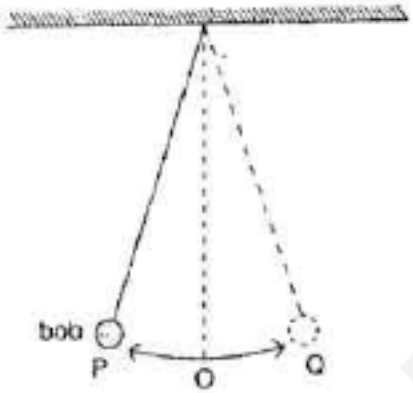
1 The figure shows an oscillating pendulum with its bob moving from P through O to Q and back to P in a repetitive manner.

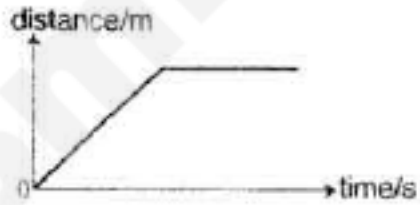


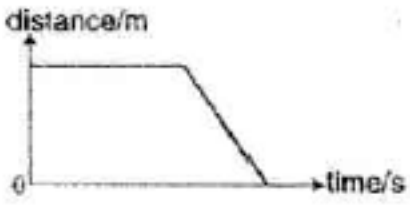
If the bob takes 0.8 s to move from P to O, what is the frequency of oscillation of the pendulum?

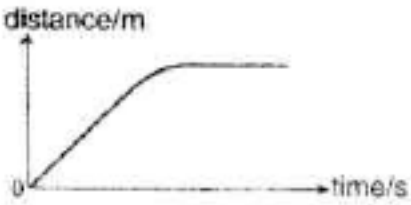
A 0.313 Hz
B 0.625 Hz
C 1.25 Hz
D 3.20 Hz

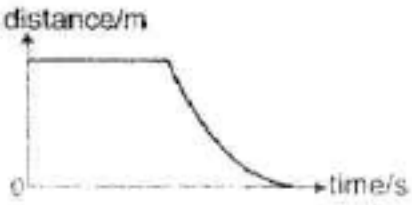
2 A man is driving along a straight road at constant speed. He brakes suddenly and the car decelerates uniformly until it comes to a stop.

Which of the following distance-time graphs correctly shows the motion of the car?

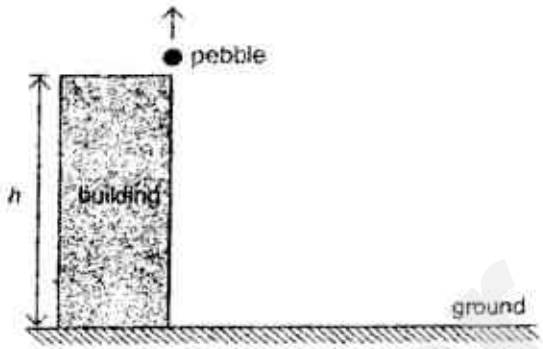
A


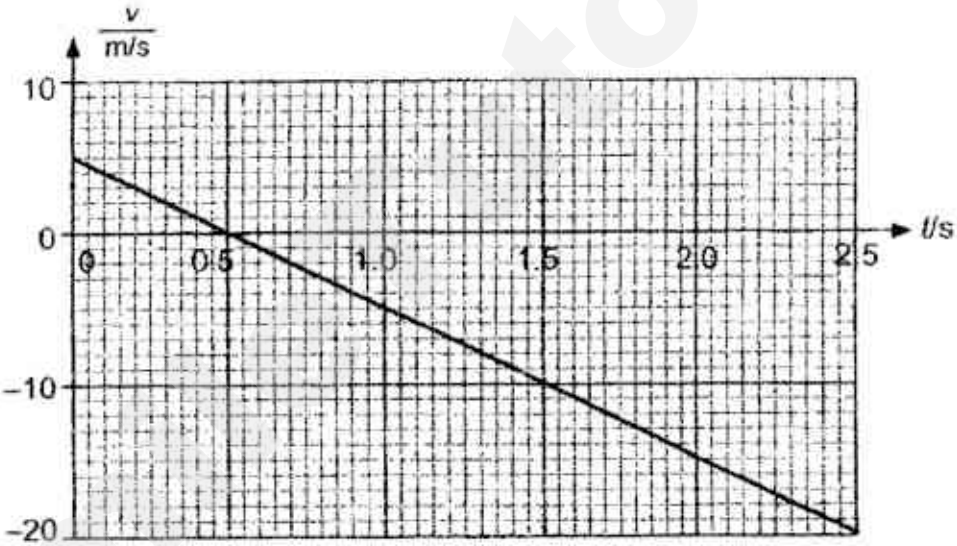
B


C


D


3 The graph shows how the velocity of a pebble projected vertically upwards from the top of a building varies with time. The pebble reaches the ground in 2.5 s.





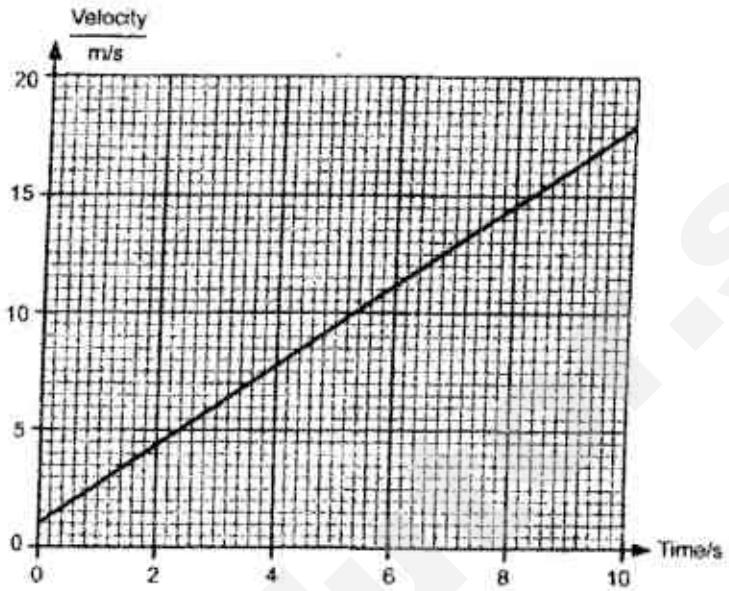
What is the height, h, of the building?

A 18.8 m B 20.0 m C 21.3 m D 31.3 m

4 A rope is being tied to a box of mass 20 kg. What is the tension in the rope when it is lifting up the box at a constant velocity and when it is lowering the box also at a constant velocity? (Take g, the gravitational field strength, to be 10 N/kg.)

	Tension when lifting up the box	Tension when lowering the box
A	100 N	100 N
B	100 N	200 N
C	200 N	200 N
D	200 N	100 N

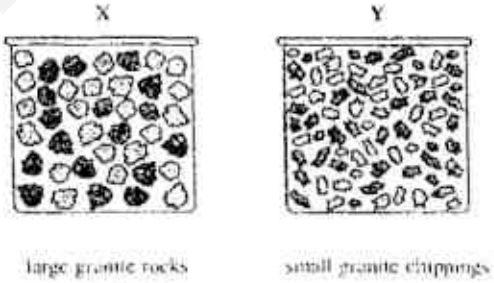
5 A crate weighing 400 N is being pushed along a horizontal surface with a constant applied force of 80 N. The figure shows the velocity-time graph of the crate. (Take g, the gravitational field strength, to be 10 N/kg.)



What is the resultant force acting on the crate?

A 68 N B 72 N C 80 N D 680 N

6 A box X full of large granite rocks is weighed. An identical box Y full of small granite chippings is then weighed.



Which box weighs more and why?

	Heavier box	Reason
A	X	There is more air in box X.
B	Y	There is less air in box Y.
C	X	The density of a rock is greater than the density of a chipping.
D	Y	The density of a chipping is greater than the density of a rock.

7 Fig. 1 shows a non-uniform cylindrical rod PQ of mass m kg. The length of the rod is 1.0 m and its centre of mass is at a distance x cm from end P.

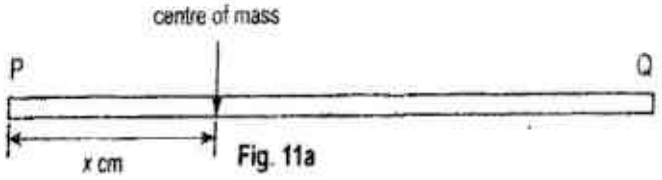


Fig. 1

Fig. 2 shows the same rod suspended about its midpoint by a string. To keep the rod horizontal, different masses are hung on the rod.

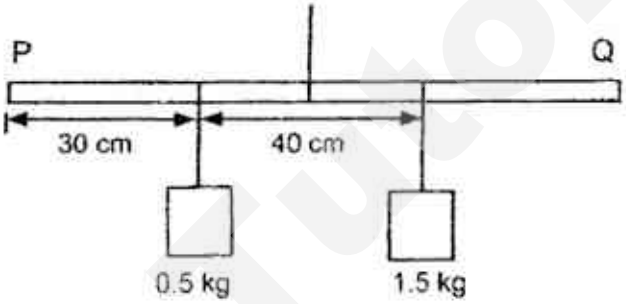
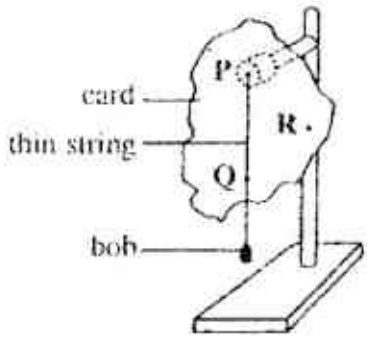


Fig. 2

Which of the following are correct values for x and m?

	x / cm	m / kg
A	20	1.0
B	30	2.0
C	30	1.0
D	50	2.0

8 The figure shows the first step in an experiment to determine the position of the centre of mass of a thin card.



What is the next step in this experiment?

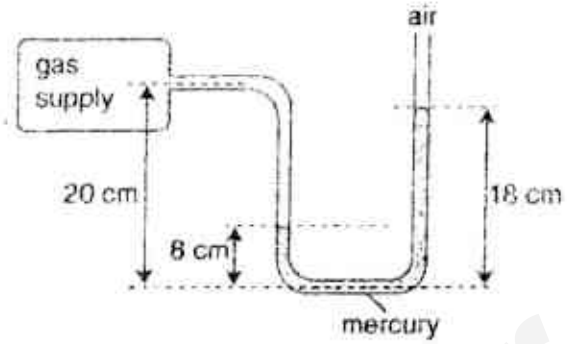
A Measure the mass of the card.
B Measure the thickness of the card.
C Find the midpoint of PQ.
D Hang the card from point R.

9 A garden hose with a diameter of 2.0 cm is aimed vertically at a horizontal surface. Water exits the hose at a high speed and exerts a pressure of 5.0 MPa on the surface.

What is the force F exerted by the water on the surface?

A 157 N B 628 N C 1570 N D 6280 N

10 A manometer containing mercury (Hg) is used to measure the pressure of a gas supply.



What is the pressure of the gas?

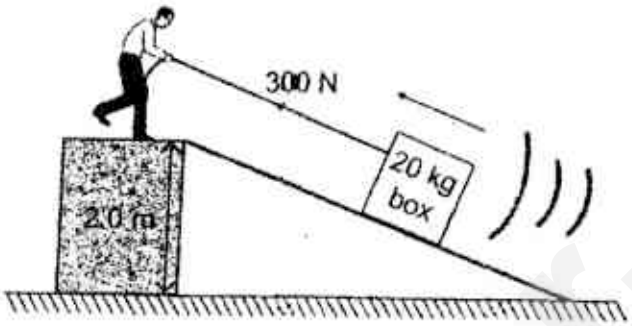
A 10 cm Hg more than atmospheric pressure
B 12 cm Hg more than atmospheric pressure
C 8 cm Hg less than atmospheric pressure
D 20 cm Hg less than atmospheric pressure

11 An arrow is shot upwards and reaches its maximum height in a much longer time than expected due to strong winds.

Which one of the following correctly states the energy changes taking place as the arrow moves towards its maximum height?

	Gravitational potential energy (E_p)	Kinetic energy (E_k)	$E_p + E_k$
A	Decreases	Increases	Remains unchanged
B	Increases	Decreases	Decreases
C	Increases	Decreases	Remains unchanged
D	Decreases	Increases	Decreases

12 A 10 m long steel ramp is inclined against a concrete block. A man standing on top of the concrete block pulls a 20 kg box from the base of the ramp up along it at constant velocity. He exerts a constant force of 300 N on the box over the entire length of the ramp.



What is the amount of energy dissipated due to friction? (Take g, the gravitational field strength, to be 10 N/kg.)

A 400 J B 2600 J C 3000 J D 3400 J

13 A sealed metal container which contains a gas is heated. Which of the following statement is correct?

A The gas molecules gain kinetic energy but not the molecules of the metal container.
B The gas molecules gain kinetic energy but the molecules of the metal container gain potential energy.
C Both the gas molecules and the molecules of the metal container gain potential energy.
D Both the gas molecules and the molecules of the metal container gain kinetic energy.

14 At a depth of 10 m, water exerts a pressure equal to that of the atmospheric pressure. A 4.0 cm^3 air bubble is released from the bottom of a pond. The volume of the bubble when it reaches the surface is 25 cm^3.

What is the depth of the pond? Assume the temperature of the bubble is constant.

A 10.0 m B 25.5 m C 52.5 m D 62.5 m

15 The conduction of thermal energy in liquids is slower than that in solids. Why is this so?

A The separation distance between adjacent molecules in a liquid is larger than that in a solid.
B Liquids generally have higher densities than solids.
C The speed of molecules moving in a liquid is slower than that in a solid.
D Liquid molecules are larger in size than solid molecules.

16 Four bars, all exactly the same size, are placed with one end in boiling water. The time taken for the temperature of the other end to increase by 2 ^{0}C are measured for each bar.

Material of bar	Time for 2 ^{0}C rise / s
Aluminium	10
Copper	5
Cork	800
Styrofoam	1200

To make a large metal tank with the least heat loss, which materials should be used for the tank and its insulation?

	Tank	Insulation
A	Aluminium	Cork
B	Aluminium	Styrofoam
C	Copper	Cork
D	Copper	Styrofoam

17 When junction X and junction Y of the thermocouple shown below are immersed in pure melting ice and steam respectively, the e.m.f. reading is 6.5 mV.

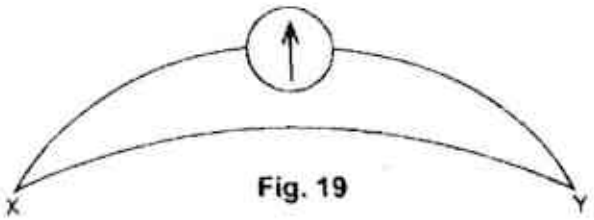


Fig. 19

Junction X is then immersed in a liquid of temperature T and junction Y is immersed in water kept at a temperature of 50 ^{0}C. The new e.m.f. reading obtained is -6.9 mV. What is the temperature, T, of the liquid?

A -56.2 ^{0}C **B** 90.0 ^{0}C **C** 144 ^{0}C **D** 156 ^{0}C

18 Four unknown liquids, A, B, C and D are heated with an electrical heater for the same amount of time. None of the liquids reached boiling point during this time.

Assuming there is no heat loss to the surroundings, which liquid has the lowest specific heat capacity?

	Mass of liquid / kg	Temperature rise / ^{o}C
A	1.0	10
B	1.5	20
C	2.0	16
D	2.0	18

19 An 80 W heater is placed in a 2.0 kg block of ice. Assuming all the energy supplied by the heater is used in melting the ice, what is the time taken, in seconds, to melt the block of ice completely? The specific latent heat of fusion of ice is 3.36×10^5 J kg^{-1}.

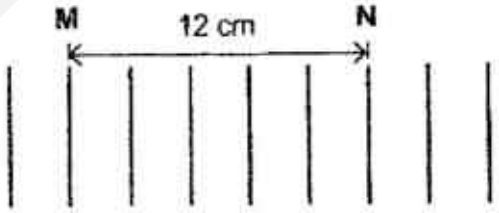
A $\frac{3.36 \times 10^5}{80 \times 2.0}$

B $\frac{80 \times 2.0}{3.36 \times 10^5}$

C $\frac{80}{3.36 \times 10^5 \times 2.0}$

D $\frac{3.36 \times 10^5 \times 2.0}{80}$

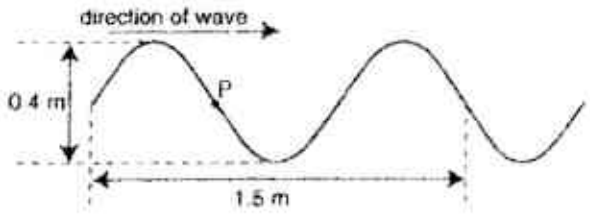
20 A straight vibrating object produces water waves in a ripple tank.



If the wavefront at position M takes 2.0 s to travel to position N, what are the speed and frequency of the waves?

	Speed / cms^{-1}	Frequency / Hz
A	6.0	2.5
B	6.0	3.0
C	12	2.5
D	7.2	3.0

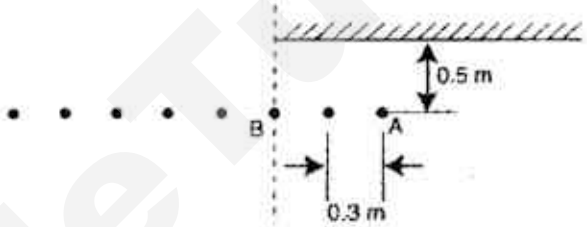
21 The figure shows a transverse wave of frequency 2 Hz with particle P at a particular instant.



What is the displacement of the particle P from its current position 0.125 s later?

A 0.125 m **B** 0.2 m **C** 0.25 m **D** 0.4 m

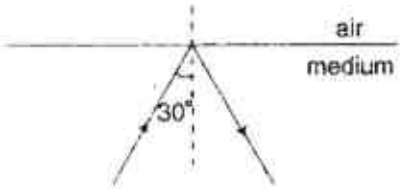
22 Eight students are standing in a straight line 0.5 m in front of a mirror. The students are spaced 0.3 m apart from each other. Student B is standing directly in front of the edge of the mirror.



How many students, including himself, will the first student, A, be able to see in the mirror?

A 3 **B** 5 **C** 6 **D** 8

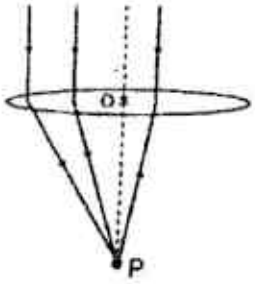
23 A ray of light travelling in an optical medium hits the medium-air boundary and reflected internally.



Which of the following can be the refractive index of the medium in which the light is travelling?

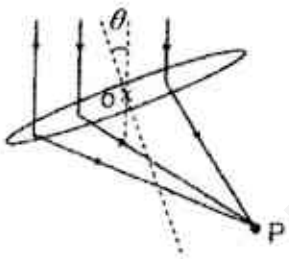
A 1.3 **B** 1.5 **C** 2.0 **D** 2.4

24 The figure shows three parallel rays of light focused by a converging lens to a single point P.

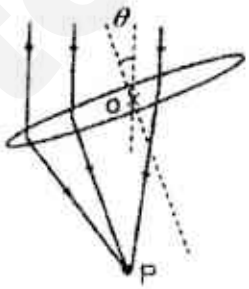


Which one of the following correctly shows how the point of focus, P, will shift when the principal axis of the lens is rotated by an angle Θ about its optical centre, O?

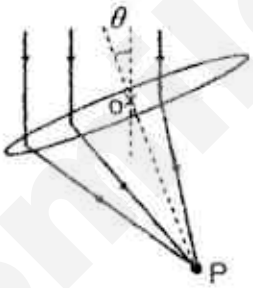
A



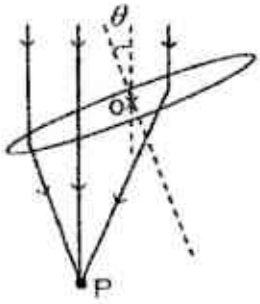
B



C



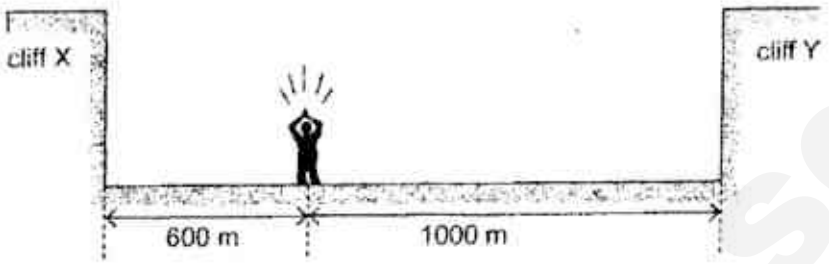
D



25 Which one of the following values can possibly be the wavelength of X-rays given that the wavelength of red light is 700 nm?

A 5×10^{-2} m **B** 5×10^{-5} m **C** 5×10^{-7} m **D** 5×10^{-10} m

26 A boy stands between two vertical cliffs, X and Y. When he claps his hands, the echoes that he hears from cliffs X and Y are at a time interval of 2.42 s apart.



He then moves 100 m towards cliff Y and claps his hands again. What is the new time interval between the echoes?

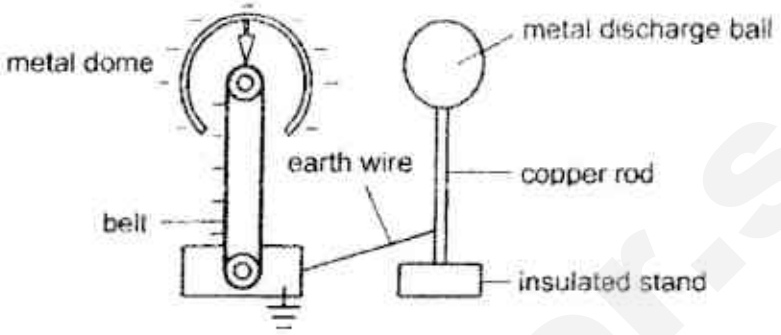
A 0. 26 s **B** 1.21 s **C** 2.42 s **D** 3.63 s

27 A tuning fork, X, produces a sound wave with a frequency of 1000 Hz while another tuning fork, Y, produces a sound of frequency 500 Hz.

Which one of the following correctly describes the speed and pitch of the sound produced by tuning fork Y in comparison with that of tuning fork X?

	Tuning fork Y	
	Speed of sound	**Pitch**
A	Different	Lower
B	Different	Higher
C	Same	Lower
D	Same	Higher

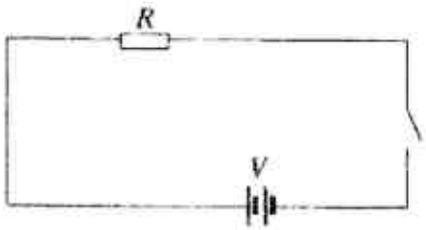
28 The figure shows a Van de Graaf generator being used together with a discharge ball to produce sparks. When the metal dome accumulates enough negative charges, sparks are produced between the metal dome and the metal discharge ball.



If a charge of 1.6×10^{-6} C flows in 1.2 ms, what are the size and direction of current flow?

	Size of current	Direction of current
A	1.33×10^{-3} A	From discharge ball to dome
B	1.33×10^{-3} A	From dome to discharge ball
C	1.92×10^{-3} A	From discharge ball to dome
D	1.92×10^{-3} A	From dome to discharge ball

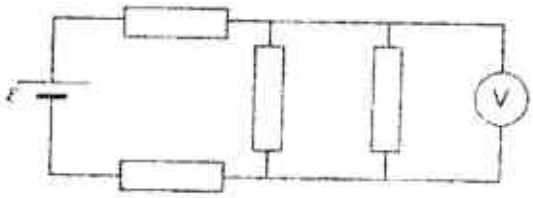
29 A wire of resistance R is connected to a battery of e.m.f. V and represented by the resistor in the figure.



The wire is then replaced with another of the same material but twice the length and twice the cross-sectional area. What is the current flowing in the circuit when it is connected to the new wire?

A $\frac{V}{4R}$ B $\frac{V}{2R}$ C $\frac{V}{R}$ D $\frac{2V}{R}$

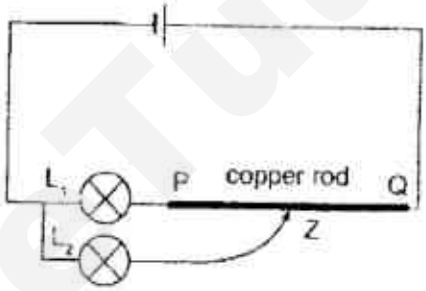
30 The figure shows four identical resistors connected to a cell of e.m.f. $\mathcal{E}$.



If the reading on the voltmeter is 2.0 V, what is the e.m.f. $\mathcal{E}$?

A 2.0 V **B** 6.0 V **C** 8.0 V **D** 10.0 V

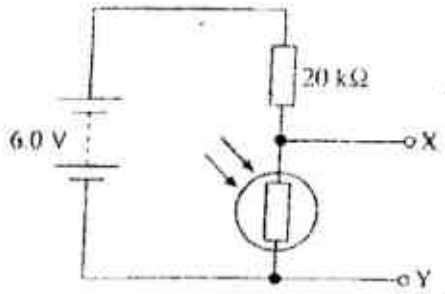
31 Two identical bulbs, L_1 and L_2, and a piece of bare copper rod PQ are connected in a circuit. One end of L_2 is connected to a crocodile clip Z which is initially clipped at the midpoint of PQ.



What will happen to the brightness of both lamps when Z is shifted towards Q?

	Brightness of L_1	Brightness of L_2
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	Decreases	Decreases

32 The circuit shows a potential divider which consists of a 20 kΩ fixed resistor and a light-dependent resistor (LDR). The potential divider is used to switch on a lamp when it gets dark. The potential difference across XY is 0.60 V when the lamp is switched on.



What is the resistance of the LDR when the lamp is switched on?

A 1.8 kΩ **B** 2.2 kΩ **C** 160 kΩ **D** 180 kΩ

33 An electrical appliance with three wires, X, Y and Z, is connected to a 240 V a.c. mains. The current and potential of each of the wires when the appliance is working correctly are given in the table below.

	Current / A	Voltage / V
Wire X	3.5	0
Wire Y	0	0
Wire Z	3.5	240

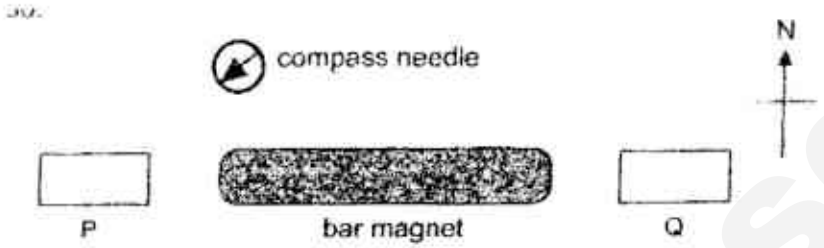
Based on the table, which of the following correctly identifies the three wires?

	Wire X	Wire Y	Wire Z
A	Live	Neutral	Earth
B	Neutral	Live	Earth
C	Live	Earth	Neutral
D	Neutral	Earth	Live

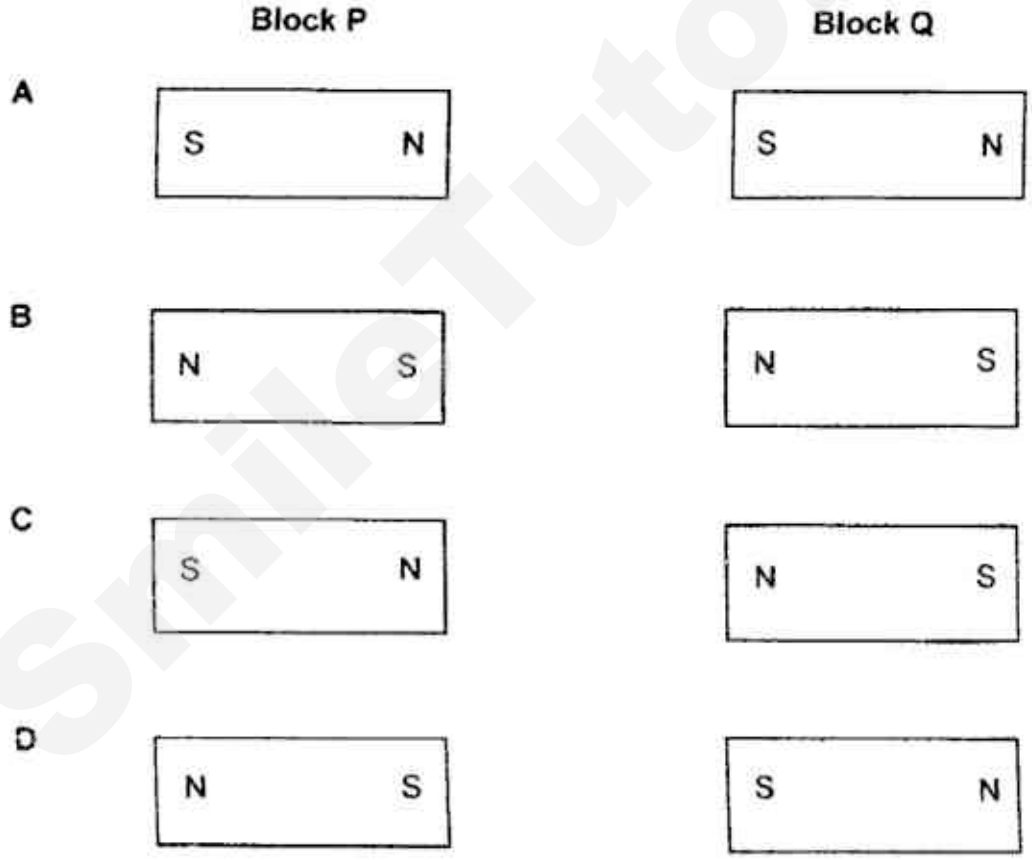
34 The following electrical devices are operated from the same voltage supply at the stated duration. Which one of the devices is the least costly to operate?

	Power rating of device	Duration of usage
A	5.0 kW	50 s
B	200 W	20 min
C	30 W	2 h
D	15 W	0.5 day

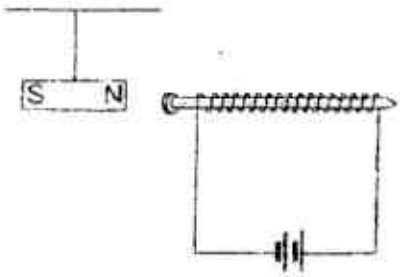
35 Two soft iron blocks, P and Q, are placed at both ends of a bar magnet. The poles of the bar magnet are not labelled. A compass is placed next to the magnet and points in the direction as shown in the figure.



Which one of the following diagrams correctly shows the poles induced on P and Q?



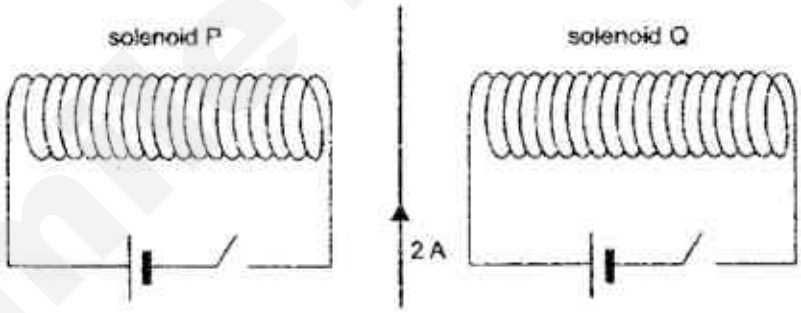
36 A length of wire connected to a battery is wound around an iron nail. A magnet which is suspended by a thread is placed near the iron nail.



What will happen to the magnet?

A The magnet moves away from the nail.
B The magnet moves towards the nail.
C The magnet swings towards to and away from the nail.
D The magnet does not move.

37 A straight wire, carrying a current of 2 A, is placed between two solenoids, P and Q.



What will happen to the wire when both solenoids are switched on?

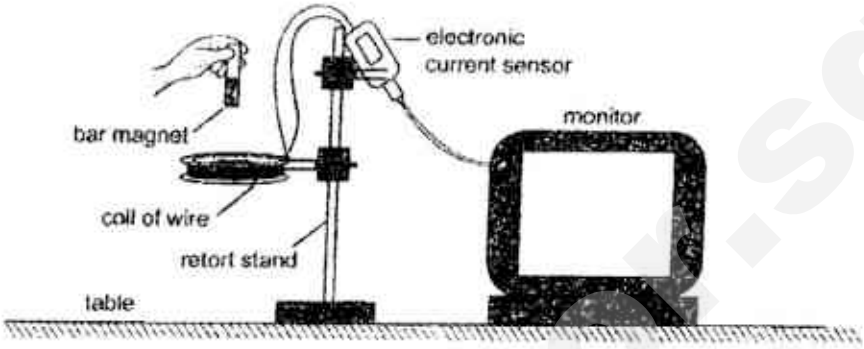
A It will move out of the plane of the paper.
B It will move into the plane of the paper.
C It will move towards solenoid P.
D It will move towards solenoid Q.

38 The diagram shows a beam of electrons entering a magnetic field.

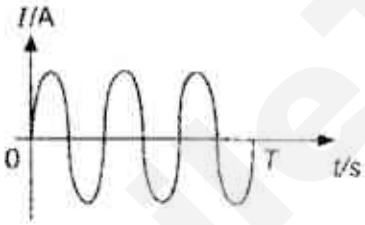
What will be the initial direction of the deflection of the electrons as the beam passes through the magnetic field?

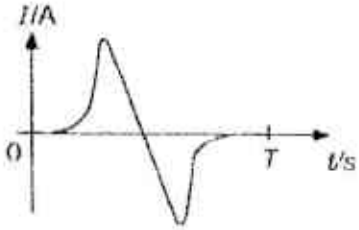
A Into the paper
B Out of the paper
C Towards the bottom of the paper
D Towards the top of the paper

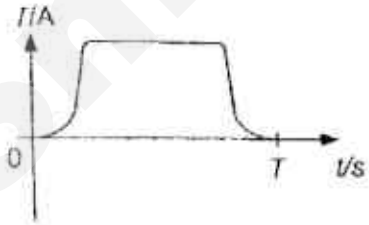
39 A bar magnet is dropped vertically through a coil of wire. The ends of the coil are attached to an electronic sensor which displays the induced current in the form of a current-time graph on the monitor. The magnet takes T seconds to reach the table top.

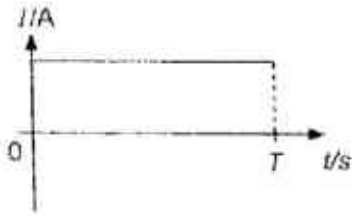


Which of the following graphs best displays the variation of the induced current I with time t?

A


B


C


D


40 The output voltage-time graph of an a.c. generator is shown in Fig. 1.

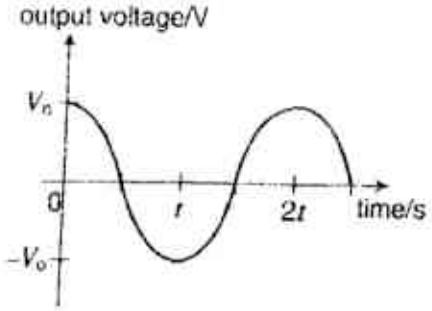


Fig. 1

The output voltage can be changed by the following ways:

(i) Increase the frequency of rotation of the coil.
(ii) Increase the number of turns of the coil.
(iii) Increase the strength of the magnet.

Which of the following ways are possible to obtain the output voltage shown in Fig. 2?

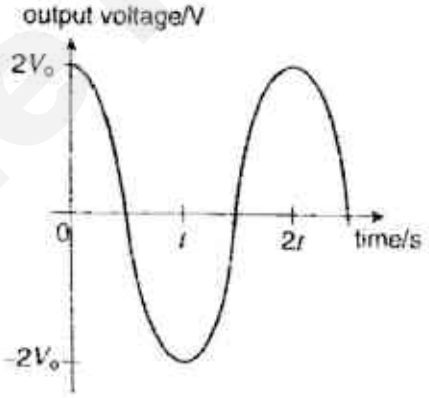


Fig. 2

A (i) and (ii)
B (i) and (iii)
C (ii) and (iii)
D (i), (ii) and (iii)

--- End of paper ---

1) A	6) B	11) B	16) D	21) B	26) B	31) A	36) B
2) C	7) C	12) B	17) D	22) B	27) C	32) B	37) A
3) A	8) D	13) D	18) D	23) D	28) A	33) D	38) C
4) C	9) C	14) C	19) D	24) B	29) C	34) C	39) B
5) A	10) A	15) A	20) A	25) D	30) D	35) A	40) C

Section A
[50 marks]

Answer all the questions in the spaces provided.

For Examiner's Use

1 An athlete of mass 56 kg stands on a trampoline as shown in **Fig 1.1.**

Fig. 1.1

(a) The surface of the trampoline is stretched. State the form of energy stored in the stretched surface of the trampoline.

..... [1]

(b) The stretched surface of the trampoline pushes the athlete vertically upwards. The velocity of the athlete is 5.0 ms^{-1} at the moment she loses contact with the surface.

(i) Calculate the energy stored in the stretched surface of the trampoline.

Energy stored = ... [1]

(ii) Determine the maximum height reached by the athlete. Ignore air resistance.

Height = ... [2]

For Examiner's Use

(c) On **Fig 1.2**, sketch the velocity-time graph for the **upwards** motion of the athlete,

(1) without air resistance and

(2) with air resistance.

Label the graphs **(1)** and **(2)** respectively. [2]

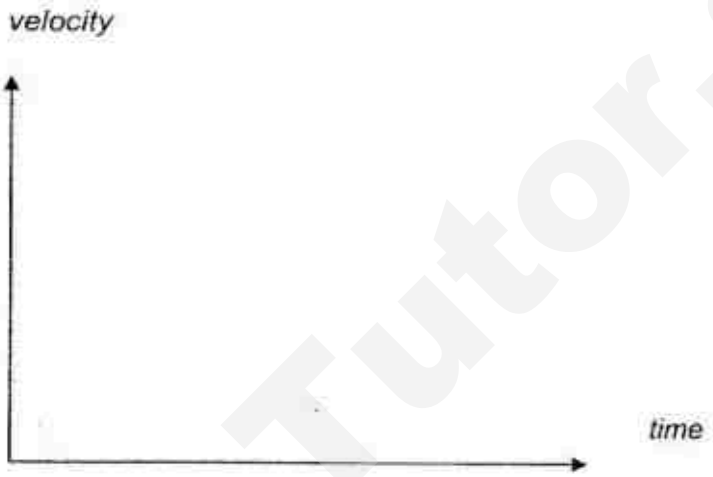


Fig 1.2

2 A sky-diver jumps from a stationary balloon. **Fig 2.1** shows the two forces, X and Y acting on the sky-diver. The mass of the sky-diver is 70 kg.

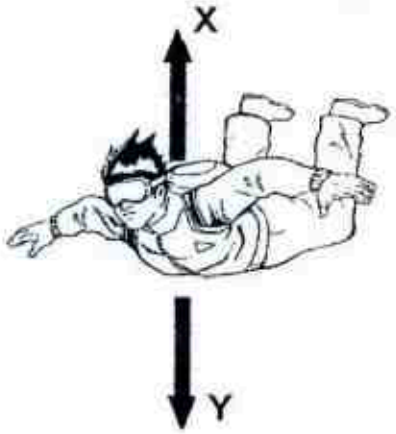


Fig 2.1

(a) (i) Name the forces X and Y.

..... [1]

For Examiner's Use

(ii) Using ideas of forces, explain why the initial acceleration of the sky-diver is 10 ms^{-2}.

.....

..... [1]

(b) The sky-diver initially accelerates upwards at the moment he opened his parachute. Explain why the sky-diver accelerates upwards.

.....

.....

.....

..... [2]

(c) Fig 2.2 shows how the force X on the sky-diver varies over time.

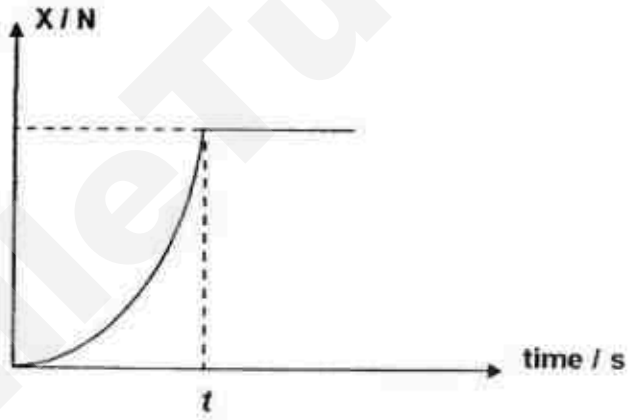


Fig 2.2

(i) Calculate the magnitude of X at time t. Explain your answer.

.....

.....

..... [2]

(ii) Another sky-diver using an identical parachute takes longer than time t to reach terminal velocity. State one possible reason for this.

..... [1]

For Examiner's Use

3 A gymnast balances herself on a beam as shown in **Fig 3.1**. The beam is uniform with 80 kg mass.

Fig 3.1

(a) **(i)** On **Fig 3.1**, mark the centre of gravity (cg) of the gymnast with a cross (X). **[1]**

(ii) Explain the type of equilibrium shown by the gymnast in **Fig 3.1**.

.....

..... **[1]**

(b) **Fig 3.2** shows the gymnast in another position on the beam. The mass of the gymnast is 50 kg.

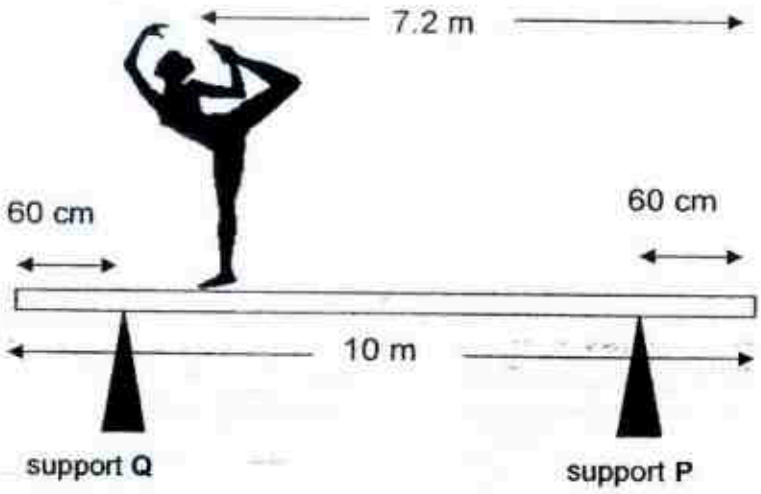


Fig 3.2

For Examiner's Use

(i) Determine the force exerted by support **Q** on the beam.

Force = ... [2]

(ii) Without further calculation, explain briefly how the force exerted by support **P** on the beam changes when the gymnast moves towards support **P**.

.....

.....

..... [2]

4 A curved metal mirror focuses the heat energy from the Sun on to a small tank containing water. The area of the mirror is 1.2 m^2. The energy needed to raise the temperature of 1 kg of water by 1°C is 4200 J.

(a) Assuming that the average amount of energy received from the Sun at the mirror per square metre per second is 500 J, calculate the minimum time taken to raise the temperature of 4 kg of water from 20°C to 100°C.

Time taken = ... [2]

For Examiner's Use

(b) Only some of the energy incident on the mirror actually reaches the water. Suggest the reason for this.

..... [1]

(c) **Fig 4.1** illustrates how the temperature of the water changes when the mirror is used.

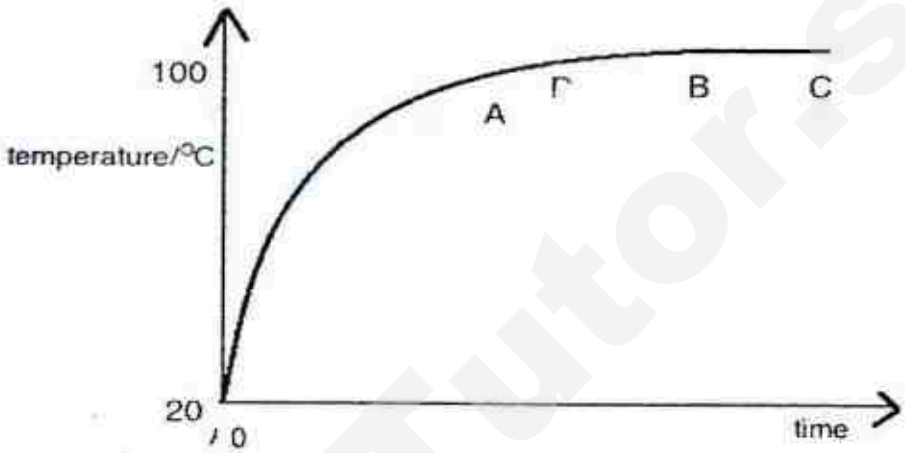


Fig 4.1

Explain why the temperature of water

(i) changes slowly in AB and

.....

..... [1]

(ii) remains constant in BC.

.....

..... [1]

(d) Explain why the temperature of the water rises to 100°C whereas the surface of the mirror remains quite cool.

.....

.....

.....

..... [2]

5 A round-bottomed flask is connected to a mercury manometer. The air inside the flask is warm. The arrangement is shown in **Fig 5.1**.

For Examiner's Use

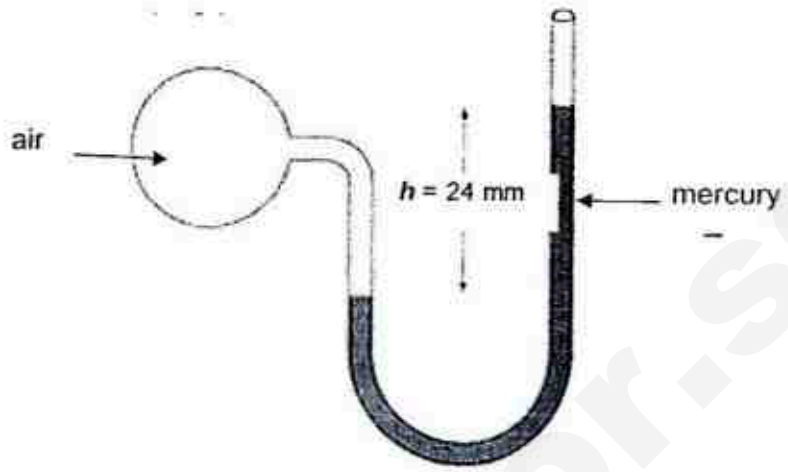


Fig 5.1

(a) Taking atmospheric pressure to be 760 mm of mercury, calculate the pressure of the air inside the flask. Express your answer in **Pascal**. (density of mercury is 13600 kgm^{-3})

Pressure of air = ... **[2]**

(b) The air inside the flask cools. State and explain what happens to the height *h* of the mercury.

.....

.....

.....

..... **[2]**

For Examiner's Use

6 The wavelength of four electromagnetic waves including infrared waves is given in **Fig 6.1.**

Type of Wave	Wavelength
Infrared wave	0.18 mm
A	0.5 μm
B	10 cm
C	1100 m

Fig 6.1

(a) Which of the waves, **A**, **B** or **C** is *visible light*?

..... **[1]**

(b) A TV station broadcasts its programmes at 5×10^3 kHz.

(i) Name the electromagnetic wave used for TV broadcast.

..... **[1]**

(ii) Calculate the wavelength of the wave.

Wavelength = ... **[2]**

(c) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Why would an X-ray telescope based on Earth **not** be able to detect X-rays emitted from distant stars?

.....

..... **[1]**

For Examiner's Use

7 (a) Fig 7.1 shows a bar magnet.

Fig 7.1

Draw on **Fig 7.1** to show the pattern and direction of magnetic field lines around the magnet. **[1]**

(b) Fig 7.2 shows a student's design for a simple wind speed gauge.

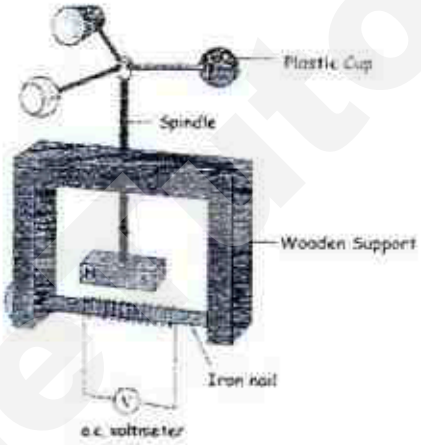


Fig 7.2

(i) Explain why the wind causes an **a.c.** electromotive force to be generated.

.....

.....

.....

.....

..... **[3]**

(ii) The gauge is not sensitive enough to measure light winds. Suggest one way that the design can be modified to make the gauge more sensitive.

..... **[1]**

For Examiner's Use

8 Fig 8.1 shows the path of a ray of light through a right-angled prism.

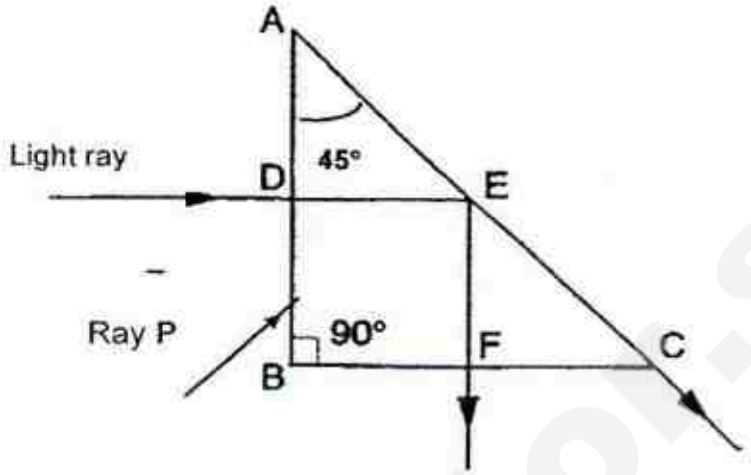


Fig 8.1

(a) Explain what occurs at point E where the light ray splits into F and C.

.....

..... [2]

(b) On Fig 8.1,

(i) mark and label the critical angle (c), for the prism. [1]

(ii) complete the path for Ray P. [1]

(c) Determine the speed of the light ray at point F.

Speed = ... [2]

For Examiner's Use

9 A small drop of oil placed between two charged plates experiences a force **F** as shown in **Fig 9.1**.

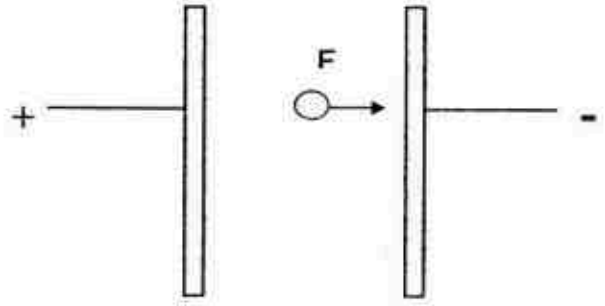


Fig 9.1

(a) Suggest and explain the type of charge carried by the drop of oil.

.....

.....

..... **[2]**

(b) **Fig 9.2** shows the actual path taken by the drop of oil in between the plates.

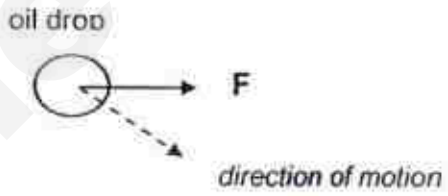


Fig 9.2

Explain why the oil moved in the direction shown.

.....

.....

..... **[2]**

End of Section A

Section B
[30 marks]

Answer all the questions in this section.
Answer only one of the alternative questions in **Question 12**.

For Examiner's Use

10 **Fig. 10.1** shows part of the heating circuit of a domestic shower.

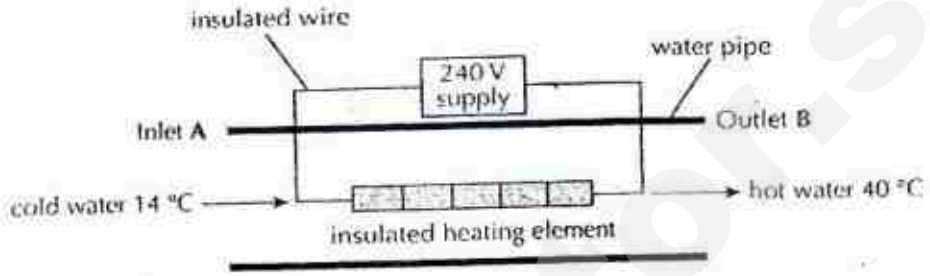


Fig. 10.1

Cold water continuously enters the pipe at inlet A and hot water continuously exits through outlet B. The entire insulated heater is immersed inside the water.

The following data are provided:
Temperature at inlet A = 14 ^{0}C
Temperature at inlet B = 40 ^{0}C
Specific heat capacity of water = 4.2×10^3 J kg^{-1} ^{0}C^{-1}
Operating voltage of heater = 240 V
Power rating of heater = 7.2 kW

(a) Explain how heat is transferred from the heating element to the water.

.....

.....

.....

.....

..... **[2]**

For Examiner's Use

(b) From the given information, determine the rate at which the mass of the water flows through the pipe.

Rate of mass of water = ... [2]

(c) Suggest one reason why your answer in (b) is only an estimate.

.....

..... [1]

(d) Calculate the current flowing in the heating element when it is operating at 7.2 kW.

Current = ... [2]

(e) Explain why the initial current in the heating element is greater than the current calculated in (d) when the shower unit is switched on.

.....

.....

..... [2]

(f) In some countries, shower units are operated from a 110 V supply. Suggest one disadvantage of using a 110 V supply for the same domestic purposes.

.....

..... [1]

For Examiner's Use

11 Fig 11.1 shows sound waves in air from different sources.

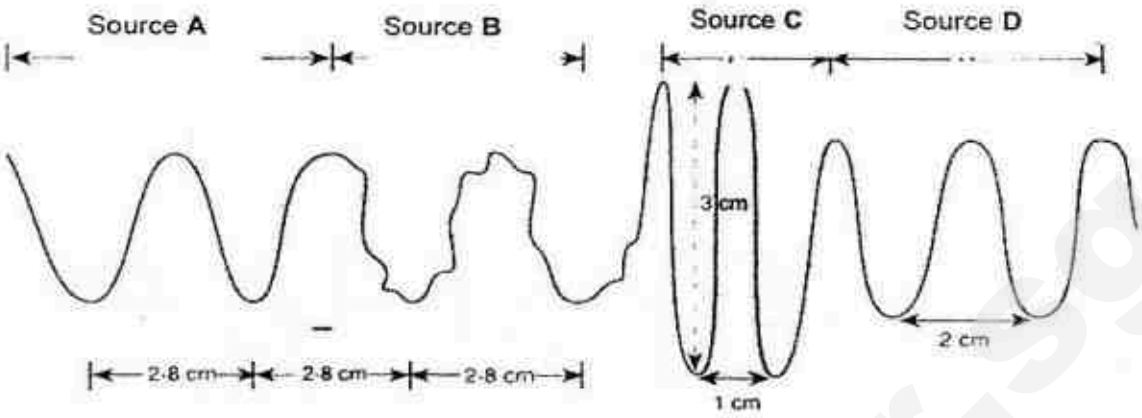


Fig 11.1

(i) Which two sound waves have the same pitch? Explain your answer.

.....

..... [2]

(ii) The speed of sound in air is approximately 330 ms^{-1}. Determine the frequency of the sound wave produced by source **A**.

Frequency = ... [2]

(iii) Suggest and explain whether the sound produced by source **A** is suitable for medical use.

.....

..... [2]

For Examiner's Use

(b) A fisherman sends sonar waves from the base of the boat to a shoal of fish underneath it. The emitted signal and its reflected signal from the fishes are displayed on the screen of the oscilloscope in **Fig 11.2**.

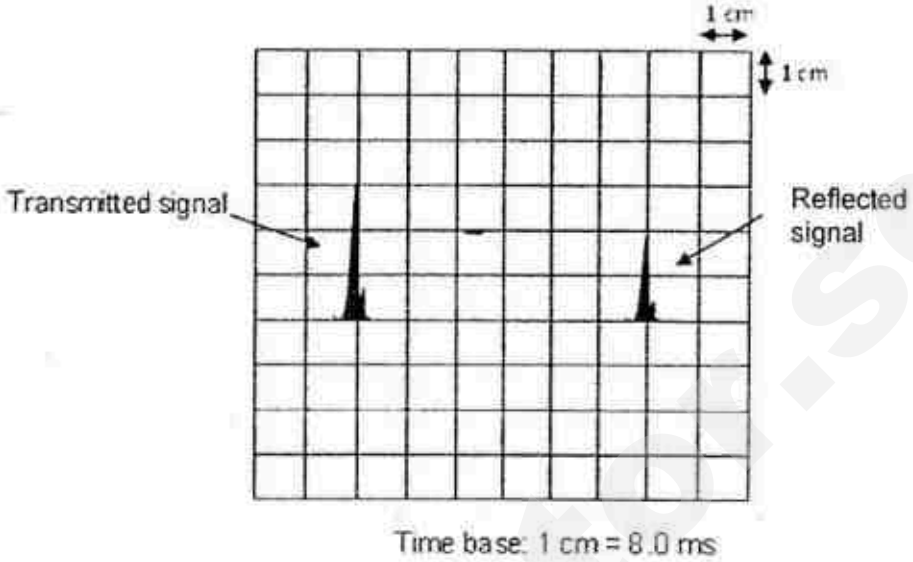


Fig 11.2

(i) Given that the speed of sound in water is 1500 ms^{-1}, calculate the distance between the shoal of fish and the boat.

Distance = ... **[2]**

(ii) The shoal of fish swims closer to the boat. State two changes the fisherman might observe in the trace displayed on the oscilloscope screen.

1..... **[1]**

2..... **[1]**

12 EITHER

For Examiner's Use

(a) Fig 12.1 shows a magnetic relay used to operate the switch of a machine in a factory.

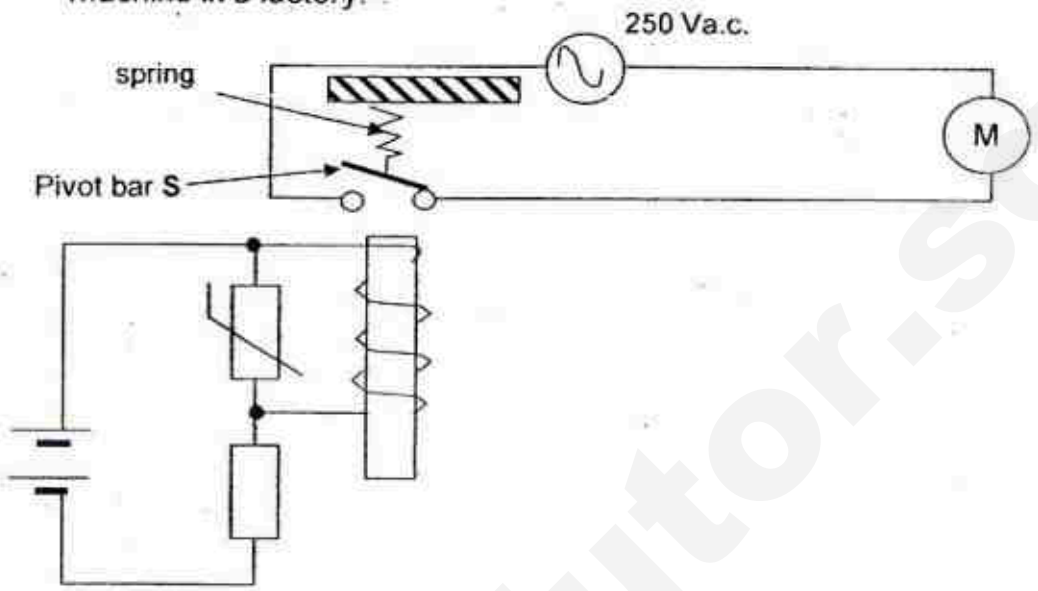


Fig 12.1

(a) Explain how the magnetic relay works when the temperature around the thermistor decreases.

