flux density of a magnetic field is defined as the force exerted on a unit length of conductor carrying a unit current placed at right angles to the field.	**1**
		Marker's comment		
		(ii)	Parallel to the field	**1**
		Marker's comment		
		(iii)	**1.** Torque = Fd $2.1 \times 10^{-3} = F (2.8 \times 10^{-2})$ F = 0.075 N (no marks for using 4.5 cm)	 **1** **1**
			Marker's comment	
			2. Zero, since B field and current are parallel.	**1**
			Marker's comment	
		(iv)	F= N (BILsin θ) 0.075 = 150 (B) (0.185)(0.045) B = 0.060 = 60 mT	**1** **1**
			Marker's comment	
		(v)	Sine graph	**1**
			Marker's comment	

		(vi)	Correct identification of direction of force (in or out of plane) Clear diagram with proper labeling of B field, current and angle of rotation 	**1** **1**
			Marker's comment	
9	**(a)**		The principle of conservation of momentum states that total momentum in a closed system remains constant if and only if the net external forces acting on the bodies are zero.	**B1** **B1**
			Marker's comment	
	(b)	**(i)**	Rightwards as positive: $\Sigma p_i = \Sigma p_f$ (0.0200)(8.0) + (0.0100)(5.0) = (0.0200)(-2.0) + (0.0100) v $v = 25\ \text{m s}^{-1}$	 **M0** **C1** **A1**
			Marker's comment	
		(ii)	Rightwards	**B1**
		(iii)	On 0.0100 kg object: $\Sigma F = \Delta p/\Delta t$ $= m\,(v_f - v_i)/\ \Delta t$ $= (0.0100)\ [(+25) - (5.0)]/0.120$ $= 1.67$ N Alternatively: On 0.0200 kg object: $\Sigma F = \Delta p/\Delta t$ $= m\,(v_f - v_i)/\ \Delta t$ $= (0.0200)\ [(-2) - (+8)]/0.120$ $= -\ 1.67$ N By Newton's Third Law, ΣF on 0.0100 kg object = ΣF on 0.0200 kg object = 1.67 N	 **M0** **C1** **A1** **M0** **C1** **A1**
			Marker's comment	
		(iv)	If both objects stop at the same instant, the total momentum of both objects is zero at that instant.	**B1**

			However, before the collision, the total momentum of both objects was non-zero. This violates the principle of conservation of momentum which specify that the total momentum remains non-zero.	**B1**
	(c)	**(i)**	Normal Force (upwards), Weight of A = 5 g (downwards), Tension (leftwards), frictional force on A by B = 12 N (leftwards) and frictional force on A by ground (leftwards) and Applied Force = 40 N (rightwards) Correct Direction & Properly labelled -1 for each missing or additional or forces drawn in incorrect direction -1 for each forces not labelled properly	**B2**
		(ii)	Normal Force (upwards), Weight of B = 3 g (downwards), Tension (leftwards) and frictional force on B by A = 12 N Correct Direction & Properly labelled -1 for each missing or additional or forces drawn in incorrect direction -1 for each forces not labelled properly	**B2**
		(iii)	T = f_{BA} = 12 N	**A1**
		(iv)	f_{AG} + T + f_{AB} = 40 f_{AG} + 12 + 12 = 40 f_{AG} = 16 N Force by ground = $\sqrt{((3+5)(9.81))^2 + 16^2}$ = 80 N	 **C1** **B1** **A1**
		(v)	Block B will slow down (because of friction). Block B will then change direction and accelerate towards the right.	**B1** **B1**
			Marker's comment	