.....

.....

.....

.....

.....

..... [3]

(b) (i) In Fig 12.1, indicate the N-pole of the electromagnet. [1]

(ii) Suggest a suitable material for the pivot bar S. Give a reason for your choice.

.....

.....

..... [2]

For Examiner's Use

(c) (i) By referring to **Fig 12.1**, explain clearly the advantage of using a magnetic relay to operate the machine.

.....

.....

..... [2]

(ii) The machine operates at '240 V, 1.5 A' and runs 12 hours daily. Calculate the cost of operating the machine per day. (cost of electricity per unit is 15 cents)

Cost = ... [2]

OR

(a) **Fig 12.1** shows a small step-down transformer used in the charger for an electric screwdriver. There are 3200 turns on the primary coil (N_p).

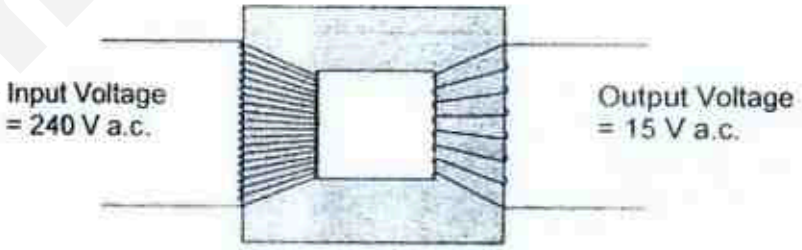


Fig 12.1

(i) Calculate the number of turns on the transformer's secondary coil (N_s). (Assume transformer is ideal)

N_s = ... [2]

For Examiner's Use

(ii) Explain clearly the effect of using thin wires in the secondary coils of the transformer.

.....

.....

..... [2]

(b) The plug of the electric screwdriver is opened and the wiring of the plug is shown in **Fig 12.2**.

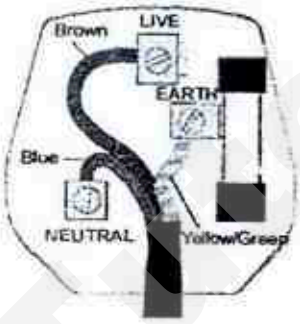


Fig 12.2

(i) Explain what is wrong with the wiring for the plug.

..... [1]

(ii) Explain the danger this wiring would pose.

.....

.....

..... [2]

(c) (i) The wiring of the plug is corrected and the electrical screwdriver is used. The power of the electrical screwdriver is 65 W.

Determine the operating current of the screwdriver.

Current = ... [1]

(ii) A 13 A fuse is used in the plug. Explain the disadvantage of using the fuse.

For Examiner's Use

.....

.....

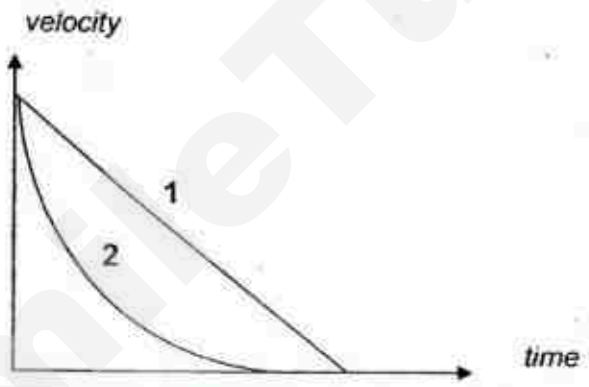
..... [2]

---- END OF PAPER ----

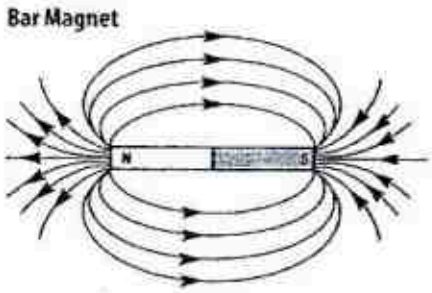
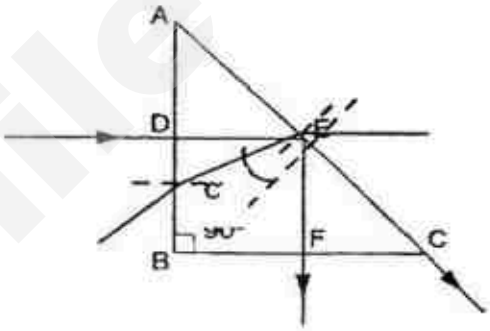
Physics 5059 Paper 2

Marking Scheme

Section A (50 marks)

Qn	Answer	Marks
1(a)	Elastic Potential Energy (EPE)	A1
(b)(i)	EPE = gain in KE= ½ mv^2 EPE = ½ $(56)(5)^2$ EPE = 700 J	 C1 A1
(ii)	Gain in GPE = Loss in KE mgh = 700 h = 700 / (56 x 10) h = 1.25 m	 C1 A1
(c)	**Note** * 2 lower than 1 * 2 reaches 0 m/s faster than 1  	 A1 A1
		7m
2(a)(i)	X- Air resistance, Y – Weight (or Gravitational Force)	A1
(ii)	Air **resistance is negligible** in the beginning hence the sky-diver undergoes **free fall**.	B1
(b)	Air resistance **is greater than** his weight. An **upward resultant force** causes him to accelerate upwards.	B1 B1
(c)(i)	Magnitude of X = 700 N At t, sky-diver reaches **terminal velocity** (where **force X = force Y**)	A1 B1
(ii)	The sky-diver has a **greater weight**. (do not accept mass)	A1
		6m
3(a)(i)	* cross marked to indicate c.g. of the gymnast **MUST be directly above her hand**.	A1

		
(ii)	The gymnast is in **unstable equilibrium** because she will **turn/topple** when she moves slightly, **lowering her c.g.** * basically students need to give **definition of unstable equilibrium**	A1
(b)(i)	Taking moments about P, sum of cm = sum of acm $(F_Q \times 8.8) = (500 \times 6.6) + (800 \times 4.4)$ $8.8F_Q = 3300 + 3250 = 6820$ $F_Q = 775$ N	 C1 A1
(ii)	Taking moments **about Q, clockwise moment increases.** To maintain **equilibrium anticlockwise- moment and hence F_P increases.**	B1 B1
		6m
4(a)	Energy reflected by mirror = Thermal energy gained by water $Pt = mc(\theta_f - \theta_i)$ $500(1.2)t = 4(4200)(100 - 20)$ $600t = 1344000$ t = 2240 s (37.3 min)	 C1 A1
(b)	The thermal energy is absorbed by the container or some thermal energy is absorbed by the mirror.	A1
(c)(i)	At **higher temperatures,** water **loses more** thermal energy to the surroundings which leads to **smaller temperature rise.**	B1
(ii)	Water **reaches its boiling point** and **boiling occurs at constant temperature.**	B1
(d)	Most of thermal energy incident on the **container** of water is **absorbed.** The amount of thermal energy **absorbed by the reflector is lesser than the amount of thermal energy reflected** by it.	B1 B1
		7m
5(a)	$P_a = P_a + P_l$ $P_a = (0.76 + 0.024)(13600)(10)$ $P_a = 1.07 \times 10^5$ Pa	 C1 A1
(b)	**KE** of the air molecules **decreases when its temperature drops.** The air molecule exerts **less pressure** on the liquid making h **shorter.**	B1 B1
		4m
6(a)	A	B1
(b)(i)	Radio waves	B1
(ii)	$\lambda = \frac{v}{f} = \frac{3\times10^8}{5\times10^6}$ $\lambda = 60m$	C1 A1
(c)	x-rays are absorbed by the atmosphere	B1
		5m

7(a)	 * mark is only awarded if **both** pattern and direction of field is correct.	B1
(b)(i)	**Wind** causes the **magnet to rotate** with the spindle. Magnetic **flux from alternating poles** (of magnet) constantly **link/cut the coils.** **Change in direction of flux** linking the coils **induces a.c.** electromotive force.	B1 B1 B1
(ii)	Increase the number of coils / use stronger magnet.	B1
		5m
7(a)	Angle of incidence (i) at E is equal to critical angle (c) of the prism. Part of the light is **reflected into the prism** while the rest **refracted along the prism.**	B1 B1
(b)(i) (b)(ii)	* to complete ray P (i) rays with arrows to indicate direction (ii) normal lines are drawn 	B1 B1
(c)	$\frac{c}{v} = \frac{1}{\sin c}$ $v = c \times \sin c$ $v = 3 \times 10^8 \times \sin 45$ $v = 2.12 \times 10^8 m/s$	C1 A1
		6m
9(a)	The oil is **positively-charged.** It experiences a **resultant force** in the direction of the negatively-charged plate.	B1 A1
(b)	**Weight** of oil acts **vertically downwards** on it. The force **F and its weight produce resultant force in the direction of motion.**	B1 B1
		4m
	Total for Section A	**50 marks**

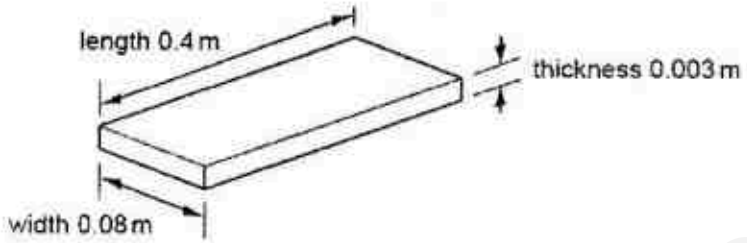
Section B (30m)

10(a)	Heat is transferred to the water from the heating element **by conduction**. The water molecules **gained thermal energy** when they **knock/get in contact** with the heating element as they move around the heating element.	B1 B1
(b)	Let m = mass of water flowing through the pipe in t s Q = m c ΔΘ Pt = m c ΔΘ 7200 x t = m x 4200 x (40 – 14) [C1 including formula) m/t = 0.0659 kg / s	 C1 A1
(c)	Some heat is lost to the surroundings.	B1
(d)	I = P/V = 7200/240 I = 30 A	C1 A1
(e)	Initially the heater has lower resistance since it is cooler. Since I = V/R and V is constant, the initial current is greater.	M1 A1
(f)	To obtain the **same power** output using a smaller voltage supply, a **larger current** is generated which may lead to **over-heating of the wires.**	B1
		10m
11(a)(i)	Wave **A** and Wave **B**. Both waves have the **same period** which means they have **same pitch (frequency)**.	A1 B1
(ii)	$f = \frac{v}{\lambda} = \frac{330}{0.028}$ $f = 1.18 \times 10^4\ Hz$	C1 A1
(iii)	**Ultrasound** is used for **medical purpose**. Since the **frequency is lower than the frequency of ultrasound** (2.00×10^4 Hz), the sound wave **cannot** be used for medical purpose.	B1 B1
(b)(i)	Time taken = 6 x 0.008s = 0.048s v = 2d/t d =vt/2 = (1500 x 0.048)/2 d = 36 m	A1 A1
(b)(ii)	(1) the reflected signal has higher amplitude (2) distance between the incident signal and reflected signal is shorter.	A1 A1
		10m
12	**Either**	
(a)	When **temperature** (of thermistor) **decreases**, its **resistance increases.** The **voltage** across the thermistor **increases** and causes a **larger current** to flow through solenoid. The electromagnet becomes **strongly magnetized** and **attracts S** to close the switch.	B1 B1 B1
(b)(i)	**Top** of iron core is N-pole.	A1
(ii)	Iron It can be **magnetised and demagnetised** quickly.	M1 A1
(c)(i)	The relay **prevents** the user from **direct contact with high voltage** of power supply. Hence it **prevents/minimize** the risk of **electric shock**.	B1 B1
(ii)	Total energy used = (1.5 x 240 x 12)/1000 = 4.32 kWh Cost = 15 cents x 4.32 = 64.8 cents	C1 A1

		10m
12	Or	
(a)	$N_s = \frac{V_s \times N_p}{V_p}$ $N_S = \frac{15 \times 3200}{240}$ $N_s = 200$	C1 A1
(ii)Rt)	Secondary **current will increase** for a step-down transformer. Thin wires have **higher resistance** and will **heat up quickly** **(I^2Rt)**.	B1 B1
(b)(i)	The earth and live **wires are switched**.	A1
(ii)	The **chassis** of the appliance **becomes live**. The user will **get an electric shock** when he is **in contact** with the appliance.	M1 A1
(c)(i)	I = P/v I = 65/15 = 4.33A	A1
(ii)	The fuse **cannot protect** the appliance. In case of a fault, excessive current will **damage the appliance before causing the fuse to melt.**	B1 B1
		10m

The End

1 A manufacturer needs to measure accurately the dimensions of a wooden floor tile. The approximate dimensions of the tile are shown.



Which instruments measure each of these dimensions accurately?

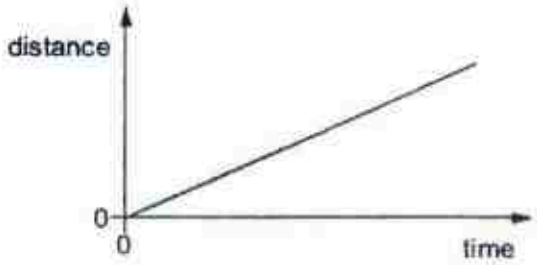
	length	thickness	width
A	metre rule	micrometer	vernier calipers
B	metre rule	vernier calipers	micrometer
C	micrometer	metre rule	vernier calipers
D	vernier calipers	micrometer	metre rule

2 A 50 g bob takes 0.25 s to move from point P to point Q.

If the 50 g bob is replaced by a 100 g bob, what is the frequency of the oscillation?

A 0.50 Hz B 1.00 Hz C 2.00 Hz D 4.00 Hz

3 The diagram shows the distance-time graph of a car.



The car is travelling along a straight road up a hill.

Which quantity for the car is constant and greater than zero?

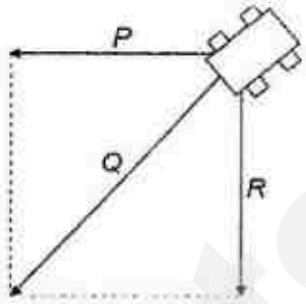
A acceleration
B resultant force
C kinetic energy
D gravitational potential energy

4 An object is thrown with velocity 5.2 ms^{-1} vertically upwards on the Moon. The acceleration due to gravity on the Moon is 1.62 ms^{-2}.

What is the time taken for the object to return to its starting point?

A 2.5 s B 3.2 s C 4.5 s D 6.4 s

5 A trolley is acted on by three forces *P*, *Q* and *R* in magnitude and direction as shown in the diagram. A single force *F* could balance these forces.



What should be the magnitude of *F*?

A Q B R C Q + R D 2Q

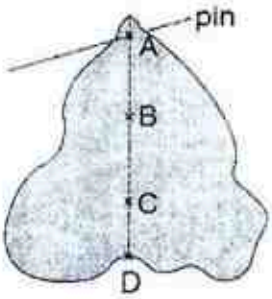
6 A block on a rough horizontal table is acted on by two horizontal forces of magnitudes 10 N and 2 N as shown in the diagram. The block remains at rest on the table.

What is the resultant force acting on the block if the force of magnitude 10 N is removed?

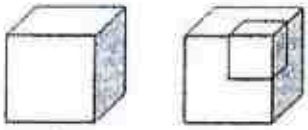
A 0 N B 2 N C 6 N D 8 N

7 A piece of uniform card is suspended freely from a horizontal pin.

Which point is its centre of mass?



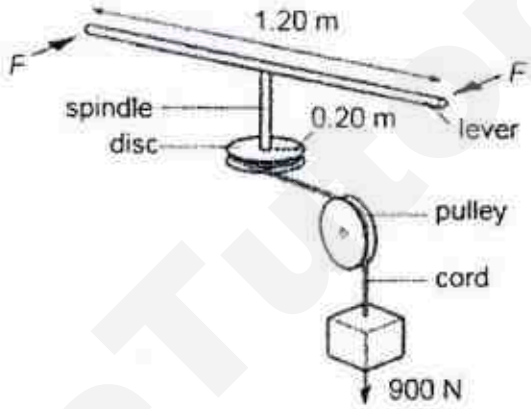
8 A cube of mass 5.0 kg with sides 0.20 m long has a cube of sides 0.10 m cut from its corner as shown in the diagram.



What is the density of the remaining portion?

A 25 kg/m³ B 547 kg/m³ C 625 kg/m³ D 714 kg/m³

9 A spindle is attached at one end to the centre of a lever 1.20 m long and at its other end to the centre of a disc of radius 0.20 m. A cord is wrapped round the disc, passes over a pulley and is attached to a 900 N weight.



What is the minimum force *F*, applied to each end of the lever, that could lift the weight?

A 75 N B 150 N C 300 N D 950 N

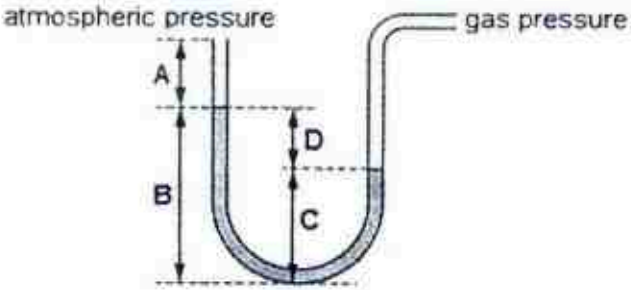
10 A body of mass 2.0 kg falls from rest. At a point 5.0 m above the level of the ground, its speed is 8.0 ms^{-1}.

If the body does not rebound, what is the amount of energy converted to thermal and sound energy on impact?

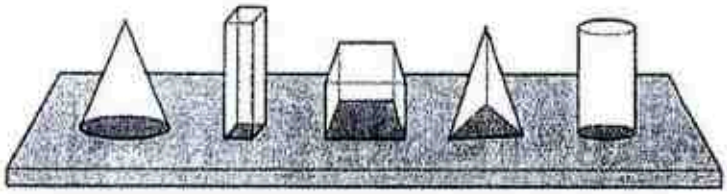
A 20 J B 64 J C 100 J D 164 J

11 The pressure of the gas supply in the laboratory is measured using a manometer.

Which distance gives the pressure of the gas above atmospheric pressure?

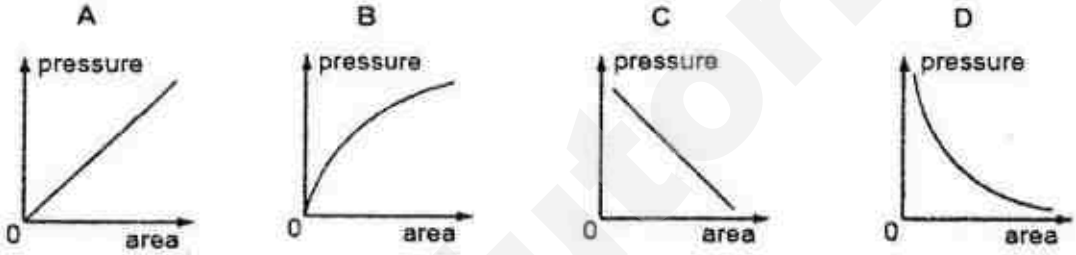


12 Five blocks have the same mass but different base areas. They all rest on a horizontal table.

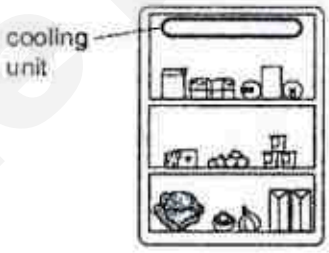


A graph is plotted to show the relationship between the pressure exerted on the table and the base area of the block.

Which graph shows this relationship?



13 The diagram shows the inside of a refrigerator.



When the refrigerator is first switched on, what happens to the air near the cooling unit?

	the particles of this air	the density of this air
A	become smaller	decreases
B	become smaller	increases
C	move closer together	decreases
D	move closer together	increases

14 A faulty thermometer reads 10 °C and 90 °C when placed in melting ice and steam respectively.

If this thermometer is uniformly graduated, what is the true temperature when the thermometer reads 40 °C?

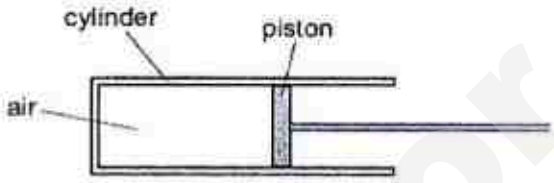
A 27.5 °C **B** 32.0 °C **C** 37.5 °C **D** 42.0 °C

15 The temperature of water from Tap A and Tap B is 25 °C and 75 °C respectively.

If a mixture of water at 40 °C is required, what is the ratio of the mass of water from Tap A to that of water from Tap B? Assume no heat is lost to the surrounding.

A 3 : 7 **B** 2 : 3 **C** 3 : 1 **D** 7 : 3

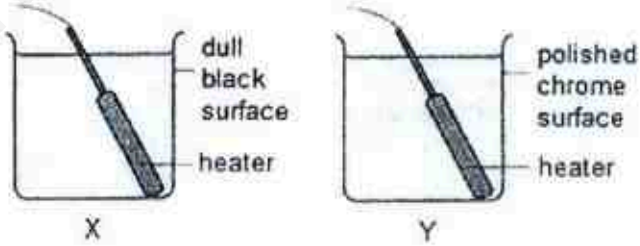
16 Air is trapped in a cylinder by a piston. The piston is pushed further into the cylinder while the temperature remains constant.



How do the pressure, volume, average molecules distance and average speed of molecules of the air in the syringe change?

	pressure	volume	average molecules distance	average speed of molecules
A	decrease	decrease	decrease	unchange
B	decrease	increase	increase	decrease
C	increase	decrease	decrease	unchange
D	increase	increase	increase	increase

17 The diagram shows two copper cans, X and Y, with outer surface of different texture filled with the same amount of water at room temperature and heated by heaters of same power.



Which of the following statements is correct?

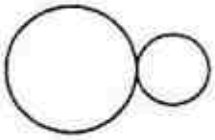
A Water in X boils faster because dull surface is a good absorber.

B Water in X boils faster because dull black surface is a better insulator.

C Water in Y boils faster because polished chrome surface is a poor radiator.

D Water in both cans take same length of time to boil because texture of outer surface will not affect the rate of energy absorbed by the water.

18 Two metal spheres of different radii are in thermal contact in a vacuum as shown.



The spheres are at the same temperature. Which statement must be correct?

A Each sphere has the same internal energy.

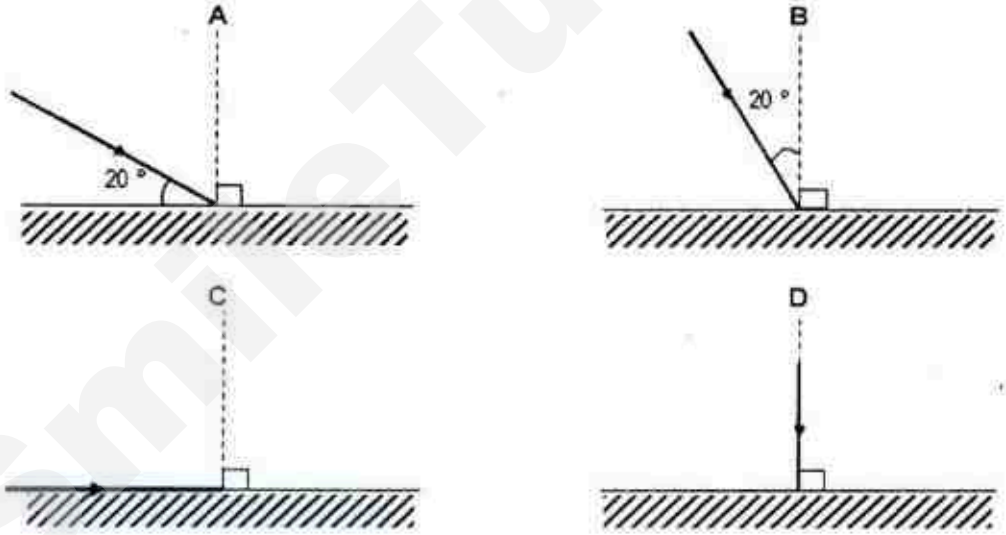
B Both spheres radiate energy at the same rate.

C There is no net transfer of thermal energy between the spheres.

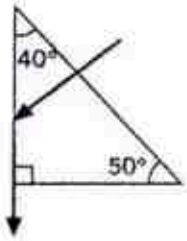
D The larger sphere has a greater average internal energy per atom than the smaller sphere.

19 In each of the following diagrams, a light ray is incident on a plane mirror.

Which diagram shows the smallest angle of incidence for the light ray?



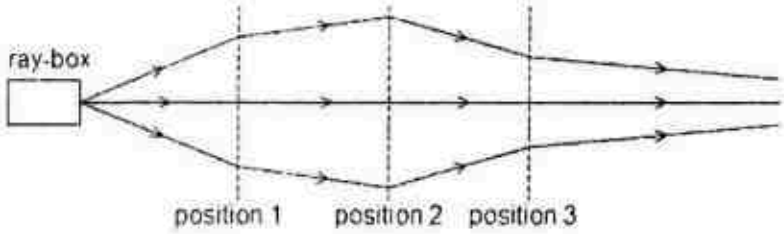
20 A ray of light enters an unknown medium and travels along the path as shown in the diagram.



What is the refractive index of the unknown medium?

A 1.30 **B** 1.46 **C** 1.50 **D** 1.56

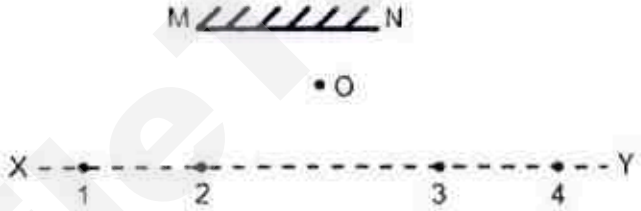
21 The rays of light from a ray-box pass through three lenses placed at positions 1, 2 and 3.



What type of lens is used at each position?

	position 1	position 2	position 3
A	converging	converging	converging
B	converging	converging	diverging
C	diverging	converging	diverging
D	diverging	diverging	converging

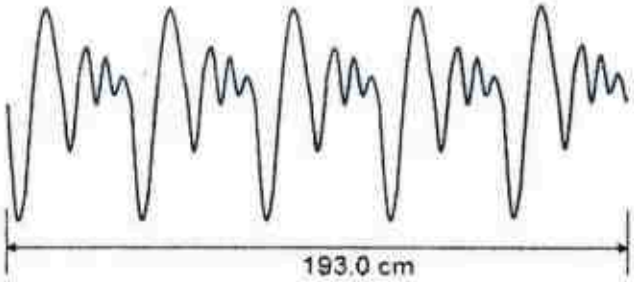
22 An object O is placed in front of a plane mirror MN as shown in the diagram. A student moves her eye along the line XY to observe the image of O.



At which point(s) on the line XY can the student see the image of O?

A 2 only.
B 2 and 3 only.
C 1, 2 and 3 only.
D 1, 2, 3 and 4.

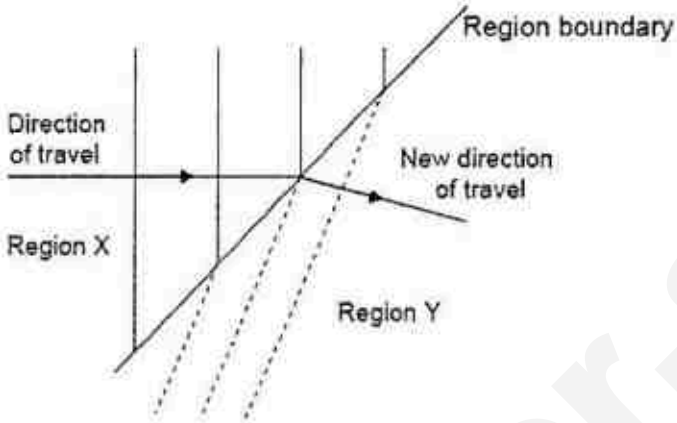
23 The waveform of a sound wave is shown in the diagram.



Given that the speed of sound in air is 340 ms^{-1}, what is the frequency of the sound wave?

A 1.76 Hz B 8.8 Hz C 176 Hz D 880 Hz

24 Water waves travel from region X to region Y.



Which row gives the wavelength of water waves, speed of water waves, type of region X and type of region Y as the waves travels from X to Y?

	wavelength	speed	region X	region Y
A	decrease	increase	deep water	shallow water
B	decrease	decrease	deep water	shallow water
C	increase	increase	shallow water	deep water
D	increase	decrease	shallow water	deep water

25 A ship is equipped with certain devices.

Which device is not an application of electromagnetic waves?

A the radar system
B the sonar system
C the infra-red system for night navigation
D the wireless telecommunication system

26 Which electromagnetic waves could be used in sunbeds?

A gamma
B ultraviolet
C visible light
D Infra-red

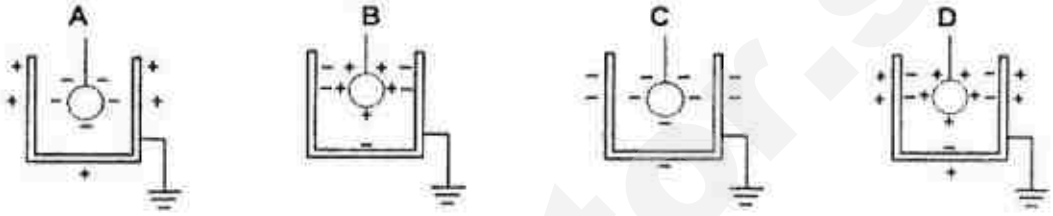
27 A 200 m long copper wire of diameter 2 mm has a resistance of 108 Ω.

What is the resistance of a second piece of copper wire that is twice as long and half as thick?

A 54 Ω **B** 108 Ω **C** 432 Ω **D** 864 Ω

28 A charged sphere is suspended by an insulating thread inside a metal can. The outside of the can is earthed.

Which diagram shows the resulting charges on the sphere and on the can?



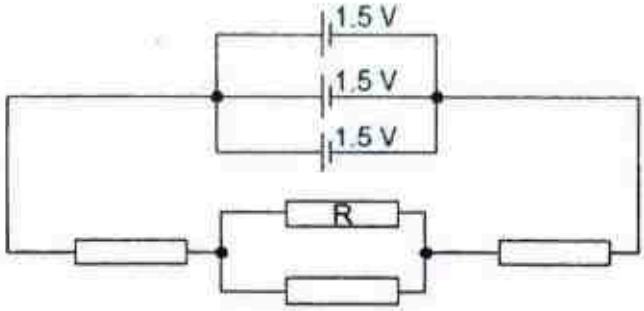
29 A student is trying to reorganize his Physics notes on the sequence of charging two neutral metal spheres by induction. Six separate steps were found randomly written as follows:

U Bring earth connection to one sphere
V Bring charged rod near one sphere.
W Bring both spheres into contact with each other.
X Remove earth connection.
Y Remove charged rod.
Z Separate both spheres.

How should he organise his notes to correctly reflect the sequence of charging the two neutral metal spheres by induction?

	first →			*last*
A	V	W	U	Z
B	V	U	X	Y
C	W	U	V	X
D	W	V	Z	Y

30 Four resistors of equal resistances are connected to a power supply as shown.

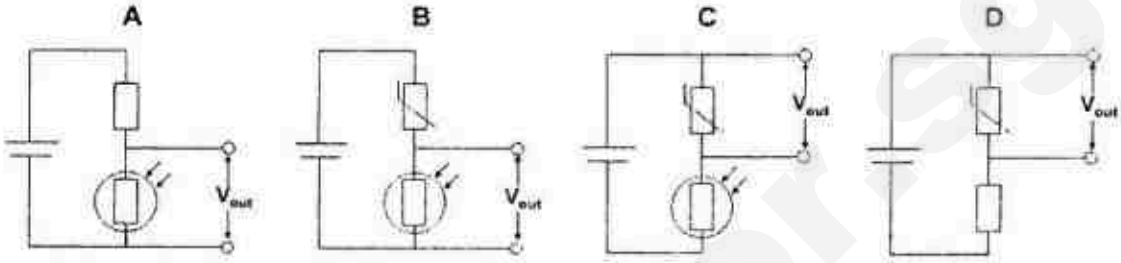


45 C of electric charges flows through resistor R in 3.0 minutes.

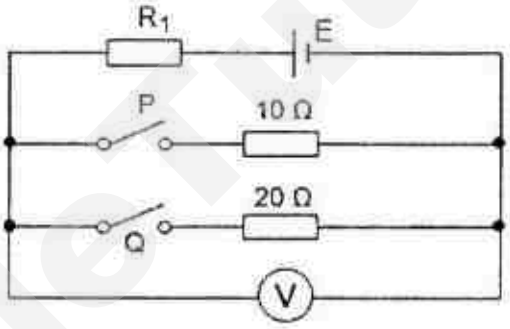
What is the effective resistance of the circuit?

A 3.0 Ω B 6.0 Ω C 9.0 Ω D 18 Ω

31 In which of the following circuit set up would V_{out} be the greatest in a warm and dark room?



32 The diagram shows a circuit in which all the switches are open.



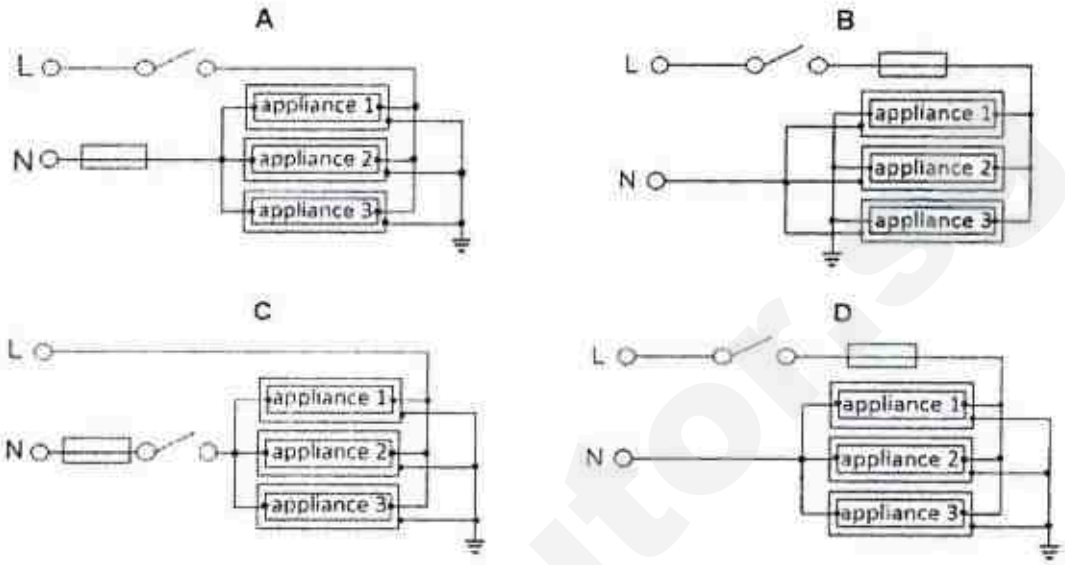
When only switch P in the circuit is closed, the reading in the voltmeter is 4 V. When only switch Q in the circuit is closed, the reading in the voltmeter is 4.8 V.

What is the resistance of resistor R_1?

A 5 Ω B 10 Ω C 15 Ω D 20 Ω

33 An electrical technician is planning to set up the electrical wiring of an office.

Which of the following circuit diagram should he adopt for a correct and safe wiring set up?



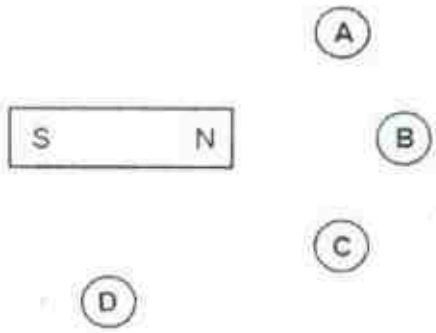
34 An electric cooker takes a current of 13 A from a 220 V power supply when it is operating normally.

How long would it take for the cooker to convert 5,148,000 J of electrical energy?

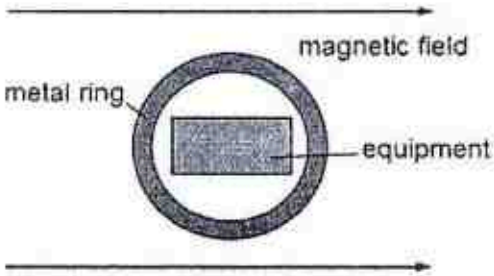
A 0.5 h **B** 1.0 h **C** 1.5 h **D** 2.0 h

35 Four plotting compasses are placed near a bar magnet. You may ignore any effects of the Earth's magnetic field.

In which position does the compass appear like this,  ?



36 A metal ring screens a piece of equipment from a magnetic field.



Which metal should be used for the ring, and why?

	metal	reason
A	copper	the metal carries the field lines around the equipment
B	copper	the metal is non-magnetic
C	iron	the metal carries the field lines around the equipment
D	iron	the metal is non-magnetic

37 In the diagram, electrons are moving to the right in the conductor.

What is the direction of the magnetic field at point P?

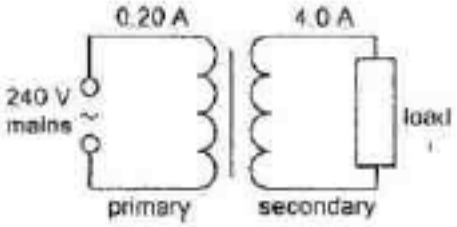
A into the page
B out of the page
C to the right
D to the left

38 The diagram shows a beam of electrons entering a magnetic field. The direction of the field is into the page.

What will be the initial direction of the deflection of the electrons as the beam passes through the field?

A into the page
B out of the page
C towards the bottom of the page
D towards the top of the page

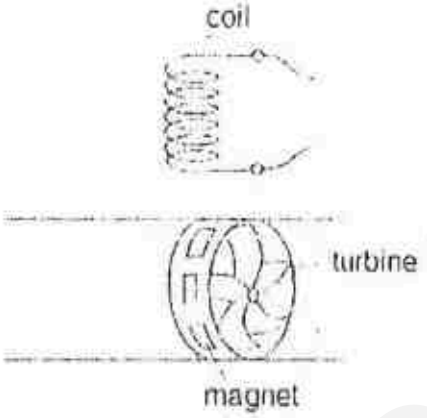
39 An ideal transformer supplies power to a load. In order to deliver a current of 4.0 A to the load, the primary coil draws a current of 0.20 A from the 240 V mains.



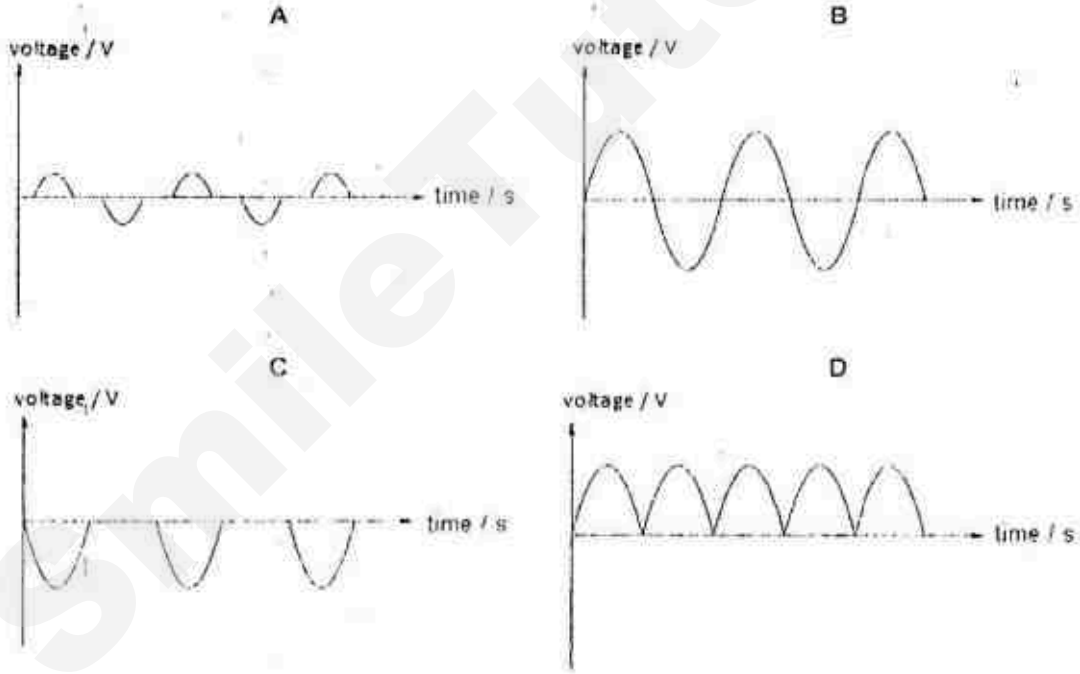
Which set of values below is correct?

	number of turns in the primary coil	number of turns in the secondary coil	potential difference across the load / V
A	400	8000	12
B	400	8000	4800
C	8000	400	12
D	8000	400	4800

40 A flowmeter is used in many industries to measure the volume of liquid passing through a pipe per unit time as shown. When the liquid flows through the turbine, the magnets attached on it rotate.



Which of the following voltage-time graphs shows the signal detected by the coil?



Marking Scheme for Physics Preliminary Examination 2017 (NHHS)

Answer for preliminary examination P1

1	A	2	C	3	C	4	D	5	D
6	A	7	C	8	C	9	B	10	D
11	D	12	D	13	D	14	C	15	D
16	C	17	C	18	C	19	D	20	D
21	B	22	C	23	D	24	B	25	B
26	B	27	D	28	B	29	D	30	A
31	B	32	A	33	D	34	A	35	C
36	C	37	B	38	C	39	C	40	B

Section A (50 marks)

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

1 A climber of weight 700 N is rappelling down a cliff. At the instant shown in Fig. 1.1, the tension T in the rope is perpendicular to the force F acting on the climber by the cliff wall and he is stationary.

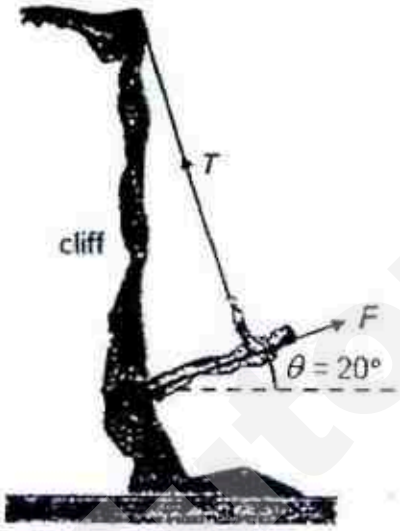


Fig. 1.1

(a) By drawing a labelled scaled diagram, determine the magnitude of T.

T = _____ [3]

(b) The climber lean backwards to reduce the value of θ. The tension in the rope is maintained perpendicular to the force *F* and the climber is stationary.

State and explain how this change affects the magnitude of tension in the rope.

_____

_____

_____ [2]

2 **(a)** Neutron stars are created when giant stars die in supernovas and their cores collapse, with the protons and electrons essentially melting into each other to form neutrons. A neutron star has a mass of 5.2×10^{30} kg and radius 1.7×10^{4} m.

Calculate the mean density of the star.

density = _____ [3]

(b) A small Neutron Star typically has *gravitational field strength* of a billion times stronger than planet earth.

(i) Define gravitational field strength of planet earth.

_____

_____ [1]

(ii) Hence, estimate a value for the gravitational field strength of a neutron star.

gravitational field strength = _____ [1]

(iii) Suggest with a reason, why the density of a Neutron Star is likely to vary with distance from the centre of the star.

_____

_____ [1]

3 An un-opened soda drink can was tilted and released as shown in Fig. 3.1. It was observed that the soda can toppled over.

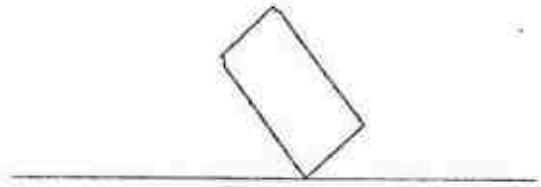


Fig. 3.1

(a) (i) Define centre of gravity (c.g.)

_____

_____ [1]

(ii) Mark accurately the c.g. of the soda can on Fig. 3.1. [1]

(iii) Hence, explain why the soda can topples over when released.

_____

_____ [1]

(b) The soda can in Fig. 3.1 was opened and its contents were emptied completely. Some water was added to the empty can. It was once again tilted and after a few trials, it was observed that the can was able to balance on its edge as shown in Fig. 3.2 on its own.

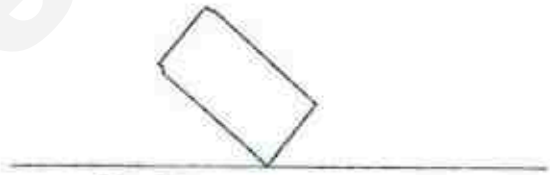


Fig. 3.2

(i) On Fig 3.2, draw a possible water level when the can is balanced. [1]

(ii) Hence explain in terms of moments why the soda can was able to balance on its edge.

_____

_____

_____ [2]

(c) The total weight of the can and the water in Fig 3.2 is about 1.2 N. State the net force acting on the can in its balanced position and give a reason for your answer.

_____

_____ [1]

4 A person paddling in a small boat uses a paddle to propel himself forward as shown in Fig. 4.1. With each horizontal back stroke of 50 cm, he applies a force of 50 N, propelling the boat 2.0 m forwards.

Fig. 4.1

(a) State the useful energy changes as the paddler propels the boat forwards.

_____

_____ [1]

(b) Describe how work is done by the paddler in propelling the boat forwards.

_____

_____

_____

_____ [2]

(c) **(i)** Calculate the work done by the paddler during one stroke of the paddling motion.

work done = _____ [2]

(ii) Hence calculate the average resistive force exerted by the water on the boat in one stroke.

average resistive force = _____ [2]

5 A thermocouple thermometer is made from two different metals and a voltmeter. One junction of the thermocouple thermometer is placed in a beaker containing pure melting ice. The other junction is placed inside a high-temperature furnace, as shown in Fig. 5.1.

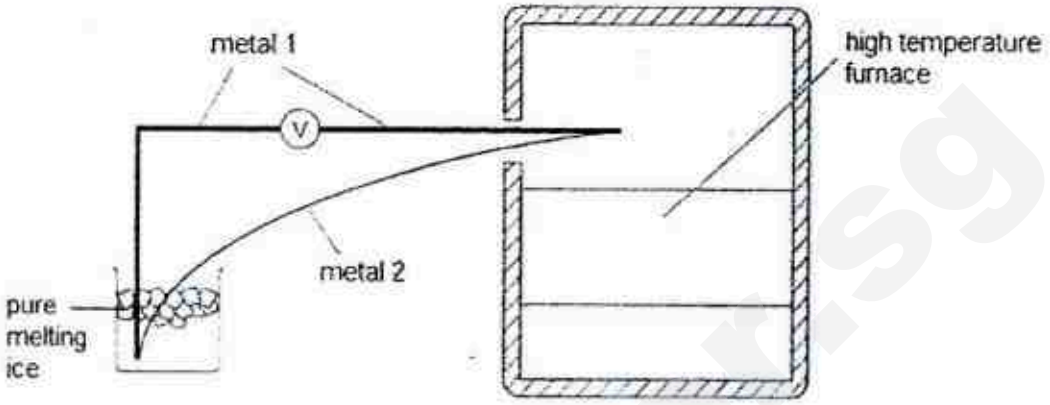


Fig. 5.1

(a) Describe how the two fixed points, namely the ice point and steam point and the reading of the voltmeter can be used to determine the value of the temperature in the furnace.

_____

_____

_____

_____

_____

_____ [2]

(b) The thermocouple thermometer has a linear output over the operating temperature range of the furnace.

(i) State what is meant by a *linear output* for a thermocouple thermometer.

_____

_____ [1]

(ii) The junction inside the furnace is at temperature T. Fig. 5.2 shows the reading V of the voltmeter at two values of T that are within the operating temperature range of the furnace.

T / °C	V / mV
750	6.19
824	6.80

Fig. 5.2

When the furnace is operating at a high temperature, the furnace door is opened and the reading of the voltmeter falls to 6.60 mV.

Calculate the temperature of the junction inside the furnace at the instant.

temperature = _____ [2]

6 A car has a gas-filled shock absorber for each of its four wheels. Fig. 6.1 shows one of these shock absorbers.

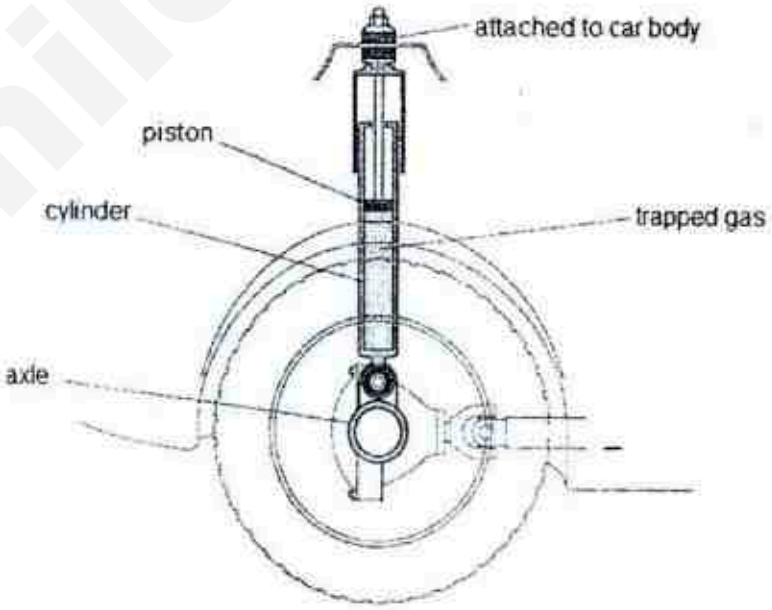


Fig. 6.1

The axles are attached to the cylinders. The body of the car is supported by the four pistons, which can move up and down inside the cylinders.

(a) Explain how the molecules of the gas trapped inside the cylinder by the piston exert a pressure on the cylinder.

_____

_____

_____ [2]

(b) At the end of a long journey, the temperature of the trapped gas in the shock absorbers has increased substantially.

State and explain the effect of the increased temperature of the gas on the height of the car body above the road surface.

_____

_____

_____

_____

_____

_____ [3]

7 (a) Fig. 7.1 shows a side view of a water wave in a ripple tank.

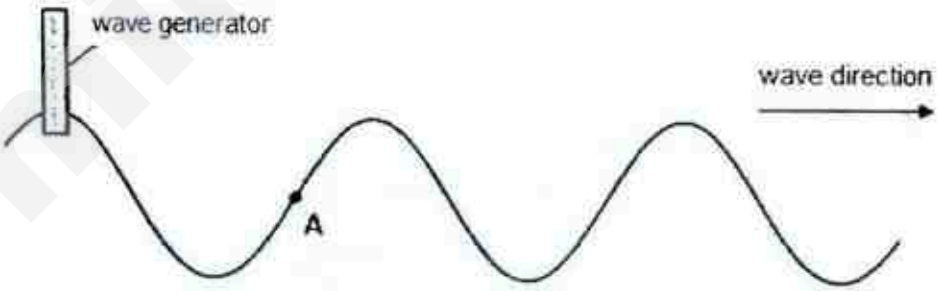


Fig. 7.1 (full scale)

(a) (i) Describe the type of wave shown in Fig. 7.1.

_____

_____ [1]

(ii) On Fig. 7.1, draw arrow to show the direction in which particle **A** is moving at this instant. [1]

(iii) On Fig. 7.1, mark a point on the wave to represent a particle **B** that is travelling at the same speed as particle **A**, but in the opposite direction to particle **A**. Label this point as **B**. [1]

(iv) The speed of the water wave is 4.0 cms^{-1}.

Using measurements taken from Fig. 7.1, calculate the frequency of the wave.

frequency = _____ [1]

(b) The tuning dial on a radio displays three different bands which are labelled frequency modulation (FM), medium wave (MW) and long wave (LW) respectively. The frequency range for each band is shown in Fig. 7.2.

Band	Frequency Range
FM	88 – 108 MHz
MW	540 – 1600 kHz
LW	150 – 270 kHz

Fig. 7.2

(i) The radio receives a signal with a wavelength of 1.2 km.

Determine the band (from Fig. 7.2) that the radio is tuned to.

band = _____ [2]

(ii) State the type of electromagnetic wave used in satellite TV programmes broadcast.

_____ [1]

8 Fig. 8.1 shows an air bubble that has attached itself to the reflective surface of a wall in a water tank. The shape of the air bubble is identical to that of a hemisphere. A light ray P is incident on the air bubble. The refractive index of water is 1.30.

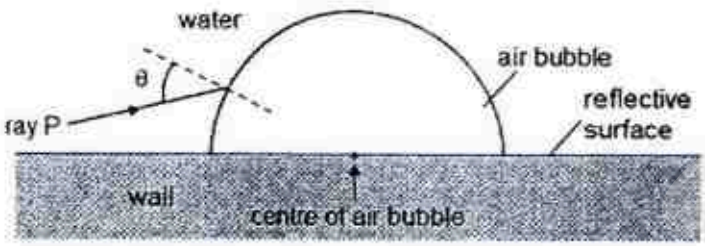


Fig. 8.1

(a) Explain what is meant by *total internal reflection*.

_____

_____

_____ [2]

(b) Calculate the critical angle of light ray from water to air.

critical angle = _____ [2]

(c) If angle θ = 40 °, complete the path of ray P till it emerges back into water. [2]

(d) Fig. 8.2 shows a fish in the tank, swimming towards the reflective surface of the tank.

On Fig. 8.2, draw accurately a ray diagram to show how a light ray from a point S from the base of the plant gets reflected off the reflective surface into the fish's eye.

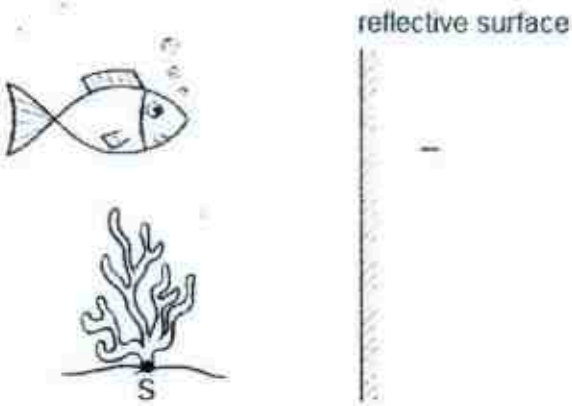


Fig. 8.2 [2]

Section B (30 marks)

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 An object of mass 50 g was projected at an angle θ to the horizontal as shown in Fig. 9.1 as part of an investigation. The effect of air resistance was ignored in this experiment.

Fig. 9.1

The horizontal distance x and the vertical height h measured from the starting point was tracked by a sensitive equipment and the data is shown in Fig. 9.2.

time/ s	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.2	4.3	4.4
x/ m	0	10.6	21.2	31.8	42.4	53.0	63.6	74.2	84.8	89.1	89.1	89.1
h/ m	0	9.4	16.2	20.6	22.4	21.8	18.6	13	4.9	0.9	0.0	0.0

Fig. 9.2

(a) Describe with supporting evidence from Fig. 9.2, the motion of the object

(i) in the horizontal direction,

_____

_____

_____ [2]

(ii) in the vertical direction.

_____

_____

_____

_____ [2]

(b) State why the motion in the horizontal direction differs from that of the vertical direction.

_____

_____ [1]

(c) Determine the average velocity of the object in the horizontal direction till the time it lands.

average velocity = _____ [2]

(d) Describe a pair of *action-reaction* forces experience by the object at time t = 3.0 s.

_____

_____

_____ [2]

(e) If air resistance was taken into consideration, suggest one observable difference in the data obtained in Fig. 9.2.

_____

_____ [1]

10 (a) A coil of wire is wrapped around a plastic tube as shown in Fig. 10.1. Inside the tube are two pieces of soft iron. Two compasses A and B are placed near it. When the switch is closed, the compass needles point in the direction of the magnetic field produced at each position. You may ignore the magnetic field of the Earth in this question.

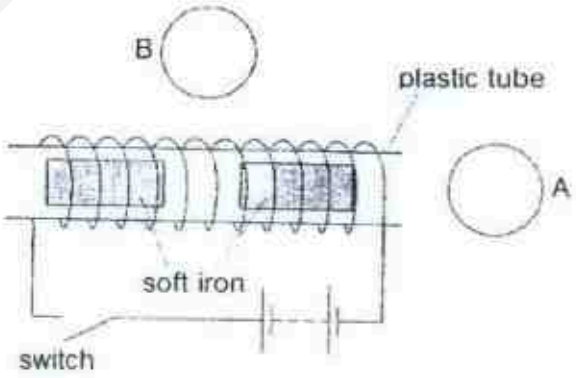


Fig. 10.1

(i) On the Fig. 10.1, mark arrows, in compasses A and B to show the direction of the magnetic field at each position after the switch has been closed. [2]

(ii) When the switch is closed, a direct current flows through the coil and the pieces of iron move.

State and explain how the two pieces of iron move.

_____

_____

_____

_____ [2]

(iii) State and explain the change, if any, on the movement of the two pieces of iron when the direct current is replaced with an alternating current.

_____

_____

_____

_____ [2]

(b) Fig. 10.2 shows a coil ABCD placed in a magnetic field. The coil is able to rotate about the axis.

Fig.10.3 shows the front view of the combined magnetic field formed from the interaction of the magnetic field from the magnet and the magnetic field produced by the current in the coil.

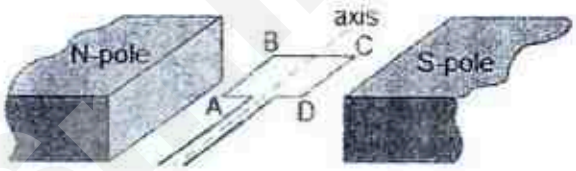


Fig. 10.2

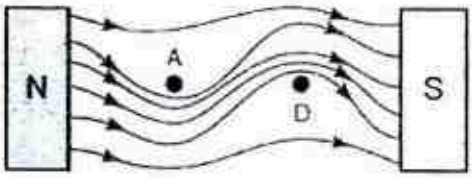


Fig. 10.3

(i) For the instant shown in Fig. 10.3, determine if the current at A is flowing in or out of the page. Explain your answer.

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) State how the pattern of the magnetic field lines above D changes if the same material of wire with a greater thickness is used instead.

_____ [1]

EITHER

11 A submarine is undergoing testing and it is brought through some dives in sea water. The density of sea water and mercury is 1025 kg/m^3 and 13600 kg/m^3 respectively. The gravitational field strength is 10 N/kg.

(a) The atmospheric pressure at sea level on the day of the testing was 750 mmHg.

Explain what is meant by *750 mmHg*.

_____ [1]

(b) At the start of the testing, the submarine was floating at sea level. Two barometers P and Q of identical tubes and uniform cross sectional area as shown in Fig. 11.1 were placed at the top of the submarine, one in front and one at the back.

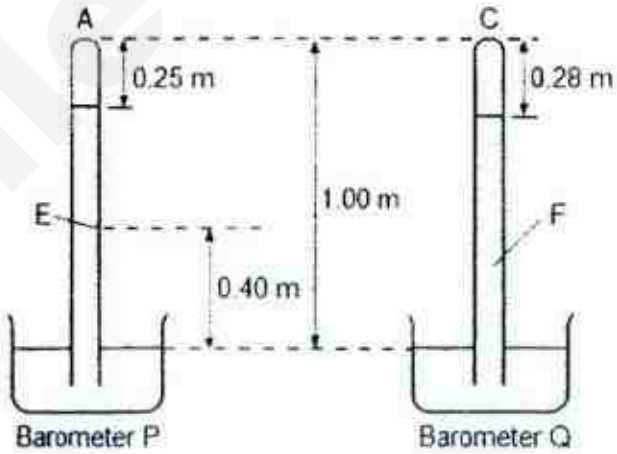


Fig. 11.1

(i) State the pressure at point E in barometer P in mm Hg

pressure = _____ [1]

(ii) State which barometer is correctly measuring the atmospheric pressure at sea level. Explain your answer.

_____

_____

_____

_____ [2]

(c) As part of the test, the submarine submerges to a depth of 70 m below sea level. Between 50 m to 70 m, the submarine was descending at a constant velocity of 2.0 m/s. The total mass of the submarine is about 2.18×10^6 kg including crew and equipment.

(i) Determine the net force acting on the submarine when it was 60 m below sea level.

net force = _____ [2]

(ii) Calculate the total pressure acting on the submarine in Pa when it is at a depth of 70 m.

pressure = _____ [3]

(d) To withstand the high pressure in deep waters, the hull (outer body) of the submarine is usually made of steel. The density of steel is about 7700 kg/m^3.

Suggest how the submarine is able to stay afloat at sea level despite the density of the hull being higher than seawater.

_____

_____ [1]

OR

11 A potential divider is connected across a 6.0 V d.c. power supply as shown in Fig. 11.2. V_{out} is used to drive the heating element of a greenhouse for the regulation of room temperature.

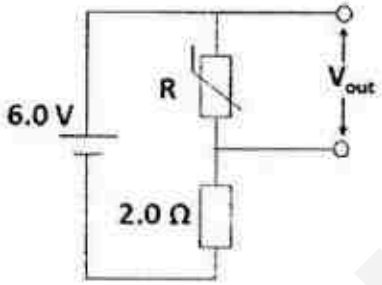


Fig. 11.2

Fig. 11.3 shows how the resistance of the thermistor changes with temperature.

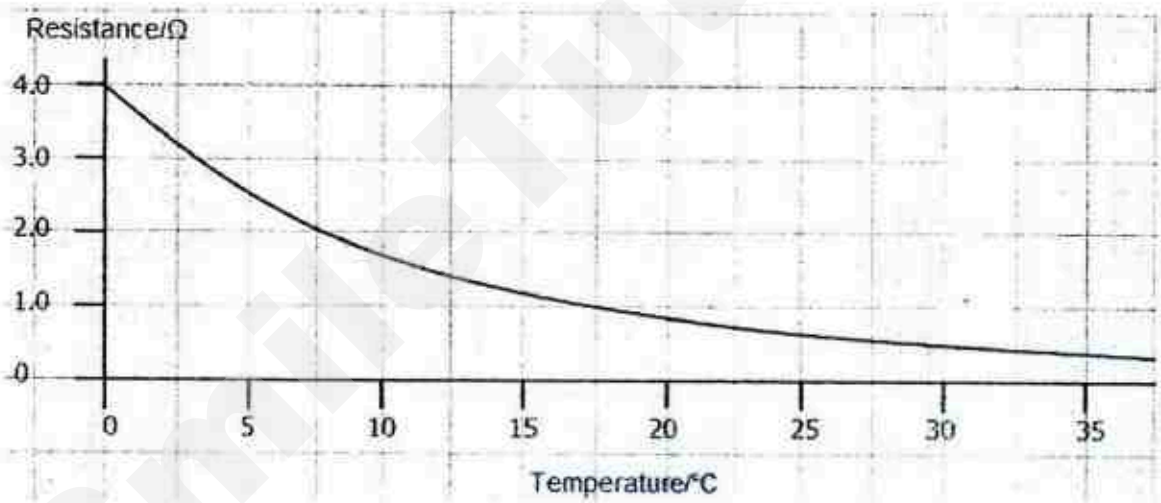


Fig. 11.3

(a) Explain how the use of a thermistor in the potential divider helps to regulate the temperature in a greenhouse.

_____

_____

_____

_____ [2]

(b) In the current environmental setting, it was measured that in one minute, 720 J of electrical energy was converted from chemical potential energy in the power supply.

Calculate

(i) the amount of charge passing through the power supply in one minute,

charge = _____ [2]

(ii) the potential difference (p.d.) across the 2.0 Ω resistor,

p.d. = _____ [2]

(iii) the temperature of the environment.

temperature = _____ [2]

(c) The 2.0 Ω fixed resistor in Fig. 11.2 is replaced with a 4.0 Ω fixed resistor.

Describe and explain how this change affects the amount of heat supplied by the heating element for the same environmental temperature.

_____

_____

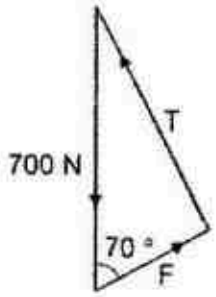
_____

_____ [2]

Marking Scheme for Physics Preliminary Examination 2017 (NHHS)

Section A

1 (a)



appropriate vector diagram 1
direction and labels 1
T = 660 N ± 10 N 1

(b) Increases. 1
Resultant of force F and weight of climber increases. Magnitude of tension must increase to ensure no net force acting on climber. 1
(Or when θ decreases, F has to decrease in order to maintain 90^0 with T. When F decreases, T increases)

2 (a) $\rho = m/V$ use of m/V 1
$= 5.2 \times 10^{30}$ kg/ $\{4/3 \times \pi \times (1.7 \times 10^4)^3\}$ calculation of volume 1
$= 2.53 \times 10^{17}$ kg/m^3 1

(b) (i) Gravitational field strength is the gravitational force acting per unit mass 1

(ii) 10 N/kg $\times 1.0 \times 10^9 = 10^{10}$ N/kg 1

(iii) Concentration of mass changes with distance/ mass not uniformly distributed. 1

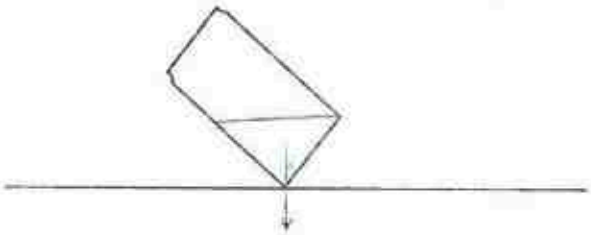
3 (a) (i) The point through which the whole weight seems to act. 1

(ii)

1

(iii) **Anti-clockwise moments due to the weight** acting at the cg causes the can to topple. 1

(b) (i)



water level about 1/3 1

(ii) Weight acting at the new cg passes through the pivoting point in contact 1

zero moment (because of zero perpendicular distance) 1

(c) zero net force as equal reaction force cancels the weight Or zero net force as can is in equilibrium. 1

4 (a) Chemical potential energy of paddler to kinetic energy of boat 1

(b) When he pushes the paddle backwards, **work is done to push the water backwards.** 1
According to Newton's Third Law, the water pushes the paddle, does work on the paddle, pushing it and the boat forward. 1

(c) (i) work done = force × distance traveled by paddle
= 50 × 0.50 1
= 25 J 1

(ii) work done by paddler = work done against water resistive force
25 = F_R × 2.0 1
F_R = 12.5 N 1

5 (a) Obtain the voltage reading when the two junctions are placed in ice and steam points. Placing one junction in ice point and the other into the furnace, obtain the new voltage reading. 1
Temperature in the furnace can be determined using the linear relationship between voltage produced and temperature difference. (i.e E α Δθ relationship mentioned) 1

(b) (i) The output voltage is proportional to temperature change/ difference 1

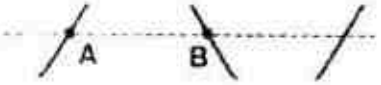
(ii) 6.19 = k(750) OR
k = 6.19/750 (6.80 – 6.19)/(824-750) = (6.6 – 6.19)/(T-750) 1
6.6 = (6.19/750) T
T = 800 °C T = 800 °C 1

6 (a) Molecules in random motion **collide/bombard** with the wall of cylinder 1
exerting a force on the wall
and hence **pressure** due to **force per unit area** on the wall. 1

(b) Car (body) will be **higher above** the ground/off the ground. 1
As temperature of the gas increased, kinetic energy of molecules will increase. 1
Hence molecules collide with wall **more vigorously and frequently,**
pressure acting on the piston **increases**, pushing the car higher above the ground. 1

7 (a) (i) Transverse wave as particles in medium vibrate perpendicular to the direction of motion of wave. 1

(ii) ↓ 1

(iii) 

1

(iv) $f = v/\lambda = 4/4.4$
$= 0.91$ Hz 1

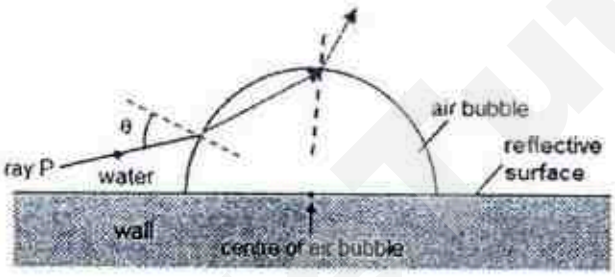
(b) (i) $v = f\lambda$
$3 \times 10^8 = f(1200)$
$f = 2.5 \times 10^5$ Hz 1
Band: LW 1

(ii) Radiowaves / microwaves 1

8 (a) It occurs when light is *totally and internally reflected* in the denser medium when light **exits into an optically less dense medium** 1
at an angle of incidence in the optically denser medium **greater than the critical angle.** 1

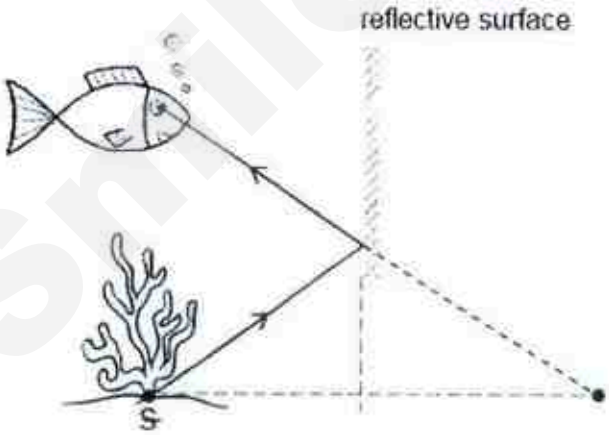
(b) $n = 1/\sin c$
$\sin c = 1/1.30$ 1
$c = 50.3°$ 1

(c)



bend away from normal in air 1
bend towards normal in water 1

(d)



appropriate ray diagram 1
accuracy + direction 1

Section B

9 (a) (i) The horizontal velocity remains constant up till time t = 4.0s (or 4.2s) 1
The horizontal distance travelled every 0.5s remains constant at 10.6m 1

(ii) The velocity in the vertical direction decreases for the first two seconds as the displacement travelled every 0.5s decreases. 1
The velocity increases from t =2.0s to t = 4.0s as the displacement covered every 0.5s increases in the opposite direction. 1

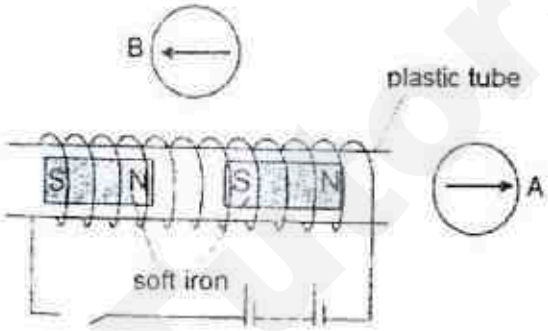
(b) Gravity is acting against the object in the vertical direction and gravity has no effect on the horizontal motion. 1

(c) ave horizontal velocity = total horizontal displacement / total time of flight
= 89.1/4.3 1
= 20.7 m/s 1

(d) Earth's gravitational force of attraction on the object (action) 1
Object's **equal** gravitational pull of earth (reaction) 1

(e) Maximum vertical height reached is lowered/ max horizontal distance reached at faster time/ Max horizontal distance reached is smaller. 1

10 (a) (i)



1

1

(ii) The two pieces of soft iron will move towards each other 1
as the pieces of iron will be temporary magnet with two ends facing each other have unlike poles 1

(iii) Pieces of iron still move towards each other 1
since at any one instant, two ends facing each other still have unlike poles (except that the polarities alternate at the same frequency as the alternating current) 1

(b) (i) **Out of page.** 1
The magnetic field below A is stronger than the magnetic field above coil A, hence a net upward force acting on A. 1
Using Fleming left hand rule, the force acting on A (thumb) is perpendicular to both the direction of the magnetic field (forefinger) and the direction of the current through the rod (second finger). Hence the current in the coil flows out of page. 1

OR
Magnetic field lines in the same direction strengthen the magnetic field while magnetic field lines in the opposite direction weaken the magnetic field. 1
As the combined magnetic field above A is weaker than the combined magnetic field below A, magnetic field due to current in the wire at must be travelling in an anticlockwise direction. 1
Using right hand grip rule, current is flowing **out of page.** 1

(ii) The magnetic field lines will be **closer** to each other. 1

Either

11	(a)	(i)	Pressure exerted by 750 mm of mercury column	1
	(b)	(i)	p = 350 mm Hg	1
		(ii)	Barometer P.	1
			The mercury column above the surface of barometer P is exactly 750 mm and atmospheric pressure is 750 mm Hg (other variations can be accepted)	1
	(c)	(i)	F_{net} = ma	
			= m (0) {either via formulae or statement}	1
			= 0 N	1
		(ii)	total pressure = $P_{atm} + P_{seawater}$	
			= (0.75×13600×10) + (70×1025×10)	1,1
			= 820 kPa	1
	(d)		The overall density of the submarine is actually less than density of seawater (due to the large amount of air present in the tanks)	1

OR

11	(a)		When the temperature falls, R increases, resulting in a greater V_{out} and hence increasing the heating of the room.	1
			When the temperature rises, R decreases, resulting in a smaller V_{out} and hence decreasing the heating of the room.	1
	(b)	(i)	V = W/Q	
			6 = 720/Q	1
			Q = **120 C**	1
		(ii)	I = Q/t	
			= 120/(60) = 2.0 A	1
			V = IR = 2 × 2 = **4.0 V**	1
		(iii)	R = V/I = (6 – 4)/2	
			= 1.0 Ω	1
			temperature = **17.5 °C** (from graph)	1
		(iv)	For the same environment temperature, pd across thermistor will reduce,	1
			hence amount of thermal energy supplied by heating element will decrease.	1

Marking Scheme for Physics Preliminary Examination 2017 (NHHS)

Answer for preliminary examination P1

1	A	2	C	3	C	4	D	5	D
6	A	7	C	8	C	9	B	10	D
11	D	12	D	13	D	14	C	15	D
16	C	17	C	18	C	19	D	20	D
21	B	22	C	23	D	24	B	25	B
26	B	27	D	28	B	29	D	30	A
31	B	32	A	33	D	34	A	35	C
36	C	37	B	38	C	39	C	40	B

SINGAPORE CHINESE GIRLS' SCHOOL
Preliminary Examination
Secondary Four

CANDIDATE NAME

CLASS 4

INDEX NUMBER

Physics

5059/01

Paper 1 Multiple Choice

4 August 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, class and index number on the Question Paper and Answer Sheet in the spaces provided.

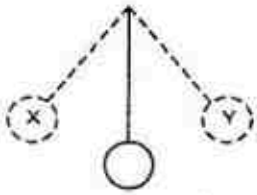
There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C, D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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 question paper consists of 18 printed pages

1 The time taken for a pendulum to swing from position X to position Y is 0.60 s.



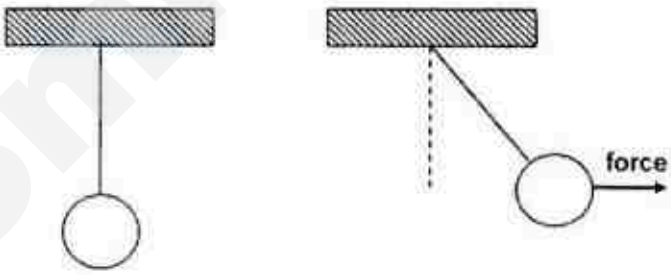
How many periods are there in one minute of oscillations?

A 5
B 10
C 50
D 100

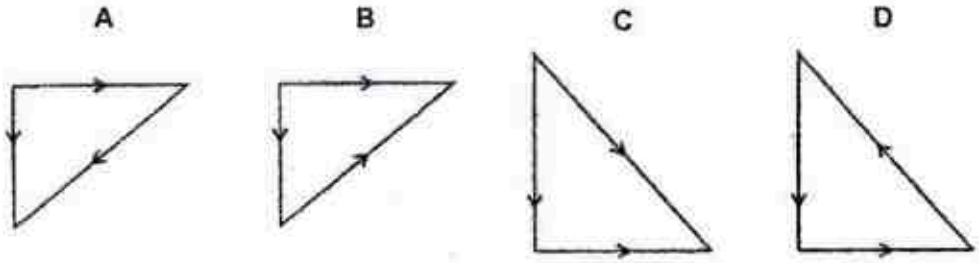
2 Which of the following pairs of physical quantities do not have the same unit?

A	friction	electrostatic force
B	heat capacity	latent heat
C	latent heat	kinetic energy
D	rate of energy conversion	power

3 A simple pendulum with a heavy bob is suspended from a ceiling by a string. The bob is then pulled to one side and held stationary with the string taut.



Which vector diagram represents the forces acting on the bob in its new position?



4 At t = 0 s, a stone is thrown vertically up into the air at 20 m/s.

Which of the following best describes the motion of the stone in the air at t = 2.0 s?

	speed / m/s	acceleration / m/s^2
A	10	0
B	10	10
C	0	0
D	0	10

5 A girl takes 90 s to walk 80 m towards the north. She then runs 60 m towards the east for 10 s.

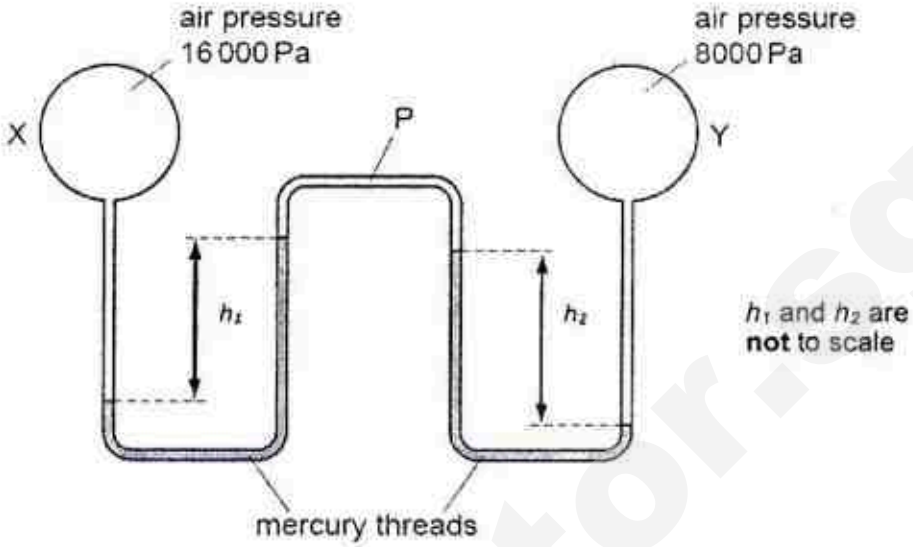
What is her average speed and average velocity?

	average speed / m/s	average velocity / m/s
A	1.4	1.0
B	1.4	6.1
C	2.0	1.0
D	3.4	6.9

6 A bottle full of mercury has a mass of 730 g. When the same bottle is filled with an unknown liquid P, its mass is 100 g. If the mass of the empty bottle is 50 g, calculate the density of the unknown liquid P. (Density of mercury = 13600 kg/m^3)

A 1.0 g/cm^3
B 2.0 g/cm^3
C 7.3 g/cm^3
D 14.6 g/cm^3

7 Two bulbs X and Y containing air at different pressures are connected by a tube P which contains two mercury threads.



The density of mercury is 13 600 kg m^{-3}.
Which pair of values of h_1 and h_2 is possible?

	h_1 / cm	h_2 / cm
A	2.0	8.0
B	4.0	2.0
C	6.0	6.0
D	8.0	2.0

8. A student left two identical, heavy, stone blocks resting on soft earth. One is vertical and the other is horizontal as shown in the diagram below.

The vertical block started to sink into the soft earth by 2.0 cm, but the horizontal one sinks less. Which row correctly compares the force and the pressure that the two blocks exert on the earth?

	force	pressure
A	same	different
B	same	same
C	different	different
D	different	same

9 An object of mass m is hanging by a string from the roof of a lift. The lift is moving upwards but is slowing down. The tension in the string is

A less than mg.
B exactly mg.
C greater than mg.
D zero.

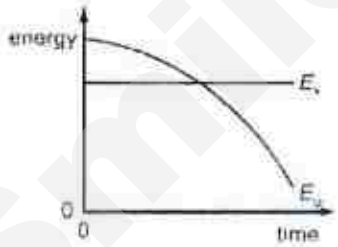
10 The gravitational field strength of the Moon at its surface is one-sixth that of Earth at its surface. If the mass of a man is 75 kg on the surface of Earth, what will be his mass and weight if he is brought to the surface of the Moon?

	mass / kg	weight / N
A	12.5	125
B	75	12.5
C	75	125
D	450	4500

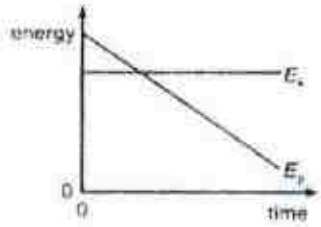
11. A metal sphere is falling at a constant velocity through a cylinder of oil.

Which of the following graphs shows the metal sphere's variation of kinetic energy E_k and potential energy E_p with respect to time?

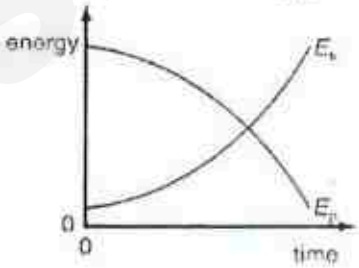
A.



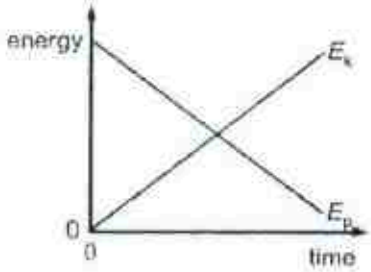
B.



C.



D.



12 A bullet of mass 0.010 kg travelling horizontally at 100 m/s is stopped after penetrating through 0.20 m of wood. What is the average retarding force applied to the bullet by the wood?

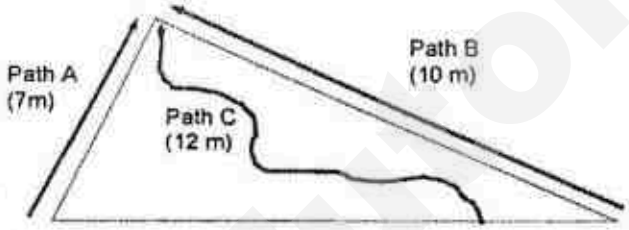
A 10 N

B 250 N

C 500 N

D 1000 N

13 There are 3 paths leading to the top of the hill as shown below. All 3 paths begin at the foot of the hill.



Assuming the friction of the ground is negligible, which of the following statements is true?

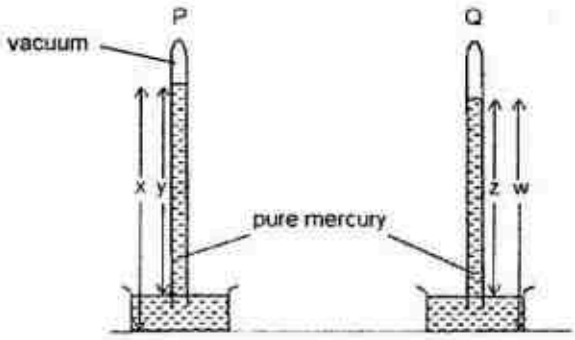
A Path C requires the most energy to reach the top.

B Path A requires the least energy to reach the top.

C Path A requires more energy than path B to reach the top.

D All three paths require the same amount of energy to reach the top.

14. The figure below shows two mercury barometers P and Q placed in troughs of mercury at the same level. The measurements of w, x, y, and z are made in cm.



Which of the following statements is correct?

A The space above the mercury in P is a vacuum and the atmospheric pressure is x cm Hg.
B The space above the mercury in Q is a vacuum and the atmospheric pressure is w cm Hg.
C The space above the mercury in Q contains a gas (or air) whose pressure is (y-z) cm Hg
D The space above the mercury in P contains a gas (or air) whose pressure is (y-z) cm Hg

15. When a liquid-in-glass thermometer is immersed in pure melting ice, the length of the liquid thread is 2.0 cm. When the thermometer is placed just above boiling water, the length of the liquid thread is 12.0 cm.

The length of the liquid thread is 8.4 cm when the thermometer is used to measure the melting point of potassium.

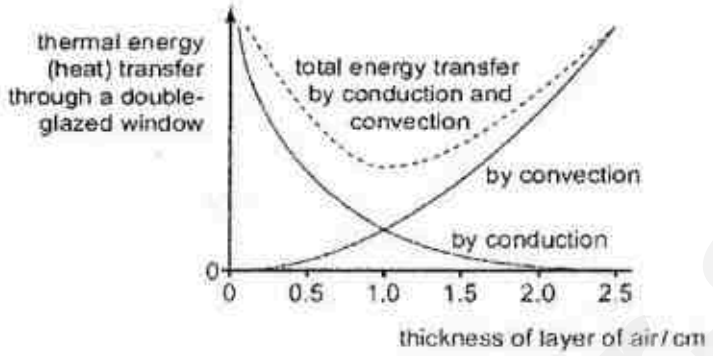
What is the melting point of potassium?

A 36 °C
B 60 °C
C 64 °C
D 84 °C

16. A piece of aluminium of mass *m* has a specific heat capacity of *c*. A piece of copper of mass *2m* has a specific heat capacity of *2c*. Both of these metals receive the same quantity of heat and the temperature of the copper rises by 10°C. By how much did the temperature of the aluminium rise?

A 5°C
B 10°C
C 20°C
D 40°C

17. A double-glazed window has two sheets of glass separated by a layer of air. Thermal energy is lost through conduction and convection through the layer of air. The amount of conduction and convection varies with the thickness of the layer of air, as shown in the graph.



Which thickness of air produces the smallest thermal energy transfer, and why?

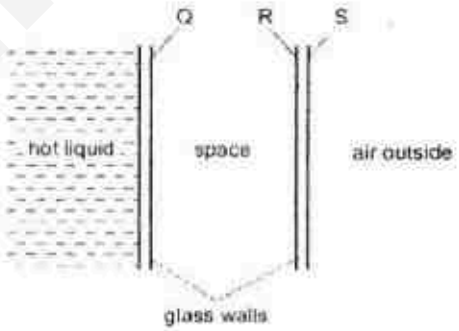
A 0.0, because there is little thermal energy transfer by convection.

B 1.0 cm, because the total thermal energy transfer is least

C 1.5 cm, because the thermal energy transfer by conduction is less significant than that by convection.

D 2.5 cm, because there is little thermal energy transfer by conduction.

18. A student needs a double-walled glass vessel to contain a hot liquid.



What reduces heat losses by radiation?

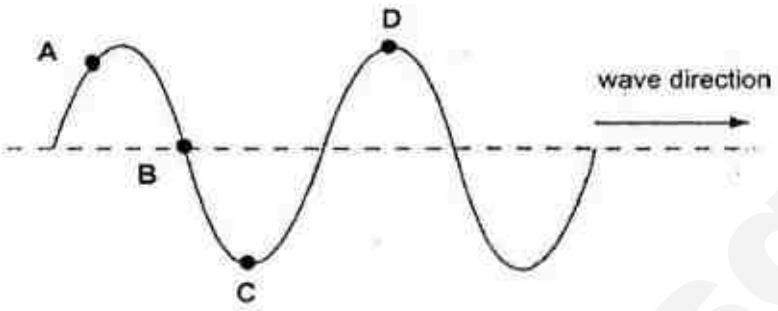
A A vacuum in the space between the walls.

B Painting surface Q black.

C Painting surface R silver.

D Painting surface S black.

19. The diagram shows a water wave moving in the direction shown.



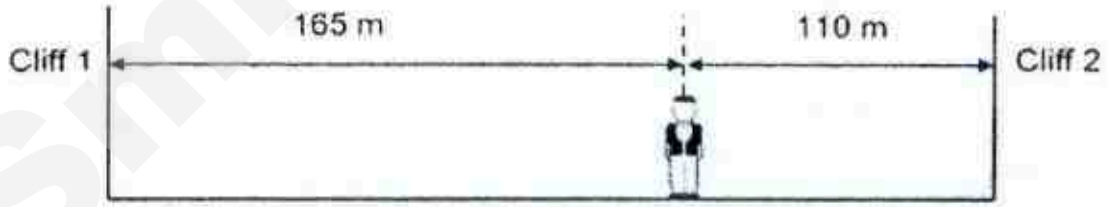
At which point is the water moving upwards with maximum speed?

20. Which of the following statements concerning EM waves is/are correct?

(1) EM waves are either transverse or longitudinal.
(2) EM waves travel at the speed of light in a vacuum.
(3) EM waves can be deflected by external magnetic and electric fields.

A (1) only
B (2) only
C (1) and ((3) only
D (2) and (3) only

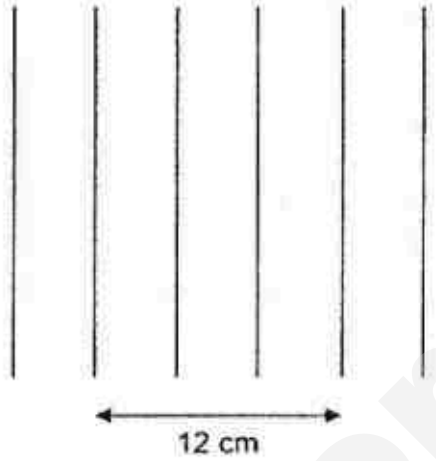
21. A man stands between two cliffs as shown in the diagram and claps his hands once.



Assuming that the velocity of sound in air is 330 m/s, what is the time interval between the 2 loudest echoes?

A 0.17s
B 0.33s
C 0.67s
D 0.83s

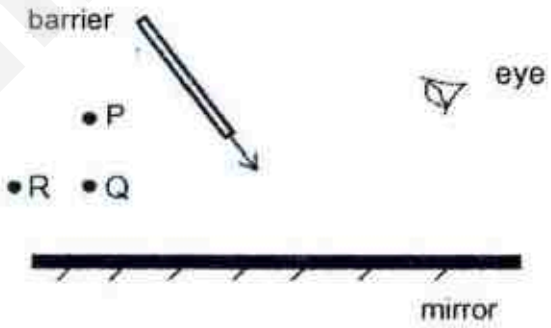
22. A ripple tank filled with water is used to study waves. The diagram shows some wavefronts when viewed from the top.



The frequency of the water waves is 20 Hz. What is the wave speed in m/s?

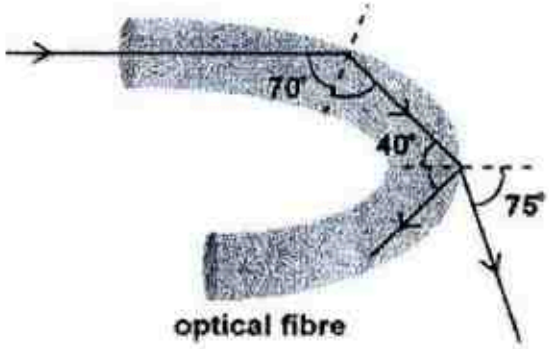
A 0.20
B 0.40
C 0.80
D 1.20

23. Three objects P, Q and R are viewed through a plane mirror as shown. When a barrier is moved towards the mirror, which of the objects will disappear first and which will disappear last?



	disappears first	disappears last
A	P	Q
B	P	R
C	Q	R
D	R	P

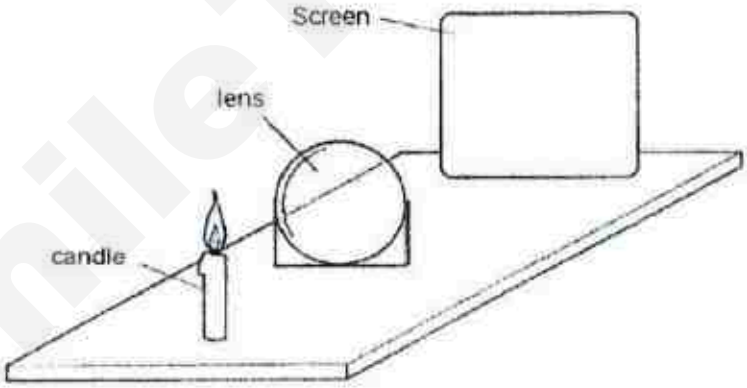
24. The diagram shows a light beam entering a piece of optical fibre.



Which of the following could be a possible value of the optical fibre's critical angle?

A 40°
B 42°
C 70°
D 75°

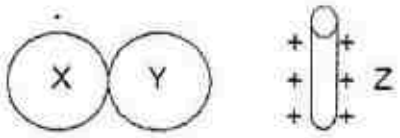
25. A thin converging lens is used to produce a focused image of a candle on a screen.



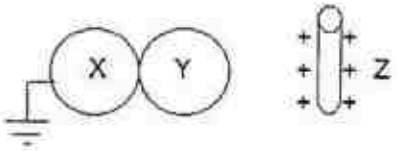
Various focused images are produced on the screen by moving the lens and the screen backwards and forwards. Which one of the following statements is always correct?

A The image is inverted.
B The image is bigger than the object.
C The image is closer to the lens than the object is.
D The image is at the principal focus (focal point) of the lens.

26. Two metallic spheres X and Y are placed in contact. A positively charged rod Z is then brought near them as shown in figure below.



Now, if X is earthed without removing Z, then



A both X and Y will be positively charged.

B X will be positively charged, and Y will be neutral.

C X will be neutral, and Y will be negatively charged.

D X will be positively charged, and Y negatively charged.

27. Three small metallic balls are hung on the wall. Any two of these balls can attract each other. Which of the following statement is correct?

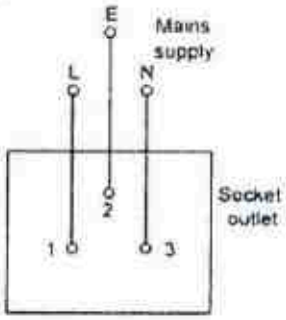
A One of the balls is positively charged while the other two are negatively charged.

B One of the balls is negatively charged while the other two are positively charged.

C One of the balls is positively charged, one is negatively charged and one is neutral.

D One of the balls is charged while the other two are neutral.

28. The diagram represents the wiring from a 240 V mains supply to a socket outlet in a house. An electrician wanted to measure the voltage at the socket outlet by connecting a voltmeter across the numbered positions.



Which of the following correctly shows the voltages across the numbered positions?

A 240 V across 1 and 2; 0 V across 1 and 3.
B 240 V across 1 and 3; 0 V across 2 and 3.
C 240 V across 1 and 3; 0 V across 1 and 2.
D 240 V across 2 and 3; 0 V across 1 and 3.

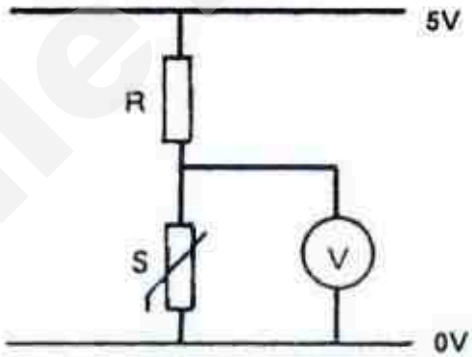
29. A power board is used for convenience to plug in multiple appliances at the same time. Assume the fuse rating of the power board is 13 A.

Which of the flowing statements are correct?

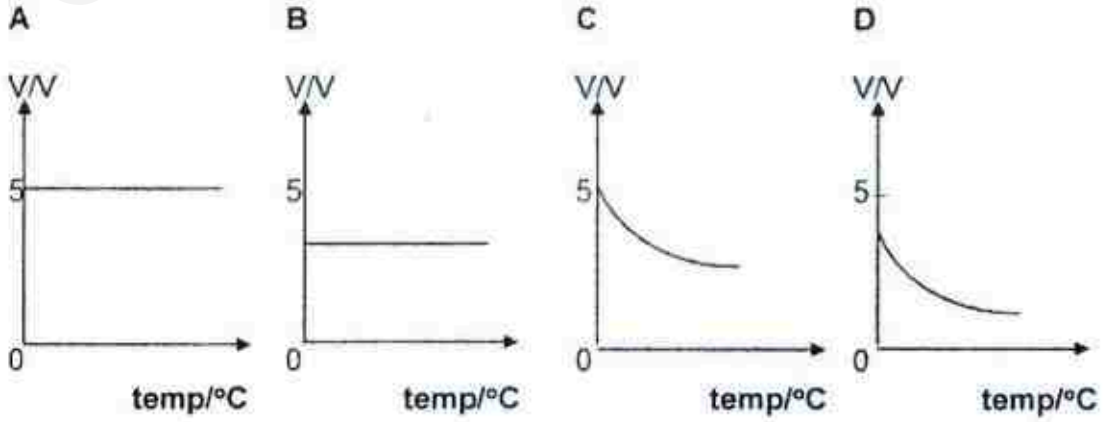
(1) The sockets on the power board are connected in parallel.
(2) The extension cable should be thickest among all the cables of the appliances.
(3) It is safe to plug an electric iron rated "220 V, 2,000 W" and an electric kettle rated "220 V, 1500 W" together in the power board and turn them on at the same time.

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3) only.

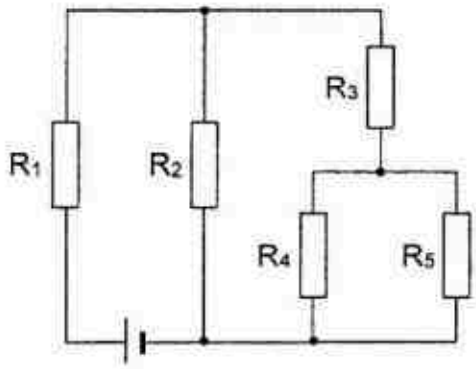
30. The following diagram shows a voltmeter V connected across a thermistor S which is in series with a resistor R.



Which graph best represents the variation of voltmeter reading V with temperature?

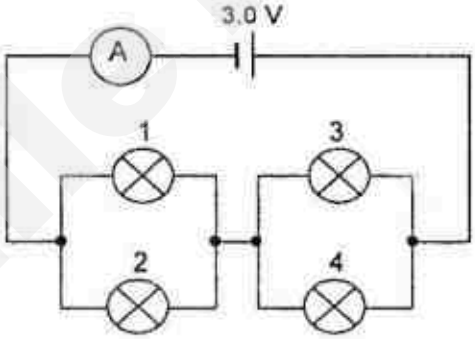


31. In the circuit shown, all five resistors have the same resistance. Which resistor will have the greatest potential difference across it?



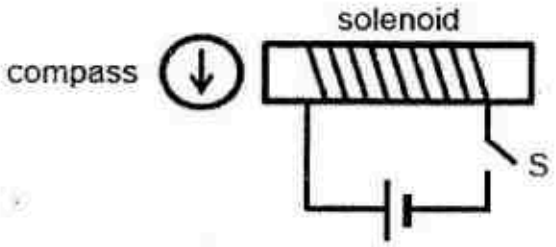
A R_1
B R_2
C R_3
D R_4 and R_5

32. Four identical light bulbs are connected to an ideal battery as shown in the diagram. The filament of Bulb 1 breaks. What happens to the ammeter reading and the brightness of the remaining bulbs?



	Ammeter Reading	Bulb 2	Bulb 3	Bulb 4
A	Increase	Dimmer	Brighter	Brighter
B	Decrease	Dimmer	Brighter	Brighter
C	Increase	Brighter	Dimmer	Dimmer
D	Decrease	Brighter	Dimmer	Dimmer

33. A plotting compass is placed in front of a solenoid.



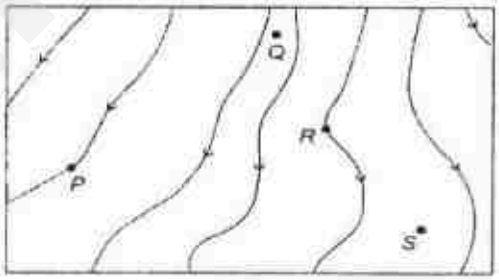
Ignoring the effects of the earth's magnetic field on the compass, what will the compass needle show when switch S is closed?

A 
B 
C 
D 

34. Which of the following statements about magnetic fields is incorrect?

A Magnetic field strength increases when the field lines become denser.
B Magnetic field lines may cross each other.
C Magnetic field lines can form closed loops.
D Magnetic field lines point from the north pole towards the south pole.

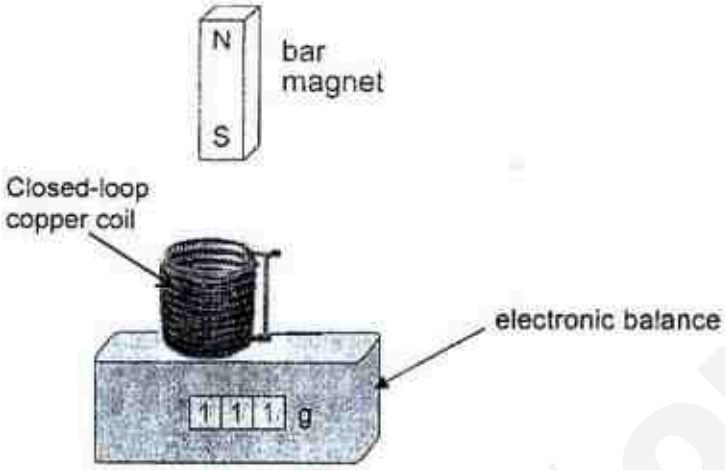
35. The diagram below shows a magnetic field within a region of space.



Which point will have the greatest magnetic field strength?

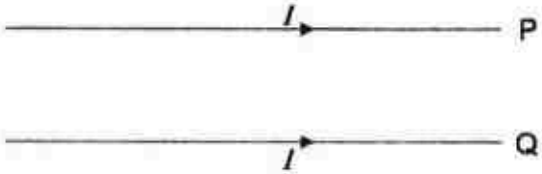
A P
B Q
C R
D S

36. An electronic balance reads 111 g when a closed-loop copper coil is placed on it as shown. A bar magnet is dropped vertically from a certain height above the coil. What is the reading of the electronic balance just before the magnet reaches the coil?



A 111 g
B initially less than 111 g, then greater than 111 g
C less than 111 g
D greater than 111 g

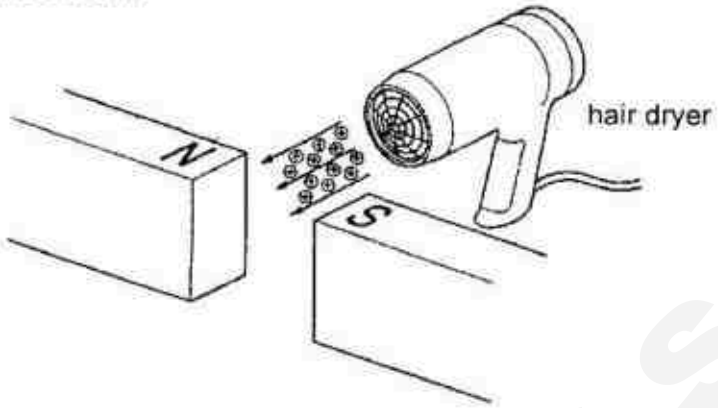
37. The diagram shows two parallel wires **P** and **Q** in the plane of the paper. **P** is fixed; **Q** is free to move.



When the same current *I* passes through each wire in the same direction, **Q** moves

A away from **P** in the plane of the paper.
B downwards into the paper.
C towards **P** in the plane of the paper.
D upwards out of the paper.

38. Hot air from a hair-dryer contains many positively charged ions. The motion of these ions constitutes an electric current.

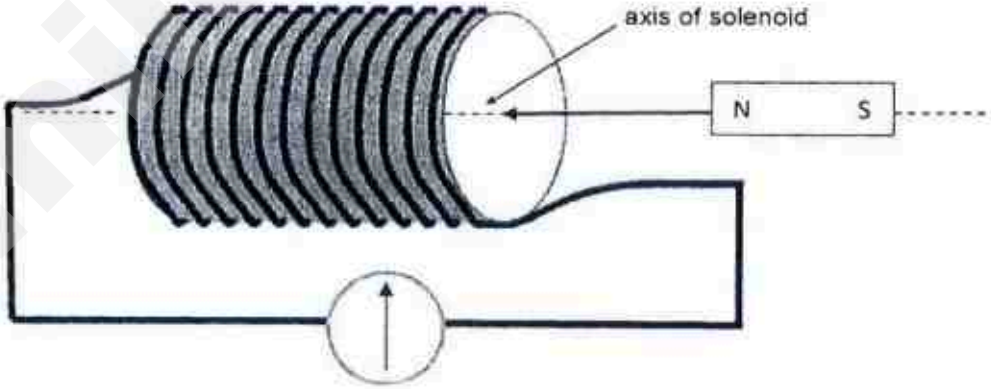


The hot air is directed between the poles of a strong magnet, as shown.
What happens to the ions?

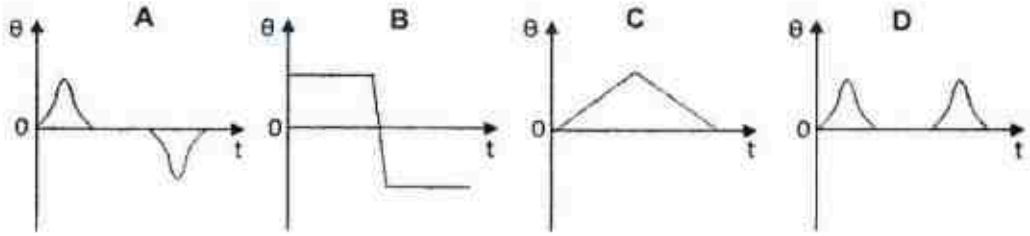
They are deflected

A downwards.
B towards the north pole N.
C towards the south pole S.
D upwards.

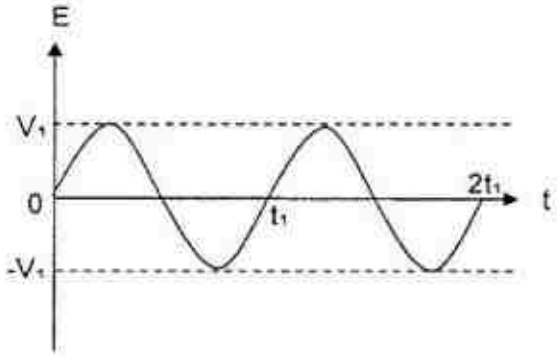
39. A short bar magnet passes at a constant speed through a long solenoid. A galvanometer is connected across the solenoid.



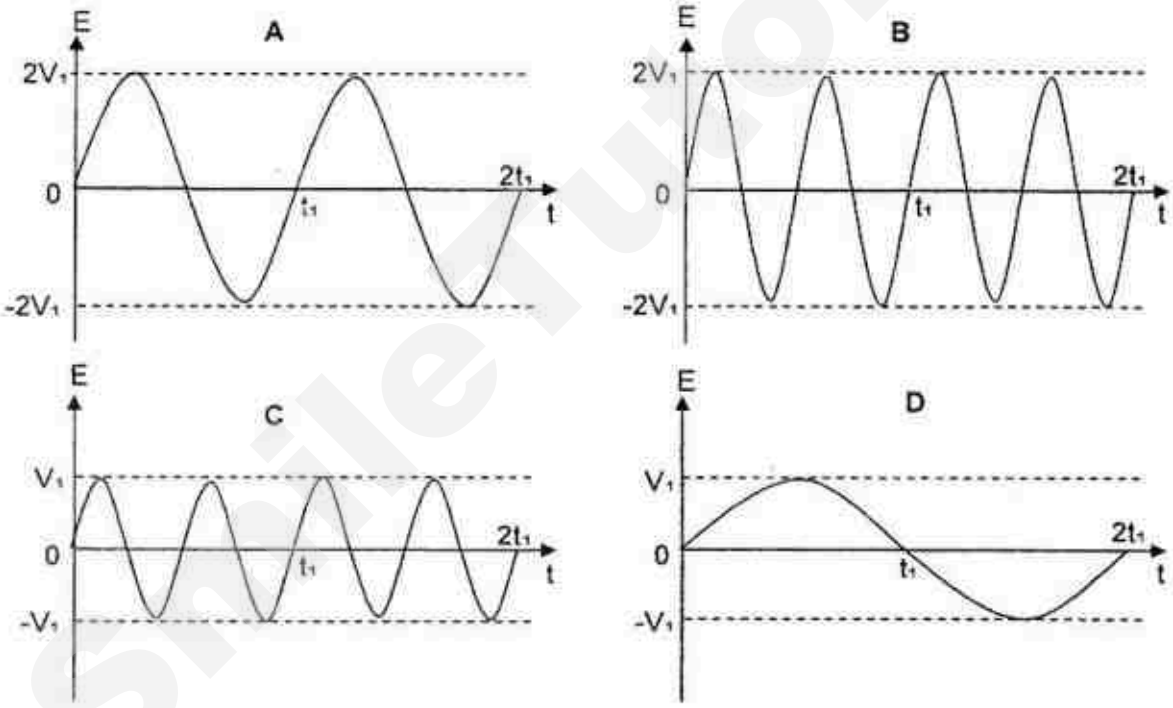
Which graph best represents the variation of the galvanometer deflection θ with time t?



40. When a coil is rotated in a magnetic field, the induced e.m.f. E varies as shown.



Which of the following graphs, drawn to the same scale, would be obtained if the speed of rotation of the coil were doubled?



Answers for paper 1

1	C		11	B		21	B		31	A
2	B		12	B		22	C		32	D
3	D		13	D		23	D		33	B
4	D		14	C		24	B		34	B
5	A		15	C		25	A		35	B
6	A		16	D		26	C		36	D
7	D		17	B		27	C		37	C
8	A		18	C		28	B		38	D
9	A		19	B		29	A		39	A
10	C		20	B		30	D		40	B

Section A

Answer **all** the questions in this section

1 Fig. 1 shows a skydiver of mass 75 kg falling vertically downwards. Arrows P and Q show the two main forces acting on the skydiver.

The gravitational field strength g is 10 N/kg.

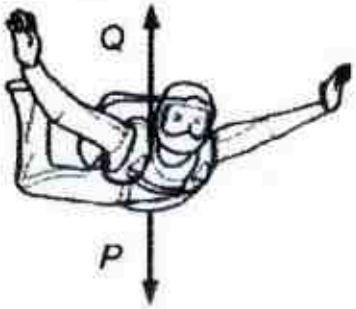


Fig. 1

(a) State the names of force P and force Q. [1]

force P .....

force Q .....

(b) Within the first 2 seconds of the fall, forces P and Q are unbalanced.

Describe and explain, the effect of unbalanced forces on the motion of the skydiver when he first started to fall.

.....

.....

..... [2]

(c) After some time, the skydiver falls at terminal velocity.

(i) State the size (magnitude) of force Q when the skydiver is falling at terminal velocity.

Magnitude of force Q = ... [1]

(ii) With reference to your answer in (c)(i), explain why the skydiver is still falling vertically downwards.

.....

.....

..... [1]

(d) Forces P and Q are not an action-reaction pair.

Suggest a reason for this.

.....

.....

..... [1]

2. A box of mass 2.00 kg is released from rest along an inclined path XY as shown in Fig. 2.1. It slides down the slope with an acceleration of 5.00 m/s^2.

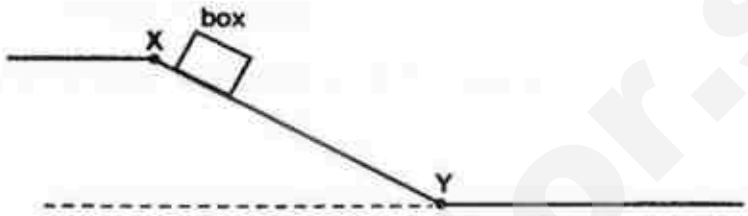


Fig. 2.1 (Not to scale)

(a) The box is released at t = 0 at X and took 8.0 s to move to Y. On Fig. 2.2, draw a velocity-time graph from t = 0 to t = 8.0 s. [1]

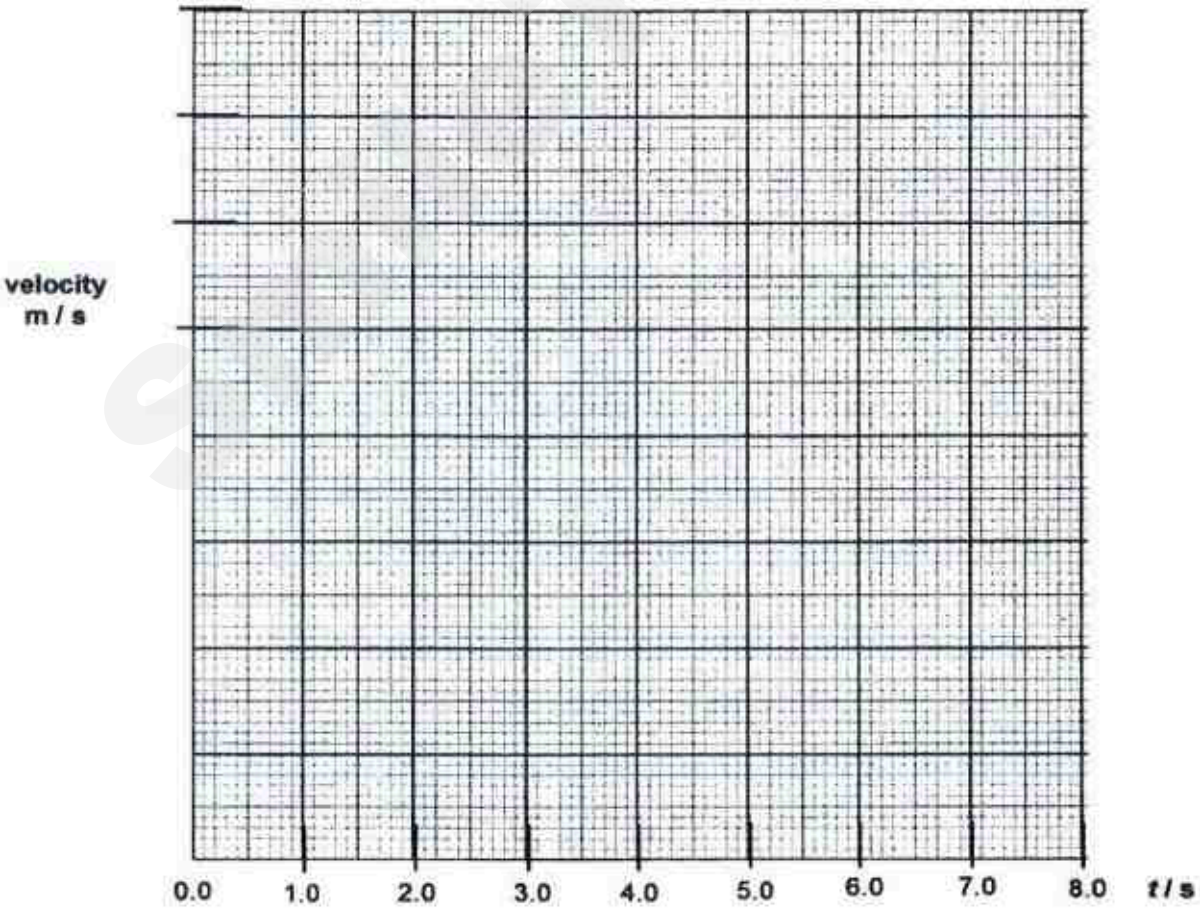


Fig. 2.2

(b) Calculate the distance the box travelled from X to Y.

distance travelled = ... m [1]

(c) Fig. 2.3 shows the box at one point in the motion. The frictional force with the surface is 3.0 N.

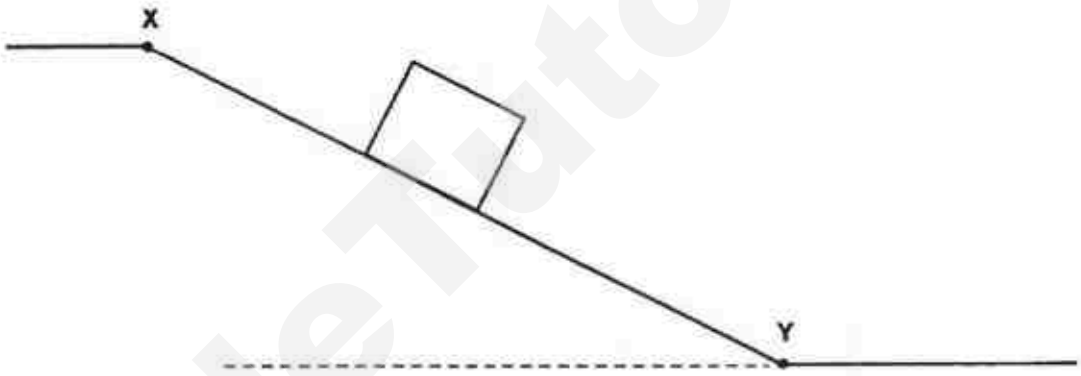


Fig. 2.3

(i) On Fig. 2.3, draw and label all the forces that act on the box. (neglecting air resistance) [1]

(ii) Determine the downward force acting on the box that is parallel to the inclined path.

force = ... N [1]

3. Fig. 3.1 shows a cross sectional view of a traffic safety barrier of mass 5.0 kg with the centre of gravity of the barrier indicated by the point C which is 0.100 m above its base, XY. Fig. 3.2 shows the three dimensional view of the barrier. The width and length of the base is 0.500 m and 0.800 m as shown.

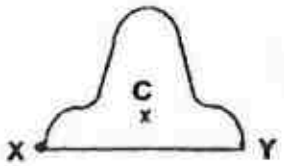


Fig. 3.1

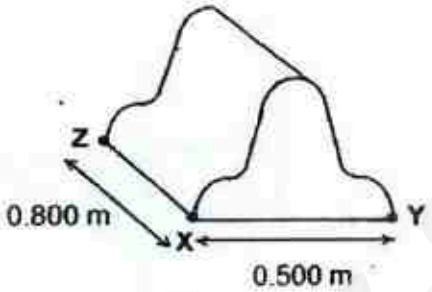


Fig. 3.2

(a) Determine the weight of the traffic safety barrier. [1]

(b) State two features in the design of the traffic safety barrier that improves the stability of the barrier.

.....

.....

..... [2]

(c) A worker needs to lift and move the safety barrier to a new location. Determine the minimum vertical force he would need to exert at point X (Fig. 3.1) to lift the barrier about point Y. [2]

(d) Would it make a difference to the minimum force required whether the worker lifts from point X or point Z? Explain your answer.

.....

..... [1]

4. Fig. 4.1 shows a mercury manometer connected to a graduated syringe. The syringe has a piston which encloses a volume a volume of air as shown. The cross-sectional area of the piston is 25.0 cm^2. The temperature of air in the tube is kept constant throughout.

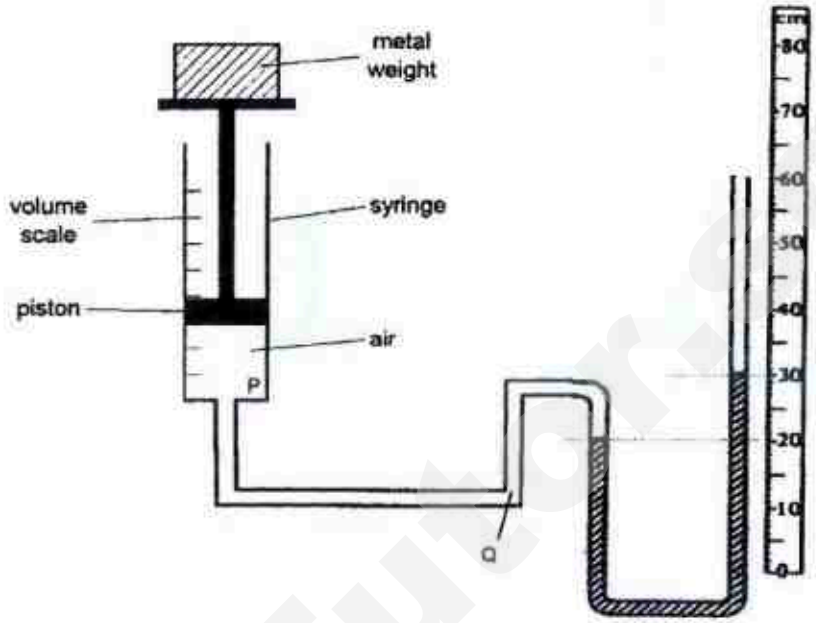


Fig. 4.1

a) Using the idea of molecules,

i) explain how the air in the syringe exerts a pressure on the walls of the syringe.

.....

.....

..... [2]

ii) explain why the pressure on P is equal to that on the end Q of the tube.

.....

.....

..... [2]

b) The piston is free to move up and down and has cross-sectional area of 25.0 cm^2. A metal weight is placed on the piston as shown. Given that the atmospheric pressure is 76.0 cm Hg and the density of mercury is 13 600 kg m^{-3},

i) determine the excess pressure exerted on the air in the enclosed tube due to the metal weight.

excess pressure = ... Pa [2]

ii) and hence, determine the mass of the metal weight and;

mass of metal = ... kg [2]

iii) the pressure of the air in the enclosed tube.

pressure in enclosed tube = ... Pa [1]

5. Fig. 5.1 shows a pool of water of depth 1.00 m. Rays of light travel in water from a lamp. The angle θ_c marked on the diagram is the critical angle for a water-air boundary. Given that the refractive index of water is 1.33.

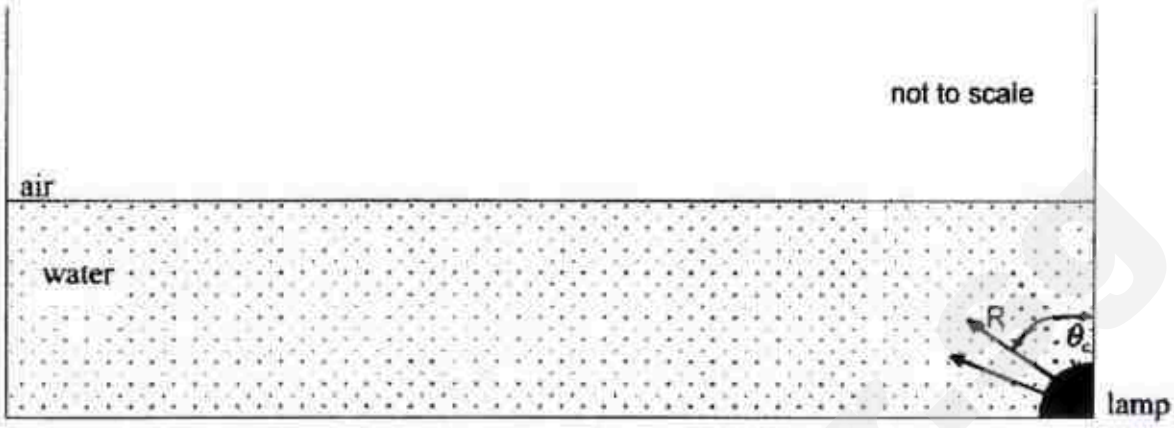


Fig. 5.1

a) Determine

i) the speed of light in water;

speed of light in water = ... m s^{-1} [2]

ii) the critical angle θ_c

θ_c = ... [2]

b) On Fig. 5.1 draw the continuation of the paths taken by the two rays shown. [2]

A thick layer of oil of a *smaller* refractive index than water is poured over the surface as shown below.

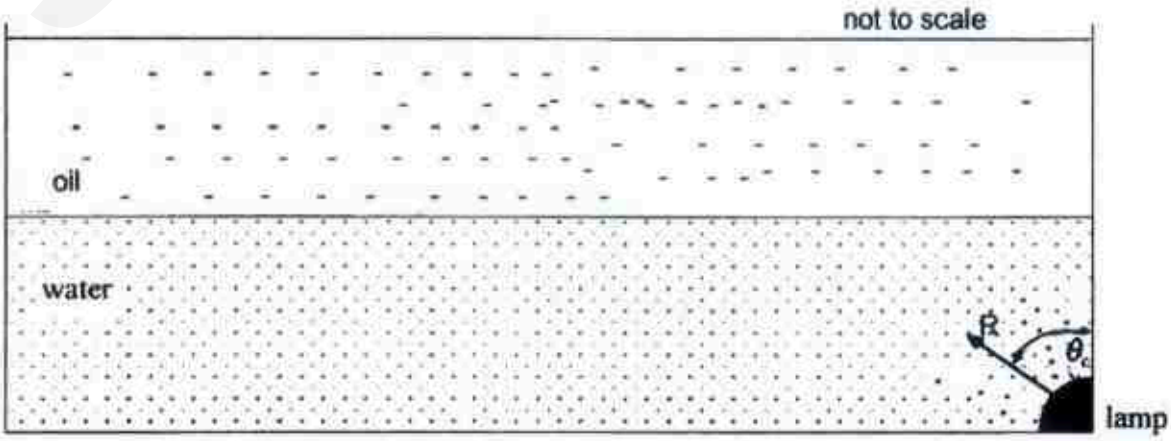


Fig. 5.2

c) Without calculation, complete the path of light ray R in Fig. 5.2 after it strikes the water-oil interface. [1]

6. Two metal conductors P and Q are mounted on insulating stands. Conductor P is given a positive charge, while conductor Q is uncharged.

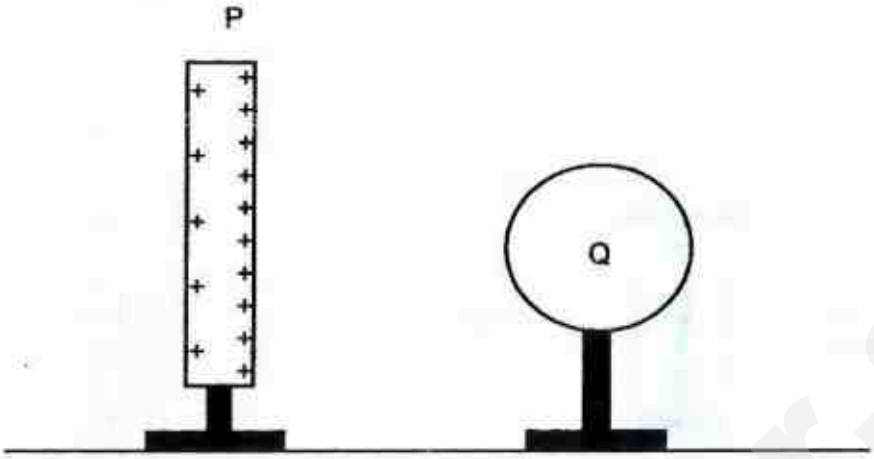


Fig. 6

a) On Fig.6,

i) draw the charges induced on conductor Q. [1]

ii) sketch the electric field pattern between conductor P and Q. [1]

b) Explain why there is more positive charge on the right-hand side of P.

.....

.....

..... [2]

7. Fig. 7 shows a motor used to raise a lift which is carrying a man inside. The power of the motor is 6400 W. The man and the lift have a total mass of 600 kg. The lift accelerates upward at 0.100 m/s^2, moving a vertical distance of 11.3 m from rest in 15 s.

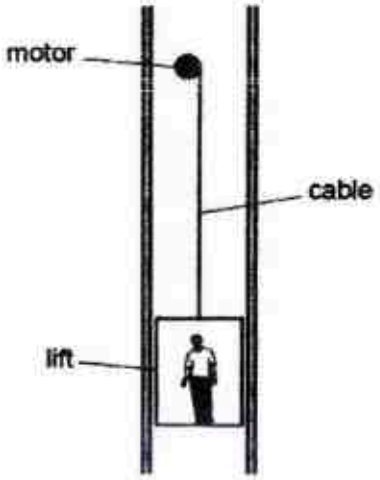


Fig. 7

(a) Calculate the tension in the cable when the lift is accelerating upwards at 0.100 m/s^2. [2]

(b) Determine the work done by the motor in 15 s. [1]

(c) Calculate the efficiency of the motor. [2]

(d) Explain how the law of conservation of energy applies from t = 0 to t = 15 s.

.....

.....

.....

..... [2]

8 Fig. 8.1 shows a simple d.c. motor. The ends of coil ABCD are soldered to metal pieces M and N. M and N are in constant contact with carbon brushes P and Q.

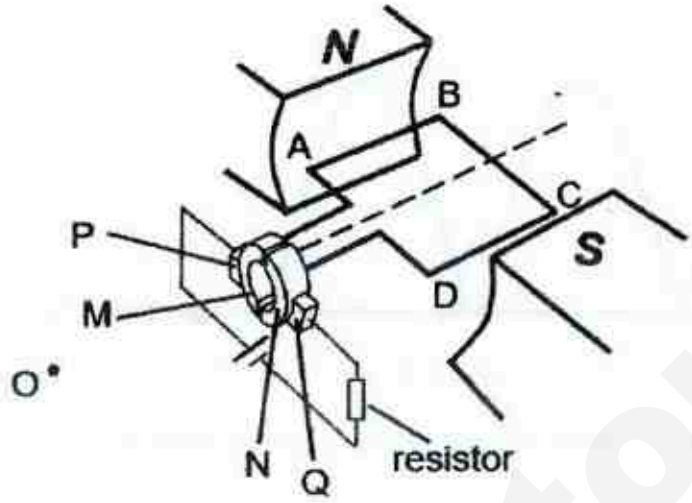


Fig. 8.1

(a) On Fig. 8.1, show the direction of current in the wires AB and CD. [1]

(b) **(i)** Explain why segment AB of the coil experiences a force. [1]

.....

.....

.....

(ii) Explain how you can determine that a downward force acts on AB. [1]

.....

.....

(iii) State the direction of the coil's rotation, as seen by an observer O. [1]

.....

.....

(c) Explain why coil ABCD rotates in the same direction after every half a rotation. [2]

.....

.....

.....

(d) Fig 8.2 shows how the turning moment varies with time when coil ABCD is rotating.

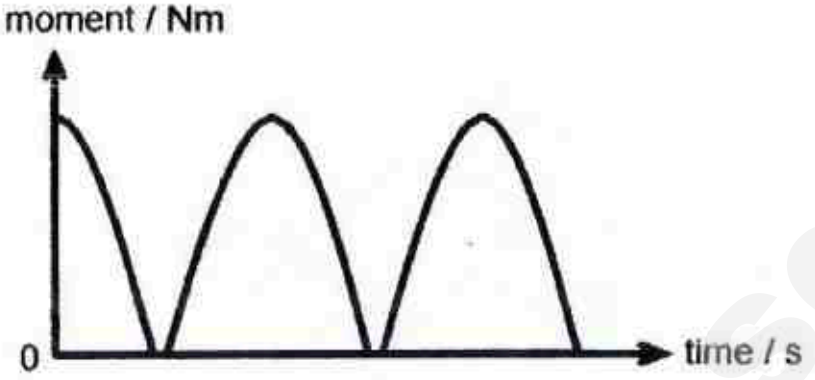


Fig. 8.2

On Fig. 8.2, mark with a 'X' when the coil is in the vertical position. [1]

Section B

Answer **all** the questions in this section

Answer only one of the two alternative questions in **Question 11**.

9. Two solid metal rods, P and Q, made from the same material, are of length 30 cm. They are each clamped at one end to an identical water bath maintained at a temperature of 100 °C, as shown in Fig. 9.1. The room temperature is 26 °C.

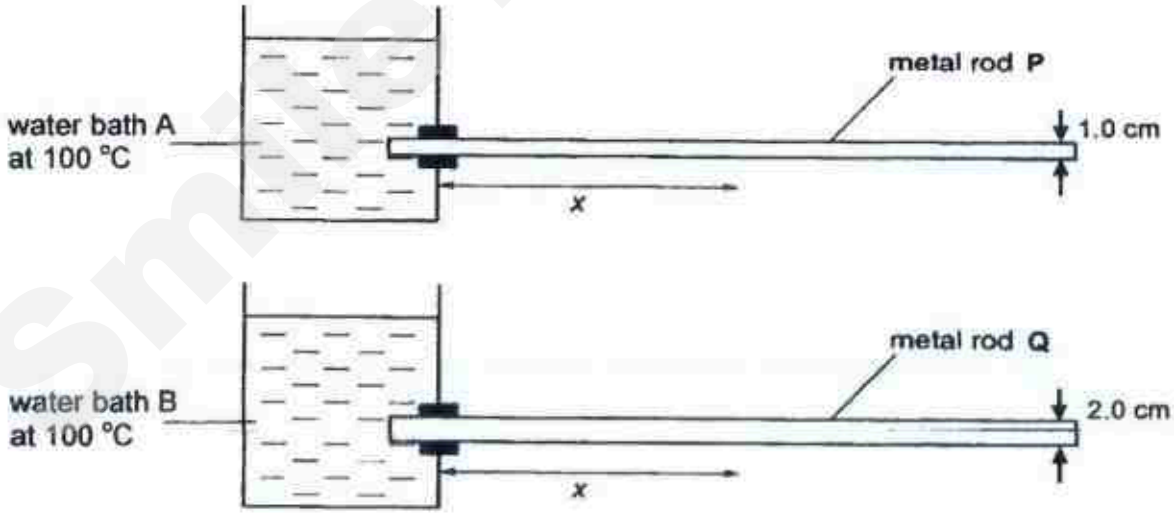


Fig. 9.1

The diameter is 1.0 cm for rod P and 2.0 cm for rod Q. The apparatus is left for 2 minutes until the temperature at any point along the rod remains constant. The temperature, θ, is measured at various distances, x using infra-red thermometer. Fig. 9.2 shows the readings obtained.

	rod P	rod Q
x / cm	θ / °C	θ / °C
0.0	100	100
2.5	88	92

5.0	76	84
7.5	68	78
10.0	61	73
12.5	55	68
15.0	50	63
17.5	46	59
20.0	42	56
22.5	38	54
25.0	36	53
27.5	35	52
30.0	34	51

Fig. 9.2

a) Using the data in Fig. 9.2, describe the relationship in **rod P** between x and drop in temperature, θ

i) for small distance, x .....

.....

ii) for large distance, x .....

.....

[2]

b) At a molecular level, explain how thermal energy is transferred away from the water bath to the end of the rods.

.....

.....

..... [2]

c) i) Explain how the data in Fig. 9.2 suggests that heat transfer along the rod is more efficient in rod Q.

.....

..... [1]

ii) State the ways in which thermal energy is lost from the end of the rod (x = 30 cm).

.....

.....

..... [1]

d) After approximately 2 minutes, the temperature at every point along rod P and Q becomes constant. State and explain whether there is a transfer of thermal energy through the rods after 2 minutes.

.....

.....

..... [2]

e) When the power of the water bath is switched off, the water cools down. State and explain which water bath will cool down more quickly.

.....

.....

.....

..... [2]

10. A circuit is set up as shown in Fig. 10.1. The resistance of the LDR varies from 800 Ω to 2400 Ω under different brightness.

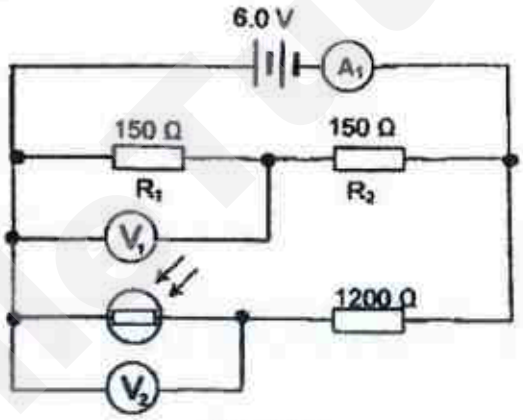


Fig. 10.1

(a) In Fig. 10.2, sketch a graph to show how the resistance of LDR varies with light intensity. [2]

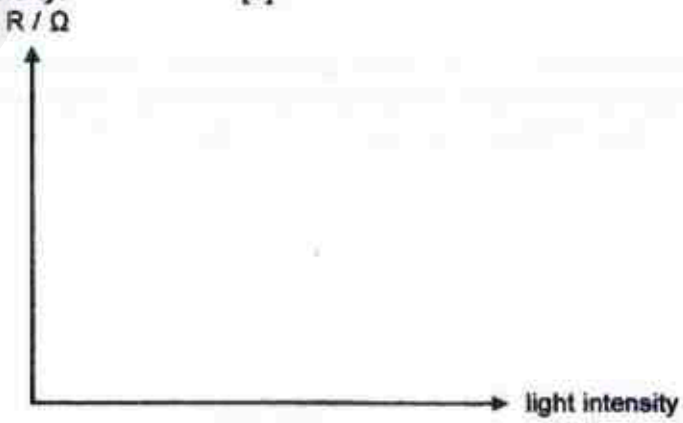


Fig. 10.2

(b) State the voltmeter reading on V_1.

V_1 = ... V [1]

c) Calculate the reading shown on the ammeter A_1 when the LDR's resistance is 800 Ω.

ammeter reading = ... A [3]

d) **i)** What is the voltmeter reading V_2 when the light intensity is low?

V_2 = ... V [2]

ii) An ammeter A_2 is now connected across points X and Y. Indicate in Fig. 10.3 below the direction of current flow. Explain your answer using numerical values where possible.

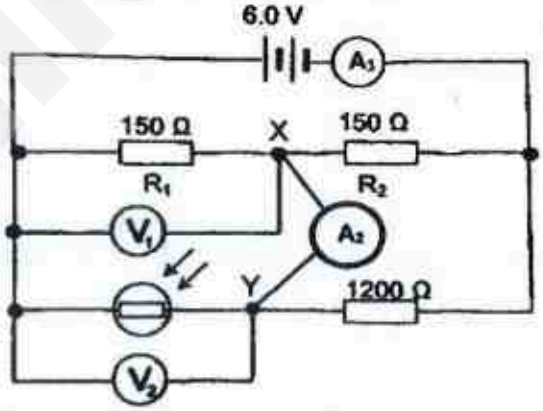


Fig. 10.3

.....

.....

..... [2]

11. Either

Sound is propagated in air as a longitudinal wave, in which there is a repeated sequence of displacements of the air particles. Fig. 11.1 illustrates nine particles, equally spaced along the line AB, in still air.

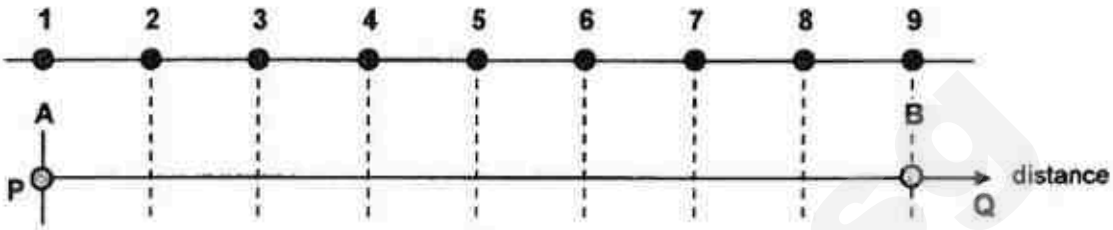


Fig. 11.1

Fig. 11.2

a) A sound wave of wavelength equal to AB is sent through the air in the direction of PQ.

i) On line PQ on Fig. 11.1, draw the possible positions of the nine particles in the wave relative to their positions in still air, when the sound wave propagates through the particles. Particles 1 and 9 have been drawn for you. [2]

ii) Sketch a graph showing how the displacement, *d* of the particles from their undisturbed positions vary along PQ on Fig. 11.2. Take direction to the right as positive. [1]

b) A sound wave can also be described in terms of a repeated sequence of changes in pressure. On Fig. 11.2, identify, and label with H, a point where the pressure is the highest. Explain your choice clearly.

.....

..... [2]

c) Fig. 11.3a shows the trace on a cathode-ray oscilloscope (C.R.O.) when a pulse of ultrasound is reflected from a distant object.

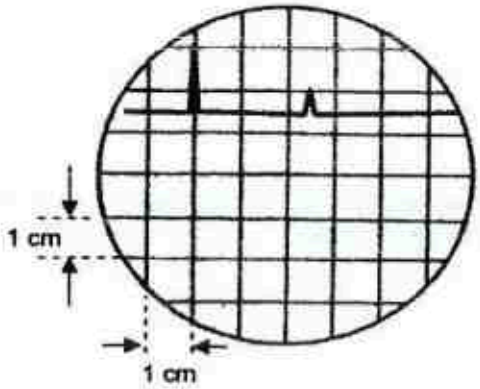


Fig. 11.3a

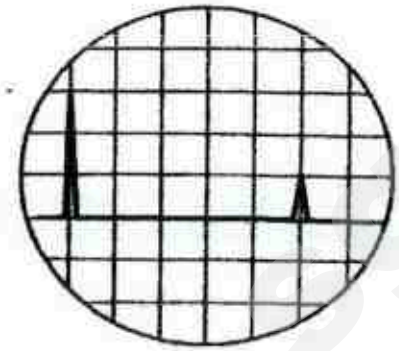


Fig. 11.3b

The controls on the cathode-ray oscilloscope are adjusted to produce the trace shown in Fig. 11.3b.

i) Explain in detail how the controls shown on the cathode-ray oscilloscope are adjusted.

.....

.....

..... [2]

ii) The larger peak shows the transmitted pulse; the smaller peak shows the reflected pulse. Explain why the reflected pulse has a smaller peak compared to the transmitted pulse.

.....

..... [1]

iii) For the trace shown in Fig. 11.3b, the Y-gain is set at 5 mV/cm with time base at 0.20 s/cm. Determine the distance of the object from the ultrasound detector given that the speed of the ultrasound is 1500 m s^{-1} in the medium.

distance = ... m [2]

11 OR

Fig. 11.4 shows a bar magnet attached to a spring oscillating above a coil of wire. The bottom of the magnet moves up and down between P and R. Fig. 11.5 shows the same magnet by itself.

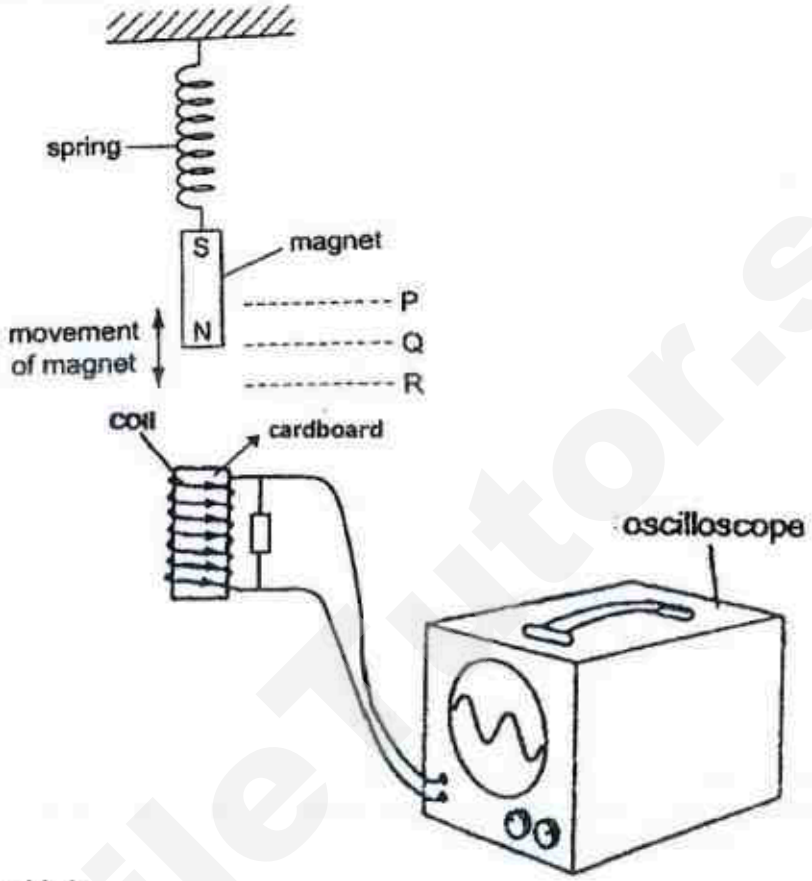


Fig. 11.4

Fig. 11.5

a) On Fig. 11.5, draw the magnetic field pattern around the bar magnet. [2]

b) When the magnet oscillates, an electromotive force (e.m.f.) is induced in the coil.

i) Explain why an e.m.f. is induced.

.....

..... [1]

ii) Explain why an increase in the amplitude of oscillation will increase the induced e.m.f. in the coil.

.....

..... [1]

iii) State and explain the position(s) of the bottom of the magnet when there is no induced electromotive force (e.m.f.) in the coil.

.....

.....

.....

..... [2]

c) The coil is connected to the y-input of a cathode-ray oscilloscope.

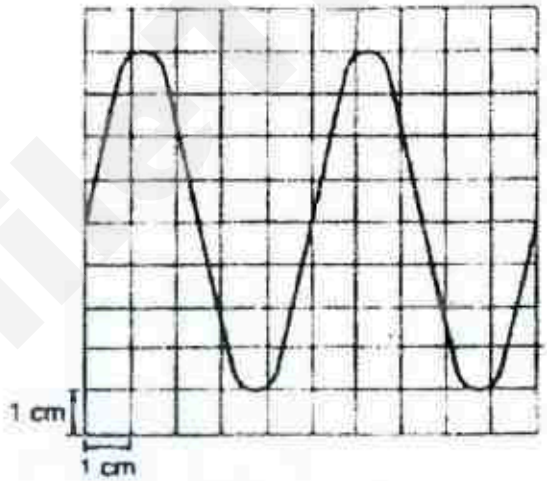


Fig. 11.6

For the trace shown in Fig. 11.6, the Y-gain is set at 2 mV/cm and time base at 0.20 ms/cm. Determine the frequency of oscillation of the bar magnet. [2]

d) When the magnet moves from P to R in Fig. 11.4, the direction of the induced current in the coil is shown by the arrows.

Explain why the current is in the direction shown.

.....

.....

.....

SCGS MS

1 (a) P – weight , Q – air resistance
(b) The skydiver begins to accelerate. [1]

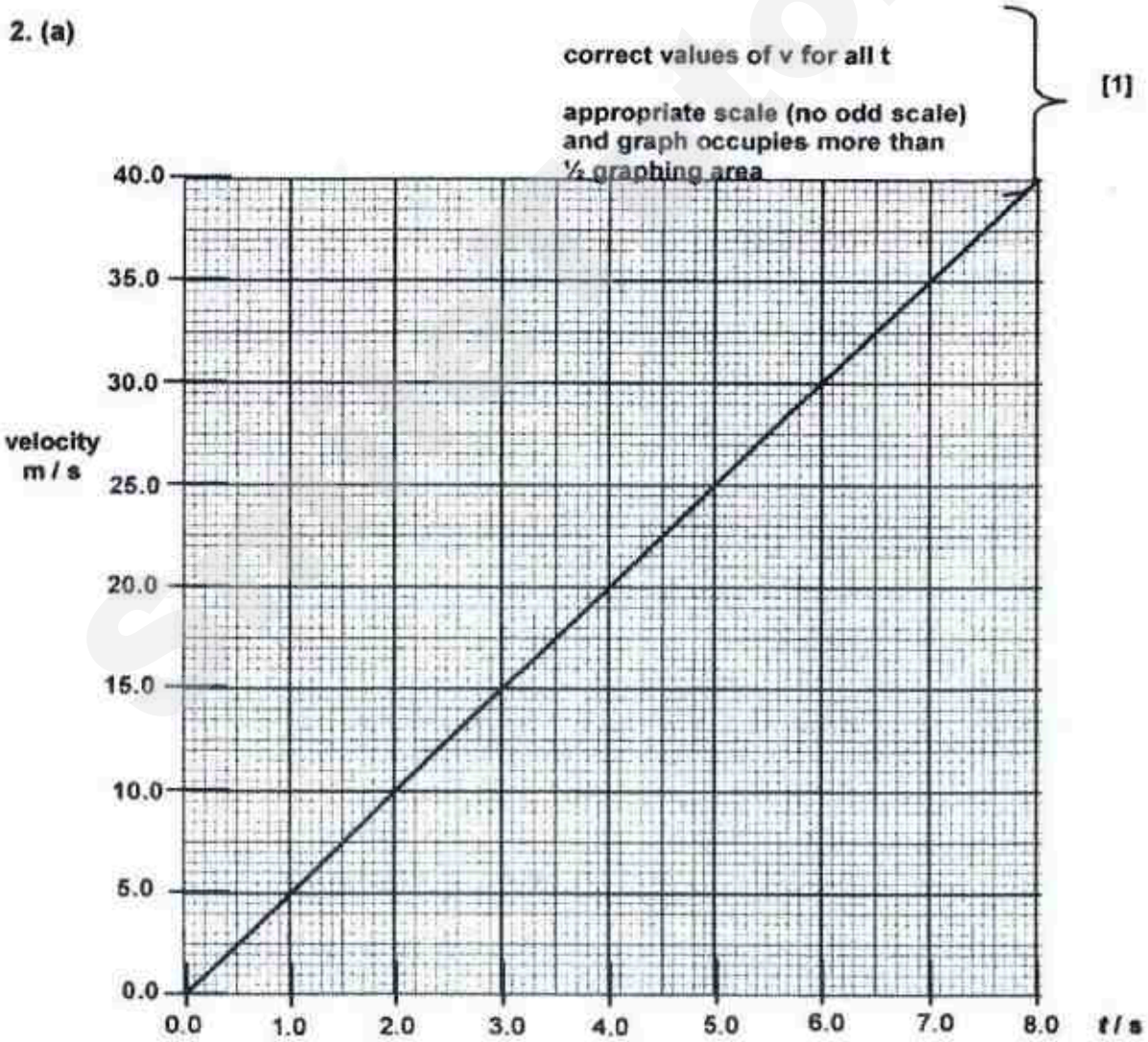
When the forces P and Q are unbalanced, a downward resultant force acts on the skydiver which causes him to accelerate towards the ground. [1]

(c)(i) Q = 750 N
(ii) When the air resistance acting against the skydiver is equal to the weight, there is no resultant force acting on the skydiver. Since he is already in motion, he continues to remain in uniform motion in the same direction due to his inertia

(d) Any one of the following:

- The forces are acting on the same body.
- The magnitudes may not always be equal.
- The forces are of different nature (contact/ non-contact)

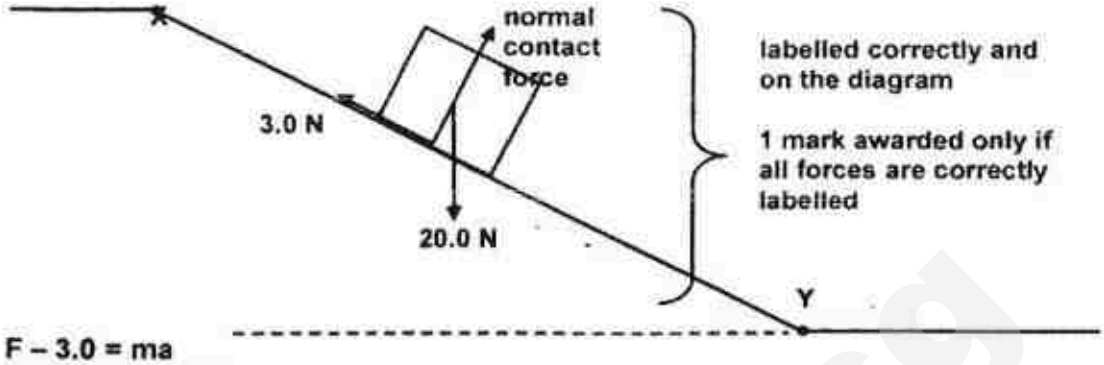
2. (a)



(b) distance travelled = area under the velocity-time graph

distance XY = ½ (8.0) (40) = 160 m [1]

(c) (i)



(ii) F – 3.0 = ma
F – 3.0 = (2.0)(5.0)
F = 13.0 N [1]

3. (a) W = mg = 5.0 x 10 = 50.0 N [1]

(b)
1. Large base area [1]
2. Low position of CG [1]

(c) Taking moments about Y, (either from front or side)
F x 0.500 = mg x 0.250 [1] substitution
Minimum force = 25.0 N [1]

(d) It would not make any difference as the CG is in the centre and the barrier is symmetrical.

4. (a) (i) The gas molecules are in constant, random motion and travel at high speeds. They collide with the piston and syringe wall, exerting an average force on the walls. [1] The average force acting per unit area of the wall gives rise to the air pressure. [1]

(ii) Due to the very large number of molecules present, and the average KE is fixed since the temperature is constant, the rate of collision / bombardment of the molecules on every point of the wall is equal. [1]

The average force the molecules exert per unit area on the wall is the same at all points in the tube. Hence, the pressure is the same. [1]

b) (i) Pressure of trapped air = $h\rho g$
= (0.100)(13600)(10) [1] substitution
= 13 600 Pa [1]

(ii)
Pressure exerted by metal = mg/A
mg / (0.0025) = 13 600 [1] substitution
mg = 34
m = 3.40 kg [1]

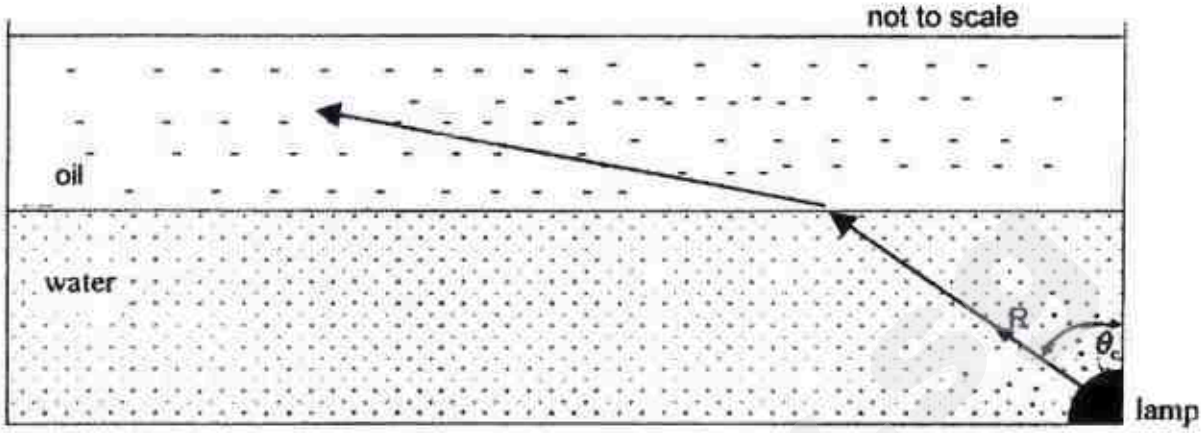
(iii) Pressure of air in enclosed tube = pressure due to metal weight + atmospheric pressure
= 13600 + (0.76 x 13600 x 10)
= 13600 + 103 360
= 117 000 Pa [1]

5. (a) (i) speed of light in vacuum/speed of light in water = 1.33 [1]
speed of light in water = 3.0×10^8 ms^{-1} / 1.33 = 2.26×10^8 ms^{-1} [1]

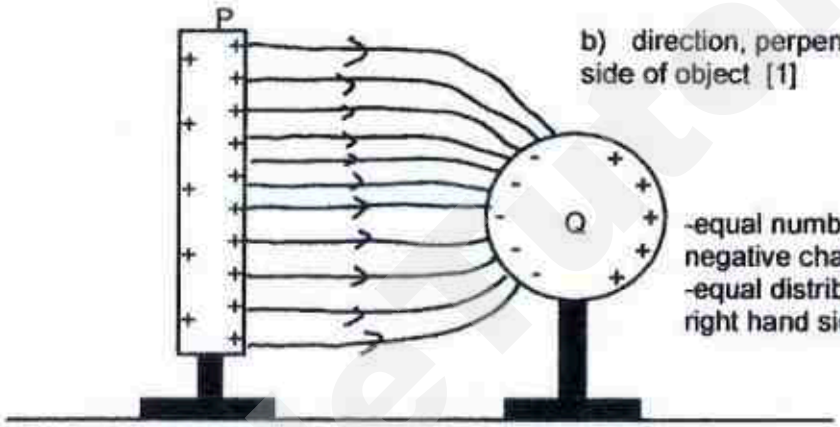
(ii)
$\sin \theta_c = 1/1.33$ [1]
$\theta_c = 48.8°$ [1]

(b)
one path shows critical angle one path shows total internal reflection

(c)



6.



b) direction, perpendicular to the side of object [1]

-equal number of positive charges and negative charges
-equal distribution of charges on left and right hand side [1]

(b) the electrons in P move away from the right hand side of P.
they are repelled by the electrons in the left hand side of Q.
the lack of electrons in the right hand side of P caused this area to have greater number of positive charges [1]

7. (a) Tension = mg + ma [1]
= 600 x 10 + 600 x 0.100 = 6060 N [1]

(b) Energy used = 6060 x 11.3 = 68,478 J [1]
= 68 500 J

(c) Useful power of motor = 68,478 ÷ 15 = 4,565.2 W [1]

Efficiency = useful power/ total power input x 100%
= 4565.2 / 6400 x 100 = 71. 3% [1]

(d) the total energy of the motor, lift and man is conserved [1].

From time t = 0 to t = 15 s, energy from the motor is used to carry the lift and man upwards, therefore converting to GPE and KE.
A portion of energy from motor is also converted to heat and sound energy.

8 (a) Direction of current from A to B and from C to D

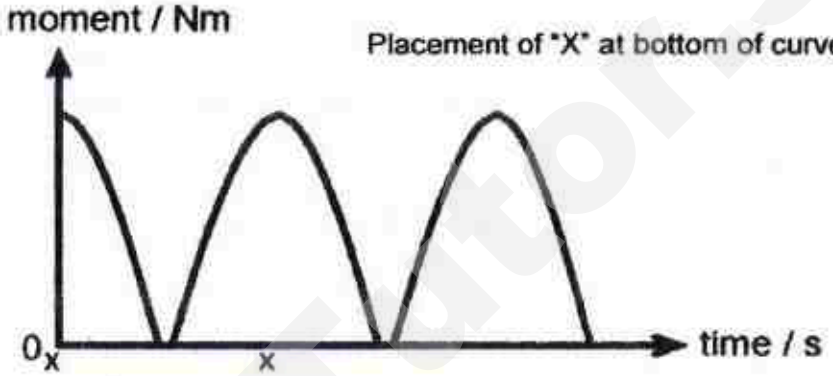
(b) (i) The circular magnetic field of a current-carrying wire interacts with the permanent magnets' magnetic field to produce a force.

(ii) Using Fleming's left hand rule, the index finger indicates the direction of the magnetic field and the middle finger indicates the direction of the current. The thumb, which indicates the direction of the induced force, is downwards.

(iii) The coil rotates in an anti-clockwise direction.

(c) After half an oscillation, the split rings M and N switch place, and the flow of current in AB and CD are reversed i.e. current flows from D to C and from B to A. [1] According to Fleming's left-hand rule, the force will now act downwards on CD and upward on AB, producing an anticlockwise moment to allow the coil to turn continuously. [1]

(d)



Placement of "X" at bottom of curve (horizontal axis).

9. (a) (i) **for *x* between 0 and 5.0 cm, the drop in temperature is 12 °C per 2.5 cm. It has the greatest drop in temperature compared to the rest of the rod.**

(ii) **for *x* greater than 5.0 cm, the drop in temperature is non-linear and of a decreasing value**

b) **The atoms of the metal rod in contact with the water bath gains thermal energy. They vibrate more vigorously and collide with the neighbouring atoms, transferring energy to them [1]. The free moving electrons also carries the energy to the rest of the metal rod. [1]**

c) i) **rod Q shows a lesser temperature drop for the same distance *x***

(ii) **convection current to the surrounding air**

Infra-red radiation to the surrounding

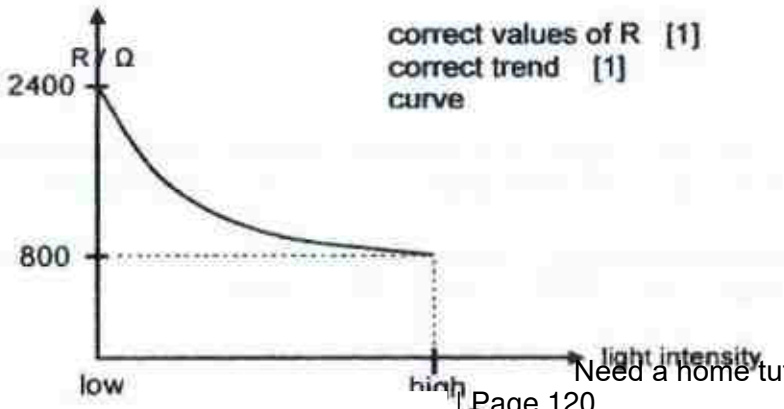
d) **Yes, thermal energy continued to be transferred through the rods after 2 minutes. [1]**

At any point along the rod, the rate of heat gain is equal to the rate of heat lost, resulting in no net heat gain and hence the temperature at that point is constant. [1]

e) **water bath B will cool down more quickly [1]**

the rate of thermal energy transfer is faster through metal rod Q [1]

10. **(a)**



correct values of R [1]
correct trend [1]
curve

(b) $V_1 = 3.0$ V

c) Total resistance $R = (1/(150+150) + 1/(800+1200))^{-1} = 261\ \Omega$ [1]
V= IR
6.0 = I (261) [1]
I = 0.023 A [1]

d) **i)** $V_2 = (2400 /(2400 + 1200) * 6.0$ V [1] = 4.0 V [1]

ii) Arrow drawn on Fig 10.3 showing direction of conventional current from X to Y. [1]
Current flows from high potential to low potential; $V_x = 3.0$ V and $V_y = 2.0$ V. [1]

11

a(i)

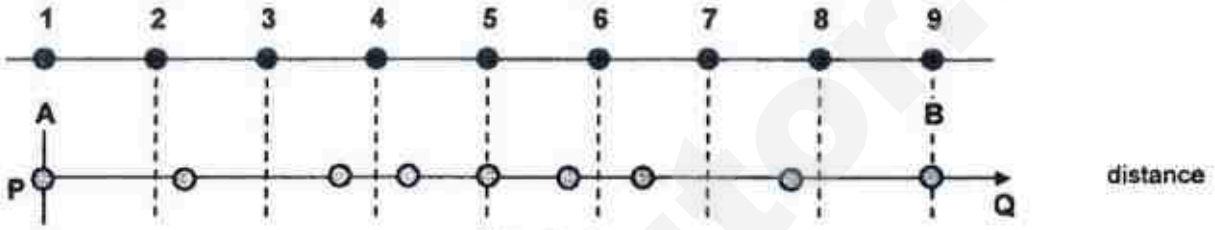


Fig. 11.1

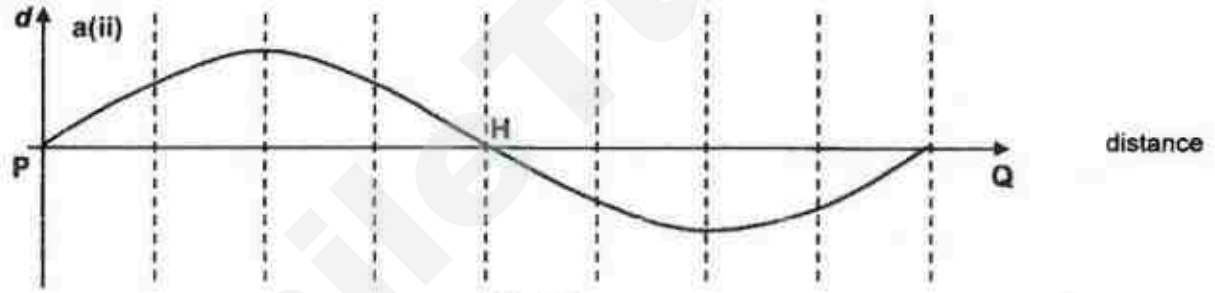


Fig. 11.2

a) **i)** must show one complete wave [1]
at least one particle at equilibrium position & particles before and after equilibrium position to be in opposite displacement [1]

ii) wave must be drawn correspond to (i)

b) Point H, a point of high pressure, occurs at where particle 5 is as this is where compressions occur due to neighbouring air particles 4 and 6 coming closer to one another [1].
(label H --- [1])

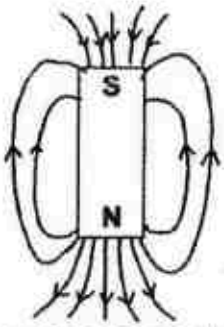
c) **i)** Adjust the Y-shift by 2.5 cm vertically down and X-shift by 1cm to the left. [1]
Adjust the Y-gain to a smaller V / cm.
Adjust the time-base to a smaller ms / cm. [1]

(ii) The pulse is transmitted over a large area and only a fraction of the transmitted energy is reflected off by the object and all the rest of the energy is lost to the surrounding/absorbed by the object after reflection.

(iii) time taken for the sound wave to travel from object = 5 cm x 0.20 s/cm x ½ = 0.50 s [1]
distance = speed x time = 1500 x 0.50 = 750 m [answer 1]

OR

11 (a) magnetic field lines must be in contact with magnet [1]
field lines show greater concentration near to magnet [1]



b) **i)** As magnet oscillates, there is a rate of change of magnetic flux linkage experience by the coil. Hence by Faraday's Law of EMI, an e.m.f. is induced in the across the coil. [1]

ii) as amplitude of oscillation is greater, magnet oscillate with greater speed. Greater rate of change of magnetic flux linkage experienced by the coil, hence emf induced increases.

iii) During the oscillation, when bottom of magnet is at 'P or R'; the magnet is stationary momentarily [1],
the coil does not experience a changing magnetic flux and hence no e.m.f. is induced at those instants. [1]

c) one cycle at 0.20 x 5 ms = 1.00 ms [1]
freq = 1/T = 1/0.001 = 1000 Hz [1]

d) According to Lenz's Law, as the coil experiences a changing magnetic flux, the current flow will be in the direction indicated in Fig.11.4, in order to *produce* a magnetic effect in the coil [1] to oppose the changing magnetic flux [1],

Answers for paper 1

1	C	11	B		21	B		31	A
2	B	12	B		22	C		32	D
3	D	13	D		23	D		33	B
4	D	14	C		24	B		34	B
5	A	15	C		25	A		35	B
6	A	16	D		26	C		36	D
7	D	17	B		27	C		37	C
8	A	18	C		28	B		38	D
9	A	19	B		29	A		39	A
10	C	20	B		30	D		40	B

TEMASEK SECONDARY SCHOOL
O Level Preliminary Examination 2017
Secondary 4 Express

PHYSICS **5059/01**

Paper 1 **1 hour**

Question Booklet
Additional materials: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are not required to hand in this booklet at the end of the paper.

Write your name, index number and class in all the work you hand in.
Write in soft pencil.

There are **forty** questions on 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 separate Answer sheet.

Read the instructions on the Answer Sheet very carefully.

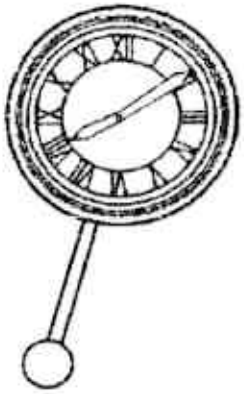
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

This document consists of **19** printed pages and **1** blank page.

Answer **all** the questions (40 Marks)

1 A pendulum clock is tuned to measure time accurately.



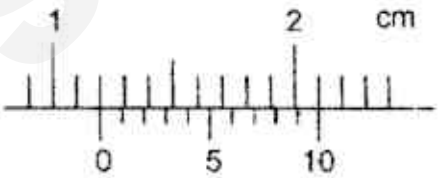
Which factor(s) will affect its ability to measure time accurately?

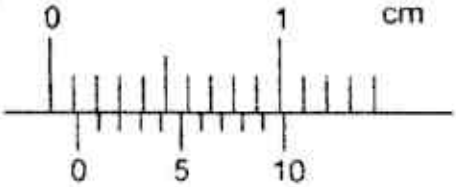
I Change in room temperature.
II Change in atmospheric pressure.
III Change in mass of the pendulum.

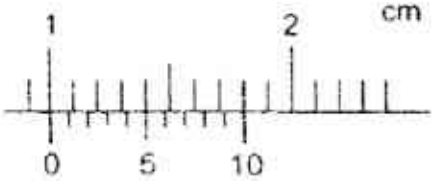
A I only **B** I and III only **C** II and III only **D** I, II and III

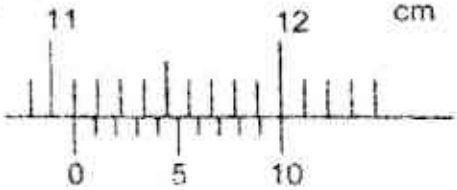
2 Universal Serial Bus (USB) cables are commonly used for charging of modern smartphones and transfer of data to computers. The width of a USB connector is measured using a vernier caliper.

Which of the following shows a possible measurement from a vernier caliper?

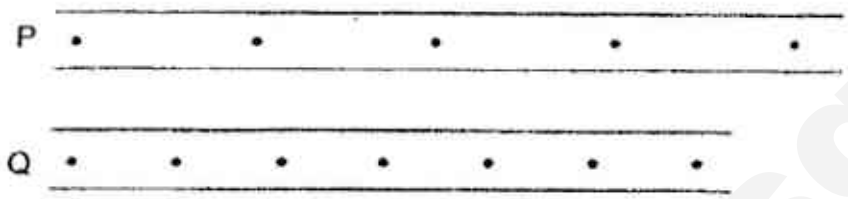
A


B


C


D


3 Two objects, P and Q are each connected to the ticker-tape timers with a frequency of 50 Hz and 100 Hz respectively. The following tapes are obtained from the entire journey of the two objects.



Which of the following statements is correct?

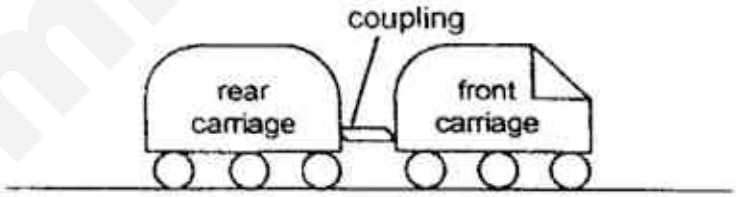
A P has a higher speed than Q, and travels a shorter distance.
B P has a higher speed than Q, and travels a longer distance.
C P has a lower speed than Q, and travels a shorter distance.
D P has a lower speed than Q, and travels a longer distance.

4 Due to a technical fault, brakes are applied on a Mass Rapid Transit (MRT) train in Singapore. The train brakes with a constant deceleration of 2.0 m/s^2 and comes to a stop after 81 m.

What is the initial velocity of the train?

A 6.4 m/s **B** 9.0 m/s **C** 18.0 m/s **D** 40.5 m/s

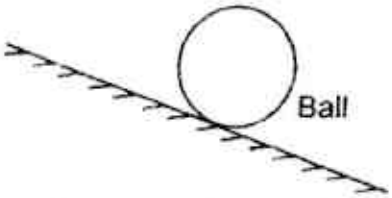
5 In a two-carriage train, an electric motor at the front carriage exerts a driving force *F*. The ratio of the mass of the front carriage to the rear carriage is 3:2.



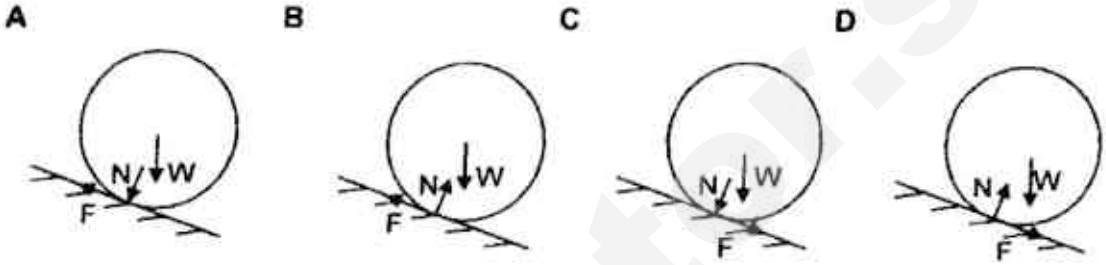
Assuming that there are no resistive forces, what is the magnitude of the tension in the coupling between the trains?

A $\frac{2F}{3}$ **B** $\frac{3F}{2}$ **C** $\frac{2F}{5}$ **D** $\frac{3F}{5}$

6 The diagram below shows a ball, with a weight of **W**, rolling down a slope at constant velocity. Frictional force **F** and normal contact force **N** are acting on the ball.

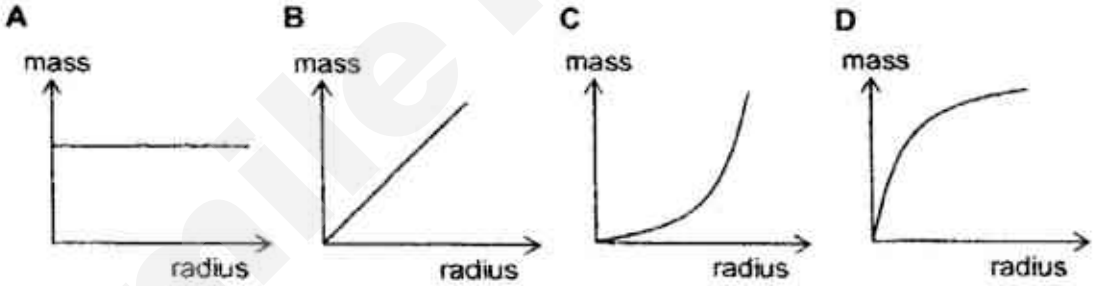


Which of the following shows the correct free-body diagram?

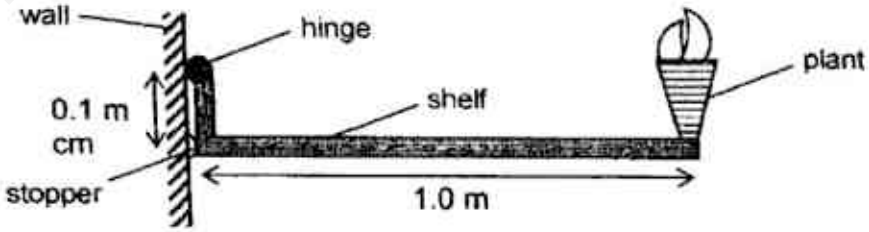


7 Steel spheres of different diameters are being manufactured in a factory.

Which of the following graphs illustrates the relationship between the radius of the sphere and its mass?



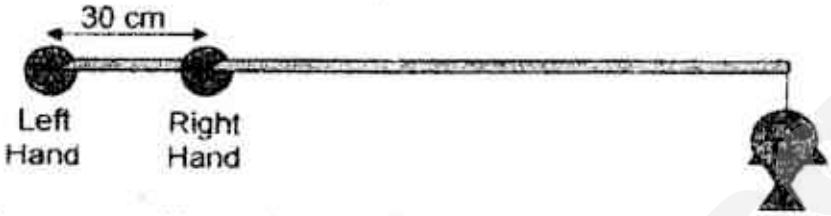
8 A foldable right-angled shelf is attached to a wall as shown below.



The weight of the shelf and plant are 10 N and 20 N respectively. If the shelf exerts a force of 240 N on the hinge, what is the horizontal distance between the centre of gravity of the shelf to the wall?

A 0.10 m **B** 0.40 m **C** 0.50 m **D** 0.60 m

9 A fisherman holds a rigid fishing rod in a horizontal position. A fish is hung at the end of the fishing rod as shown. The fishing rod has a length of 1.5 m and the fish has a weight of 15 N.

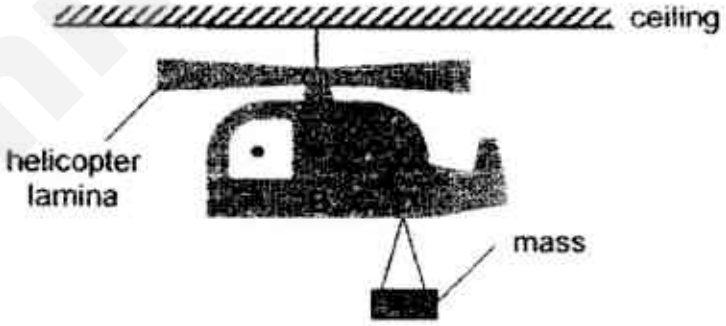


What is the force exerted by each hand if they are placed 30 cm apart?

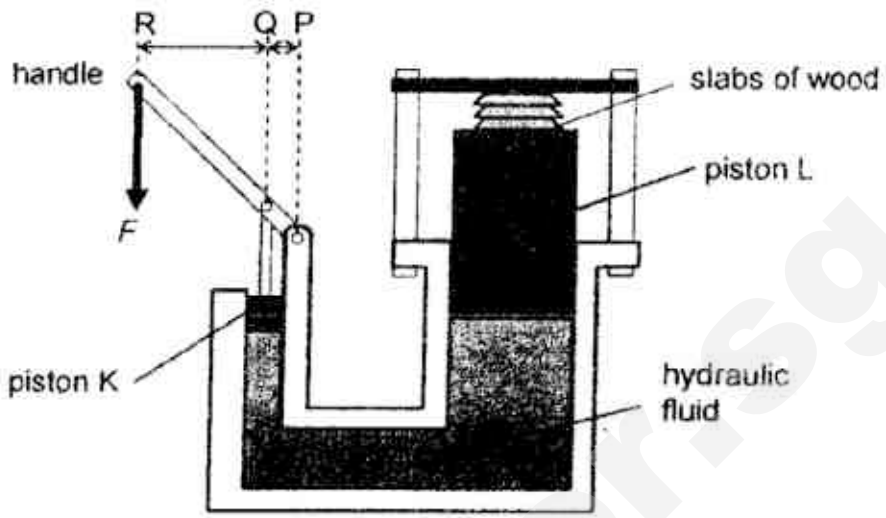
	force exerted by left hand	force exerted by right hand
A	0 N	15 N
B	0 N	75 N
C	60 N	0 N
D	60 N	75 N

10 A helicopter lamina is hung from the ceiling and a mass is attached to one end of it.

If the diagram below is in equilibrium, where is the centre of gravity of the helicopter lamina without the mass?



11 The diagram below shows a hydraulic press used to compress slabs of wood together.

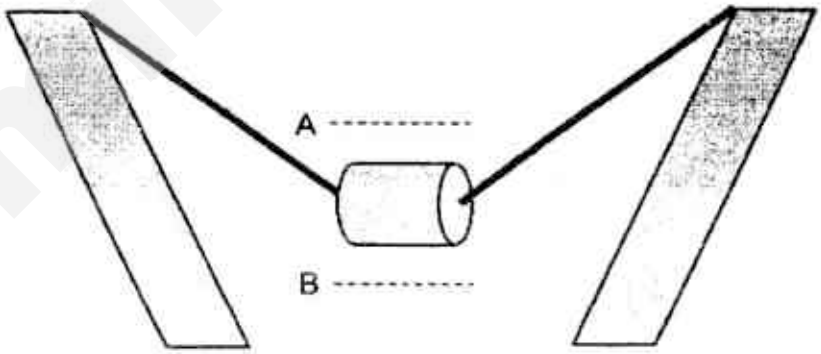


The ratio of the surface area in contact with the hydraulic fluid of piston K and piston L is 1:5, while the ratio of the horizontal distances RQ and QP are 4:1.

If piston L moves up by 1.0 cm, what is the vertical displacement of point R where force F is applied?

A 1.25 cm **B** 5.0 cm **C** 20.0 cm **D** 25.0 cm

12 A bungee ride is hung between two pillars by two elastic ropes at each end. It is now at its rest position. When displaced, the ride will oscillate between A and B.



What of the following correctly describes the energy at the two points?

	energy at point A	energy at point B
A	kinetic	kinetic
B	kinetic	potential
C	potential	kinetic
D	potential	potential

13 A box is sliding down a slope with constant velocity.

To calculate the power developed by the box to overcome friction, which of the following information is not required?

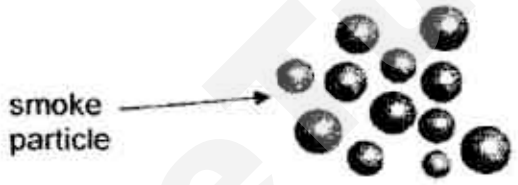
A weight of the box
B height of the slope
C normal force between the box and the slope
D total time taken for the box to reach the bottom of the slope

14 A toy car, with a mass 450 g, has an initial velocity of 0.90 m/s. It decelerates and comes to a stop after 4.0 m.

What is the magnitude net force on the toy car?

A 0.046 N B 0.18 N C 0.41 N D 4.5 N

15 In the Brownian motion experiment, illuminated smoke particles, suspended in air, are observed under a microscope.



I Air particles are in continuous random motion.
II Air molecules collide with smoke particles.
III All the smoke particles move at the same speed but different directions.

Which of the statements above are correct?

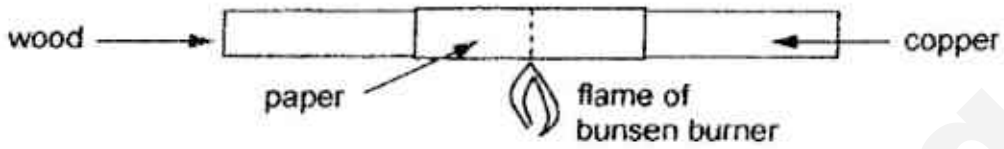
A I and II only B I and III only C II and III only D I, II and III

16 A student investigates the condensation of nitrogen gas at low temperature.

Which of the following statements incorrectly describes the behaviour of the nitrogen molecules during condensation?

A The nitrogen molecules move freely.
B The nitrogen molecules move at a slower speed.
C The nitrogen molecules occupy a smaller volume.
D The nitrogen molecules are in constant, continuous motion.

17 The diagram below shows a wooden bar and a copper bar joined together at one end with a piece of paper wrapped tightly around the centre.

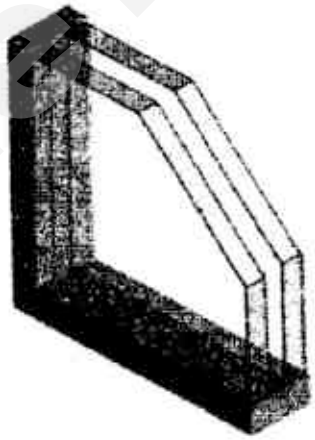


Heat is applied from the flame of a bunsen burner at the paper and the paper goes brown on one side only.

Which side of the paper goes brown and what can we conclude about wood and copper?

	brown side	copper	wood
A	copper	good conductor of heat	poor conductor of heat
B	copper	poor conductor of heat	good conductor of heat
C	wood	good conductor of heat	poor conductor of heat
D	wood	poor conductor of heat	good conductor of heat

18 The diagram below shows a side view of a double glazed window.



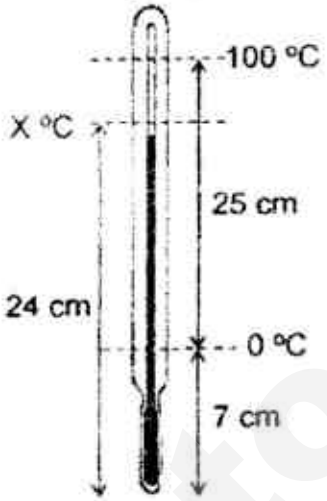
Which of the following statement(s) correctly describes the advantages of a double glazed window?

I It reduces heat transfer via convection.
II It reduces heat transfer via radiation.
III It reduces the transmission of sound.

Which of the statements is/are correct?

A I only B I and II C I and III D I, II and III

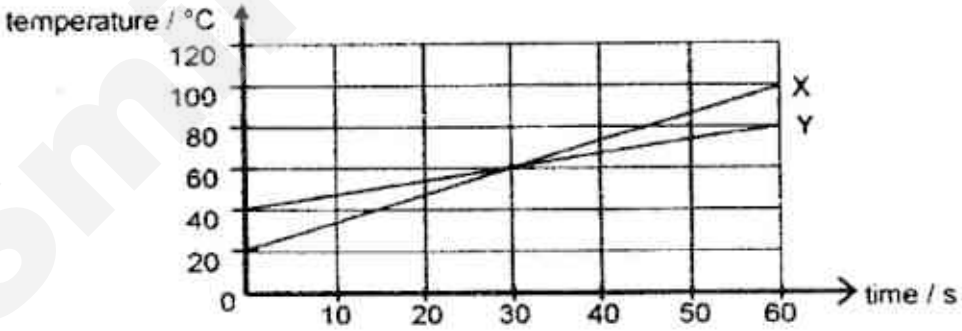
19 When a thermometer was placed in pure melting ice the mercury thread has a length of 7.0 cm when measured from the end of the thermometer bulb, as shown in the diagram. When placed in steam arising from pure boiling water at 100°C, the length of the mercury thread increases by 25.0 cm.



What is the temperature X °C if the mercury thread from the end of the thermometer is 24 cm?

A 53 **B** 68 **C** 75 **D** 96

20 Two blocks X and Y, which are made of the same metal, are heated by heaters at the same power rating. The variations of temperature with time are given below.



What is the ratio of masses X to Y?

A 1 : 2 **B** 2 : 1 **C** 1 : 4 **D** 4 : 1

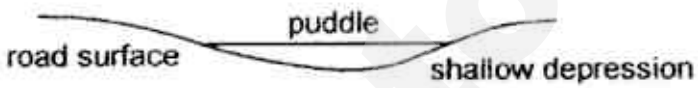
21 A cube of ice, of mass 50.0 g at -20.0 °C, is placed in a cup of water. After 95.0 s, the ice is completely melted and the temperature of the water drops from 5.0 °C to 0.0 °C.

specific heat capacity of ice = 2100 J/kg K
specific latent heat of fusion of water = 334 000 J/kg
specific heat capacity of water = 4200 J/kg K

What is the thermal energy required to melt the cube of ice at its melting point?

A 178 J **B** 2 100 J **C** 16 700 J **D** 18 800 J

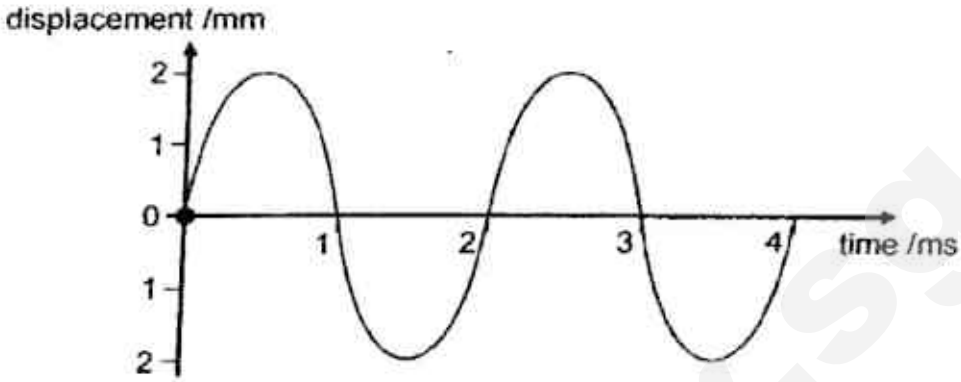
22 The diagram shows a cross-section of a rain-water puddle formed in a shallow depression in a road surface.



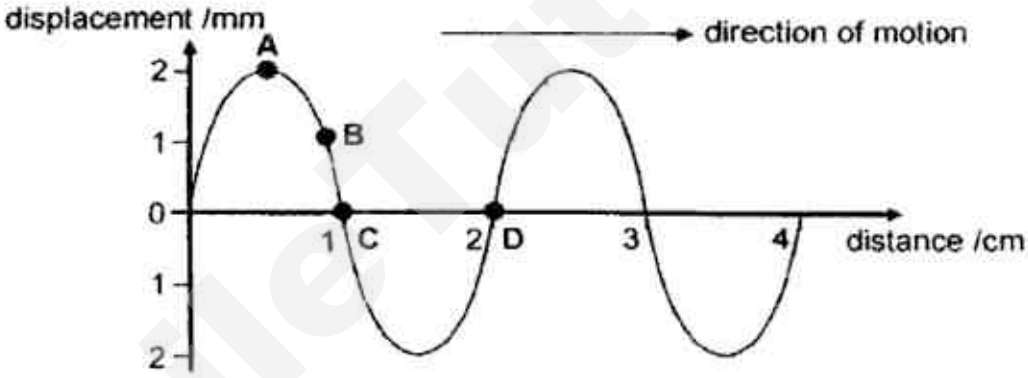
Over a period of time, air temperature, wind speed and wind direction remains constant.
Which of the following statements explains what happens to the rate of evaporation of water from the puddle over this period of time?

A It decreases, because the puddle gets shallower.
B It increases, because the puddle gets shallower.
C It decreases, because the surface area decreases.
D It increases, because the surface area decreases.

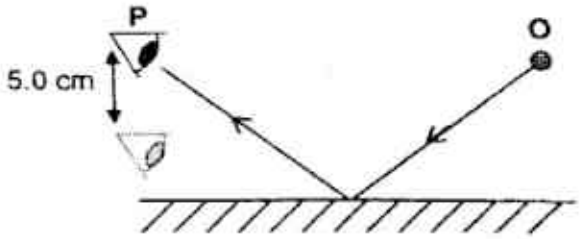
23 The following is a displacement-time graph of a particle in a wave.



Which of the following points represents the same particle of the wave one period later?



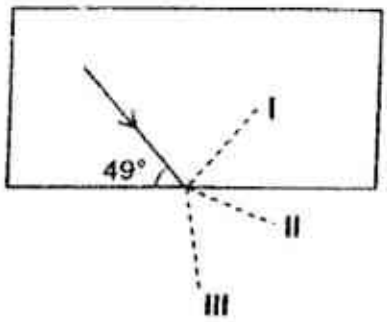
24 A boy sees the image of an object **O** from position **P**, as shown in the diagram below.



He then moves 5.0 cm closer to the mirror. Which of the following statements about the image is true?

A The image becomes magnified.
B The image position remains unchanged.
C The image moves 5.0 cm nearer to the mirror.
D The image moves 5.0 cm further from the mirror.

25 The critical angle of perspex is 42°. A light ray in a perspex block is incident on a boundary with air.

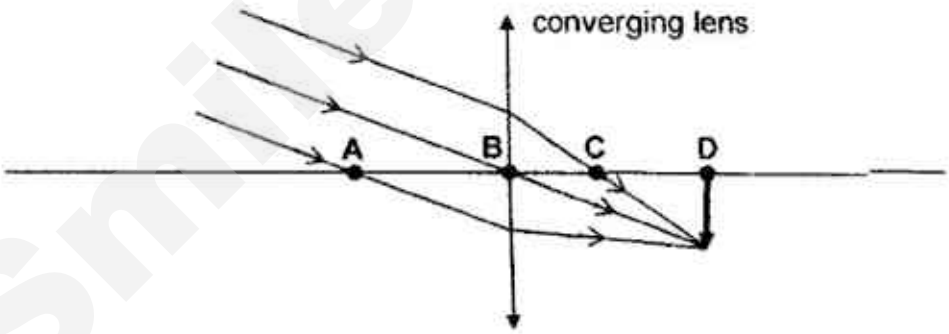


Which of the following correctly describes the subsequent path taken by the ray of light?

A The light ray is totally reflected, following path *I*.
B The light ray is totally refracted, following path *II*.
C The light ray is totally refracted, following path *III*.
D The light ray is partly reflected and refracted, following path *I* and *II*.

26 A converging lens produces a diminished, real image of an object.

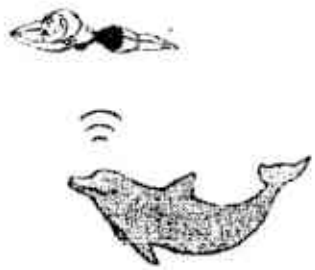
Which point is the principal focus of the converging lens?



27 Which of the following statements about X-rays and microwaves is false?

A X-rays have a higher frequency than microwaves.
B Both X-rays and microwaves can cause ionisation.
C X-rays are used in medical imaging but not microwaves.
D Microwaves are used for telecommunications, but not X-rays.

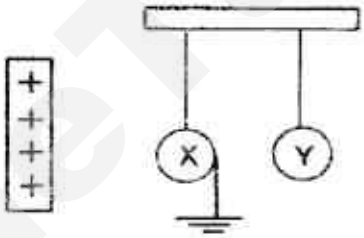
28 A dolphin emits an ultrasound wave and detects two echoes which are 40 ms apart.



Given that the speed of sound in water is 1500 m/s, what is the depth of the swimmer from the surface of the water?

A 15 m **B** 30 m **C** 60 m **D** 120 m

29 Two isolated metal spheres X and Y are initially uncharged. The diagram shows a positively charged strip being placed near metal spheres X and Y. X is then earthed momentarily and the charged strip is removed.



If it was possible for the spheres to touch each other, what are the final charges on X and Y respectively?

	X	Y
A	negative	neutral
B	neutral	neutral
C	negative	negative
D	neutral	negative

30 A storm cloud at a potential of 10^7 V with respect to Earth delivers a lightning stroke of charge 65 C to the Earth's surface in one tenth of a second.

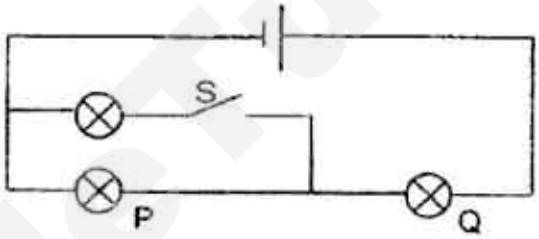
How much energy is dissipated if the potential difference remains constant?

A 6.5×10^{-6} J
B 1.5×10^{5} J
C 6.5×10^{8} J
D 6.5×10^{9} J

31 Which changes will both cause an increase in the resistance of a copper wire?

	temperature of wire	diameter of wire
A	higher	decreases
B	higher	increases
C	lower	decreases
D	lower	increases

32 In the given circuit, there are 3 identical light bulbs.

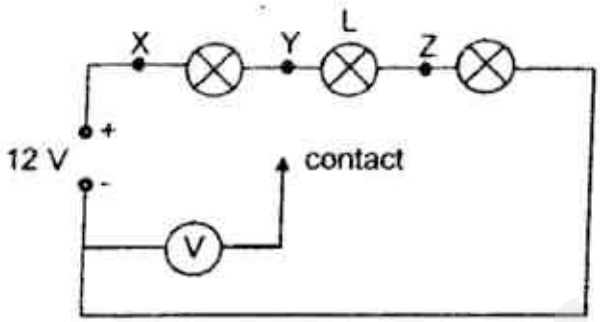


Bulbs P and Q was initially lighted up. Switch S is subsequently closed.

How does the light intensity of the light bulbs change?

	Bulb P	Bulb Q
A	No change	Becomes dimmer
B	No change	Becomes brighter
C	Becomes dimmer	Becomes dimmer
D	Becomes dimmer	Becomes brighter

33 The diagram shows three lamps in series with a 12 V supply. The lamps do not light up because lamp L has a broken filament. To test the circuit, the contact is connected in turn to points X, Y and Z.



Which of the following shows the readings of each voltmeter?

	reading at X / V	reading at Y / V	reading at Z / V
A	8	8	0
B	12	8	4
C	8	12	4
D	12	12	0

34 The ratings of some electrical appliances are shown below.

Electrical appliance	Rating
Television	135 W
Air conditioner	2.75 kW
Lamps	100 W

If the cost of 1 kWh electricity is 80 cents, what is the total cost of operating the following electrical appliances for 3 hours?

A $7.16 B $12.20 C $73.40 D $570.60

35 **Fig. 35.1** shows a compass needle pointing to the Earth's north when there are no other magnets around it. The compass is then placed at point Z, near to a magnet with a soft iron bar as shown in **Fig. 35.2**.

Fig. 35.1

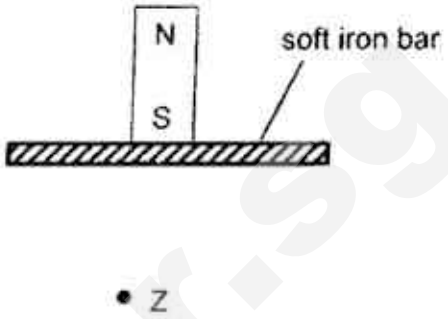


Fig. 35.2

Which of the following diagrams shows the possible orientation of the compass needle?

A

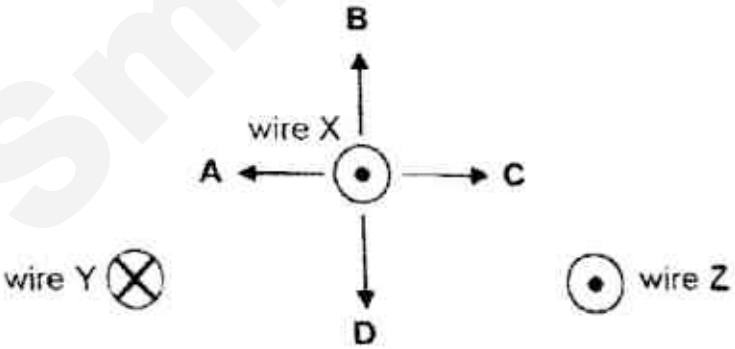
B

C

D

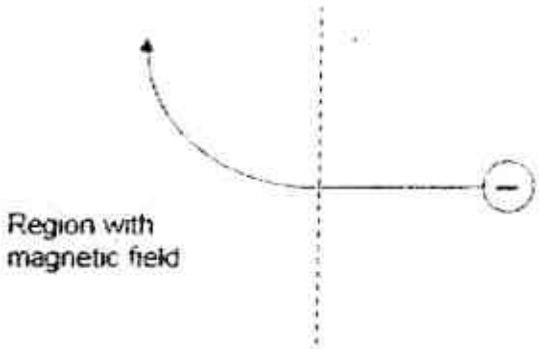
36 The figure below shows the top view of three parallel wires.

The movable wire X is placed near wires Y and Z which are both fixed in position at equidistance from X. A current of 1 A flows through the wires in the directions as shown.



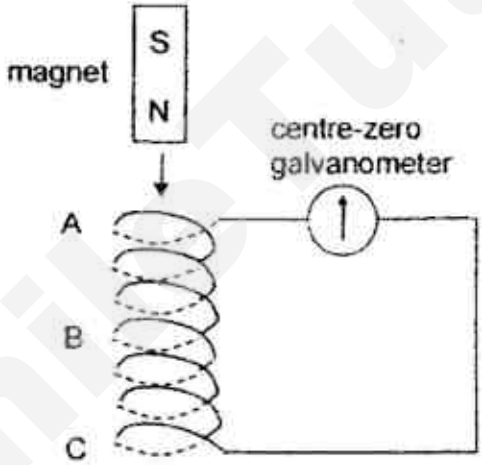
What is the direction of force (**A**, **B**, **C** or **D**) acting on wire X?

37 The diagram shows a beam of electrons entering a magnetic field. What will be the direction of the magnetic field?



A Towards the bottom of the page
B Towards the top of the page
C Out of the page
D Into the page

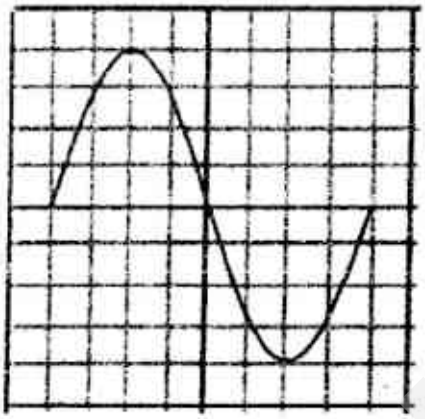
38 A diagram of a sensitive centre-zero galvanometer is shown above. A short but strong magnet then falls through the vertical solenoid ***ABC*** which is connected to the galvanometer.



What are the correct deflections as the magnet passes through positions ***A***, ***B*** and ***C***?

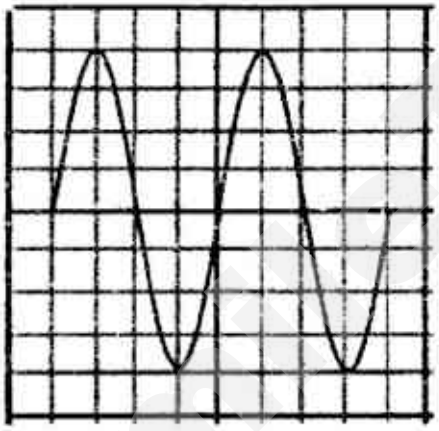
	At A	At B	At C
A	left	left	left
B	left	right	right
C	left	zero	left
D	left	zero	right

39 When a 12 V, 50 Hz supply is connected to the Y-terminals of an oscilloscope, the trace in the diagram is obtained. Each square is 1 cm by 1 cm.

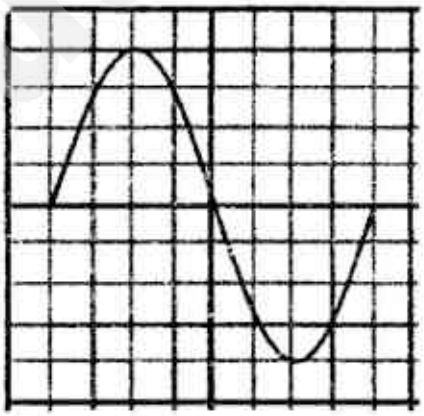


Which of the following diagrams shows the correct when the same supply is displayed with the time base set as 5.0 ms/cm?

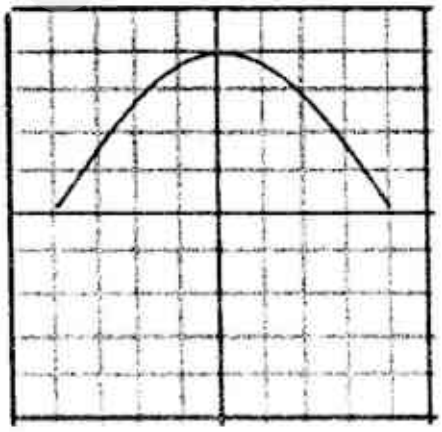
A



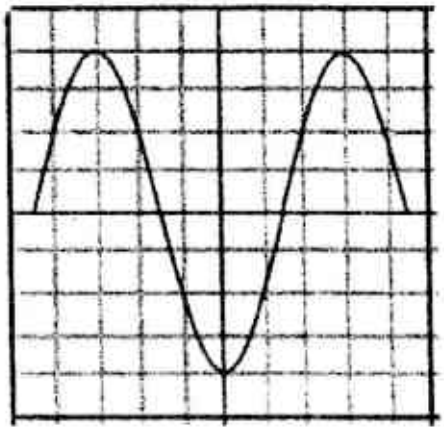
B



C



D



40 The diagram shows a long transmission line supplying energy at 240 V to two houses X and Y without using transformers. In both houses, electric heaters are switched on.

The occupier of house X switches off the heaters in his house.

What happens in house Y?

A There is a fall in the voltage supplied and in the power used.
B There is a fall in the voltage supplied but no change in the power used.
C There is a rise in the voltage supplied and in the power used.
D There is a rise in the voltage supplied but no change in the power used.

End of Paper

2017 4E PP Prelim Exam Paper

Answer Scheme

Paper 1

1	A	6	B	11	D	16	B	21	C	26	D	31	A	36	C
2	A	7	C	12	D	17	C	22	C	27	B	32	D	37	D
3	D	8	B	13	C	18	C	23	C	28	B	33	D	38	D
4	C	9	D	14	A	19	B	24	B	29	C	34	A	39	A
5	C	10	A	15	A	20	A	25	D	30	C	35	A	40	C

Name: _____ Index Number: _____ Class: _____

TEMASEK SECONDARY SCHOOL
O Level Preliminary Examination 2017
Secondary 4 Express

PHYSICS **5059 / 02**

Paper 2 **1 hour 45 minutes**

Question and Answer Booklet
Additional Material: NIL

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are required to submit this booklet at the end of the paper.

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **Questions 10** and **11** and **one** of the two alternative questions in **Question 12**.
Write your answers on the spaces provided on the question paper.

Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of physics than for correct answers.

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

Take gravitational field strength as 10 N/kg.

For official use only:

1		4		7		10			
2		5		8		11			
3		6		9		12		Total:	

This document consists of **24** printed pages.

Section A (50 marks)

Answer **all** questions.

1 Fig. 1.1 shows a Nano SIM (Subscriber Identity Module) card used in many modern smartphones.

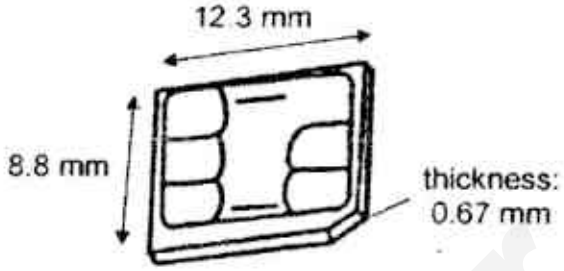


Fig. 1.1

(a) State how the dimensions of the Nano SIM card can be verified according to the stated accuracy using appropriate laboratory instruments.

.....

..... [1]

(b) State 3 base quantities and their corresponding S.I. units other than light intensity (candela).

.....

..... [1]

2 Fig. 2.1 shows a student carrying a school bag which has two straps. These two straps support the entire weight of the school bag.

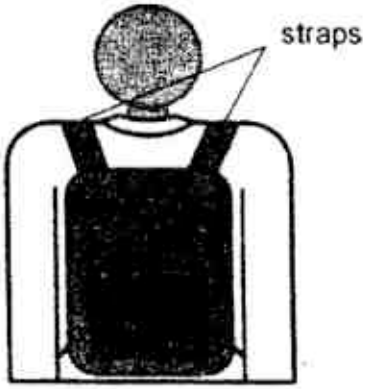


Fig. 2.1

(a) The tension in each strap is 30 N while the weight of the bag is 50 N. Using an appropriate vector diagram, determine the angle between the two straps.

angle = ... [2]

(b) (i) The straps on the school bag are lengthened such that the angle between them is reduced.

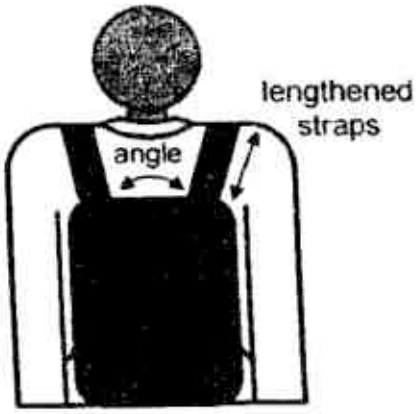


Fig. 2.2

State what happens to the tension in the straps, if any.

.....

..... [1]

(ii) State and explain the effect of the lengthened straps of the school bag on the stability of the student.

.....

.....

.....

.....

..... [2]

(c) The student decides to use a school bag with thinner straps as shown in Fig. 2.3.

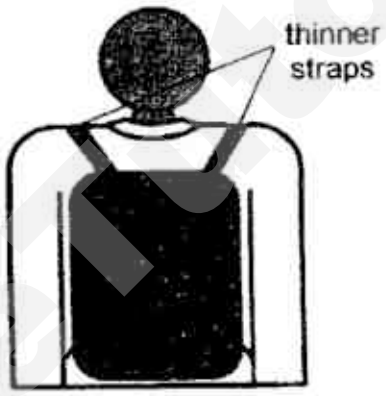


Fig. 2.3

However, the thinner straps made it uncomfortable for the student to carry the same amount of load in the bag. Explain why.

.....

.....

.....

..... [2]

3 Fig. 3.1 shows a toilet bowl that is choked.

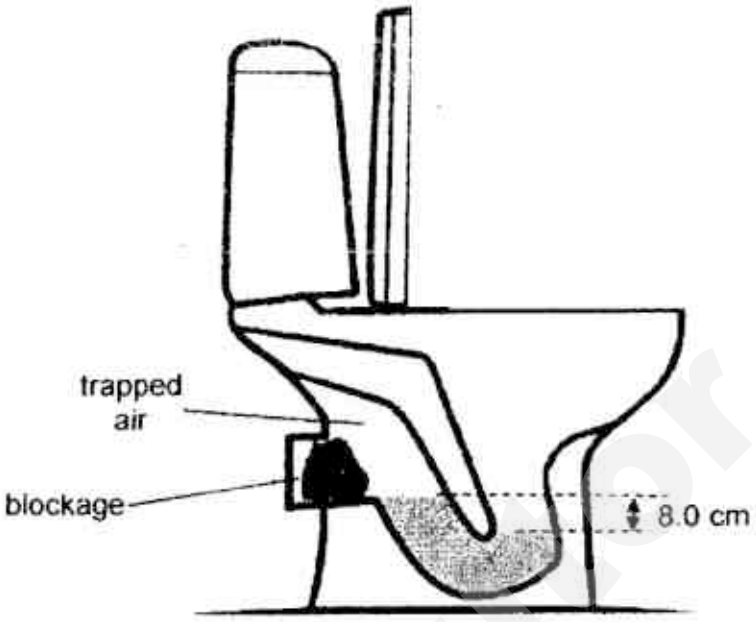


Fig. 3.1

(a) If the pressure of the trapped air in the toilet bowl is 99 kPa, find the density of the liquid in the toilet bowl.
(Take atmospheric pressure as 100 kPa.)

density of liquid = ... [2]

(b) Given that the mass of the liquid is 0.85 kg, find the volume of the liquid in cm^3.

volume of liquid = ... [2]

4 (a) Distinguish between *mass* and *inertia*.

.....

.....

..... [2]

(b) A group of students are playing a game in the physics lab. Fig. 4.1 shows the setup of the game.

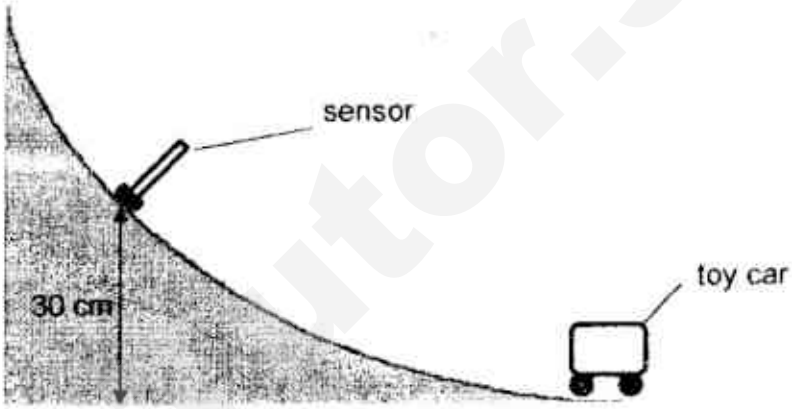


Fig. 4.1

To win, a student must exert a force on the toy car at the bottom of the slope. The toy car must then have an initial velocity such that it will just touch the sensor without causing the sensor to topple.

Determine the minimum initial velocity of the toy car that would allow a student to win. (Assume that dissipative forces are negligible.)

initial velocity = ... [2]

5 The apparatus shown in Fig. 5.1 shows a heavy piston supported by gas trapped in a cylinder at room temperature. The piston is free to move.

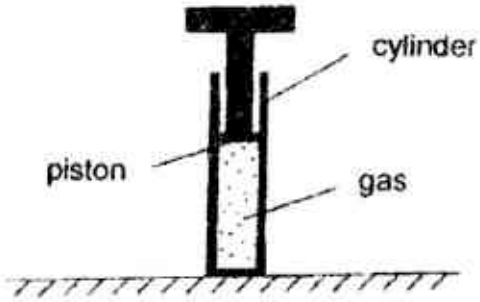


Fig. 5.1

(a) Explain how the extremely small gas molecules are able to support the weight of the piston.

.....

.....

.....

..... [2]

(b) The piston is then placed in a very cold freezer. The piston moves downwards and stops before reaching the bottom of the cylinder.

Using ideas about molecules and pressure, explain why the piston moves downwards.

.....

.....

.....

.....

.....

..... [4]

6 (a) Fig. 6.1 shows a stainless steel pot containing water and placed on an induction cooker with temperature at 120 °C.

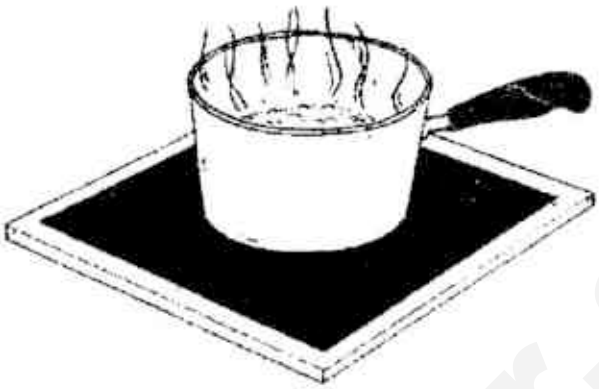


Fig. 6.1

(i) Give two reasons with explanation, how the stainless steel pot allows the water to heat up quickly.

.....

.....

.....

..... [2]

(ii) Give two reasons with explanation, how adding a lid to the pot allows the water to heat up more quickly.

.....

.....

.....

.....

.....

..... [2]

(b) In an experiment to measure the specific latent heat of vaporisation of water at its normal boiling point, the apparatus below is set up as shown in Fig. 6.2. The thermometer is to check the boiling point of the water. 9.0 g of water is evaporated when a current of 2.0 A is passed through the heating coil for 630 s. The resistance of the heating coil is 8.0 Ω.

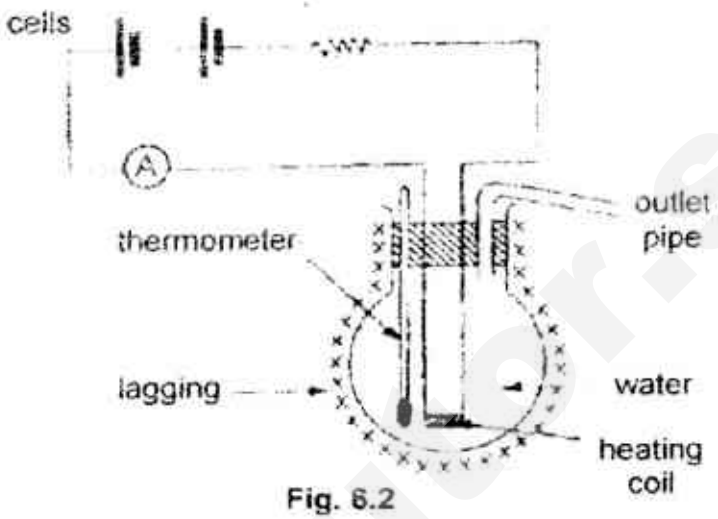


Fig. 6.2

(i) State what is meant by the *specific latent heat of vaporization*.

.....

.....

..... [1]

(ii) Calculate the specific latent heat of vaporization of water assuming that no heat escapes from the flask.

specific latent heat of vaporization = ... [2]

(iii) Explain, in terms of molecular behaviour, why temperature of water does not change during boiling.

.....

.....

.....

..... [3]

7 Fig. 7.1 shows an optical rain sensor system installed on a car's windscreen to detect the presence of rain. The optical rain sensor works on the principle of total internal reflection. The car's windscreen is made of glass.

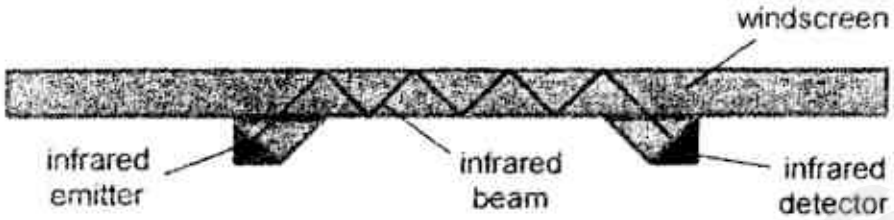


Fig. 7.1

(a) State what is meant by *total internal reflection*.

.....

..... [1]

(b) In Fig. 7.2, a droplet of rain is present on the windscreen. The infrared beam is now unable to reach the infrared detector in Fig. 7.2. Sketch and complete the path taken by the infrared beam. [1]
The refractive index of water is lower than the refractive index of glass.

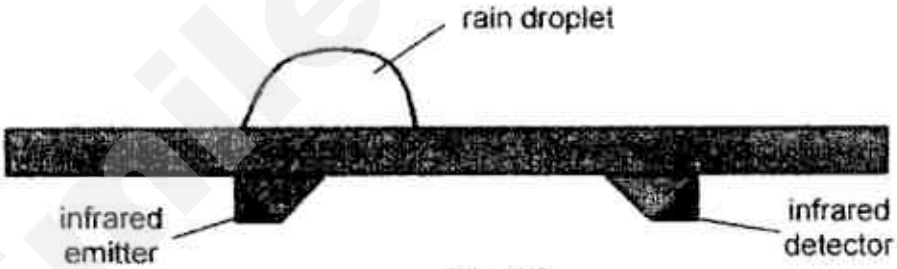


Fig. 7.2

(c) Given that the refractive index of infra-red waves in glass is 1.52, calculate the speed of infra-red waves in glass.

speed of infra-red waves in glass = ... [2]

(d) A mechanic decides to change the emitter to emit microwaves instead of infrared waves.

Given that the speed of microwaves in glass is slower than that of infra-red waves, state and explain if the microwaves will still reach the detector when there is no rain.

.....

.....

.....

..... [2]

(e) State one other use of infrared radiation.

..... [1]

8 At an airport, fuel is pumped through a pipe from a tanker to an aeroplane, as shown in Fig. 8.1.

Fig. 8.1

As the fuel flows through the pipe, the pipe becomes negatively charged. As a result, the aeroplane also becomes negatively charged.

(a) Explain how the fuel becomes charged.

.....

..... [1]

(b) Explain how the aeroplane becomes negatively charged.

.....

..... [1]

(c) Suggest and explain one problem that can arise when an aeroplane becomes charged while refueling.

.....

..... [1]

(d) To prevent the aeroplane from becoming charged, a metal cable is attached and it connects the aeroplane to the ground.

Explain how the cable prevents the aeroplane from becoming charged.

.....

..... [1]

9 Fig. 9.1 shows the relay connected in a circuit with a 12 V battery and a thermistor. The bell is initially not ringing.

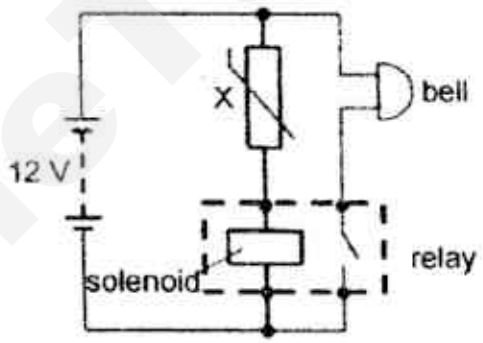


Fig. 9.1

(a) Explain why the bell rings when the temperature of the thermistor rises.

.....

.....

.....

..... [2]

(b) When the resistance of the thermistor is 2000 Ω, the current in the coil is 1.5 mA. This causes the contacts in the relay to close.
The resistance of the bell is 200 Ω.

Calculate

(i) the current passing through the bell.

current = ... [1]

(ii) the potential difference across the coil.

p.d. across coil = ... [2]

(c) Suggest an advantage of using a relay in this circuit.

.....

..... [1]

Section B (30 marks)

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

Answer only one of the two alternative questions in **Question 12**.

10 Tossing a coin has been historically used in decision-making.

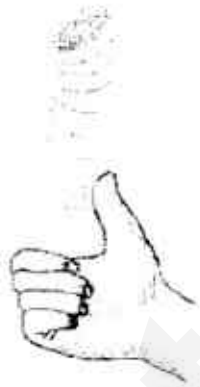


Fig. 10.1

(a) In Fig. 10.1, name and label two forces which act on the coin as it moves away from the hand, assuming that the coin does not rotate. [1]

(b) An experiment is performed to investigate the motion of a coin toss.

A coin is tossed and its displacement is recorded using a data logger. The experimental data is recorded in the table in Fig. 10.2.

t / s	d / m
0	0
0.05	0.45
0.10	0.64
0.15	0.56
0.20	0.37
0.25	0.13
0.30	- 0.15
0.35	- 0.46
0.40	- 0.79
0.45	- 1.12
0.50	- 1.45

Fig. 10.2

In Fig. 10.3 below, plot a graph of d against t using the data given. [2]

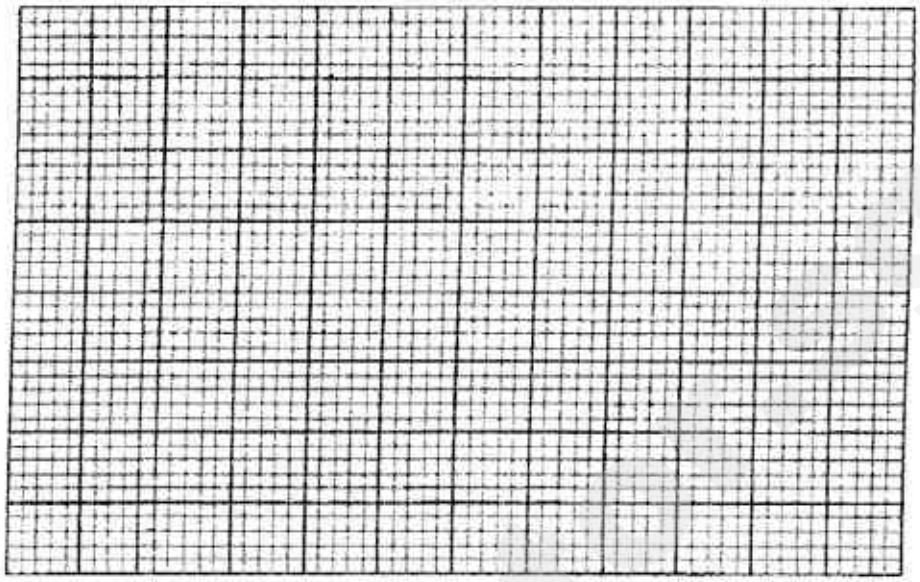


Fig. 10.3

(c) On your graph in Fig. 10.3, determine and mark the following points:

(i) point 'A', where coin's acceleration is equal to the earth's gravitational acceleration. [1]

(ii) point 'B', where coin is at maximum acceleration. [1]

(iii) point 'C', where the coin is at rest. [1]

(d) Explain how the graph in Fig. 10.3 shows that the coin reaches terminal velocity.

.....

..... [1]

(e) Using Newton's laws of motion, explain why the coin reaches terminal velocity.

.....

.....

.....

.....

.....

..... [3]

11 **(a)** Fig. 11.1 shows a type of electric motor where coil PQRS is connected to a battery and is placed between two solenoids AB and CD which are connected to a separate d.c. power supply.

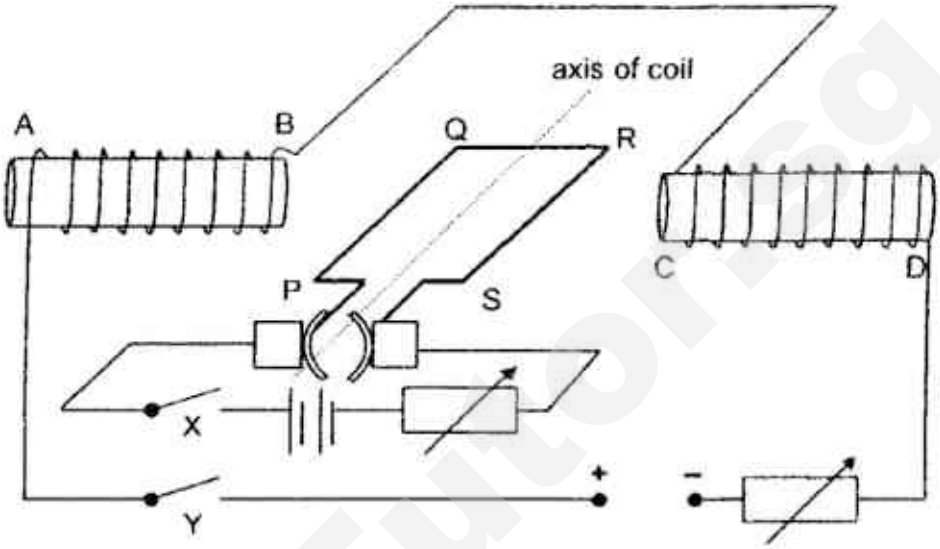


Fig. 11.1

Both switches X and Y are closed.

(i) On Fig. 11.1,

A. label the magnetic poles at B and C, [1]

B. draw arrows to indicate the direction of force experienced by sides PQ and RS of the coil. [1]

(ii) Describe the effect on the movement of coil PQRS when the d.c. power supply connected to solenoids AB and CD is replaced by an a.c. power supply of low frequency.

.....

.....

..... [1]

11 (b) Fig. 11.2 shows a device used to measure the flow of air. The turbine is made to rotate by the air that flows through it. The rim of the turbine contains twenty small magnets. The detector coil is connected to the primary coil of a step-up transformer (Fig. 11.3) to amplify the voltage signal, which is then displayed on a cathode ray oscilloscope.

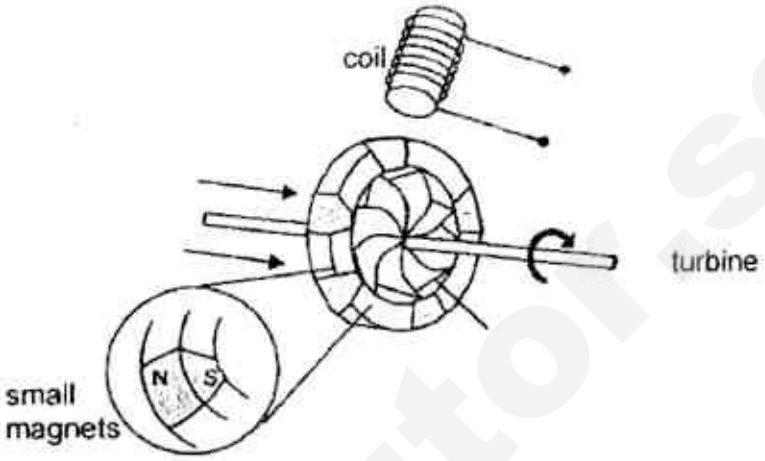


Fig. 11.2

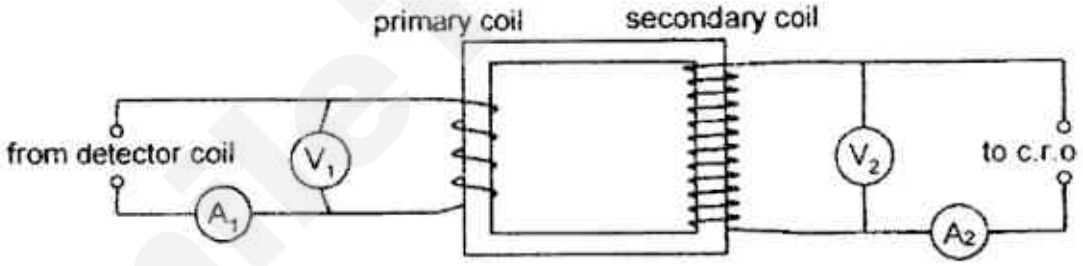


Fig. 11.3

Table 11.4 shows the data for an air flow rate of 15 cm/s. Some values are missing from the table.

Table 11.4

air flow rate/ cm^3/s	period of turbine spin / s	transformer			
		primary coil		secondary coil	
		A_1 / A	V_1 / V	A_2 / A	V_2 / V
15	2	1.8	6		

(i) Explain why an alternating e.m.f. is induced in the detector coil.

.....

.....

.....

.....

.....

..... [3]

(ii) Fig. 11.5 shows how V_1, the induced e.m.f. in the primary coil varies with time for a flow rate of 15 cm^3/s.

On the same axis below, sketch a graph to show how V_1, the induced e.m.f. varies with time when the turbine rotates with a flow rate of 30 cm^3/s. Assume that there are no dissipative forces within the turbine. Complete at least 2 waveforms.

[2]

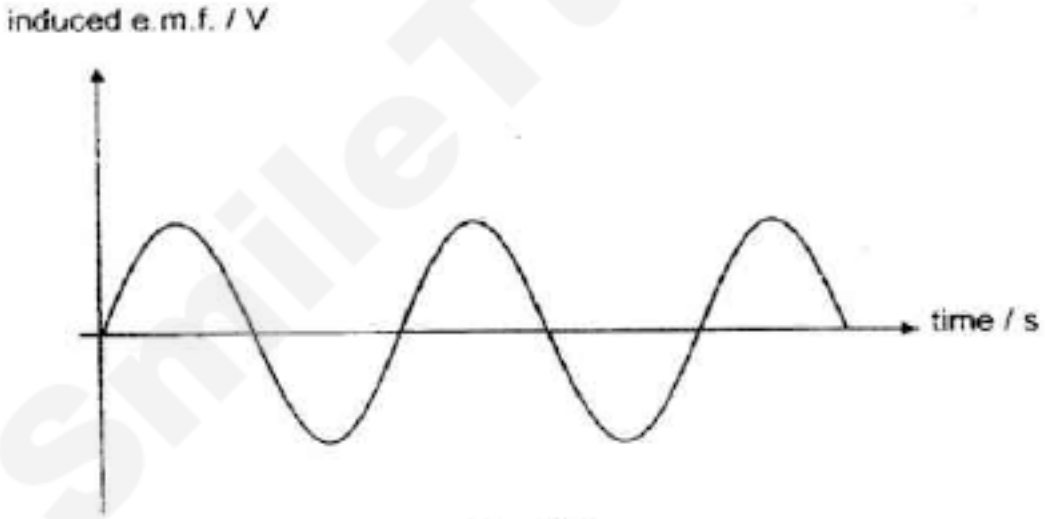


Fig. 11.5

(iii) Complete Table 11.4 by filling in the missing values of A_2 and V_2 assuming that the transformer is 100% efficient.

[2]

12 EITHER

A microphone is an input transducer which converts sound into electrical signals. A solenoid is connected to a diaphragm which picks up sound waves. The vibration of air molecules causes the diaphragm and solenoid to vibrate. The movement of the solenoid in the magnetic field generates an e.m.f. in the wires.

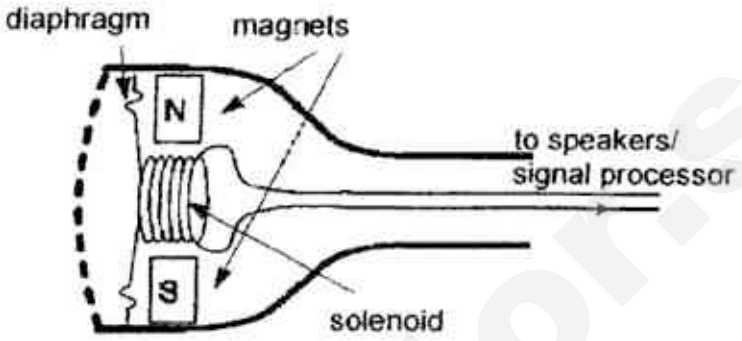


Fig. 12.1

When a microphone is connected to a cathode ray oscilloscope (c.r.o.), sound waves can be observed through the voltage fluctuations generated in the microphone.

Two microphones are connected to a c.r.o. to observe the sound generated from a musical instrument. Both traces on the c.r.o. have the same Y-gain.

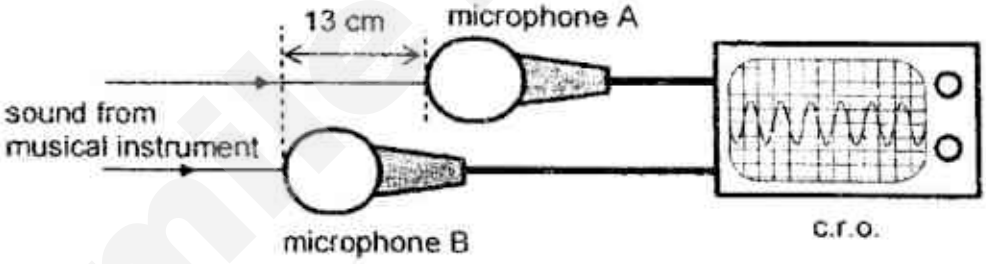


Fig. 12.2

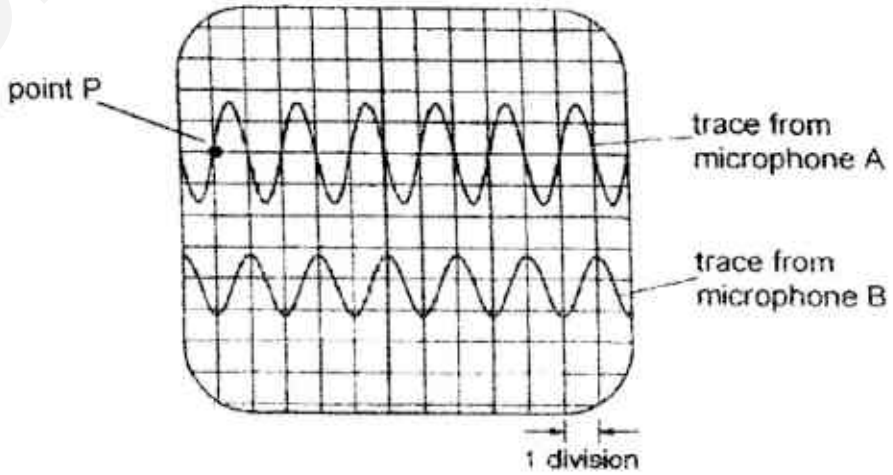


Fig. 12.3

(a) State two differences between light waves and sound waves.

.....

.....

..... [2]

(b) With reference to the traces on the c.r.o. in Fig. 12.3, compare the pitch and loudness between the sounds received by each microphone.

.....

.....

..... [2]

(c) Describe how sound is transmitted from the musical instrument to the microphones. You may include a diagram in your answer.

.....

.....

.....

.....

.....

..... [3]

(d) **(i)** State what is meant by *wavefront*.

.....

..... [1]

(ii) In Fig 12.3, mark a point on the trace for microphone B which is in phase with point P. Label this point as 'Q". [1]

(e) Given that the horizontal distance between the two microphones is one quarter of a wavelength of the sound wave, find the frequency of the sound wave.
Take the speed of sound in air as 340 m/s.

frequency = ... [1]

12 OR

Fig. 12.4 shows part of the mains electrical circuit in a house.

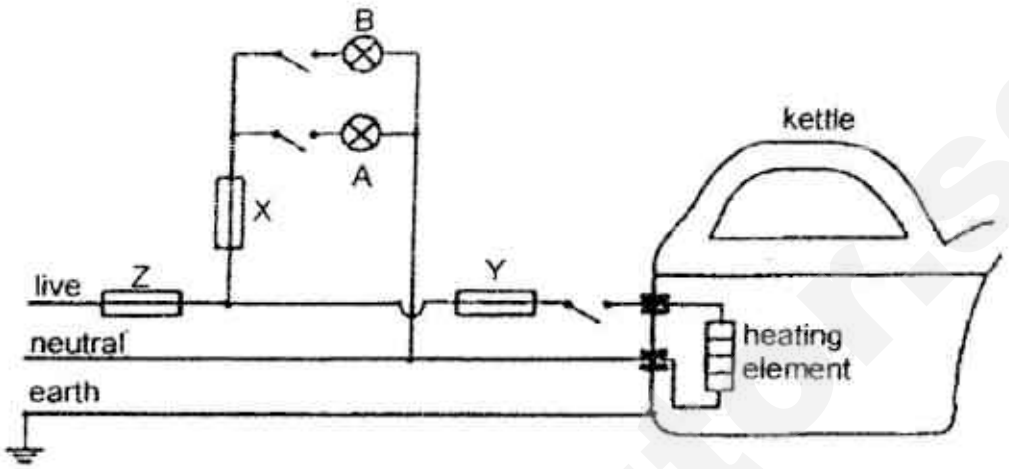


Fig.12.4

Two lamps **A** and **B**, each rated at 60 W 230 V, are connected to the live wire through fuse **X**. An electric kettle, rated at 750 W 230 V, is connected to the live wire through fuse **Y**. Fuse **Z** protects the whole circuit.
The electric kettle has a metal case which is connected to Earth.
The mains supply voltage is 230 V.

(a) Calculate the current in fuse X when all the switches all closed.

current through fuse X = ... [2]

(b) Fig. 12.5 shows the electrical wiring in table lamp A.

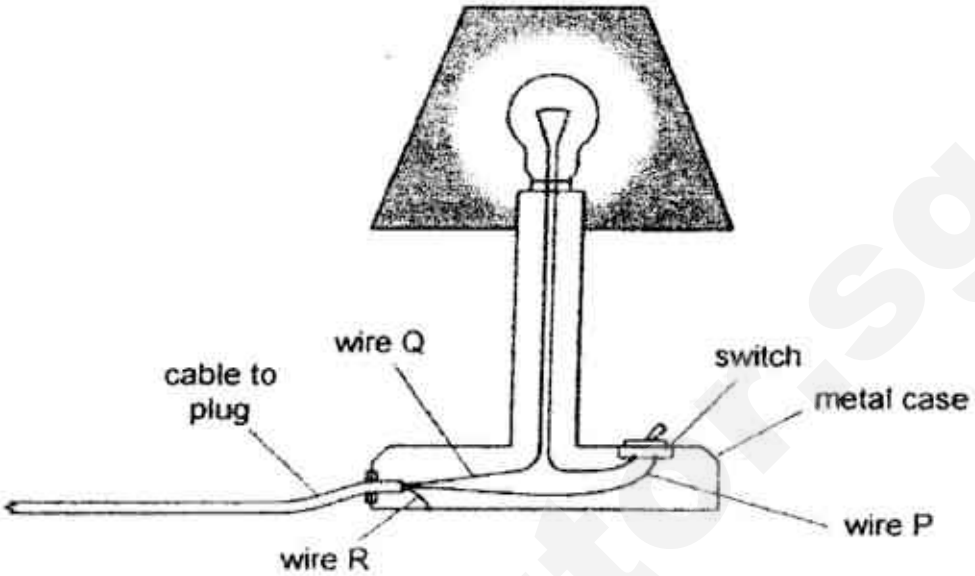


Fig. 12.5

(i) Explain why wire P rather than wire Q is connected to the live terminal in the plug.

.....

.....

.....

..... [2]

(ii) Wire P becomes loose and touches the metal case.

Explain why a person who later touches the case feels no electric shock and is not harmed.

.....

.....

.....

.....

..... [2]

(c) Instead of using fuses that have to be replaced when 'blown', circuit breakers are used. Fig. 12.6 and Fig. 12.7 show a circuit breaker before and after it has been activated respectively.

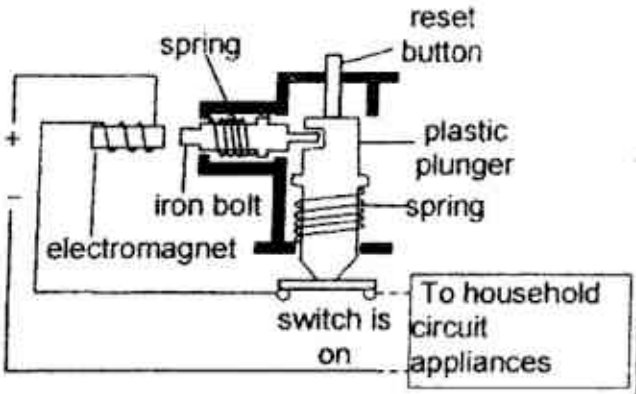


Fig. 12.6

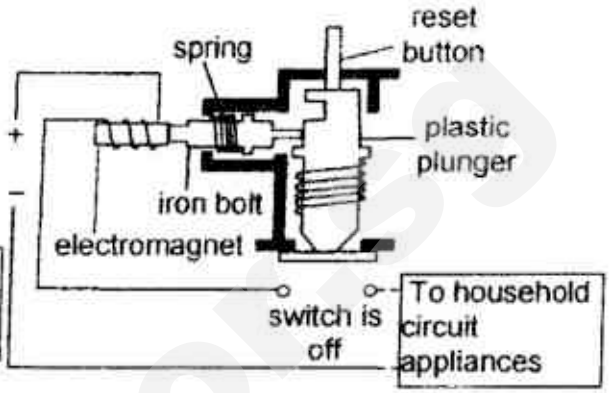


Fig. 12.7

(i) Referring to Fig. 12.6 and Fig. 12.7, explain how the circuit breaker works when an electrical fault occur and how it can be reset.

.....

.....

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.....

..... [3]

(ii) Explain why the circuit breaker cannot be reset if a steel bolt is used instead of the iron bolt.

.....

..... [1]

- **End of paper** -

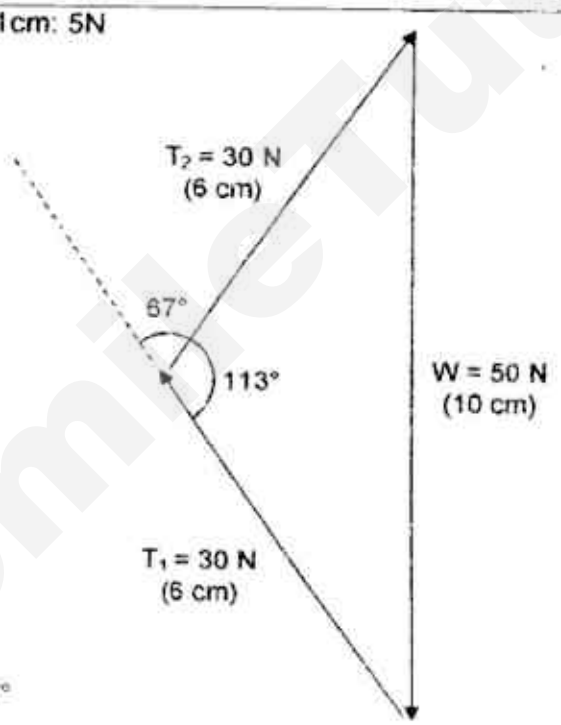
2017 4E PP Prelim Exam Paper

Answer Scheme

Paper 1

1	A	6	B	11	D	16	B	21	C	26	D	31	A	36	C
2	A	7	C	12	D	17	C	22	C	27	B	32	D	37	D
3	D	8	B	13	C	18	C	23	C	28	B	33	D	38	D
4	C	9	D	14	A	19	B	24	B	29	C	34	A	39	A
5	C	10	A	15	A	20	A	25	D	30	C	35	A	40	C

Paper 2

1a	The **length** and the **width** of the Nano SIM card can be measured using a **vernier caliper** up to a precision of **0.1 mm** while the **thickness** can be measured using a **micrometer screw gauge** up to a precision of **0.01 mm**.	[1]
1b	Temperature (K), Time (s), Length (m), mass (kg), current (A), Amount of substance (mol)	Any 3 [1]
2a	Scale: 1cm: 5N  Ans: 67°	[1] for proper diagram with labels [1] For answer, ± 1°
2bi	When straps are lengthened, the angle between the straps will be reduced. Thus, while the magnitude of weight in the vector diagram remains the same, **both tensions in the strap will be reduced** in order for forces to be balances.	[1]
2bii	When straps are lengthened, the **centre of gravity of the bag is**	[1]

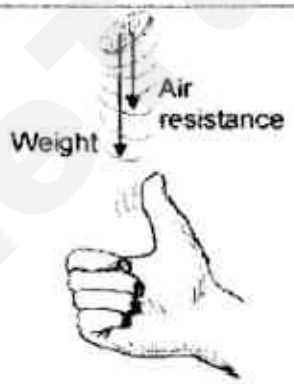
	lowered. The **overall centre of gravity** of the student with the bag will also be **lowered**. Thus, the **stability of the student increases**.	[1] if with exp
2c	The thinner strap **increases the amount of pressure on the student**. Since pressure is **force per unit area**, with the **same load (force)** and **smaller area of contact** between the strap and the student's shoulders, pressure increases.	[1] [1]
3a	Pressure of trapped air + liquid pressure of 12 cm = Atmospheric P $99 \times 10^3 + (8*10^{-2})(\rho)(10) = 100 \times 10^3$ $\rho = 1250$ kg/m^3	[1] hpg [1]
3b	Volume = mass / density = 0.85 / 1250 = 0.00068 m^3 = 0.00068×10^6 cm^3 = 680 cm^3	[1] [1] conv.
4a	Mass is a measure of the **amount of matter (not substance!)** in an object while inertia is a measure of the object's **reluctance to change in its state of motion**.	[1] [1]
4b	Loss in KE = gain in GPE $\frac{1}{2} m v^2 = m g h$ $\frac{1}{2} v^2 = g h$ $v^2 = 2 g h$ $v = \sqrt{2gh}$ $= \sqrt{2 \times 10 \times 0.3}$ = 2.45 m/s	[1] KE and GPE formula [1]
5 (a)	The air molecules in the cylinder move quickly and collide with the piston very frequently. The collisions with the wall of the piston, exert an upwards force large enough to support the weight of the piston.	[1] [1]
(b)	As the temperature of the air in the cylinder decreased, the KE of the air in the cylinder decreases / air moves slower. The force and frequency of collision of the air molecules against	[1]

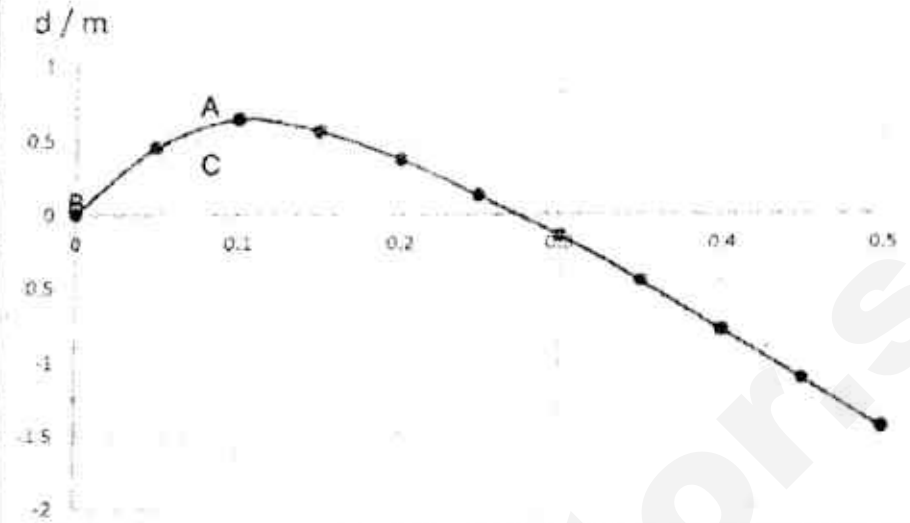
			wall of the piston decreases. Thus pressure of the air in the cylinder decreased since pressure is force per unit area, The difference in pressure between the air in the cylinder and (the pressure cause by the weight and the surrounding air) creates a resultant force downwards.	[1] [1] [1]
6	(a)	(i)	It is a good conductor of thermal energy so it transmits heat from the induction cooker quickly. It is silver, thus a poor emitter of infrared radiation so it will not lose heat so quickly to the surroundings.	[1] [1]
		(ii)	It prevents convection with the outside air. It prevents the loss of energy via evaportation of the water/ steam.	[1] [1]
	(b)	(i)	Specific latent heat of vaporization is the thermal energy needed to change a unit of mass substance from liquid to gas with no change in temperature.	[1]
		(ii)	Electrical energy lost by heating coil = Heat energy gained by water to boil $I^2Rt = ml_v$ $2^2 \times 8.0 \times 630 = 0.009 \times l_v$ $l_v = 2\,240\,000$ J/kg	 [1] [1]
		(iii)	The heat energy supplied to the water was used to **break the intermolecular bonds** between the water molecules and to **push back on the surrounding atmosphere**. **The average KE of the molecules does not change while the PE of the molecules increases.**	[1] [1] [1]
7a	Total internal reflection is the **reflection of all light (complete reflection)** at the **boundary of an optically denser medium**, **back into the medium** when its angle of incidence is greater than the critical angle.			[1]

7b	Note: bends away from normal from glass to water, but minimal refraction between water to air due to $i \approx 90°$ 	[1]
7c	$n = \frac{c}{v}$ $1.52 = \frac{3\times10^8}{v}$ $v = \left(\frac{3\times10^8}{1.52}\right) = 1.97 \times 10^8$ m/s	[1] [1]
7d	Microwaves **moves slower than infra-red so the higher refractive index of microwaves is higher** than infra-red waves. With a higher refractive index the **critical angle of microwaves is smaller** so **total internal reflection will always occur at the same angle of incidence.**	[1] [1] r/ship betw. n and crit angle
7e	Infrared thermometer, remote controllers, intruder alarms	[1]

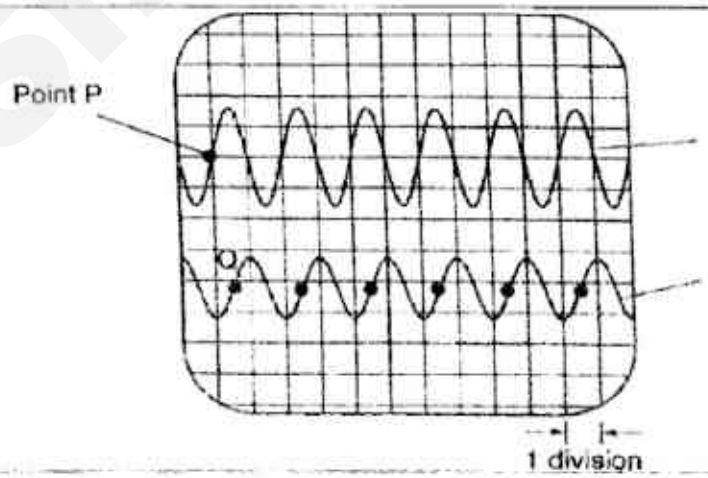
8	(a)	Electrons move from fuel to the pipe due to friction.	[1]
	(b)	The fuel will induce a negative charge on the plane.	[1]
	(c)	Due to static discharge a spark might occur and ignite fuel	[1]
	(d)	The metal cable provides a conducting path for excess negative charges/ electrons to leave the aeroplane and move to the ground	[1]
9	(a)	When the temperature of the thermistor rises, its resistance decreases. Since total resistance of the branch decreases while the potential difference across it remains the same, this will	[1]

			cause a larger current to flow through the solenoid. A stronger magnetic field is produced/ stronger electromagnet is produced and the relay switch will be closed, causing the bell to ring.	[1]
	(b)	(i)	I = V / R = 12 / 200 = 0.060 A	[1]
		(ii)	p.d. of thermistor = RI = 2000 x 1.5 x 10^{-3} = 3.0 V p.d. across coil = 12 – 3.0 = 9.0 V	[1] [1]
		(iii)	Only a small current of 1.5 mA is required to switch on the bell using the relay. Without the relay, the user needs to handle a higher and more dangerous current of 60 mA.	[1]

10a		[1]

10b **10c**		[1] Axis & scale [1] Plotting & shape [1] [1] [1]
10d	From t = 0.35 s to t = 0.50 s, gradient of the s-t graph is constant, terminal velocity of the coin is v = 0.33/0.05 = 6.60 m/s.	[1]
10e	During freefall of the coin, air resistance increases as velocity increases. At terminal velocity, air resistance becomes equal and opposite to the coin's weight and the net force on the coin becomes zero. By Newton's Second Law, the acceleration of the coin becomes zero, hence its velocity remains at terminal velocity.	[1] [1] [1]

11	**(a)**	**(i)**	**A.**	B: South C: North	[1]
			B.	PQ: Upwards force RS: downwards	[1]
		(ii)		The coil PQRS will switch its direction of rotation periodically.	[1]
	(b)	**(i)**		The revolving wheel causes each individual magnets to move towards and then away from the detector coil. As the magnets move towards the coil, the change/increase of magnetic flux linking the coil generates an induced e.m.f. As the magnets move away from the coil, direction of the induced e.m.f is reversed. Hence, an alternating e.m.f is induced in the coil.	[1] [1] [1]

		(ii)	Each complete wave is within half of the original period and induced is double of the original amplitude	[1] [1]
		(iii)	use turns ratio $N_s/N_p = V_s/V_p$ $12/4 = V_s/6$ $V_2 = 18$ V $A_2 = 0.6$ A	 [1] [1]
12a Either	Sound wave is a longitudinal wave while light is a transverse wave. Sound requires a medium to be transmitted while light does not. (speed of waves not accepted(too vague))			[1] [1]
12b	Both sound received by microphone A and B have the same pitch as the frequency is the same . The sound received by microphone A is louder than the sound received by microphone B as its amplitude is higher.			[1] [1]
	When the musical instrument is played, sound waves are produced which transfer energy without a transfer of medium. The air particles vibrate parallel to direction of wave motion and collide with each other, Causing a series of compression and rarefaction.			[1] [1] [1]
12 di	Wavefront is an imaginary line on a wave that connects all adjacent points that are in phase.			[1]
12di i				[1] Accept any of the points

12e			$f = v / \lambda = 340 / 0.52 = 654$ Hz	[1]
12 OR				
	(a)		Current through X = 2 x (60/230) = 0.522 A	[1] [1]
	(b)	(i)	Since wire Q is **directly connected to bulb** so if the live is linked wire Q, a person who touches or changes the bulb will get **an electric shock even if the lamp switch is off**. Connecting wire P to the live terminal is a safer choice because the bulb will **be isolated from live/high voltage supply when the lamp switch is off** and this prevents any **accidental electric shocks.**	[1] [1]
		(ii)	When Wire P is lose and touches the metal casing of the lamp which is earthed, for **a brief moment a high current will pass through from wire R to the earth**. As a result, the fuse at the live terminal end will **blow and isolate the live supply** from the lamp. Hence a person who later touches the case feels no shock and is not harmed.	[1] [1]
	(c)	(i)	When there is an electrical fault and the current is excessive, the electromagnet will be stronger/ strong enough to attract the iron bolt to the left by magnetic induction. The plastic plunger will **move upwards and opens the switch because of the spring**. The **circuit is open** and the current stops flowing. To reset, **the plastic plunger has to be pushed down and catches the iron bolt to close the switch.**	[1] [1] [1]
		(ii)	If a steel bolt is used, it will **still be attracted** to the electromagnet as it is a **hard magnetic material and thus retains its magnetism.**	[1]

1 A vernier caliper is used to measure the diameter of a ball-bearing.
Diagram 1 shows the reading when the vernier caliper is closed.
Diagram 2 shows the reading when the ball-bearing is placed between the jaws.

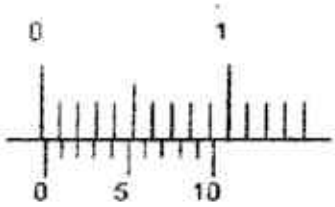


Diagram 1

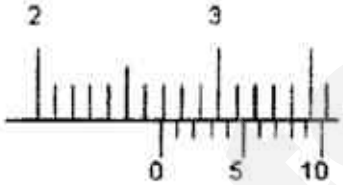


Diagram 2

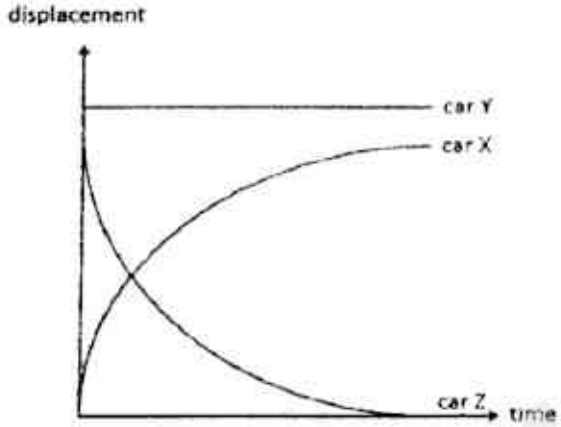
What is the diameter of the ball bearing?

A 2.48 cm
B 2.66 cm
C 2.68 cm
D 2.88 cm

2 Which has two vector quantities?

A acceleration and weight
B density and kinetic energy
C force and power
D pressure and volume

3 The graph shows how displacement varies with time for three cars X, Y and Z.



Which row describes cars X, Y and Z correctly?

	car X	car Y	car Z
A	decreasing speed	constant speed	moving in the same direction as car X
B	decreasing speed	not moving	moving in the opposite direction to car X
C	increasing speed	constant speed	moving in the opposite direction to car X
D	increasing speed	not moving	moving in the same direction as car X

4 An athlete participates in a 200 m race. In the first 10 seconds, he increases his speed from rest with a uniform acceleration of 1.0 m/s^2. Thereafter, he maintains his speed and completes the remaining distance.

What is the time he took for the entire race?

A 15 s
B 25 s
C 30 s
D 35 s

5 An object released from the top of building falls through the air with terminal velocity.

How many statement(s) is/are correct as the book continues to fall?

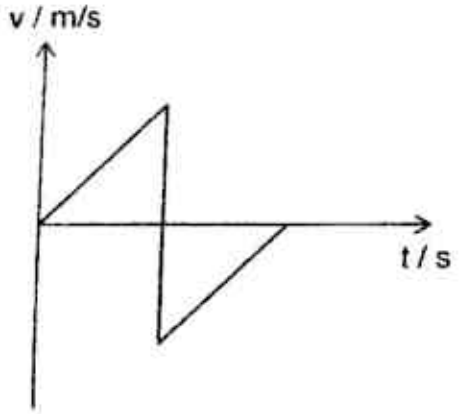
- The air resistance acting on the book will increase.
- The book will undergo uniform acceleration.
- The book will increase in velocity.
- The forces acting on the book are balanced.

A 1
B 2
C 3
D 4

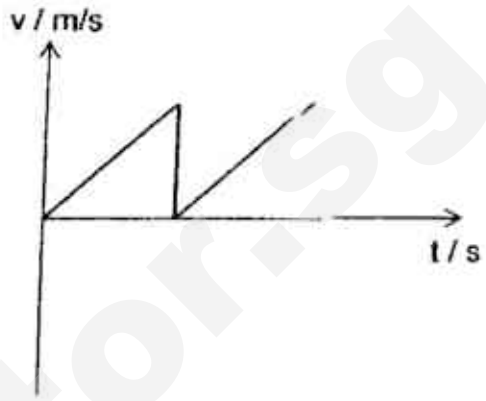
6 A ball rebounds after being dropped from a height.

Assuming that no energy is lost during its impact with the ground and air resistance is negligible, which graph best describes the motion of the ball from the time it rebounds?

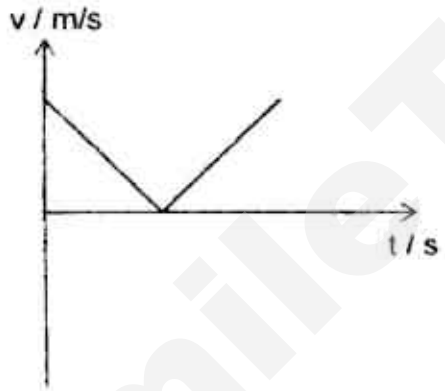
A



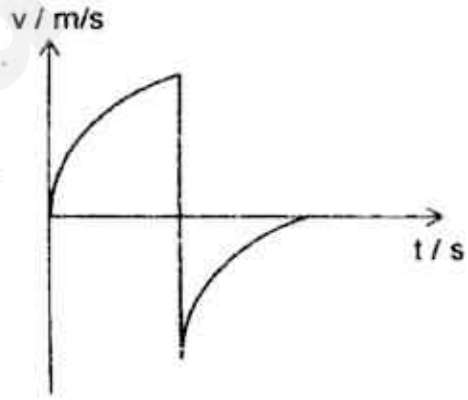
B



C



D



7 Which statement is correct?

A 1 kg of iron is heavier than 1 kg of air.

B Mass and weight for matter can both be zero.

C Gravitational field is a region in which a mass experiences a force due to gravitational attraction or repulsion.

D Gravitational field strength is the gravitational force acting per unit mass.

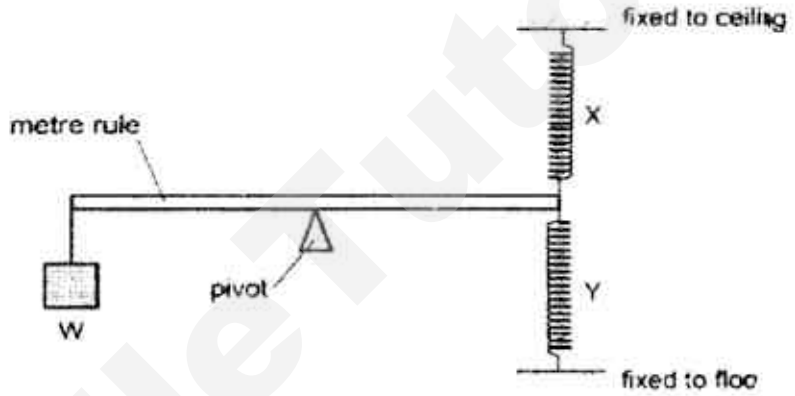
8 An alloy is made from two metals A and B.

The mass of metals A and B are 14 g and 23.5 g respectively.
The volume of metal A is 1.1 cm^3 and the alloy has a density of 15 g/cm^3.

What is the volume of metal B?

A 0.8 cm^3
B 1.4 cm^3
C 2.2 cm^3
D 2.5 cm^3

9 The diagram shows two stretched springs X and Y being attached to one end of a metre rule. A weight W is hung from the other end.



The weight W is now moved gradually towards the pivot.

How does the extension of each spring change?

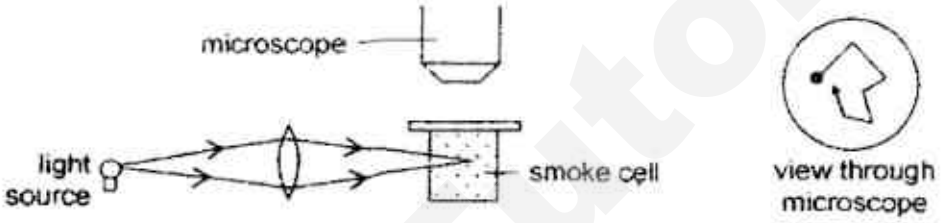
	X	Y
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

10 Four persons climbed up four different staircases. Their weights, vertical heights of the staircases and times are recorded in the table.

Which person develops the least power?

	weight / N	height / m	time / s
A	590	13	7
B	720	9	6
C	850	11	8
D	940	6	5

11 The diagram shows a light source illuminating smoke particles in air. When observed with a microscope, moving points of light are seen.



What are these moving points of light?

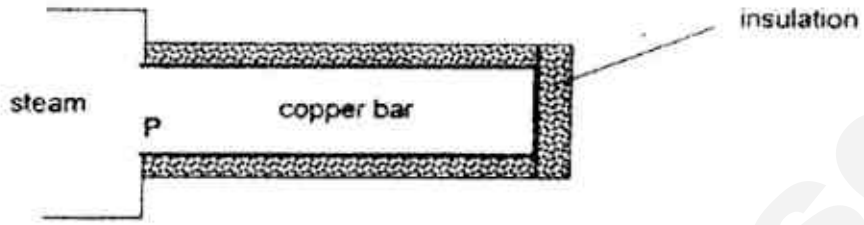
A Reflected light from smoke particles that move due to convection.

B Reflected light from smoke and air particles that move randomly.

C Reflected light from air molecules, colliding with smoke particles.

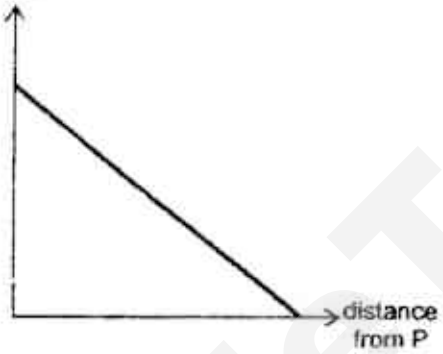
D Reflected light from smoke particles, colliding with air molecules.

12 The diagram shows a cylindrical copper bar with one end, **P**, in contact with a continuous supply of steam. The sides and the other end of the bar are well-insulated as shown in the diagram.



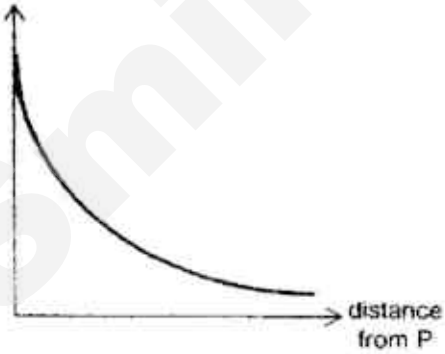
How does the temperature of the bar vary with the distance from point **P** after several hours?

A

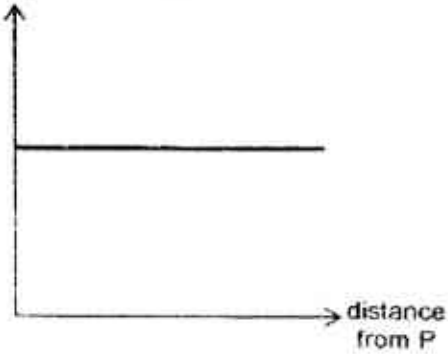


B

C



D

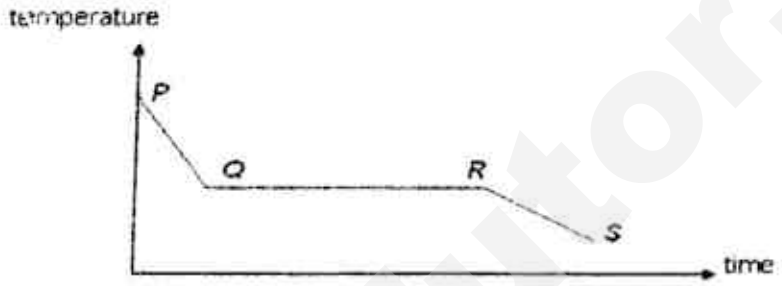


13 The resistance of a wire is 1.00 Ω at ice point and 1.40 Ω at steam point.

What is the resistance of the wire at 200 °C?

A 1.80 Ω
B 1.96 Ω
C 2.00 Ω
D 2.80 Ω

14 The graph shows how the temperature of a sample of molten wax changes as it cools.



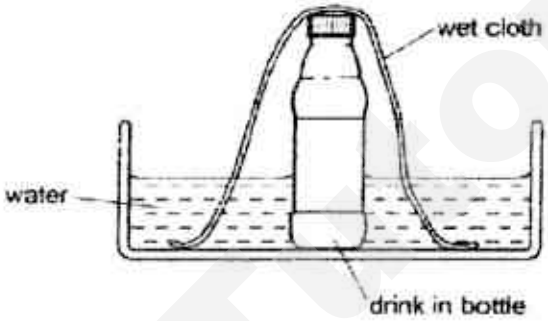
Which statement is correct?

A From P to Q, the molecules lose internal energy and molecules move more slowly.
B From Q to R, latent heat is given out to the surroundings and intermolecular forces of attraction decrease.
C From Q to R, the molecules come closer together and internal energy increases.
D From R to S, latent heat is given out to the surroundings and intermolecular forces of attraction increases.

15 Which of the following correctly shows the changes to the potential energy and the kinetic energy of the molecules of a liquid as it boils?

	potential energy	kinetic energy
A	decreases	increases
B	increases	stays the same
C	stays the same	decreases
D	stays the same	increases

16 The diagram shows a drink in a bottle placed in a bowl of water on a hot day.



The drink is kept cool by placing a wet cloth over it.

Which statement correctly explains why the drink is kept cool?

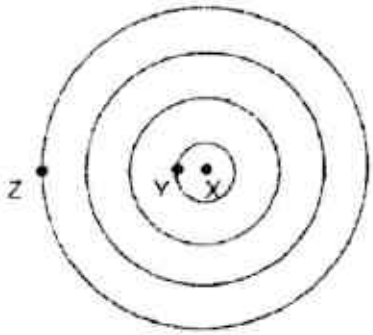
A Hot air cannot escape from the bottle.

B The cloth conducts heat from the bottle into the water.

C The drink cannot evaporate from the bottle.

D Water evaporating from the cloth cools the drink.

17 The diagram shows circular wavefronts moving from X to Z.



(diagram not drawn to scale)

The distance between Y and Z is 1.2 m and the frequency of the dipper at X is set at 15 Hz.

What is the speed of the wave?

A 4.5 m/s

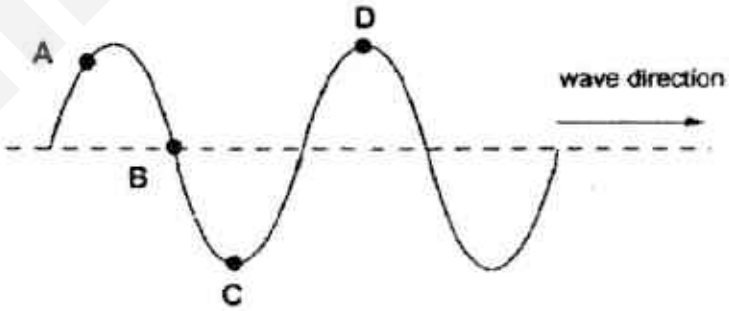
B 6.0 m/s

C 12.5 m/s

D 18.0 m/s

18 The diagram shows a water wave moving in the direction shown.

At which point is the water moving upwards with maximum speed?



19 A student makes five statements.

- All electromagnetic waves can travel in a vacuum.
- All waves obey the laws of reflection but some waves do not obey the laws of refraction.
- Sound is a longitudinal wave which travels in a direction parallel to the direction of vibrations.
- The distance between 3 consecutive crests of a transverse wave is equal to 3 wavelengths.
- Transverse waves transfer energy by transferring matter but longitudinal waves transfer energy without transferring matter.

How many statements is/are **not** correct?

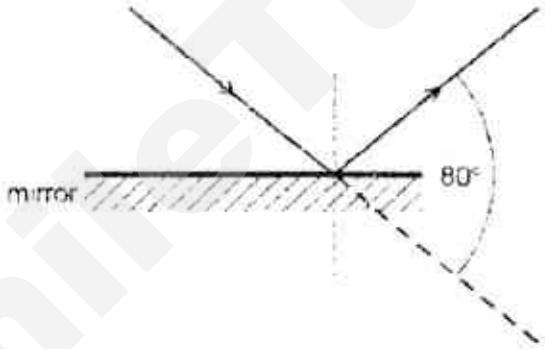
A 1

B 2

C 3

D 4

20 The diagram shows a ray of light reflecting off a mirror.



What is the angle the light ray turns through?

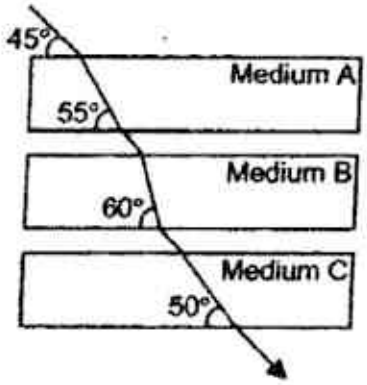
A 40°

B 50°

C 80°

D 130°

21 The diagram shows a ray of light passing through three transparent media, A, B and C.



(diagram not to scale)

Which statement is correct?

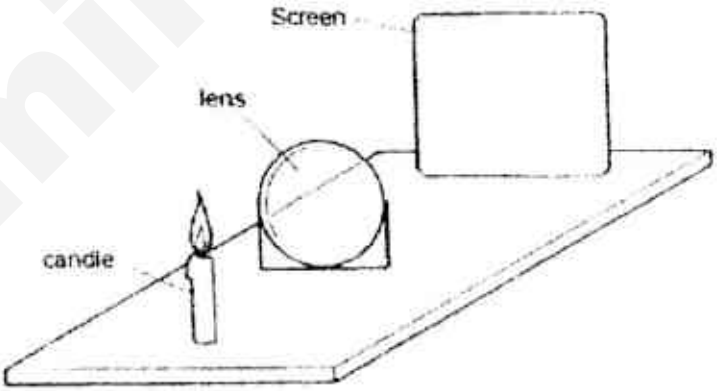
A Medium B has a lower refractive index than medium C.

B Medium B has the smallest refractive index.

C Light travels slower in medium A than in medium C.

D Light travels the fastest in medium A.

22 The diagram shows a thin converging lens placed in between a candle and a screen.



Various focussed images of the candle are produced on the screen by moving the lens and the screen backwards and forwards.

Which statement is correct?

A The image is bigger than the object.

B The image is closer to the lens than the object is.

C The image is formed at the focal point of the lens.

D The image is inverted.

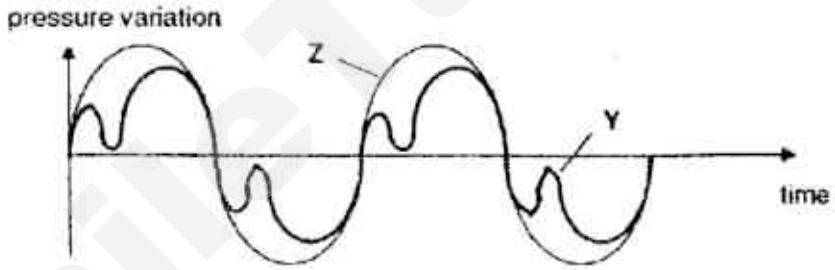
23 Which of the following is arranged in order of decreasing wavelength?

A microwaves, X-rays, visible light
B radio waves, ultraviolet rays, infra-red radiation
C radio waves, visible light, gamma rays
D ultraviolet rays, visible light, infra-red radiation

24 Which electromagnetic wave can cause structural damage to living cells and tissue?

A infra-red radiation
B microwaves
C radiowaves
D ultra-violet radiation

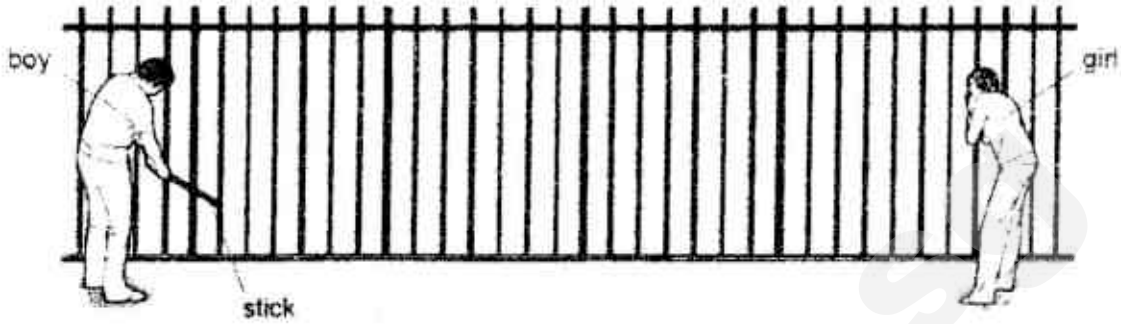
25 The diagram shows waveforms produced by a flute (Y) and turning fork (Z) played by two students.



How does the loudness and pitch of the sound from the turning fork Z compare to flute Y?

A The loudness of Y is lower but has the same pitch as compared to Z.
B Both Y and Z have the same pitch and loudness.
C The loudness of Y is higher and the pitch is lower as compared to Z.
D The loudness of Y is the same and the pitch is higher as compared to Z.

26 A boy strikes a rigid metal fence with a stick. A girl listens with her ear against the fence. One second after the fence is struck, the girl hears a sound through the air.



How long will it take for the girl to hear a sound through the fence?

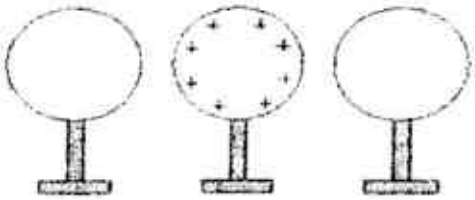
A less than 1 second

B 1 second

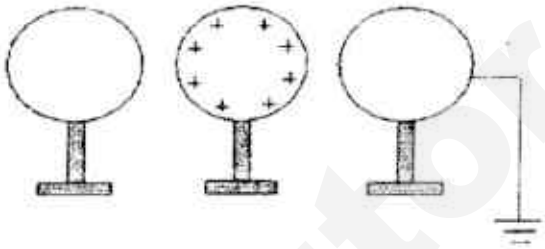
C more than 1 second

D sound cannot travel through the fence

27 The diagram shows a positively charged metal sphere placed between two uncharged metal spheres.

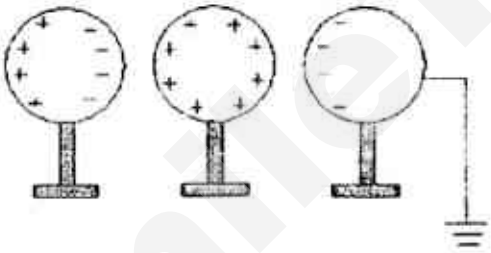


The sphere on the right is now earthed.

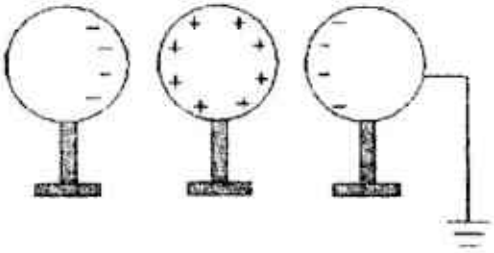


Which diagram correctly shows how the charges are distributed on the spheres?

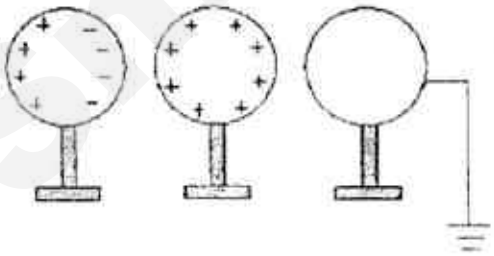
A



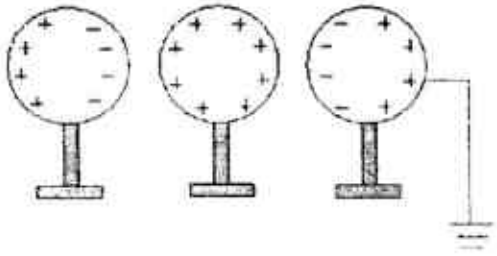
B



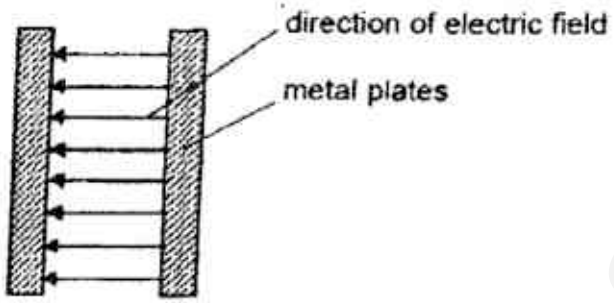
C



D



28 The diagram shows the electric field produced by two metal plates which are connected to an electrical supply.



A small negative charge is placed in the gap between the two plates.

What is the direction of the force exerted by the electric field on the negative charge?

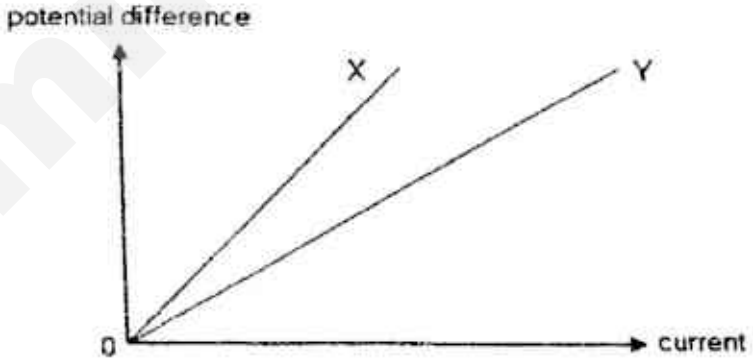
A down

B left

C right

D up

29 The diagram shows how the potential difference varies with current for two wires X and Y.



Both wires have the same length and cross-sectional area.

Which statement is correct?

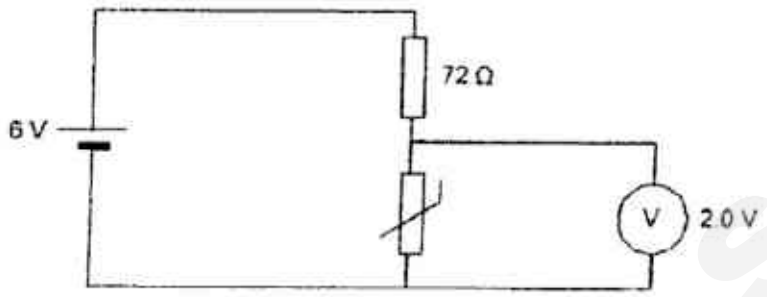
A A higher current flows through X than Y, if the same p.d is applied across them.

B Both X and Y do not obey Ohm's Law.

C The resistivity of X is greater than Y.

D Y has a greater resistance than X.

30 The diagram shows a thermistor connected in series with a 72 Ω resistor connected across a 6 V power supply. When the temperature of the thermistor is 20°C, the potential difference across it is 2.0 V.

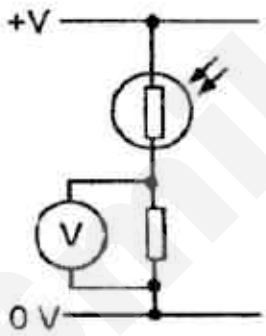


What is the resistance of the thermistor when the temperature is 20°C?

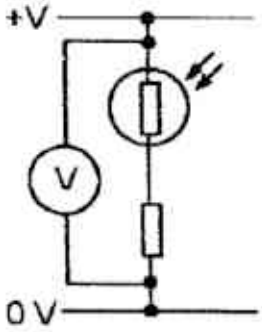
A 36 Ω
B 48 Ω
C 108 Ω
D 144 Ω

31 In which circuit does the voltmeter reading decrease when light shines on the light dependent resistor?

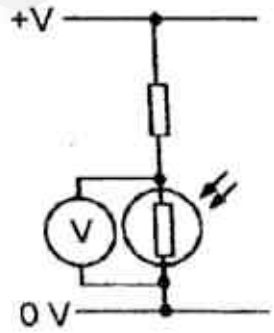
A



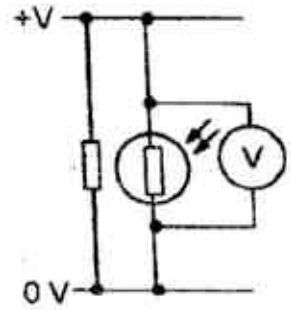
B



C



D



32 Four electric heaters are connected in parallel to the same power supply source. The resistances of the four heaters and the amount of time it was used are shown in the table.

Which heater consumed the most electrical energy?

	resistance / Ω	time / s
A	17.6	221
B	18.8	242
C	19.4	230
D	20.3	253

33 A 1.9 kW vacuum cleaner and a 200 W television is connected in parallel to a 240 V mains.

Which will be a suitable fuse rating for the mains?

A 7 A

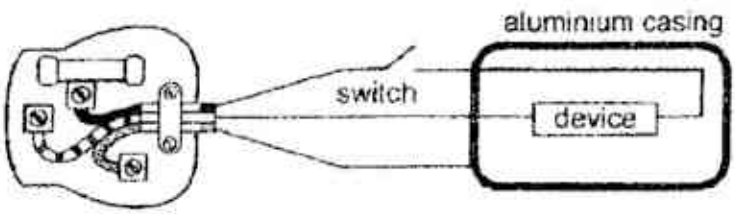
B 8 A

C 9 A

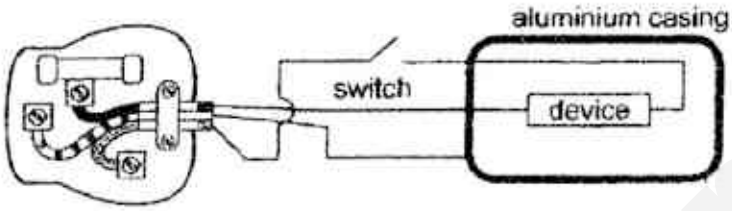
D 10 A

34 Which device is correctly wired to a three-pin plug?

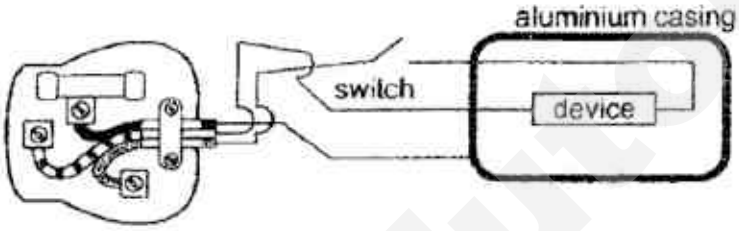
A



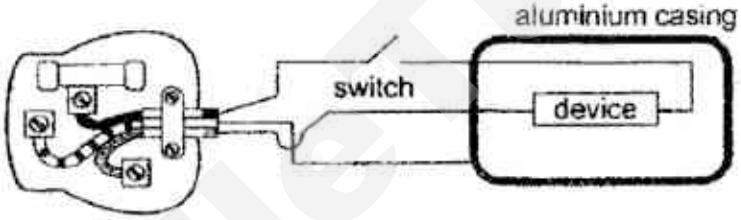
B



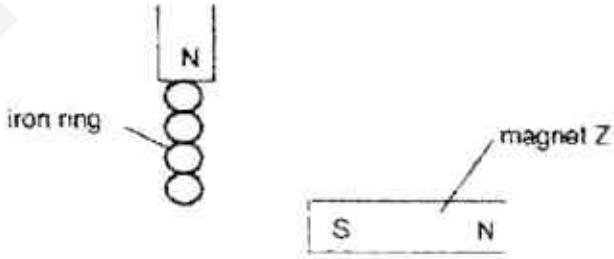
C



D



35 The diagram shows a strong magnet with four small iron rings attracted to it.



A weak magnet, Z, is brought near to the end of the lowest ring.

What will happen to the chain of iron rings?

A It will bend away from Z.

B It will bend towards Z.

C It will fall to the ground.

D It will remain still.

36 A student makes three statements on magnetism.

(i) A freely suspended magnet always points in a North-South direction.
(ii) A compass is a temporary magnet.
(iii) Electrical method of magnetisation will always produce permanent magnets

Which statement(s) is/are correct?

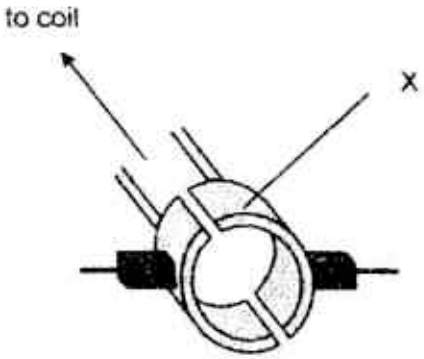
A (i) only
B (i) and (iii) only
C (ii) only
D (i), (ii) and (iii)

37 The diagram shows a beam of electrons moving in the direction shown.

What will happen to the beam of electrons as they enter into a magnetic field that goes into the plane of the paper?

A continue moving in the same direction and accelerates
B continue moving in the same direction and decelerates
C deflect downwards
D deflect upwards

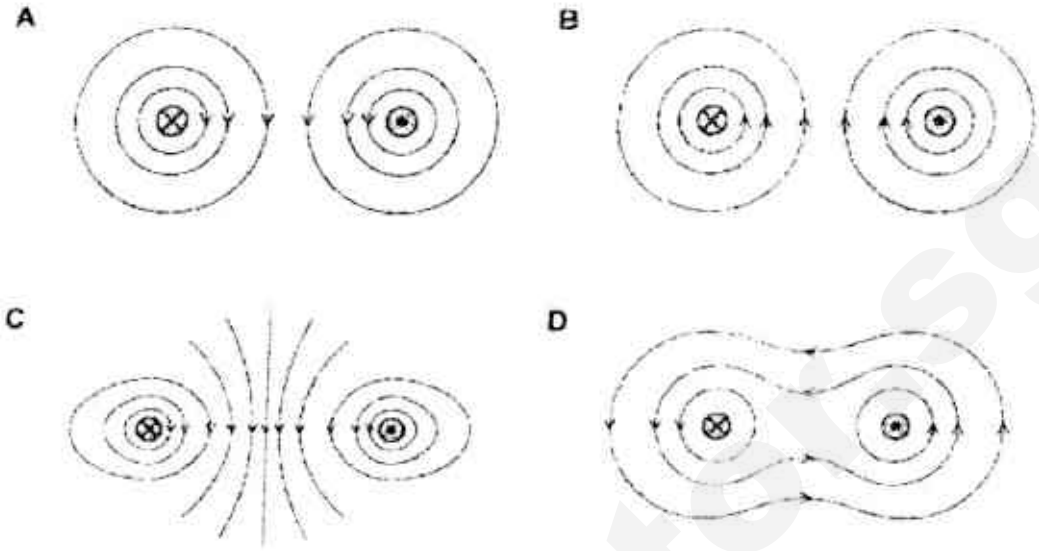
38 The diagram shows part of a d.c. motor.



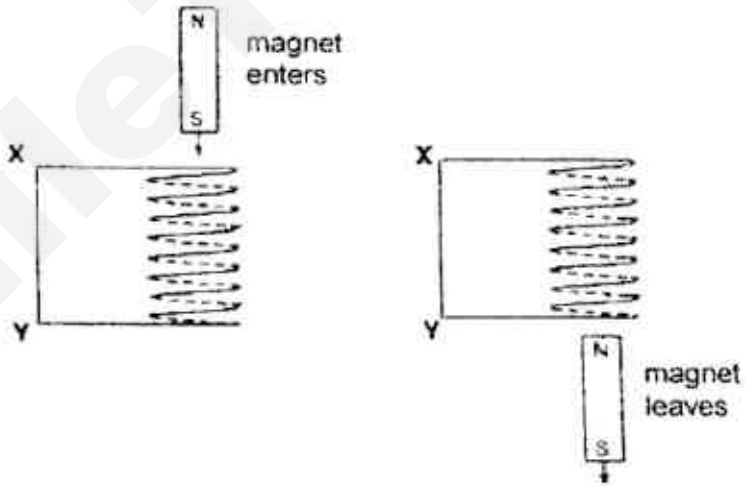
What is the function of X?

A to control the speed of rotation
B to provide a magnetic field
C to reverse the direction of current in the coil every half a revolution
D all of the above

39 Which diagram shows the correct magnetic field around two parallel wires carrying a current?



40 The diagrams below show the set-up for which a short bar magnet is dropped through a coil of wire.



Which of the following correctly indicates the direction of the induced current between X and Y?

	as magnet enters the coil	as magnet leaves the coil
A	X to Y	X to Y
B	X to Y	Y to X
C	Y to X	X to Y
D	Y to X	Y to X

2017 Preliminary Exam - Sec 4 Express
Physics (SPA) 5059 Suggested Answers & Feedback

Paper 1 (40 marks)

Qn	Ans
1	B
2	A
3	B
4	B
5	A
6	C
7	D
8	B
9	C
10	B

Qn	Ans
11	D
12	D
13	A
14	A
15	B
16	D
17	B
18	B
19	C
20	C

Qn	Ans
21	C
22	D
23	C
24	D
25	A
26	A
27	A
28	C
29	C
30	A

Qn	Ans
31	C
32	B
33	C
34	D
35	B
36	A
37	C
38	C
39	C
40	C

Section A

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

1 Fig. 1.1 shows an acrobat walking a tight rope.

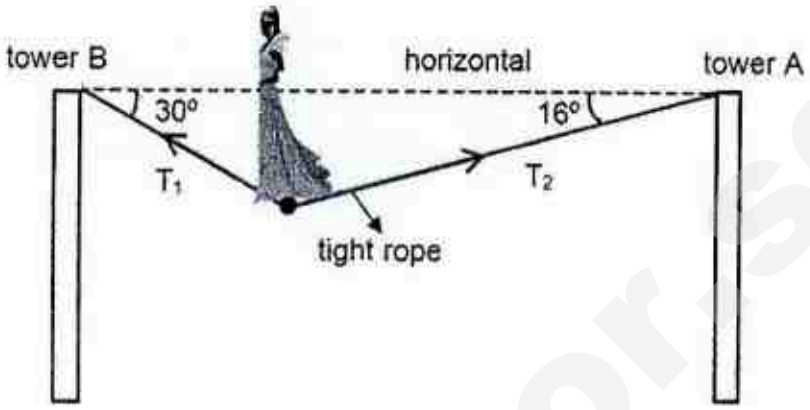


Fig. 1.1

The acrobat is at rest at the position shown in Fig. 1.1.
The tensions T_1 and T_2 in the rope are 600 N and 540 N respectively.

(a) **(i)** In the space below, draw a labelled diagram to show the resultant of the two tensions.

Determine the size of the resultant force and the direction between the resultant force and the horizontal.

resultant force = ...

direction : .....[3]

(ii) Determine the weight of the acrobat.

weight = ...[1]

(b) A second acrobat of mass 65 kg stationed at tower B jumps vertically upwards with a force of 2000 N.

The gravitational field strength is 10 N/kg.

(i) Calculate the initial acceleration of the second acrobat.

acceleration = ...[2]

(ii) On Fig. 1.2, sketch a velocity-time graph of the second acrobat from the instant she jumped upwards to the instant she lands back on tower B.

Neglect air resistance in your sketch.

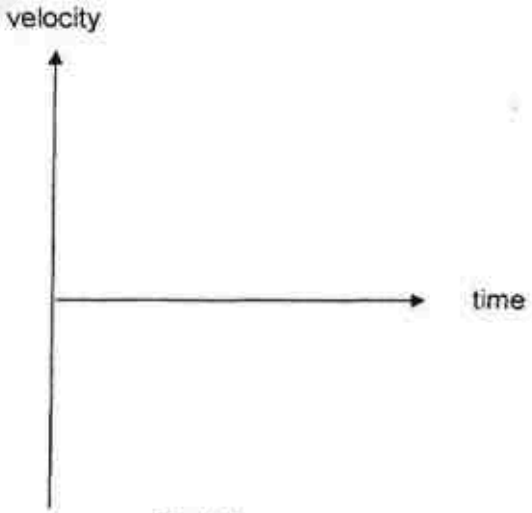


Fig 1.2

[1]

2 Fig. 2.1 shows a uniform oval disc freely pivoted at **P**. The bottom of the disc is pulled to the right by the tension in the thread **ST**.

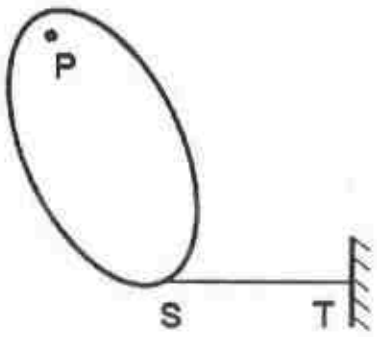


Fig. 2.1

(a) On Fig. 2.1, draw an arrow to represent

(i) the weight of the disc, marking out the position of the centre of gravity of the disc with a cross, X, [1]

(ii) the force exerted by the thread on the disc and label it as F_1, [1]

(iii) the force exerted by the pivot on the disc and label it as F_2. [1]

(b) Describe and explain what happens to the disc when the string **ST** is cut.

.....

.....

.....[2]

3 **Fig. 3.1** shows a simplified structure of a tidal generator used to generate electricity.

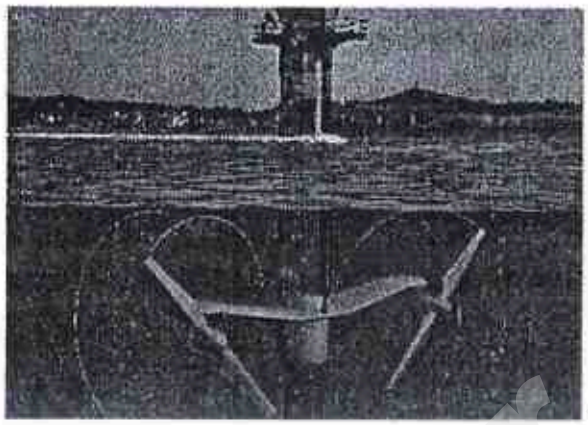


Fig. 3.1

(a) (i) State the Principle of Conservation of Energy.

.....

.....[1]

(ii) The total kinetic energy provided by tidal currents acting in a second is 111 240 J.

The efficiency of the tidal generator is 77%.

Calculate the energy output of the tidal generator in 10 min.

output = ...[2]

(iii) Give a reason why the efficiency of the tidal generator is not 100%.

.....

.....[1]

(b) Both wind turbines and tidal turbines are potentially eco-friendly and inexpensive sources of renewable energy.

State one advantage of tidal turbines as compared to wind turbines.

.....

.....[1]

4 Fig. 4.1 shows a solar heating system.

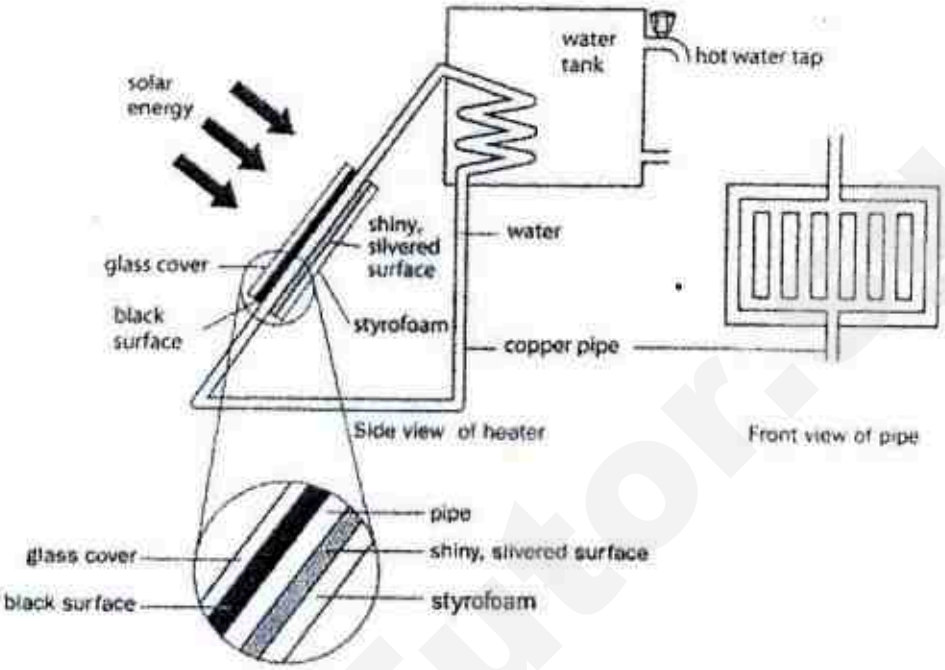


Fig. 4.1

(a) Explain how the sun causes the water in the tank to heat up.

.....

.....

.....

.....

.....

.....[4]

(b) Explain the purpose of the styrofoam.

.....

.....[1]

(c) Suggest one modification that can heat up the water at a greater rate and explain why.

.....

.....[2]

5. Fig. 5.1 shows a setup using ultrasound to detect flaws in welding. A pulse sent by the transmitter reflects from the other end of the metal into the receiver. Fig. 5.2 shows one normal C.R.O. signal display and two abnormal displays. The speed of ultrasound through the piece of metal is 3200 m/s.

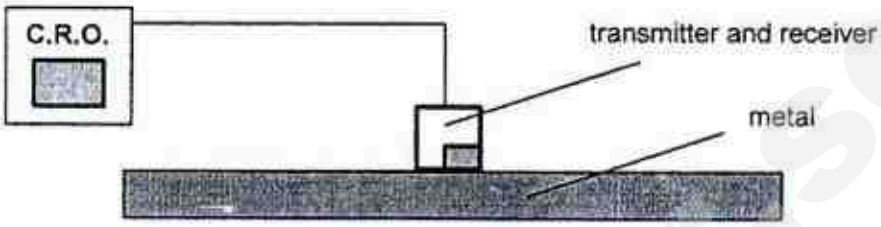


Fig. 5.1

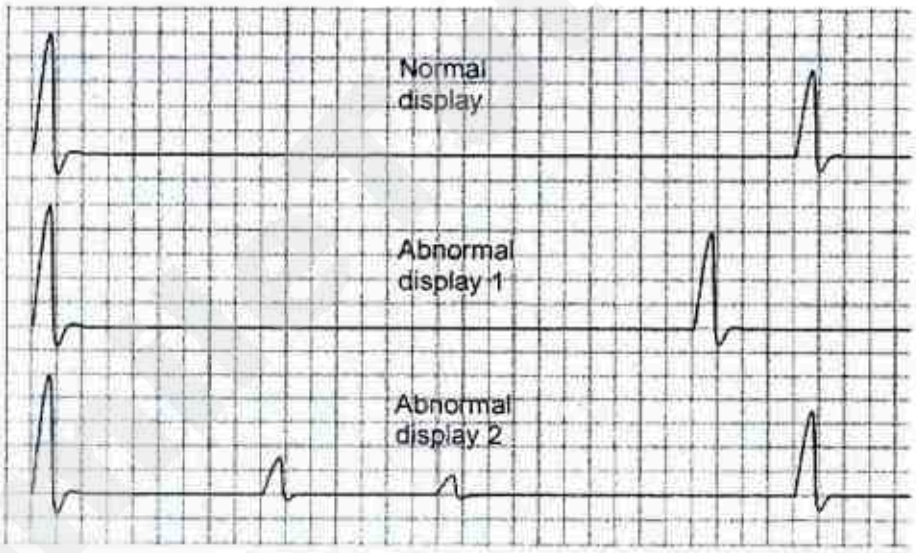


Fig. 5.2

(a) For the normal display, the time interval between the transmitted and received pulse is 30×10^{-6} s.

Calculate the thickness of the piece of metal.

thickness = ...[1]

(b) Suggest a possible reason for the abnormalities in

display 1,

.....

.....[1]

display 2.

.....

.....[1]

(c) Explain why a received pulse will have a lower amplitude than the transmitted pulse.

.....[1]

(d) Electromagnetic waves can also be used to detect flaws in welding.

(i) State one electromagnetic wave that is used.

..... [1]

(ii) Explain how the use of electromagnetic waves is different from ultrasound waves in detecting flaws.

.....

.....[1]

6 Fig. 6.1 shows the print head for an inkjet printer. The inkjet from the ink gun is charged before it is ejected downwards.

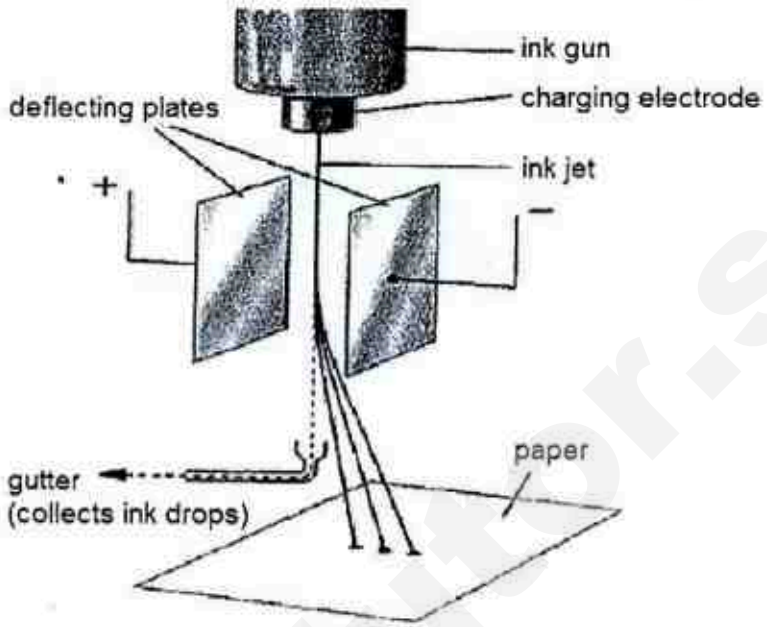


Fig. 6.1

(a) State the type of charge on the inkjet and explain your answer.

.....

.....[1]

(b) Explain why the ink particles form an even layer of coating on the paper.

.....

.....[1]

(c) Predict if an even layer of coating on the paper is more likely to be achieved by a printer in an air-conditioned room compared to a non air-conditioned room.

.....

.....

.....[2]

(d) The deflecting plates are maintained at a potential difference of 20 V. A charge of 1.5 μC is passed between the plates every second.

(i) State what is meant by potential difference.

.....

.....[1]

(ii) State the electric current passing through the plates.

current = ...[1]

(iii) Calculate the energy consumed by the plates in one minute.

energy =.....[2]

7 A magnetic relay uses a small circuit to control a larger circuit. Fig. 7.1 shows a simple magnetic relay, together with three contacts X, Y and Z, used to control the operation of two lamps L_1 and L_2.

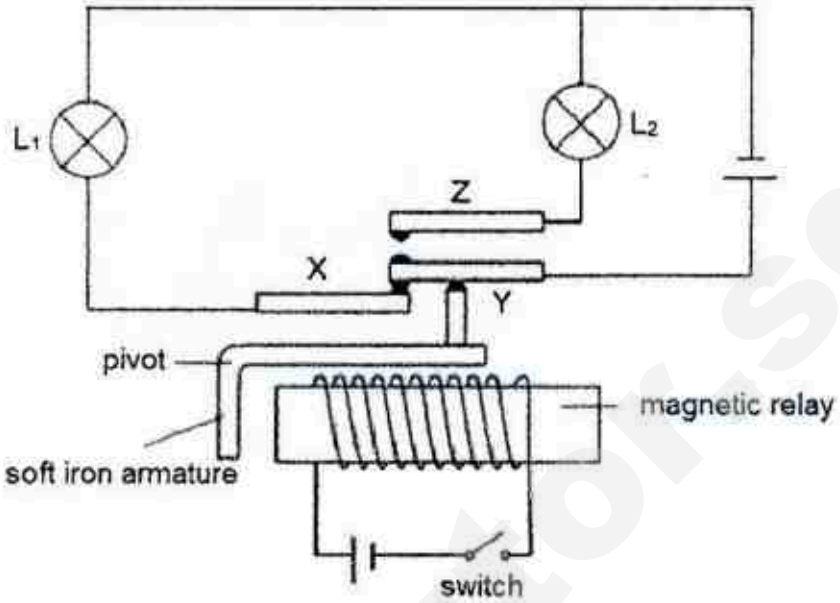


Fig 7.1

The switch is closed.

(a) On Fig. 7.1, draw the magnetic field around the magnetic relay. [2]

(b) Describe the changes that occur in L_1 and L_2.

.....

.....

.....

.....[3]

8 Fig. 8.1 shows an a.c. generator.

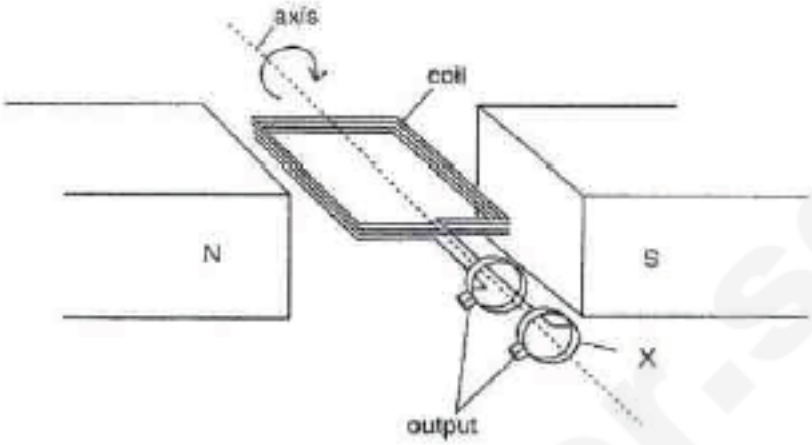


Fig 8.1

(a) The coil starts to rotate from the position shown in Fig. 8.1.

(i) Explain why the e.m.f. induced is a maximum at this instant.

.....

.....

.....[2]

(ii) The coil rotates 180° every 10 s and the maximum e.m.f. induced is 110 V.

On Fig. 8.2, sketch the voltage against time graph for the first 20 s, indicating your values clearly.

Fig 8.2

[2]

(b) State one way to increase the magnitude of the induced e.m.f.

.....[1]

(c) State component X and its function.

.....

.....[2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in Question **11**.

9 Induction cookers work on the principle of electromagnetic induction. Fig 9.1 shows an induction cooker which consists of a copper coil connected to an alternating current (a.c.) supply and a ceramic plate. When a pot made of soft magnetic material is placed on top of the cooker and the a.c. supply is turned on, electromagnetic induction leads to the pot being heated. The ceramic plate remains relatively cool.

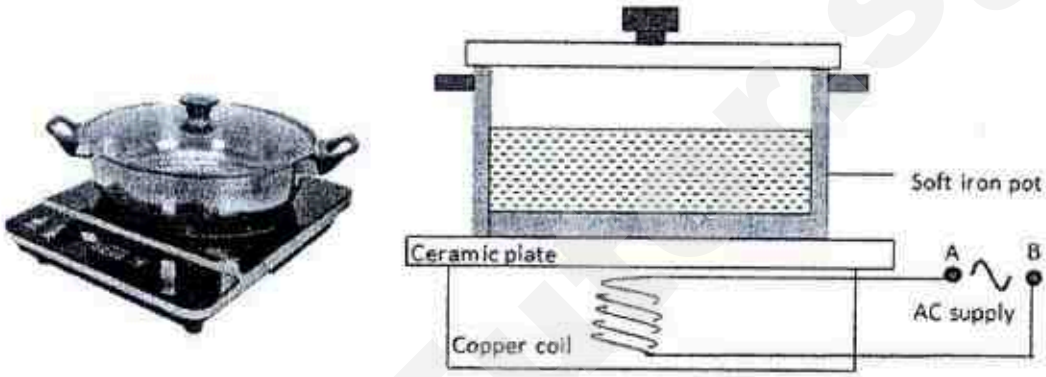


Fig. 9.1

(a) Explain how an alternating current causes a heating effect in the pot but not in the ceramic plate.

.....

.....

.....

.....

.....[3]

(b) The manufacturer is exploring alternative materials for the pot. Fig. 9.2 shows how the resistivities of two alloys **A** and **B** change with temperature.

temperature / °C	resistivity of **A** (Ωm)	resistivity of **B** (Ωm)
20	1.5×10^{-7}	7.0×10^{-7}
70	2.3×10^{-7}	8.1×10^{-7}
120	3.1×10^{-7}	9.2×10^{-7}
170	3.9×10^{-7}	10.3×10^{-7}
220	5.3×10^{-7}	13.4×10^{-7}
270	8.7×10^{-7}	18.7×10^{-7}
320	12.7×10^{-7}	26.8×10^{-7}
370	18.9×10^{-7}	37.6×10^{-7}
420	26.2×10^{-7}	58.4×10^{-7}
470	35.4×10^{-7}	80.7×10^{-7}

Fig. 9.2

(i) Using data from Fig. 9.2, describe the relationship between temperature and resistivity of **A**

1. At low temperature, ...

.....[1]

2. At high temperature, ...

.....[1]

(ii) Fig 9.3 shows the chemical composition of alloys **A** and **B**.

Alloy	A	B
carbon (%)	2	3
iron (%)	88	78
chromium (%)	10	19

Fig. 9.3

The data in Fig. 9.2 and Fig. 9.3 provides some evidence of a relationship between chromium content and resistivity. State this possible relationship.

.....

.....[1]

(c) The induction cooker has a power rating of 1800 W and contains 0.2 kg of water at a temperature of 23 °C. The pot was left on the induction cooker until all the water boiled off.

The specific heat capacity of water = 4200 J/(kg °C)
The specific latent heat of vaporization of water = 2 260 000 J/kg

Calculate the minimum time the pot was left on the induction cooker.

time =.....[3]

(d) Fig. 9.4 shows a gas stove used to heat up a pot.

Fig. 9.4

Suggest why an induction cooker is more efficient than the gas stove using the same pot with the same energy input.

.....

.....[1]

10 Fig. 10.1 shows an air pump, which is 1.0 m in length, connected to a manometer. It initially contains 2000 cm^3 of air at atmospheric pressure of 1.03×10^5 Pa. The volume of air in the narrow tube is negligible. The right side of the manometer is exposed to atmospheric pressure.

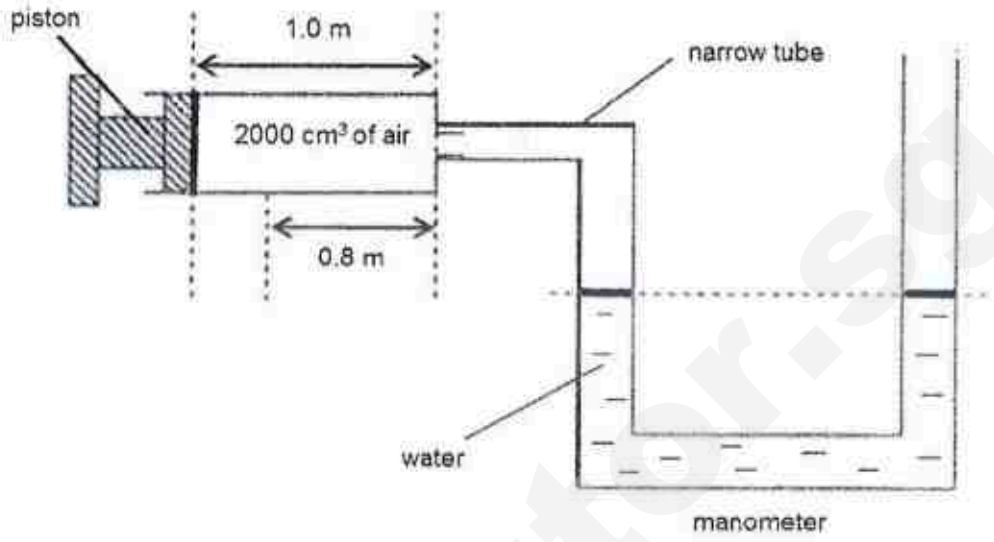


Fig. 10.1

The piston is partially pushed to the right and held steady at a distance of 0.8 m as indicated in Fig. 10.1. The temperature of the air inside the air pump remains constant.

(a) Describe the difference in the motion of the air molecules in the air pump and the water molecules in the manometer.

.....

.....

.....[2]

(b) The cross-sectional area of the piston is 2×10^{-3} m^2.

Calculate the force of air acting on the piston before it was pushed.

force = ...[2]

(c) Using ideas about molecules, explain why the pressure of the air inside the air pump increases when the piston is pushed.

.....

.....

.....

.....

.....[3]

(d) After the piston was pushed, the pressure in the air pump increases to 1.29×10^5 Pa.

The density of water is 1000 kg/m^3 and gravitational field strength is 10 N/kg.

Calculate the height difference between the water columns in the manometer.

height difference = ...[2]

(e) Explain why there is no change to the height difference between the water columns in the manometer in (d) if the diameter of the manometer tubing is increased.

.....[1]

11 EITHER

(a) Fig. 11.1 shows an electric motor where a coil PQRS is connected to a battery and is placed between two solenoids AB and CD which are connected to a separate d.c. power supply.

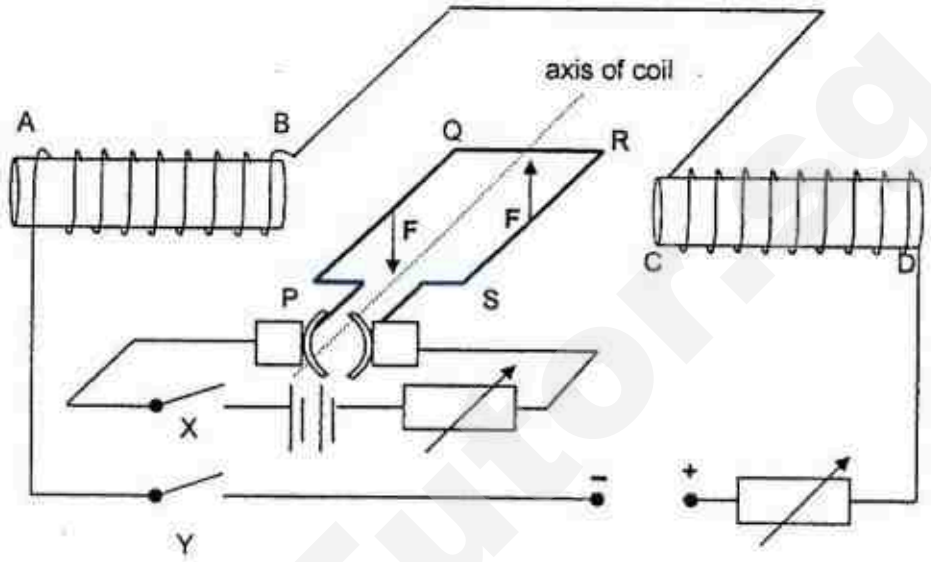


Fig 11.1

(i) On Fig. 11.1, **F** represents the force experienced by sides PQ and RS of the coil when both switches X and Y are closed.

Explain why a force is experienced by sides PQ and RS of the coil.

.....

.....[1]

(ii) The force experienced on each side of the coil is 8 N. The lengths of PQ and QR are 0.8 m and 0.5 m respectively.

Calculate the moment produced by the motor and state its direction of rotation.

moment =.....[2]

direction of rotation : .....[1]

(iii) Describe and explain the effect on the movement of coil PQRS when the d.c. power supply connected to solenoids AB and CD is replaced by an a.c. power supply.

.....

.....

.....[2]

(b) Fig. 11.2 shows a cathode-ray oscilloscope (c.r.o.) being used to measure the period and voltage of an a.c. supply.

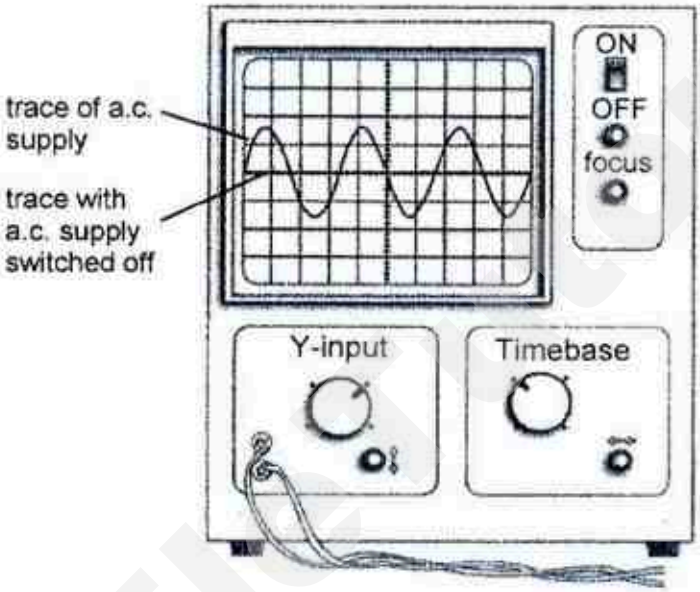


Fig 11.2

(i) The Y gain is 5 V / division and the timebase is 2 ms / division.

Using Fig. 11.2, determine the peak voltage and period of the a.c. supply.

peak voltage = ... [1]

period = ... [1]

(ii) Calculate the frequency of the a.c. supply.

frequency = ...[2]

11 OR

(a) Figure 11.3 shows a lamp and two resistors connected to a battery of e.m.f. 6.0 V.

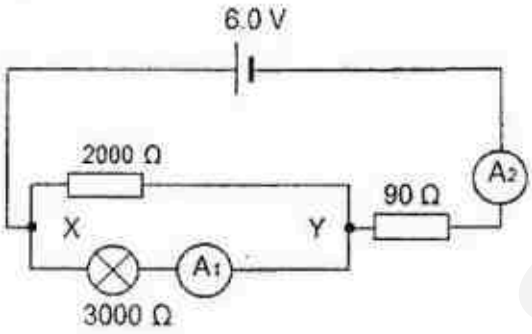


Fig. 11.3

(i) Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) Calculate the ammeter reading A_2.

ammeter reading = ...[1]

(iii) Calculate the potential difference across XY.

potential difference = ...[1]

(iv) A 100 Ω resistor was connected in parallel across the 90 Ω resistor. The ammeter reading A_1 increased. Explain why.

.....

.....[1]

(b) An a.c. source is used to light up another lamp as shown in Fig. 11.4. A transformer with 500 turns in the primary coil is attached to a 240 V, 50 Hz a.c supply. The secondary coil is connected to a 20 V, 50 W lamp that is operating under normal working condition.

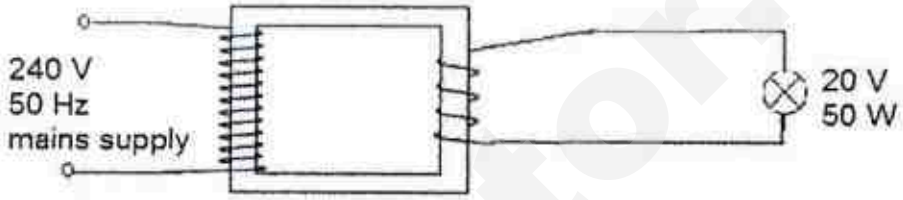


Fig. 11.4

(i) Calculate the number of turns in the secondary coil.

number of turns = ...[2]

(ii) Calculate the current flowing through the primary coil.

current = ...[1]

(iii) A thicker wire is used at the secondary coil instead of the primary coil.

Suggest a reason.

.....

.....

.....[1]

(iv) The core linking the two transformers is made of thin laminated sheets.

Explain how this improves the efficiency of the transformer.

.....

.....[1]

End of Paper

2017 Preliminary Exam - Sec 4 Express
Physics (SPA) 5059 Suggested Answers & Feedback

Paper 1 (40 marks)

Qn	Ans
1	B
2	A
3	B
4	B
5	A
6	C
7	D
8	B
9	C
10	B

Qn	Ans
11	D
12	D
13	A
14	A
15	B
16	D
17	B
18	B
19	C
20	C

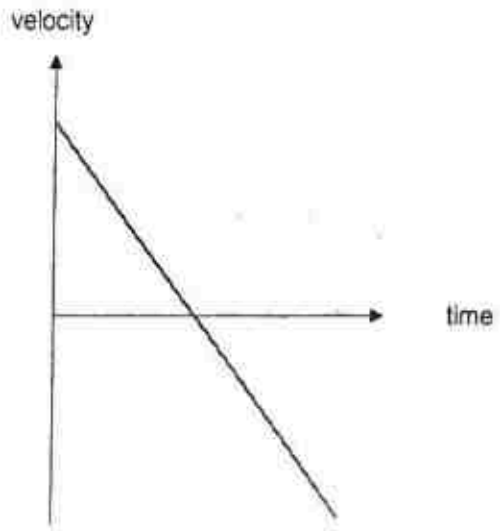
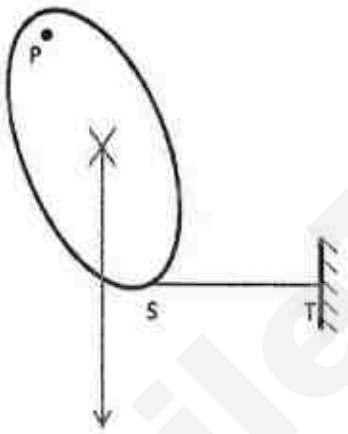
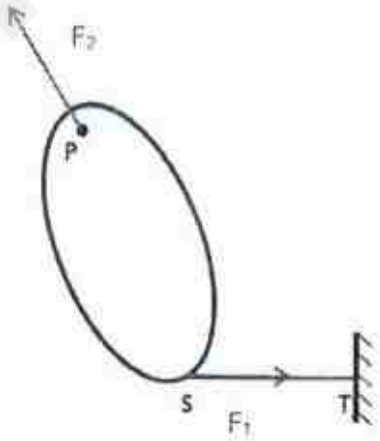
Qn	Ans
21	C
22	D
23	C
24	D
25	A
26	A
27	A
28	C
29	C
30	A

Qn	Ans
31	C
32	B
33	C
34	D
35	B
36	A
37	C
38	C
39	C
40	C

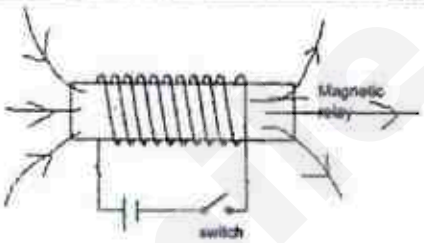
Paper 2

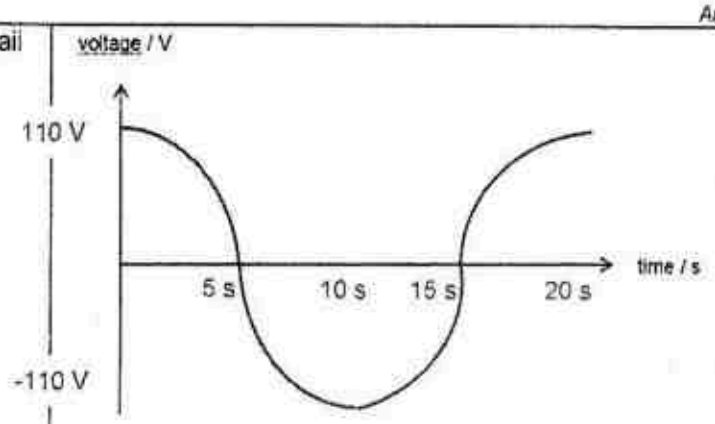
Section A (50 marks)

	SUGGESTED ANSWERS		FEEDBACK
1ai	 Scale 1 cm rep 100 N or 1 cm rep 200 N 1 mark for correct scale, shape and arrows 1 mark for magnitude of resultant force resultant force = 450 N (accept 430 to 470 N) 1 mark for direction direction: 60° with T_1 (accept 59° to 61°) OR 74° with T_2 (accept 73° to 75°)	 B1 B1 B1	
1aii	weight = 405 N (accept 430 to 470 N)	B1	
1bi	F = ma 2000 – mg = ma 2000 – 65 x 10 = 65 a a = 20.8 m/s^2	 M1 A1	

1bii		B1	
2ai	 Correct position of X and arrow vertically down passing through X	B1	
2aii 2aiii		B1 B1	
2b	The weight of the disc will produce a moment (about the pivot) and disc will rotate clockwise OR disc will come to rest with centre of gravity directly below pivot.	B1 B1	

3ai	Energy cannot be created nor destroyed but can be converted from one form to another (total amount of energy in a closed system remains constant)	B1	
3aii	Efficiency = (Useful energy output / energy input) x 100% 77 = (Electrical energy output / KE energy input) x 100 77 = (Electrical energy output / (111 240 x 10 x 60)) x 100 Electrical energy output = 51 392 880 J	 M1 A1	
3aiii	Energy is used to overcome frictional forces / resistive forces. *Do not accept heat loss / converted to other forms of energy	B1	
3b	-There are constant tidal currents compared to wind speeds which fluctuate -Tidal turbines take up less space on land to construct compared to wind turbines *Any one	B1	
4a	Pipes are heated up through radiation from sun. The pipes conduct heat to the water flowing in pipe. Water expands, becomes less dense and rises, flowing to the top of the water tank. Cool water at the tank (is denser) and sinks, flowing down the pipe to get heated, repeating the process/forming a convection current.	B1 B1 B1 B1	
4b	Poor conductor / good insulator of heat to reduce heat loss to surroundings	B1	
4c	Increase bends of pipes / use longer pipe to increase surface area / allow more time for water to heat up	B1 B1	
5a	speed = total distance / total time 3200 = (2 x thickness) / (30 x 10^{-6}) Thickness = 0.048 m	 B1	
5b	display 1: metal is too thin display 2: two cracks/cavities in metal	B1 B1	
5c	-Energy is absorbed by the metal / energy is lost to surroundings Or any appropriate answer that shows waves reflect in different directions and not all return to receiver	B1	
5di	X rays or gamma rays	B1	
5dii	Ultrasound waves use the time taken for reflection as compared to electromagnetic waves that penetrates through the metal and measures the difference in radiation passing through.	B1	

6a	Positive. Like positive charge on inkjet is repelled by positive charge on deflecting plate OR gets attracted to negative charge on deflecting plate.	B1	
6b	Inkjet charges are alike and repel each other as like charges repel, thus spreading out with an even layer of coating. *Accept repel and not deflected	B1	
6c	Yes it will be more likely to achieve an even layer of coating in an air-conditioned room. There will be less water molecule charges in the air to discharge/neutralise the inkjet charges.	B1 B1	
6di	Potential difference is the work done to drive a unit charge across a component.	B1	
6dii	$I = Q / t$ $= 1.5 \times 10^{-6} / 1$ $= 1.5 \times 10^{-6}$ A	 B1	
6diii	$E = VQ$ $= 20 \times 1.5 \times 10^{-6} \times 60$ $= 0.018$ J *allow ecf from 6dii	 M1 A1	
7a	 [1] – magnetic field arrows [1] – magnetic field shape/curvature	B1 B1	
7b	Magnetic relay is magnetised and attracts the soft iron armature. This breaks contact X with the battery and L1 switches off. Contact Y now touches contact Z and L2 lights up.	B1 B1 B1	
8ai	The magnetic field lines are being cut at the greatest rate / rate of change of magnetic flux is maximum. From Faraday's law, the magnitude of the induced current / e.m.f is directly proportional to the rate of change of magnetic flux and thus the e.m.f induced is maximum.	B1 B1	

8aii	 [1] – shape [1] - values	B1 B1	
8b	Increase speed of rotation / increase number of turns of coils / use stronger magnet / insert soft iron core (any one)	B1	
8c	Slip ring. To ensure the induced current in circuit / coil is transferred to the output.	B1 B1	

Section B

9a	An alternating current in the circuit creates a changing magnetic field/flux in the soft iron pot. This induces a current in the soft iron pot which heats up the pot. The ceramic plate does not heat up as it is an insulator of electricity (and no current flows through it). *Do not accept insulator of heat as question is not referring to transfer of heat between iron pot and ceramic plate	B1 B1 B1	
9bi	1. Low temperature: resistivity varies linearly with temperature / resistivity increases at a constant rate with temperature 2. High temperature: resistivity increases at an increasing rate with temperature	B1 B1	
9bii	As chromium content increases, the resistivity increases. *accept resistivity varies linearly with chromium content linearly with a positive gradient. **Do not accept resistivity is directly proportional to chromium content.	B1	
9c	Thermal energy required to change water from 23°C to 100 °C $Q = mc\Delta\theta$ $= 0.2 \times 4200 \times (100 - 23)$ $= 64\ 680$ J Thermal energy required to change water from 100°C to steam at 100 °C $Q = ml_v$	M1	

	= 0.2 x 2 260 000 = 452 000 J Total energy needed = 64 680 + 452 000 = 516 680 J E = Pt 516 680 = 1800 x t t = 287 s *Accept 288 s (*minimum time)	M1 A1	
9d	For the same energy input, the gas stove loses more heat to the surroundings compared to the induction stove.	B1	
10a	Air molecules move freely and randomly at very high speeds. Water molecules move freely within liquid in random motion / sliding over one another.	B1 B1	
10b	p = F / A $1.03 \times 10^5 = F / (2 \times 10^{-3})$ F = 206 N	 M1 A1	
10c	When volume decreases, the number of air molecules per unit volume increases. The frequency of collision of air molecules with the walls increases, which increases the force of collision with the walls. *1 mark for every 2 correct sub-points This increases the force per unit area and the pressure.	B1 B1 B1	
10d	pressure difference = density x gravitational field strength x height difference $(1.29 - 1.03) \times 10^5 = 1000 \times 10 \times h$ h = 2.6 m	 M1 A1	
10e	The height difference depends on the pressure difference between the 2 water columns, (which does not depend on the cross sectional area of tubing).	B1	
11	EITHER		
11ai	The magnetic field of the current and magnetic field of the magnet interact to give a resultant magnetic field producing a force.	B1	
11aii	M = F x d = 8 x 0.25 x 2 = 4 Nm anticlockwise	 M1 A1 B1	

11aiii	The force acting on coils PQ and RS will change direction repeatedly. This will cause the coil to rotate anticlockwise and then clockwise repeatedly.	B1 B1	
11bi	Peak voltage = 5 V / div x 1.6 div = 8.0 V *accept 1.4 or 1.8 div (1.4 div x 5V / div = 7.0 V, 1.8 div x 5V / div = 9.0 V) 3 periods = 10 divisions 1 division = 2 ms 10 divisions = 20 ms 3 periods = 20 ms period = 20/3 = 6.67 ms *accept 3.2, 3.4 and 3.6 div (3.2 div x 2ms / div = 6.4 ms 3.4 div x 2 ms / div = 6.8 ms 3.6 div x 2 ms / div = 7.2 ms	B1 B1	
11bii	f = 1/T = 1 / 6.67 x 10^{-3} = 150 Hz *allow ecf from 11bi	 M1 A1	
11	OR		
11ai	Parallel resistance = $(1/2000 + 1/3000)^{-1}$ = 1200 Ω Total resistance = 1200 + 90 = 1290 Ω	M1 A1	
11aii	I = V/R = 6 / 1290 = 4.65 x 10^{-3} A *allow ecf from 11ai	 B1	
11aiii	p.d. across XY + p.d. across 90 Ω = 6 V p.d. across XY + 4.65 x 10^{-3} x 90 = 6 p.d. across XY = 5.58 V OR R_{xy} = $(1/2000 + 1/3000)^{-1}$ = 1200 Ω V_{xy} = I R_{xy} = 4.65 x 10^{-3} x 1200 = 5.58 V OR V_{xy} = (1200/1290) x 6 = 5.58 V	 B1	
11aiv	Effective resistance will decrease. Main current in circuit will increase / A2 will increase.	B1	

11bi	No. of turns in secondary/no. of turns in primary = voltage at secondary / voltage at primary No. of turns in secondary/500 = 20/240 No. of turns in secondary = 41.7	M1 A1	
11bii	power at primary = power at secondary VI (pri) = P(sec) 240 x I = 50 I = 0.208 A	B1	
11biii	Higher current at secondary which will leading to increased heating effect. Thicker wire is used as it has lower resistance which will reduce heating effect	B1	
11biv	The laminated sheets reduce eddy currents and reduce heating losses / energy lost as heat / joule heating effect	B1	

O

ANDERSON SECONDARY SCHOOL
Preliminary Examination 2017
Secondary Four Express & Five Normal (Academic)

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

PHYSICS **5059/01**

Paper 1 Multiple Choice

28 August 2017

1 hour

0800 – 0900h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid/tape.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** or **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 **16** printed pages.

1 A pair of vernier calipers is used to measure the outer diameter of a metal ring. With the jaws fully closed, the reading is as shown in diagram 1. With the jaws closed around the metal ring, the reading is as shown in diagram 2.

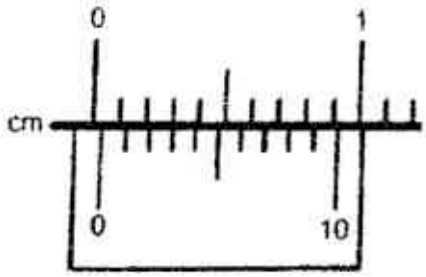


diagram 1

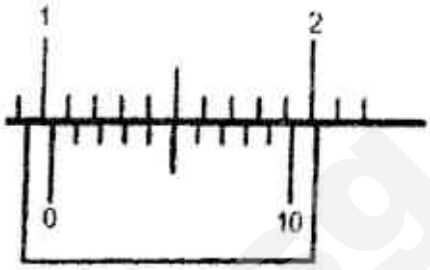


diagram 2

The ring is 1 mm thick along its circumference.

What is the inner diameter of the ring?

A 0.81 cm **B** 0.91 cm **C** 0.99 cm **D** 1.00 cm

2 Which pair contains two vector quantities?

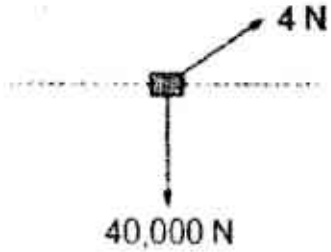
A acceleration and time

B displacement and temperature

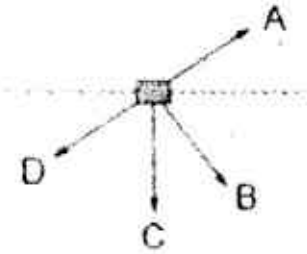
C force and displacement

D velocity and work done

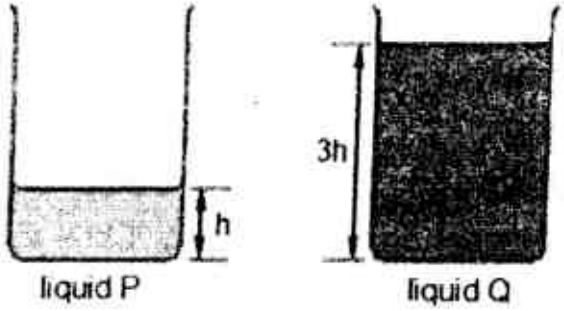
3 Forces of 4 N and 40,000 N act on an object in the directions shown.



Which arrow best shows the direction of the resultant force on the object?



4 Liquids P and Q have the same mass and are placed in identical containers.



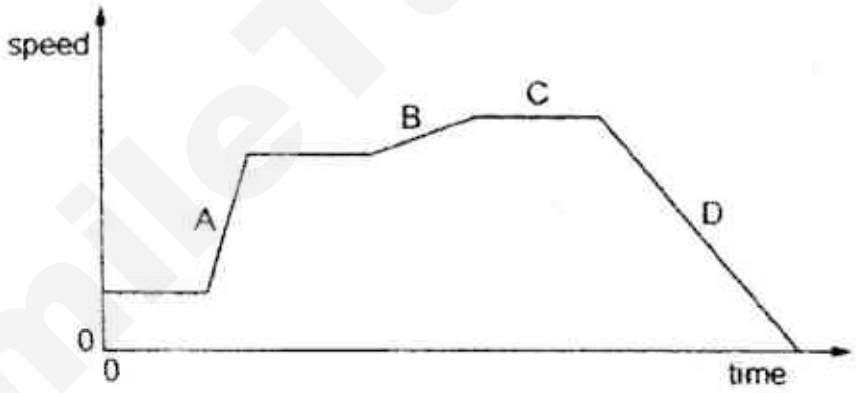
Liquid P has a density of p.

What is the density of liquid Q?

A $\frac{1}{9}p$ **B** $\frac{1}{3}p$ **C** p **D** $3p$

5 The graph shows how the speed of a car travelling in a straight line changes with time.

Which section shows the largest rate of change of velocity?



6 The man in the diagram is falling towards the Earth at a terminal velocity.

Which of the following statements describes the air resistance he is experiencing?

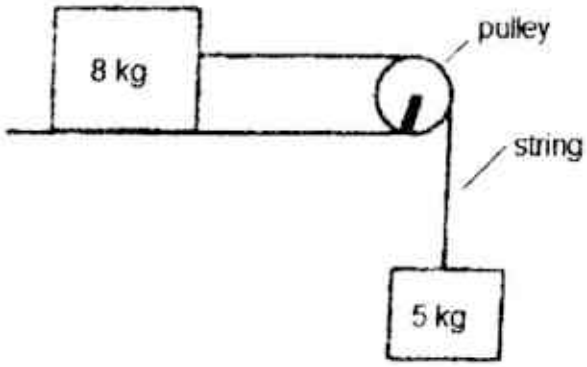
A It is smaller than his weight as he has spread his hands out.

B It is smaller than his weight as he is moving downwards.

C It is equal to his weight as he is not accelerating.

D It is equal to his weight as he is in freefall.

7 An 8.0 kg block is placed on a smooth table and attached to a 5.0 kg block with a string. The string runs over a frictionless pulley as shown in the diagram below.



Ignoring air resistance, determine the acceleration of the 5 kg mass.

A 3.0 ms^{-2} **B** 3.9 ms^{-2} **C** 5.0 ms^{-2} **D** 16.7 ms^{-2}

8 A beam balance cannot be used to measure the mass of a body if there is no gravitational field. This is because the body will have no _____.

A acceleration

B air

C air resistance

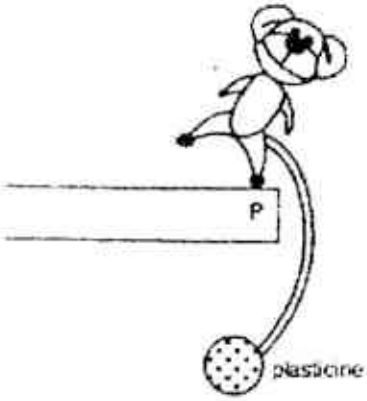
D weight

9 In a tennis match, Rob hits the ball of mass 60 g towards James with a speed of 40 m/s. James hits the ball back to Rob along the same path with a speed of 40 m/s.

Given that the contact time with the racket is 5.0 ms, calculate the force exerted by James in returning the ball.

A 0 N **B** 400 N **C** 480 N **D** 960 N

10 A toy monkey is placed at the edge of a table at point P as shown. The toy can be balanced on the table by adding a lump of plasticine at the end of the tail.



Determine the position of the toy's centre of gravity.

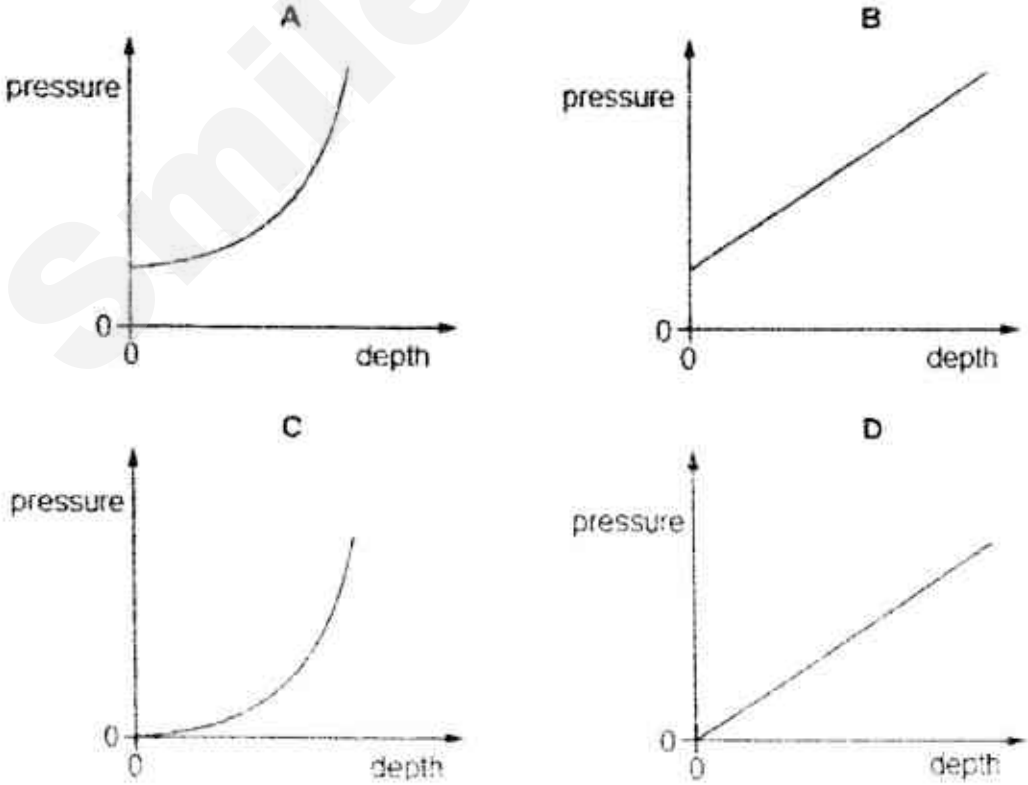
A directly above P

B directly below P

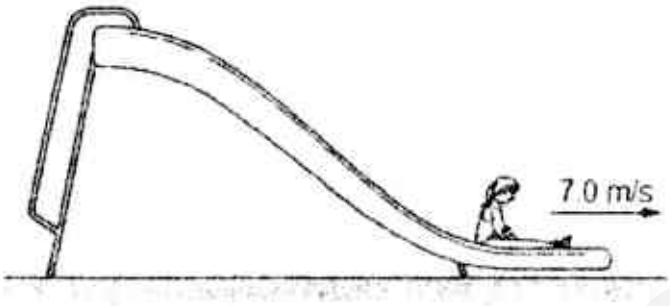
C directly above the plasticine

D directly below the plasticine

11 Which graph shows how the total external pressure acting on a submarine varies at different depths below the surface of the sea?



12 A child of mass 30 kg slides down from the top of a smooth slide with an initial speed of 0.5 m/s.



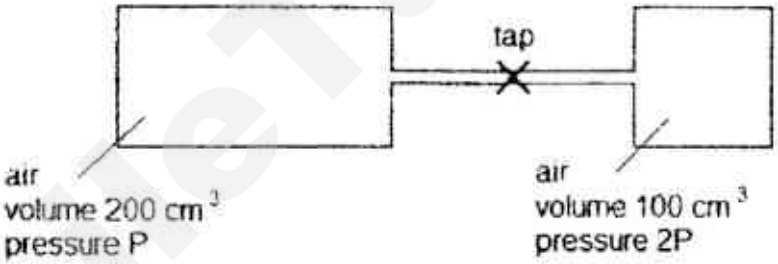
What is the height of the slide?

A 0.50 m **B** 2.43 m **C** 2.45 m **D** 6.50 m

13 Two cylinders are connected by a thin pipe, with the tap closed.

One cylinder has a volume of 200 cm^3 and contains air at pressure P.

The other cylinder has a volume of 100 cm^3 and contains air at pressure 2P.



What is the final pressure of the air after the tap is opened?

A $\frac{1}{2}P$ **B** P **C** $\frac{4}{3}P$ **D** 2P

14 John uses a microscope to observe the behavior of smoke particles placed in an air-filled container. He observes bright specks of light.

Where is this light coming from?

A smoke particles vibrating

B smoke particles moving randomly

C air particles and smoke particles vibrating

D air particles and smoke moving randomly

15 On a cold day, a total of 50 MJ of thermal energy (heat) is lost through the windows, roof, floors and walls of the Tan family home. A heater is installed in the house to supply thermal energy.

The heater should supply

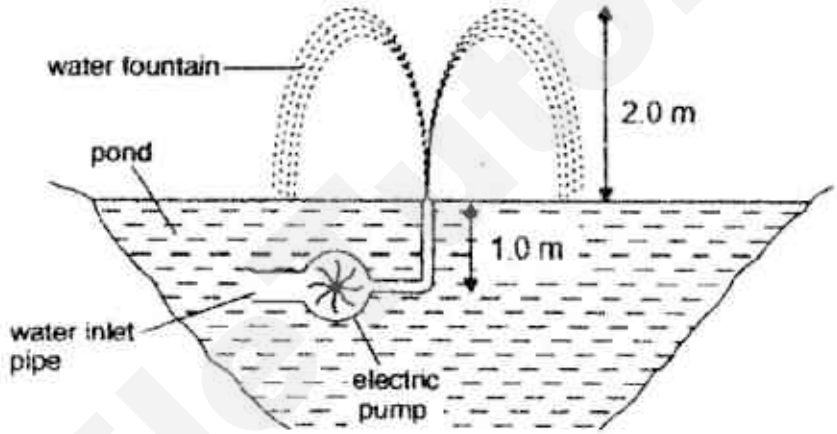
A less than 50 MJ of energy as the house also absorbs heat from the surroundings.

B less than 50 MJ of energy as the Tan family members radiate heat.

C more than 50 MJ of energy to keep the house warmer than the surroundings.

D more than 50 MJ of energy as the Tan family members radiate heat.

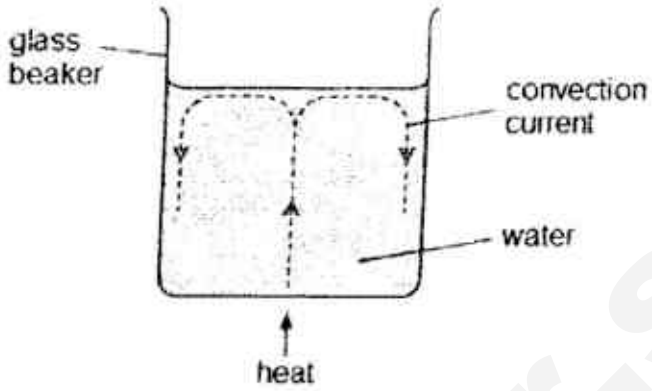
16 A water fountain has an electric pump installed 1.0 m below the surface. 0.50 m^3 of water flows through the pump every hour and this water is shot 2.0 m into the air.
Take the density of water to be 1000 kg/m^3.



Calculate the work done by the pump every hour.

A 0 kJ **B** 5 kJ **C** 10 kJ **D** 15 kJ

17 A glass beaker contains water. When the center of the base of the beaker is heated, a convection current is set up.



Which statement explains this?

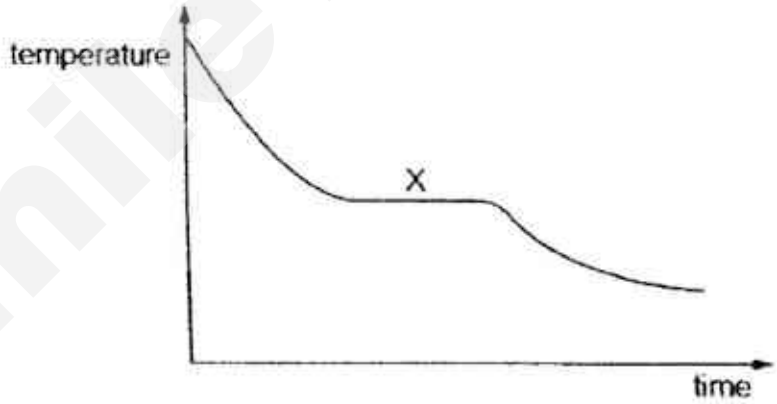
A The water above the heat source rises because it becomes less dense.

B The water above the heat source rises because it has gained energy.

C The water at the sides sink because it becomes denser.

D The water at the sides sink because it has lost energy.

18 A hot liquid is poured into a beaker. It is left to cool towards room temperature.



What is occurring at region X?

A water molecules gain internal potential energy and move closer together

B water molecules gain internal potential energy and move further apart

C water molecules lose internal potential energy and move closer together

D water molecules lose internal potential energy and move further apart

19 A thermocouple thermometer indicates 0.1 mV at ice point and 2.6 mV at 400 °C. What will be the temperature when the thermocouple indicates 3.0 mV?

Assume potential difference in the thermocouple varies linearly with temperature.

A 300 °C **B** 404 °C **C** 462 °C **D** 464 °C

20 Which pair travels as longitudinal waves?

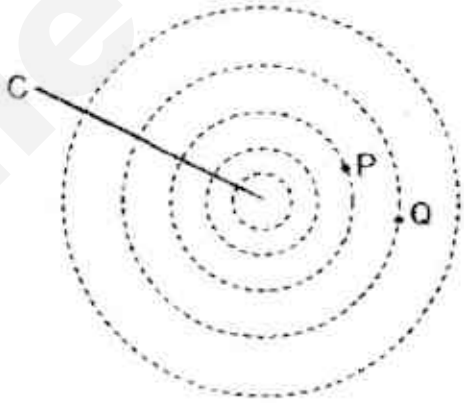
A a radio wave in air and a sound wave in a solid
B a sound wave in a solid and a sound wave in air
C a sound wave in air and an infra-red wave in space
D an infra-red wave in space and a radio wave in air

21 A wave of frequency 13 000 Hz travels 1300 m in 4.0 s.

What is the wavelength of the wave?

A 0.025 m **B** 0.10 m **C** 325 m **D** 1300 m

22 A vertical stick is repeatedly dipped in and out of the water at C at a constant rate, forming a wave pattern as shown in the diagram.



Two buoys, P and Q, are placed in the path of the wave pattern.

Which of the following statements about the buoys is correct?

A Both buoys are in phase.

B Both buoys are 45° out of phase.

C Both buoys are 90° out of phase.

D Both buoys are 180° out of phase.

23 Which wave property has the same value for all X-rays travelling in air?

A amplitude

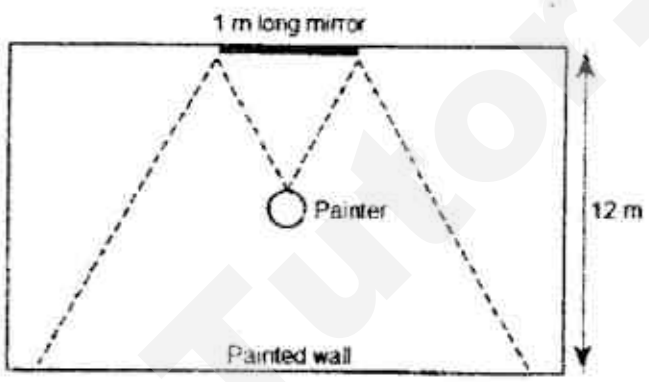
B frequency

C speed

D wavelength

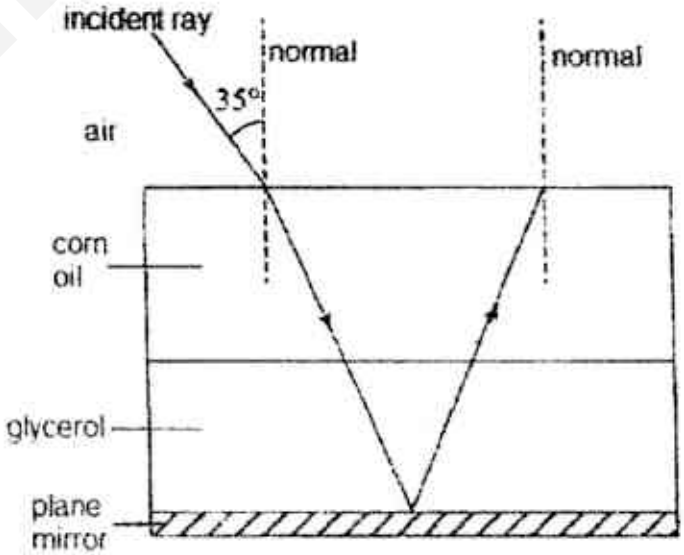
24 A painter standing at the center of a rectangular room looks into a 1.0 m long mirror on the center of the wall.

What is the length of the opposite wall he can see?



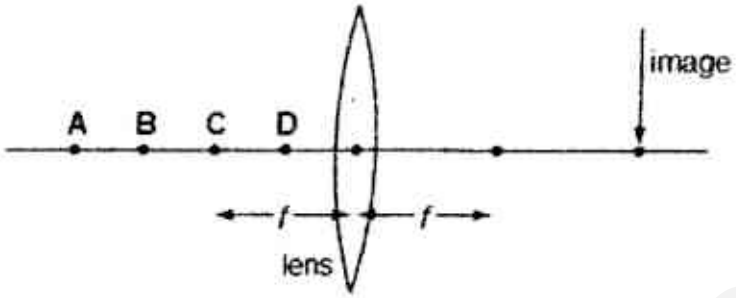
A 2.0 m **B** 3.0 m **C** 6.0 m **D** 12.0 m

25 A ray of light is incident on layer of corn oil. Beneath the corn oil is a layer of Glycerol and a plane mirror at the bottom. The refractive index of the glycerol is 1.45. Determine the angle of reflection at the plane mirror



A 16° **B** 23° **C** 35° **D** 67°

26 The diagram shows a thin converging lens of focal length f.

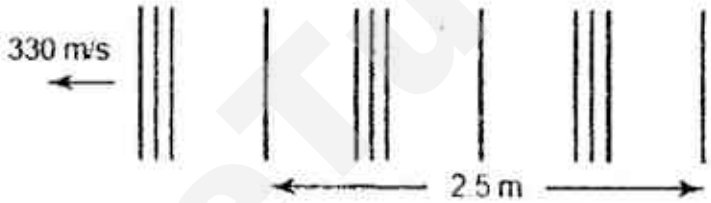


Where must an object be placed to produce a real image in the position shown?

27 What is a possible frequency of an ultrasound wave?

A 10 Hz **B** 300 Hz **C** 10 kHz **D** 30 kHz

28 A longitudinal wave travelling at 330 m/s produces the waveform shown below.

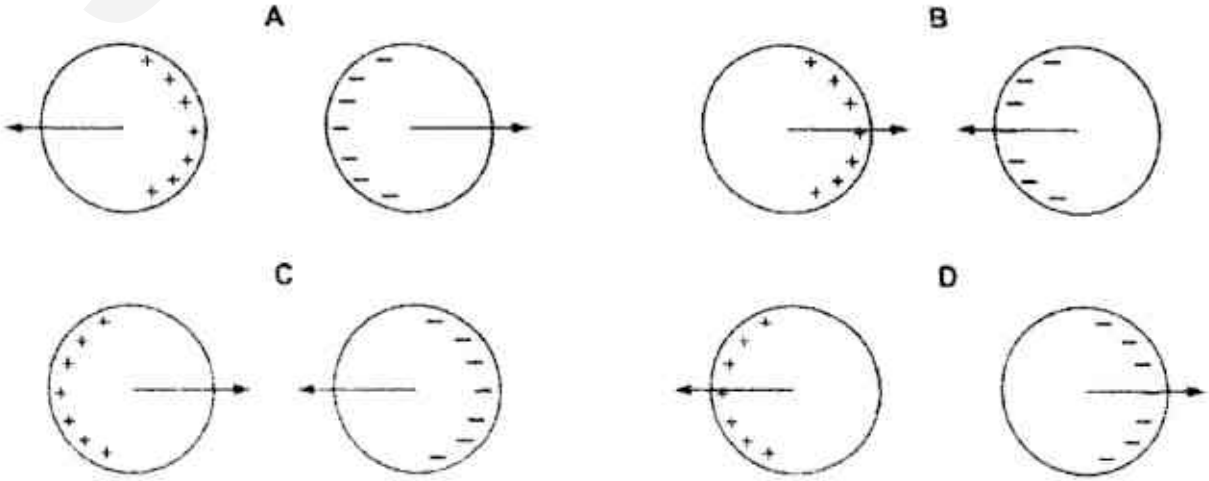


What is the frequency of the sound wave?

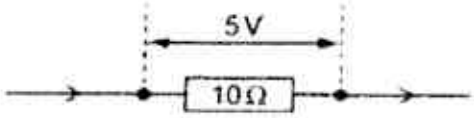
A 132 Hz **B** 198 Hz **C** 264 Hz **D** 330 Hz

29 Two charged conducting spheres are placed close to one another. One sphere is positively charged and the other is negatively charged.

Which diagram shows the distribution of charges and the forces acting on the spheres?



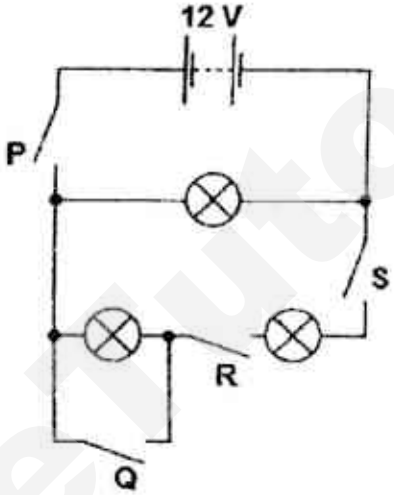
30 The potential difference across a 10 Ω resistor is 5 V



How much charge passes through the 10 Ω resistor in 20 s?

A 10 C **B** 50 C **C** 100 C **D** 200 C

31 The circuit shown consists of three identical lamps. The lamps are rated at 5 W, 12 V.



Which switches need to be closed for two lamps to be operating at normal brightness?

A R and S

B Q, R and S

C P, R and S

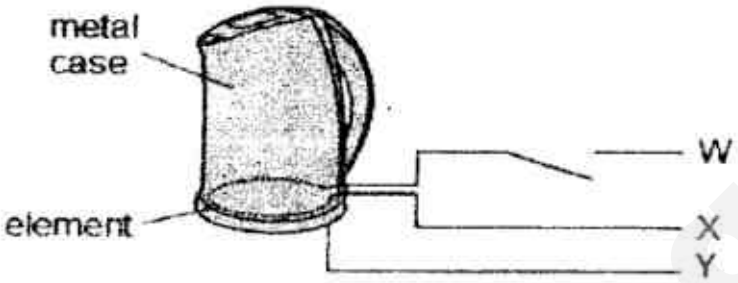
D P, Q, R and S

32 The resistance of a wire is 1.0 Ω. A second wire is made of the same material but has twice the length and half the radius.

Determine the resistance of this wire.

A 1.0 Ω **B** 2.0 Ω **C** 4.0 Ω **D** 8.0 Ω

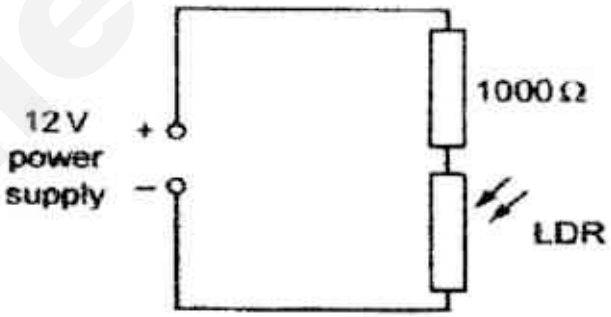
33 The diagram represents part of a household circuit containing an electric kettle.



Which row correctly identifies the wires W, X and Y?

	W	X	Y
A	live	neutral	earth
B	neutral	live	earth
C	live	earth	neutral
D	neutral	earth	live

34 In a darkened room, a 1000 Ω resistor and a light-dependent resistor (LDR) are connected in series with a 12 V power supply.



The curtains are opened and light falls on the LDR.

What happens to the voltage across the LDR?

A becomes zero

B increases

C decreases

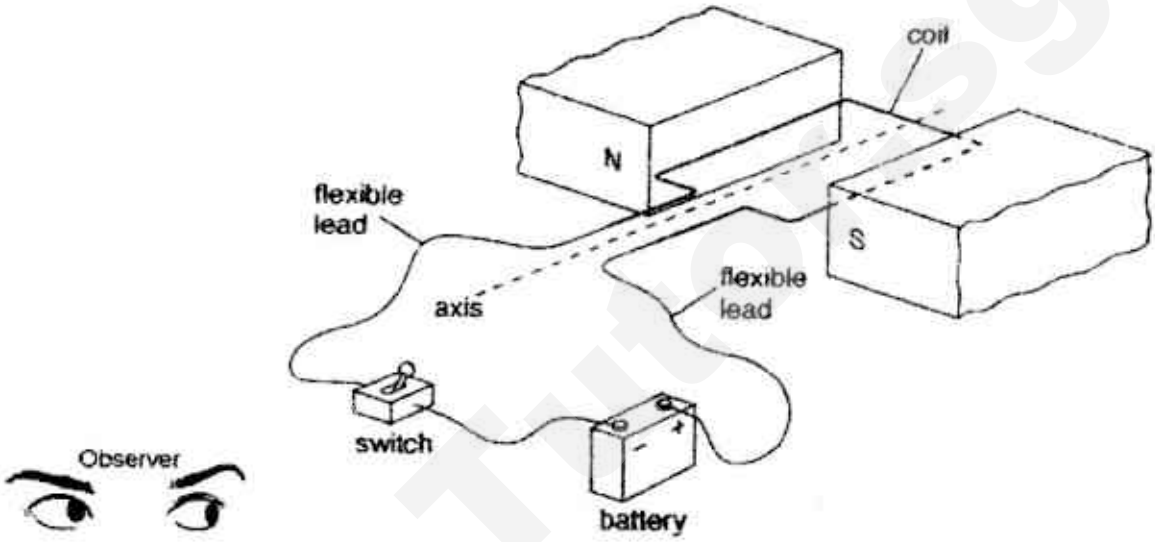
D remains unchanged

35 A rice cooker is rated at 600 W, 240 V. It takes 30 mins to cook a pot of rice.

If the electrical energy cost $0.20 per kWh, what is the cost of cooking this pot of rice?

A $0.06 **B** $0.10 **C** $1.20 **D** $6.00

36 The figure shows a coil in a closed circuit and connected to a battery. The coil is placed between the poles of a magnet.



From the observer's point of view, describe the motion of the coil.

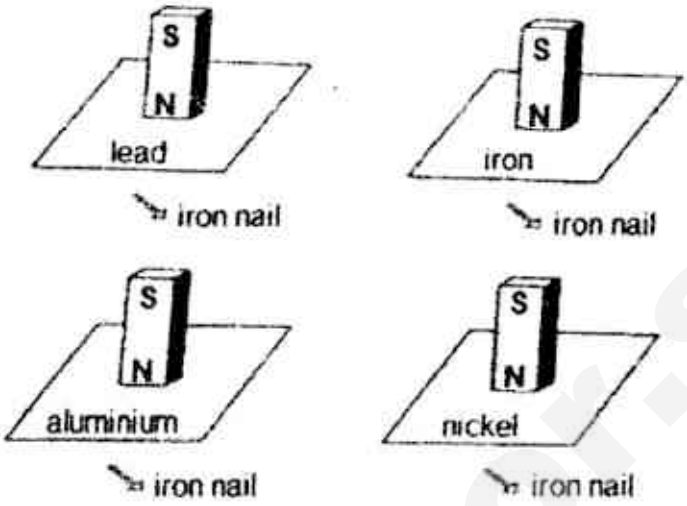
A The coil rotates anticlockwise 90° and comes to a stop.

B The coil rotates anticlockwise 180° and comes to a stop.

C The coil rotates clockwise 90° and comes to a stop.

D The coil rotates clockwise 180° and comes to a stop.

37 Four sheets of different materials are placed between magnets and iron nails as shown in the diagram.



Which sheet(s) will attract the iron nail?

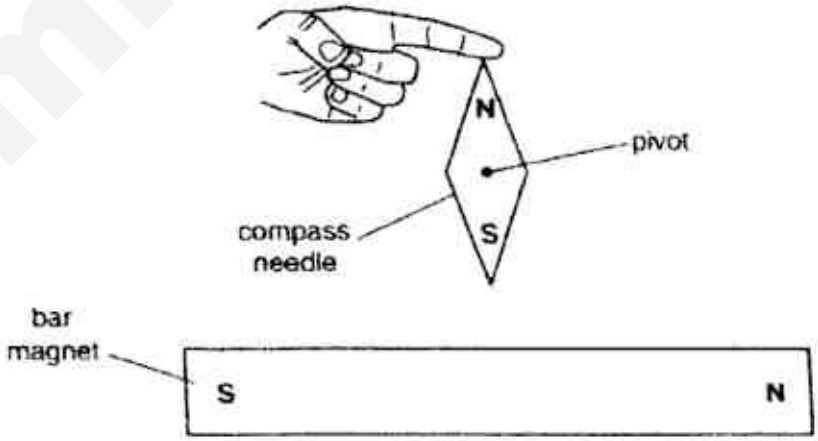
A iron only

B lead only

C iron and nickel

D aluminum, iron and nickel

38 A compass needle is placed next to a bar magnet and is aligned to the Earth's magnetic north. The compass needle is free to pivot about its center and is held in place by a finger.



What happens to the compass needle once the finger is removed?

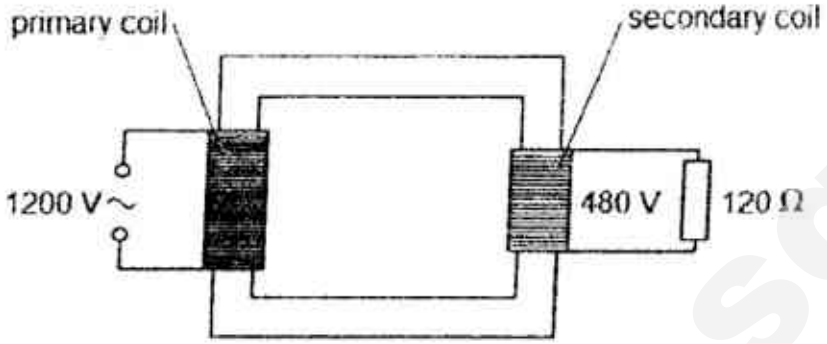
A remains stationary

B rotates 90° anticlockwise about the pivot and stops

C rotates 90° clockwise and the pivot stops

D rotates continuously about the pivot

39 The secondary coil of an ideal transformer is connected to a 120 Ω resistor. A 1200 V alternating current source is connected to the primary coil.

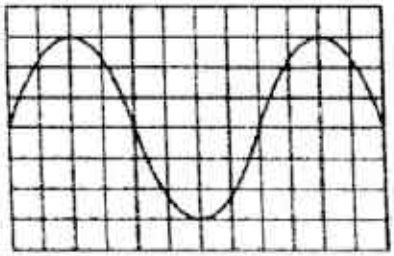


What is the power dissipated in the resistor and the current in the **primary** coil?

	Power / W	Current / A
A	480	1.6
B	480	4.0
C	1920	1.6
D	1920	4.0

40 An alternating voltage of frequency 3.0 Hz is applied to the Y-plates of a cathode-ray oscilloscope (c.r.o.).

The diagram shows the screen of the c.r.o.



What is the time taken for the spot to cross the screen?

A 0.5 s **B** 1.0 s **C** 4.5 s **D** 9.0 s

END OF PAPER

A	C	C	B	A	C	B	D	D	B
11	12	13	14	15	16	17	18	19	20
B	B	C	B	C	D	A	C	D	B
21	22	23	24	25	26	27	28	29	30
A	A	C	B	B	A	D	C	B	A
31	32.	33	34	35	36	37	38	39	40
D	D	A	C	A	C	B	B	C	A

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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2017
Secondary Four Express & Five Normal (Academic)

CANDIDATE NAME:

CLASS: /

INDEX NUMBER:

PHYSICS **5059/02**

Paper 2 Theory

21 August 2017

1 hour 45 minutes

1045 – 1230h

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 HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all quantitative** answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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.

Section A	
Section B	
Total	

This document consists of 20 printed pages.

Section A

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

1 Fig. 1.1 shows part of a hydroelectric system that generates electricity from moving water.

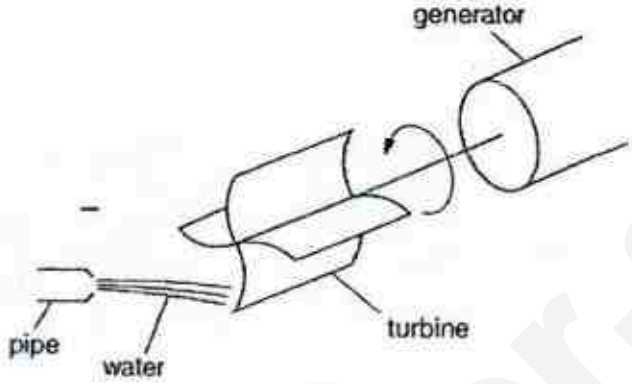


Fig. 1.1

Every minute, water with kinetic energy of 14 000 J emerges from a pipe. The water turns a turbine that is connected to the generator. Half of the kinetic energy of the water is given to the generator.

(a) Calculate the power input to the generator.

power = ... [2]

(b) State why only half of the water's kinetic energy is received by the generator.

.....

..... [1]

(c) The nozzle of the pipe is made smaller while maintaining the volume of water released every second. In an ideal system, explain how this affects the turbine's rotation speed.

.....

.....

.....

..... [2]

2 Fig. 2.1 shows six men on a ship attempting to raise its anchor. Each man pushes against a handle with a force of 80 N at a distance of 1.2 m from the axis of rotation. The chain, which supports the anchor, wraps around the axle which has a radius of 0.5 m.

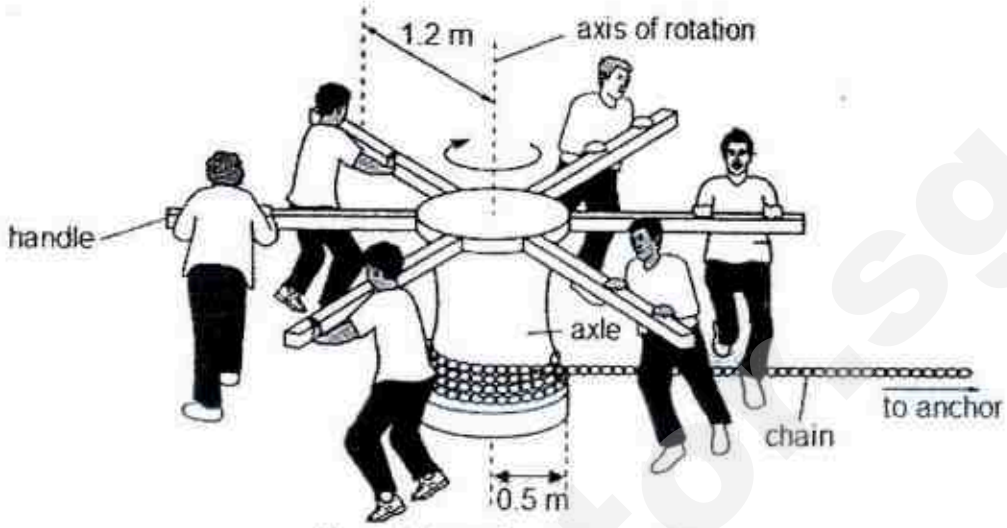


Fig. 2.1 (not drawn to scale)

(a) State the principle of moments.

.....

.....

..... [2]

(b) Calculate the total moment produced by the six men about the axis of rotation.

moment = ... [2]

(c) Determine the weight of the anchor.

weight = ... [1]

(d) Using Fig. 2.1, explain why the effort needed by the men will vary over time.

.....

.....

.....

..... [2]

3 A farmer uses a hydraulic system to operate machinery that is pulled behind a tractor. Two cylinders and the flexible pipe that joins them contain oil. Two pistons keep the oil in the cylinders. The arrangement is shown in Fig. 3.1.

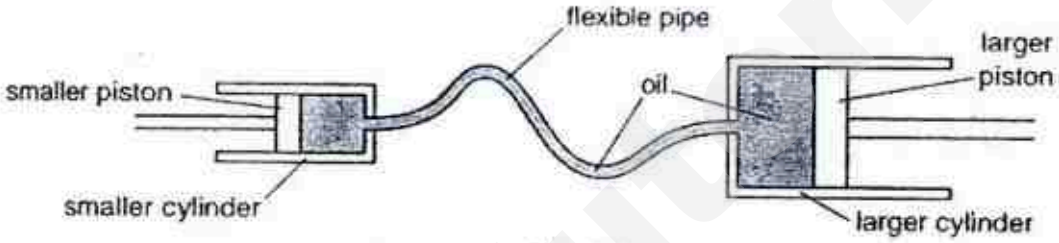


Fig. 3.1

The cross-sectional area of the smaller and larger cylinders are 0.048 m^2 and 0.14 m^2 respectively. The smaller piston exerts a force of 1000 N on the oil.

(a) Explain what is meant by *pressure*.

.....

..... [1]

(b) Calculate the pressure of the oil in the larger cylinder. Give your answer in Pa.

pressure = ...Pa [2]

(c) Hence, calculate the force exerted on the larger piston.

force = ... [1]

(d) The smaller piston moves 10 cm. Calculate the distance moved by the larger piston. Give your answer in cm.

distance = ...cm [2]

(e) Explain why the actual distance moved by the piston will differ from value in (d).

.....

..... [1]

4 Fig. 4.1 shows a satellite above the television station where a television signal is generated. The satellite was launched from the Earth's surface to a height of 35 km. At this height, the Earth's gravitational field strength is smaller than at the Earth's surface.

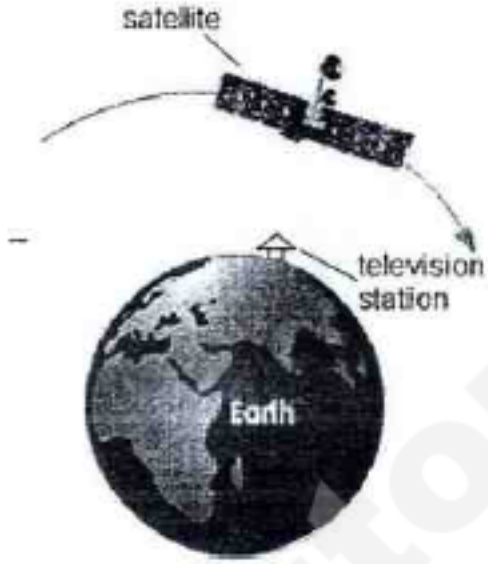


Fig. 4.1

(a) Which component of the electromagnetic spectrum is used to transmit the television signal to the satellite?

..... [1]

(b) State **one** advantage of using satellites to transmit television signals.

.....

..... [1]

(c) On Fig. 4.1, indicate the gravitational force (weight) acting on the satellite. [1]

(d) The gravitational force acting on the satellite decreases as it goes further from the Earth's surface. Explain.

.....

.....

.....

..... [2]

(e) Given the gravitational force acting on it, suggest why the satellite does not crash into the Earth's surface.

.....

..... [1]

5 In many cities, energy consumption is high when surrounding temperatures are high. To reduce energy consumption, it is proposed that the outer walls of office buildings be built entirely with glass windows instead. Fig. 5.1 shows an example of a glass window.

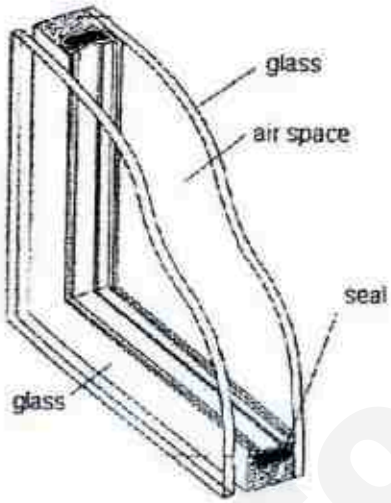


Fig. 5.1

(a) Explain why the energy consumption is high in office buildings on a hot day.

.....

.....

.....

..... [2]

(b) By using terms related to methods of heat transfer, explain how the air in between the glass panels help to reduce energy consumption?

.....

.....

.....

..... [2]

(c) What is one advantage of having a vacuum between the glass panels instead?

.....

..... [1]

(d) Suggest the purpose of the seal in the window?

.....

..... [1]

(e) State one other source of energy consumption that will be reduced with the use of glass windows for the entire outer wall.

.....

..... [1]

6 Fig. 6.1 below shows the design of a fuel tank that comes with an optical fuel gauge. When the fuel in the tank runs low, the light activated switch in the gauge is triggered. At present, the fuel tank holds rocket fuel.

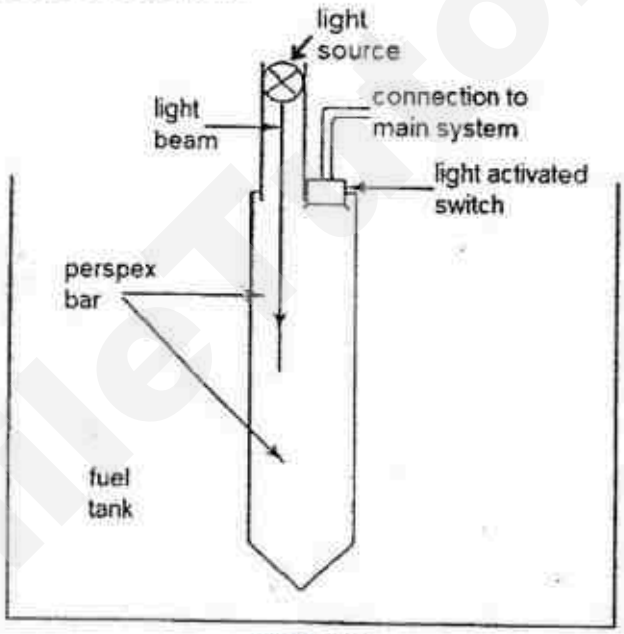


Fig. 6.1

The refractive index of air, rocket fuel and perspex are 1.0, 1.3 and 1.5 respectively.

(a) Calculate the critical angle of light at a perspex-air boundary.

critical angle = ... [2]

(b) State how the critical angle in (a) will compare to the critical angle of light at the perspex-rocket fuel boundary.

.....

..... [1]

(c) Describe and explain the path of the light beam when the tank is **empty**.

.....

.....

.....

..... [2]

(d) The tank is now filled with rocket fuel. Complete the path of the light beam in Fig. 6.1. [1]

(e) This tank may not be suitable for storing all types of liquids.
With reference to the refractive index, explain why this is so.

.....

.....

.....

..... [2]

7 Fig. 7.1 shows Lewis in the middle of his marathon run. He pours a cup of water over his head to cool himself down.

Fig. 7.1

(a) He utilizes 420 kJ of energy in the first mile. Given that the efficiency of his muscles in doing work to move him forward is 70%,

(i) calculate, in kJ, his useful energy output for the first mile,

energy = ...kJ [2]

(ii) suggest **one** way in which the remaining energy was utilized.

.....

..... [1]

(b) Explain, using ideas about molecules, how pouring water over his head keeps him cool.

.....

.....

.....

.....

..... [2]

8 Fig. 8.1 shows a new type of braking system design planned for use in a lorry.

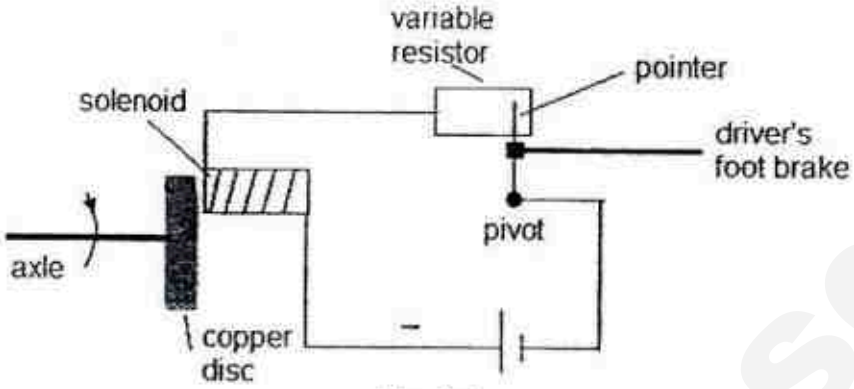


Fig. 8.1

The axle, which is attached to the copper disc, is connected to the wheels of the lorry through a series of gears. When the axle rotates, the wheels of the lorry rotate as well.

When there is a need to reduce the speed of the lorry, the solenoid (wire wound around soft iron core) is to attract and make contact with the copper disc, providing the necessary friction to reduce its speed of rotation.

(a) Identify one error in this design and how it can be corrected.

.....

.....

.....

..... [2]

(b) Describe how the current in the circuit varies as the driver depresses the brake.

.....

.....

.....

.....

..... [2]

(c) More braking force is needed. To achieve this, describe **one** change that can be made to this design.

.....

..... [1]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11.**

9 Raj and Ramesh are cyclists. They are physically very similar and ride identical bicycles along a straight fair road as shown in Fig. 9.1.

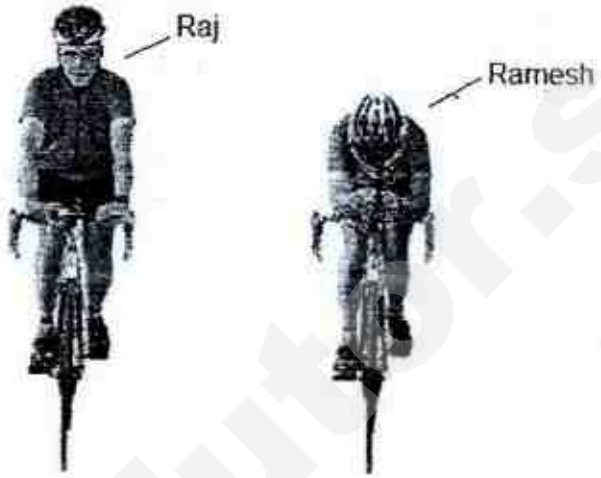


Fig. 9.1

Fig. 9.2 shows the power, P they exert on their bicycles measured against the velocity, v, they attain.

	Raj	Ramesh
P/W	v/ms^{-1}	v/ms^{-1}
10	1.5	1.5
20	3.0	3.0
40	4.5	4.6
75	6.0	6.3
150	8.0	8.6
225	9.5	10.5
300	10.8	12.3
375	11.7	13.7

Fig. 9.2

(a) Using the data given in Fig. 9.2,

(i) state which cyclist is more efficient at higher speeds. Explain your answer.

.....

.....

.....

..... [2]

(ii) suggest why both cyclists attain identical velocities for power inputs of less than 20 W.

.....

..... [1]

(b) On Fig. 9.3, sketch the velocity-power graph for **Ramesh**.

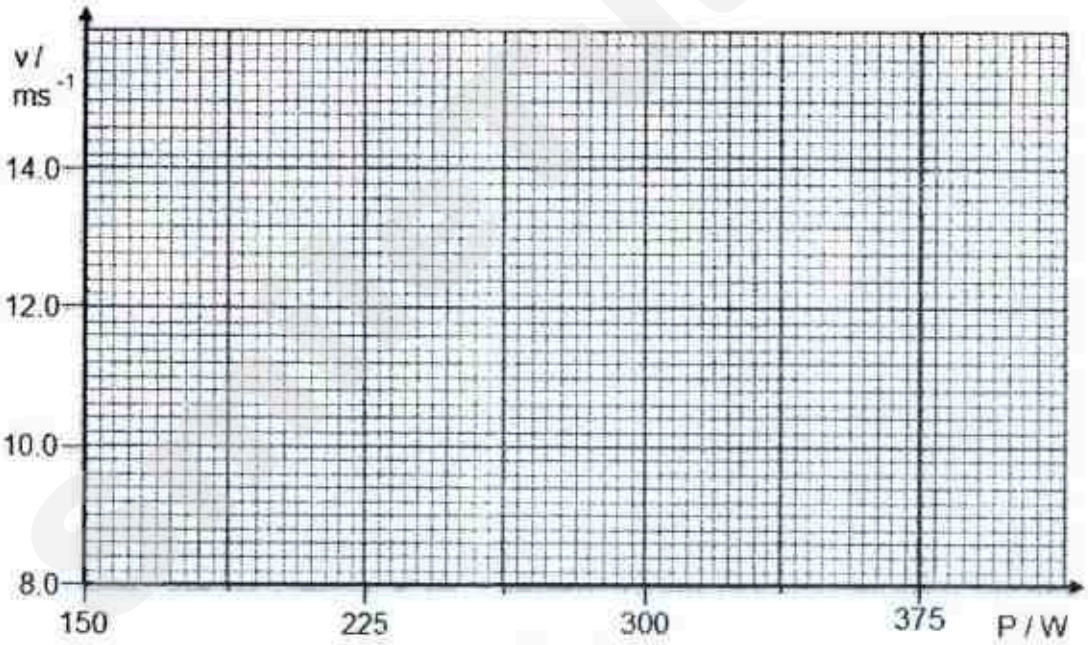


Fig. 9.3 [2]

(c) State how the velocity-power graph shows that Ramesh's rate of change of velocity decreases as his power input increases.

.....

..... [1]

(d) Compare the riding position of both cyclists to explain the difference in their ability to ride fast.

.....

.....

.....

.....

..... [3]

(e) After some time, the straight road begins to slope downwards. Both cyclists stop pedalling, yet they continue moving.

Explain why both cyclists need not pedal to continue moving.

.....

..... [1]

10 A student makes a 2.0 V battery by connecting two cells of electromotive force (e.m.f.) 2.0 V in parallel. The batteries, two ammeters and three different resistors are used to set up the circuit shown in Fig. 10.1. One of the resistors, X, is placed in a container of water.

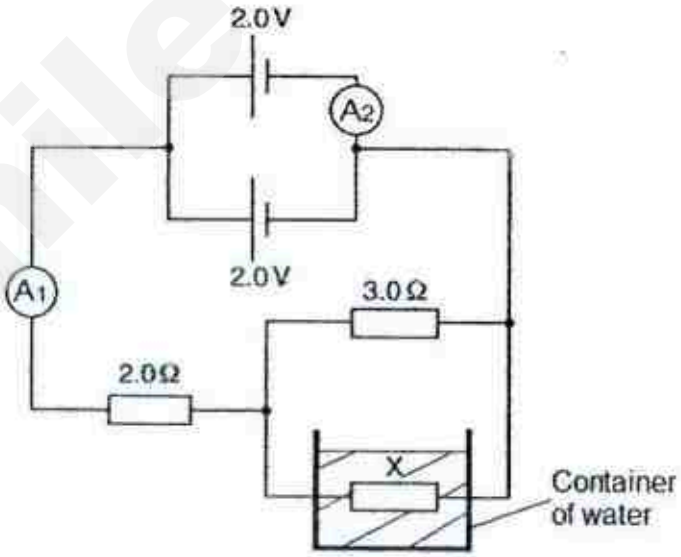


Fig. 10.1

(a) Explain what is meant by an *electromotive force*.

.....

..... [1]

(b) Given that combined resistance of resistor X and the 3.0 Ω resistor is 1.5 Ω, determine the

(i) resistance of X,

resistance = ... [1]

(ii) ammeter readings A_1 and A_2,

ammeter reading A_1 = ... [1]

ammeter reading A_2 = ... [1]

(iii) current through resistor X.

current = ... [1]

(c) State the advantage of placing the batteries in parallel.

.....

..... [1]

(d) Resistor X dissipates heat as current flows through it. This heat is used to boil the water around resistor X.

(i) Calculate the power loss due to heat in resistor X.

power = ... [1]

(ii) Given that the water has a mass of 10 g and a temperature of 35 °C, calculate the temperature of the water after ten minutes.

Take the specific heat capacity of water to be 4200 J/(kg°C).

temperature = ... [3]

11 EITHER

Factories that utilize fossil fuels produce polluted air as a waste product. This polluted air usually contains unburnt carbon, carbon dioxide, methane and nitrous oxide.

Fig. 11.1 shows an electrostatic precipitator which is used to filter the particles from this polluted air before it is released into the open. Particles are attracted to the positively charged collection plates after acquiring a charge at the charging plates.

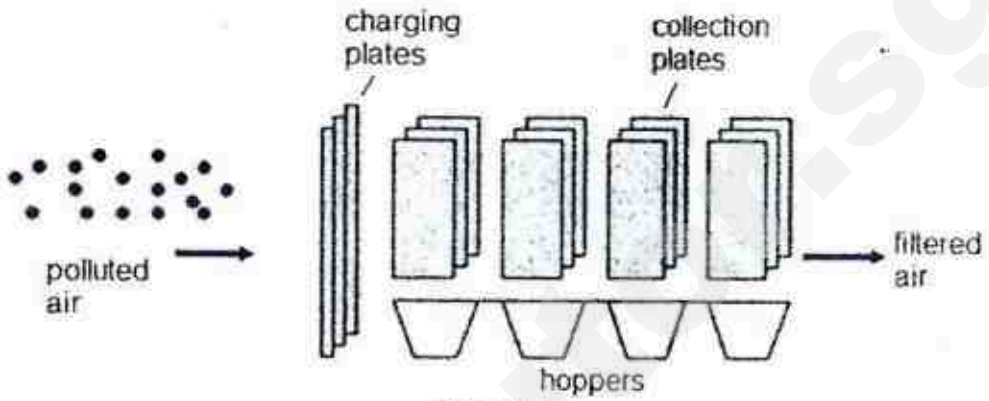


Fig. 11.1

(a) State **two** ways in which polluted air can be harmful.

.....

.....

.....

..... [2]

(b) State the charge on the charging plates.

..... [1]

(c) Describe the process by which the particles acquire a charge at the charging plates.

.....

.....

.....

..... [2]

(d) The particles spread out after passing through the charging plates. Explain.

.....

..... [1]

(e) Every three hours, the process is stopped. No polluted air is sent into the precipitator and the collection plates are discharged. Most, but not all, of the particles are then found in the hoppers, which are containers placed directly below the collection plates.

(i) Explain the purpose of discharging the collection plates every three hours.

.....

.....

.....

..... [2]

(ii) Explain why some particles continue to remain on the collection plates.

.....

.....

..... [1]

(f) State **one** limitation of this system in dealing with polluted air.

.....

..... [1]

OR

Fig. 11.2 shows a setup to turn on a light bulb in a room. Two coils, A and B, are wound around an iron ring. Coil A is connected to a direct current (d.c.) source and coil B forms a closed circuit with the light bulb in series.

A compass is placed close to Coil B. The direction of the Earth's magnetic north is also indicated.

The switch is initially open.

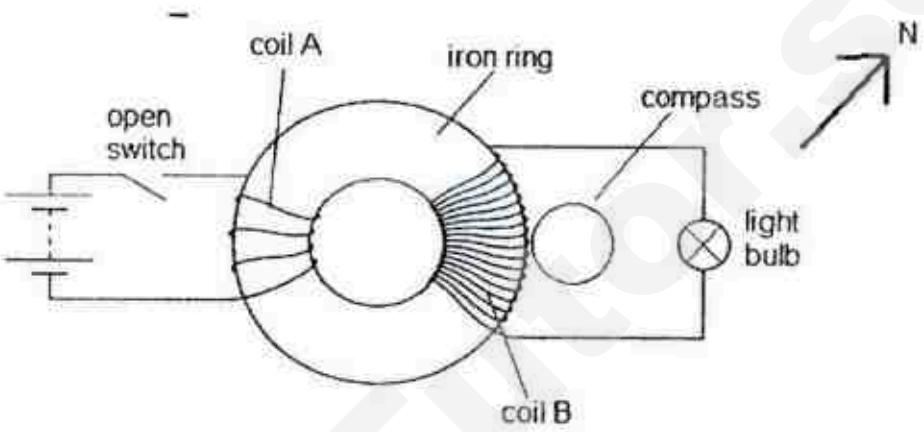


Fig. 11.2

(a) Mark on the compass in Fig. 11.2 the direction of its north-seeking pole. [1]

(b) The switch is now closed.

(i) Explain how an e.m.f. is induced in coil B.

.....

.....

.....

.....

.....

..... [3]

(ii) On Fig. 11.2, draw, with an arrow, the direction of the induced current in coil B. [1]

(iii) State observations made of the light bulb and the compass.

.....

.....

.....

..... [2]

(c) The d.c. source is now replaced with a 10 V, 2.0 Hz alternating current (a.c.) source. The light bulb is sufficiently bright but flickers.

Describe and explain how this setup can be improved.

.....

.....

.....

..... [2]

(d) The iron ring is now removed.
State the impact on the induced e.m.f. in coil B.

.....

..... [1]

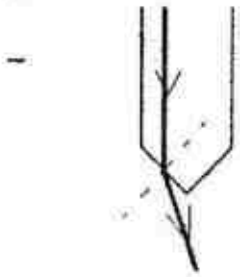
END OF PAPER

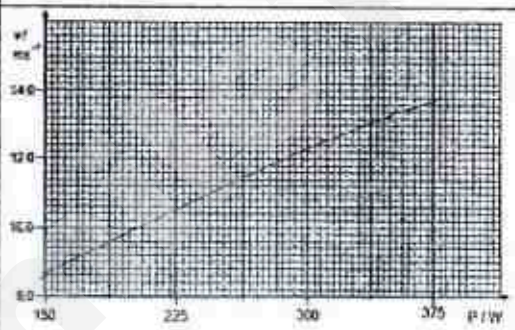
Anderson Secondary School
2017 Secondary 4 Express Preliminary Examination
Physics (5059/2) Mark Scheme

Overall 1 mark penalty each for missing unit and sig fig unless otherwise stated.

Question	Solution	Marks	Remarks
1 (a)	Power = (1/2 x 14000) / 60 = **120 W** (to 2 s.f.)	[1] [1]	Minus 1 mark for wrong unit
(b)	Energy used to **overcome friction** between the mechanical parts OR Energy used to **overcome torque** of the blades	[1]	Need to indicate where the friction or torque is present
(c)	The rotation speed of the turbine remains **unchanged** as the **energy transferred to the turbine**/blades is unchanged	[1] [1]	
2 (a)	When a system is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot.	[1] [1]	
(b)	Moments = 6 x 1.2 x 80 = **576 Nm** = **580 Nm (2 s.f.)**	[1] [1]	Minus 1 mark for wrong unit
(c)	Weight = 576 / 0.5 = **1152 N** = **1200 N (2 s.f.)**	[1]	No e.c.f. No mark if wrong unit
(d)	**Circumference / size of the axle** is **not constant** / varies. A **smaller axle circumference** will mean a **smaller effort** is required by the men as the **total moments needed decreases**. (vice versa)	[1] [1]	No marks if an explanation is not offered by candidate.
3 (a)	Pressure is the force acting per unit area	[1]	
(b)	pressure = (1000 / 0.048) = **21 000 Pa** (to 2 s.f.)	[1] [1]	
(c)	force = (20 833 x 0.14) = **2900 N** (to 2 s.f.)	[1]	No e.c.f.
(d)	$F_s \times d_s = F_i \times d_i$ $1000 \times 10 = 2916 \times d_i$ d_i = **3.40 cm** (to 2 s.f.)	[1] [1]	

Question	Solution	Marks	Remarks
(e)	There has to be **work done against friction** between the sides of the piston and the inner walls of the cylinder.	[1]	Need to provide details on where the friction is to get the mark.
4 (a)	Microwaves	[1]	
(b)	Having the **ability to transmit signals globally** to parts that are **not in line of sight** of the television station	[1]	
(c)	Arrow pointing from satellite to center of Earth	[1]	
(d)	Earth's **gravitational field strength decreases** as we go higher. Since **W = mg and its mass remains unchanged**, the satellite's weight decreases.	[1] [1]	
(e)	It has a **velocity** component that is **horizontal** / parallel to the Earth's surface.	[1]	
5 (a)	Temperature within building will be higher than on a cool day. More energy is consumed as cooling systems work to cool the building to the desired temperature.	[1] [1]	
(b)	Air transfers heat mostly **through conduction and radiation** in this case. Air is a **poor conductor of heat**. Hence **reduces heat transferred** into the building.	[1] [1]	
(c)	The vacuum will **eliminate heat loss through conduction**	[1]	
(d)	Seals prevent the **leakage of cooled air** from within the building.	[1]	
(e)	Energy consumption from **lighting in the building** will be reduced as the glass windows allow more of the sunlight into the building.	[1]	Need not explain the reason
6 (a)	$c = \sin^{-1}(1/1.5)$ $= 41.8°$ (1 d.p)	[1] [1]	
(b)	The critical angle in (a) will be **smaller** than at the perspex-rocket fuel boundary.	[1]	

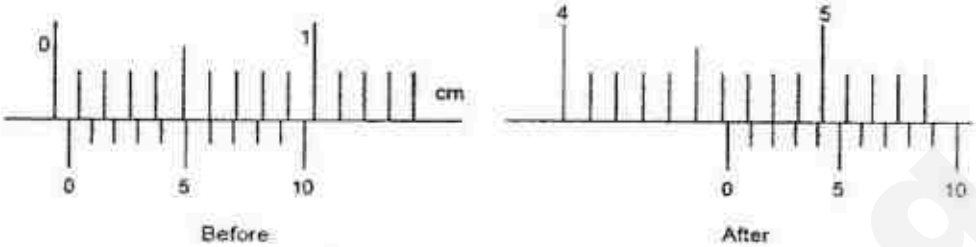
Question	Solution	Marks	Remarks
(c)	Light beam will undergo **total internal reflection** at the **perspex-air boundary twice** before hitting the **light activated switch.** This happens as the **angle of incidence will be greater than the critical angle at these boundaries.**	[1] [1]	
(d)		[1]	Light ray bends away from normal.
(e)	Some liquids would have a refractive index of **less than 1.3**. Hence, a **smaller critical angle** at the boundary. **Total internal reflection occurs even when tank is full**, triggering of the sensor.	[1] [1]	
7 (a) (i)	Energy = 0.7 x 420 = 294 kJ **= 290 kJ (2 s.f.)**	[1] [1]	
(a) (ii)	Released as thermal energy from his body OR Energy needed to overcome air resistance.	[1]	
(b)	**More energetic** water molecules near the **surface of the water** evaporate. **Average kinetic energy** of remaining molecules molecules **decreases**. Hence, **temperature** of water **decreases**, creating **cooling effect**.	[1] [1]	
8 (a)	The **copper disc** cannot be used as it is **not a magnetic material.** Disc should be made of iron/nickel/ cobalt.	[1] [1]	Insufficient to say it needs to be made of a soft magnetic material. Must state at least one of them.
(b)	As the driver depresses the brake, the **pointer rotates about the pivot** and **moves further to the left** along the variable resistor.	[1]	

Question	Solution	Marks	Remarks
	This **decreases** the resistance of the variable resistor and hence **the overall resistance** of the circuit, leading to an **increase in the current** flowing through the circuit.	[1]	
(c)	Increase the current in the circuit by using a higher voltage battery / smaller variable resistor / more turns of wire in the coil to strengthen the magnetic field around solenoid.	[1]	Do not accept increase current without explanation on how to achieve that.
9 (a) (i)	**Ramesh** is more efficient. With power inputs of 75 W and above, he has consistently achieved a higher velocity for the same power input.	[1] [1]	No marks if no explanation offered. Need to reference data from table.
(a) (ii)	At these relatively low velocities, air **resistance** experienced by both cyclists is **comparable**, making their attained velocities identical.	[1]	
(b)		[1] [1]	→1 mark for all points plotted correctly →1 mark for correct shape
(c)	**The gradient of the graph decreases as the power input increases.** This indicates a decreasing acceleration.	[1]	
(d)	Ramesh's body is lower on his bicycle, making **his surface area against the wind / facing front smaller than** Raj's. **Air resistance** acting on the cyclists **increases** as their **speed increases** Smaller surface area **reduces air resistance**. For a given power input, Ramesh **can travel faster before experiencing the same air resistance** as Raj.	[1] [1] [1]	

Question	Solution	Marks	Remarks
(e)	A **component of their weight** along the slope provides a forward force on them.	[1]	
10 (a)	It refers to the energy required to drive a unit of charge around a circuit.	[1]	
(b) (i)	$(1/1.5) = (1/R_x) + (1/3.0)$ R_x = **3.0 Ω**	[1]	
(b) (ii)	e.m.f. = (combined resistance) x A_1 2.0 = (3.5) I Reading for A_1 = **0.57 A** (2 s.f.) Reading for A_2 = 1/2 (A_1) = **0.29 A** (2 s.f.)	 [1] [1]	Answer must be in decimal
(b) (iii)	I_x = (Rx / (Rx + 3.0 Ω)) x A_1 I_x = **0.29 A** (2 s.f.)	[1]	
(c)	The desired e.m.f. and hence **current** in circuit can be provided for **twice** as **long.**	[1]	
(d)	$P_{loss} = I^2R$ $= (0.286)^2 \times (3.0)$ = **0.25 W** (2s.f.)	 [1]	
(e)	Energy dissipated by resistor X = Pt = (0.245)(60)(10) = 147 J Pt = mc(Δθ) 147 = (0.010)(4200)(temp -35) temp = **39 °C** (2 s.f.)	 [1] [1] [1]	 1 mark e.c.f.
Either			
11 (a)	The polluted air can be **hazardous to health**, such as breathing problems It can also **damage the environment**, such as global warming or acid rain.	[1] [1]	
(b)	Negative charge	[1]	
(c)	Particles are **charged by friction.** They **rub against the charging plates** and **electrons transfer over to the particles**, making them negatively charged.	[1] [1]	
(d)	The particles have **like charges** and like charges **will repel** each other.	[1]	

Question	Solution	Marks	Remarks
(e) (i)	To **remove the build-up of particles** on the **collection plates.** Discharging the plates **reduces** the **force of attraction** between the particles with the plate, **causing them to fall into the hoppers** below.	[1] [1]	
(e) (ii)	These particles **have sufficient charge** to **maintain a force of attraction** with the discharged (neutral) plates.	[1]	
(f)	Only the particles are removed but the **gases** released are not **chemically treated** and remain harmful.	[1]	
Or			
11 (a)	parallel to the earth's magnetic north	[1]	
(b) (i)	When the **switch** is closed, current flows in the **primary** coil creates a magnetic field around it. As a result, there will be a **change in the magnetic flux / cutting of field lines linking the secondary coil.** An e.m.f. **will** be induced in the secondary coil to **oppose this change** and it will be **proportional to the rate of change of** the magnetic flux / cutting of field lines.	[1] [1] [1]	
(b) (ii)	(Arrow going clockwise)	[1]	To reflect creating a N pole at the bottom end of coil B
(b) (iii)	The light bulb turned **on momentarily** before turning off. The compass **pointed vertically upwards momentarily** before returning to its original position.	[1] [1]	
(c)	To use an **a.c.** source with a **higher frequency.** This will turn the bulb **on and off** at a **faster rate to eliminate flickering.**	[1] [1]	
(d)	The induced e.m.f will be **smaller** in magnitude.	[1]	

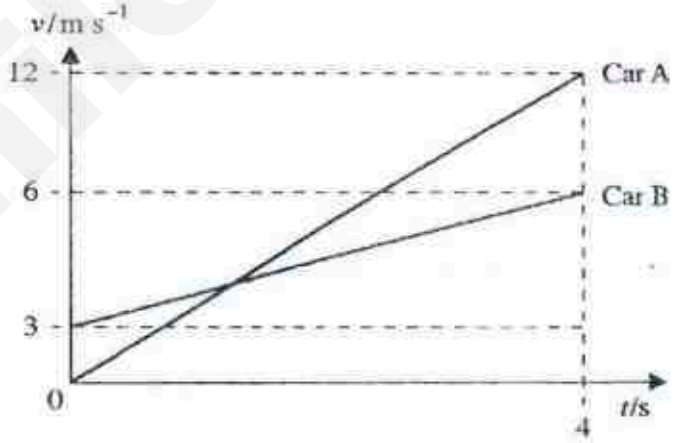
1 The following shows a set of vernier caliper readings before and after a coin was placed between its jaws.



Find the zero error and the corrected radius of the coin, in cm.

	zero error	corrected radius
A	-0.04	2.33
B	-0.04	2.44
C	0.06	2.28
D	0.06	2.38

2 The velocity-time graphs of Car A and Car B are shown below. How far apart are the two cars at 4.0 s?



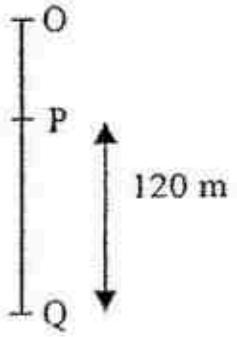
A 6.0 m

B 18 m

C 24 m

D 42 m

3 An object released from rest at **O** falls freely under gravity and passes through **P** and **Q** as shown. If the object takes 4 s to move from **P** to **Q** where **PQ** is 120 m, how much time does the object take to fall from **O** to **P**?



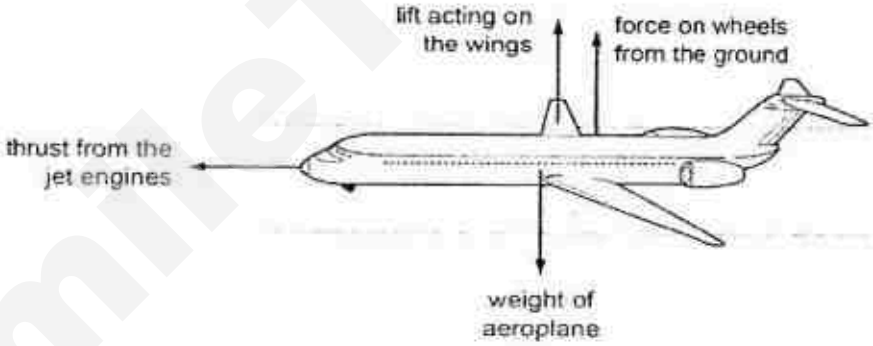
A 1.0 s

B 2.0 s

C 3.0 s

D 4.0 s

4 In the diagram shown, an aeroplane is half way along a runway before it takes off. The arrows show the directions of four forces acting on the aeroplane.



The acceleration of the plane is 2 m/s^2. The resistive forces acting on the aeroplane are negligible.

Which is the largest force?

A the force on the wheels from the ground

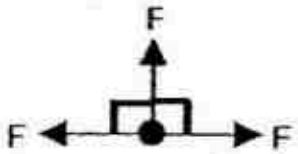
B the lift acting on the wings

C the thrust from the jet engines

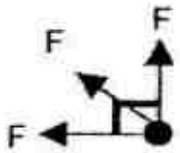
D the weight of the aeroplane

5 Three forces of the same magnitude are acting on a small body. Which combination below will give the biggest magnitude for the resultant force?

A

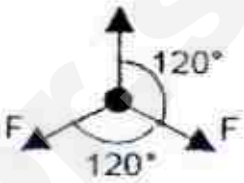


B



C

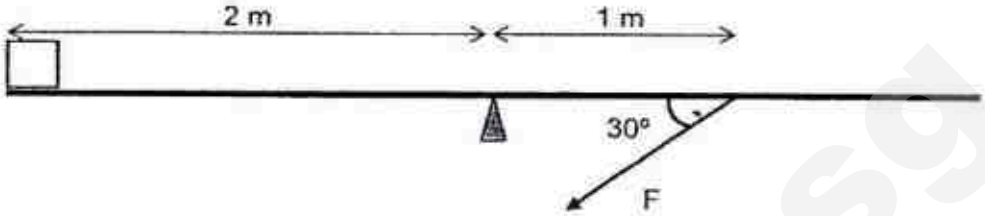
D



6 A sealed rigid container containing helium is cooled down. No gas enters or leaves the container during the cooling process. Which of the following shows the correct changes to the properties of the helium in the container?

	mass	weight	density
A	increase	decrease	increase
B	decrease	decrease	decrease
C	no change	decrease	no change
D	no change	no change	no change

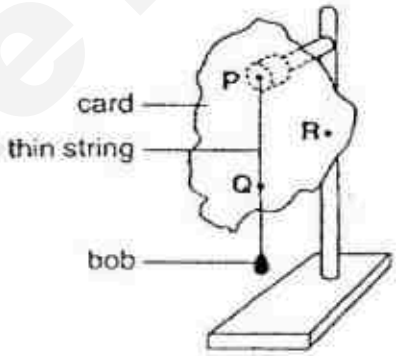
7 The diagram shows a cubic box with uniform mass of 2 kg and sides 30 cm placed on one end of a uniform plank. The plank is pivoted at its centre. A force F is applied on the other side of the plank to balance the box.



Given that the gravitational field strength is 10 N/kg, what is the magnitude of the force F?

A 37 N
B 40 N
C 74 N
D 80 N

8 The diagram shows the first step in an experiment to determine the position of the centre of gravity of a thin card.



What is the next step in this experiment?

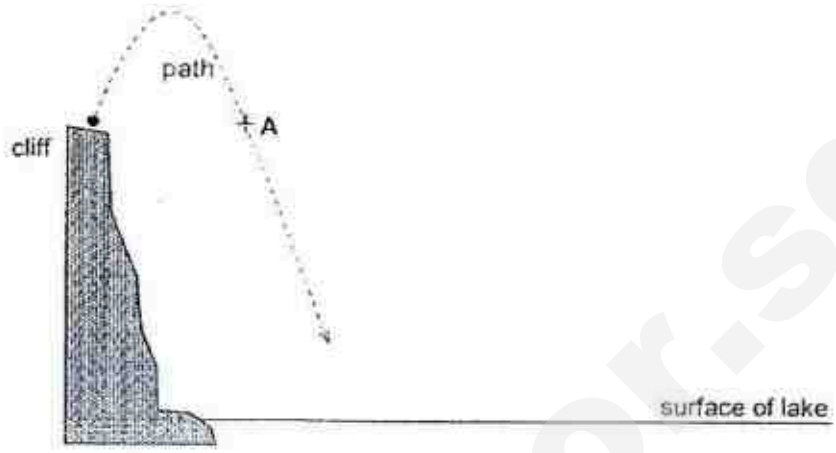
A Find the mid-point of PQ as the centre of gravity of the card

B Hang the card from point R.

C Balance the card on a finger to determine the centre of gravity of the card.

D Measure the mass of the card on an electronic balance.

9 The diagram shows the path of a ball thrown from a cliff before dropping into the lake.



The gravitational potential energy of the ball is taken to be zero when the ball is at the surface of the lake. Air resistance is negligible.

Which statement(s) about the ball's energy is/are correct?

(I) At point A the ball possesses maximum kinetic energy.

(II) At the surface of the lake the ball possesses minimum kinetic energy.

(III) The ball possesses less gravitational potential energy when it is in the lake than when it is at the surface of the lake.

(IV) The sum of the ball's gravitational potential energy and kinetic energy is constant before the ball enters the lake.

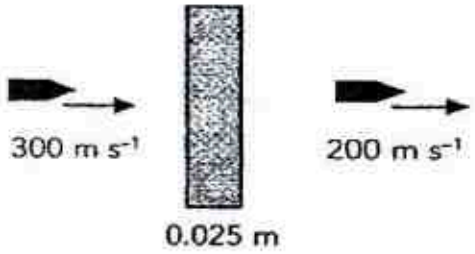
A II only

B I, II and IV only

C III and IV only

D IV only

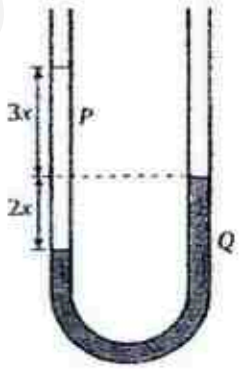
10 When a bullet of mass 0.020 kg moving at 300 m/s strikes a fixed wooden block of thickness 0.025 m, it emerges with a speed of 200 m/s as shown in the figure below.



Find the frictional force acting on the bullet as it is going through the wooden block.

A 9000 N
B 12000 N
C 15000 N
D 20000 N

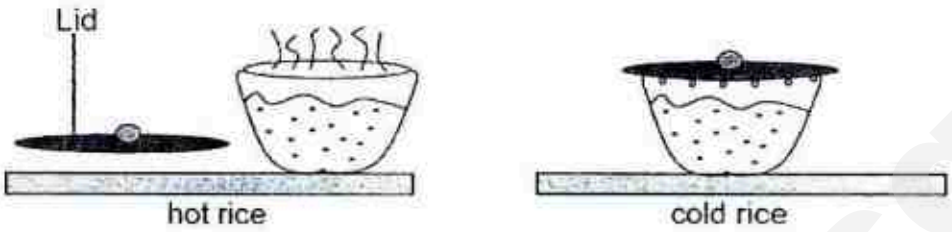
11 The diagram shows two liquids, *P* and *Q*, which do not mix. The liquids are in equilibrium in an open U-tube.



What is the ratio of density of *P* to density of *Q*?

A 1/2
B 5/2
C 2/3
D 2/5

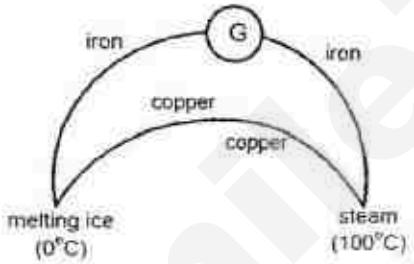
12 The diagram shows a bowl of hot rice which is covered with an airtight lid and left to cool.

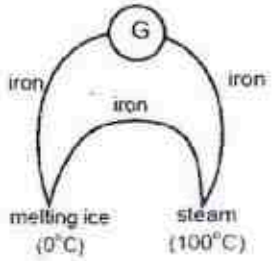


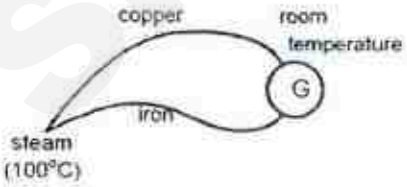
Why is it difficult to lift the lid when the rice is cold?

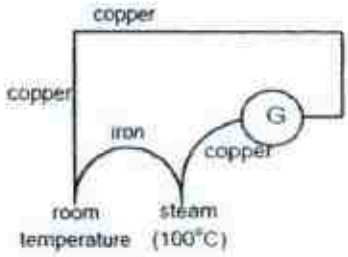
A The adhesive force between the water molecules and the lid is strong.
B The air pressure inside the bowl is lower than the atmospheric pressure.
C The number of air molecules in the bowl has decreased.
D Water vapour condenses on the lid.

13 Which of the following is not a thermocouple?

A


B


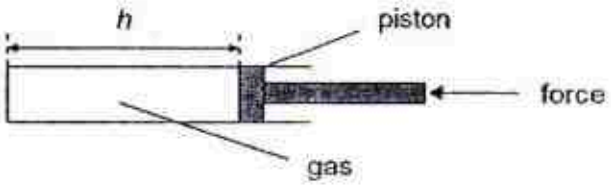
C


D


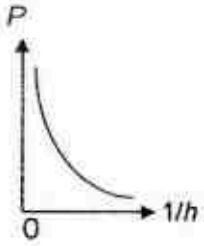
14 A faulty thermometer reads 10 °C and 90 °C when placed in melting ice and steam respectively. If this thermometer is uniformly graduated, find the true temperature if the thermometer reads 40 °C.

A 24.0 °C B 34.0 °C C 37.5 °C D 47.5 °C

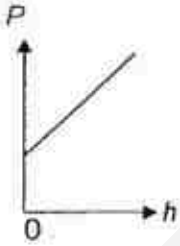
15 A column of gas is slowly compressed by a force on the piston, as shown in the diagram below.

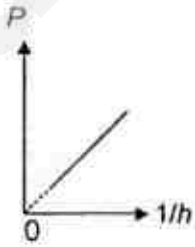


Which of the following graphs correctly shows the relation between the gas pressure P and the length of the gas column h if the temperature of the gas remains constant?

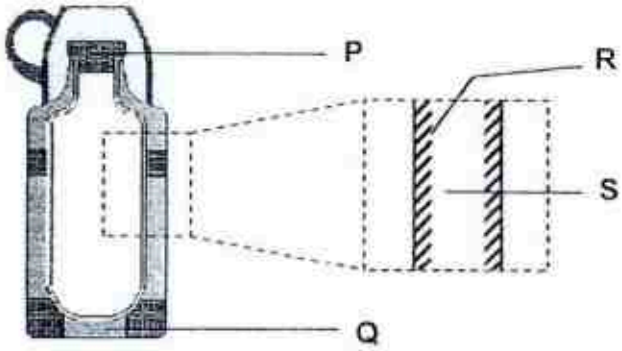
A


B


C


D


16 The figure below shows the internal structure of a vacuum flask.



Which of the components help(s) to reduce heat loss through convection?

A R only
B P, Q and S only
C P only
D P and S only

17 Complete the blanks in the following paragraphs.

An object that is painted ___(i)___ will get hot quickly under the hot sun, because such surfaces are ___(ii)___ of ___(iii)___.

___(ii)___ appear ___(i)___ because they also absorb all ___(iv)___.

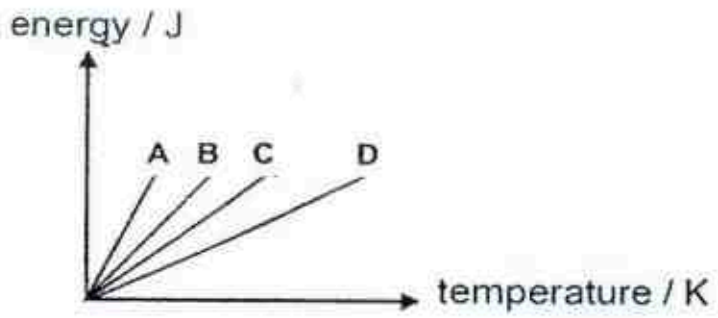
	(i)	(ii)	(iii)	(iv)
A	white	poor absorbers	infrared radiation	ultraviolet radiation
B	white	poor emitters	ultraviolet radiation	infrared radiation
C	black	good emitters	ultraviolet radiation	visible light
D	black	good absorbers	infrared radiation	visible light

18 The table gives the specific heat capacities of four materials.

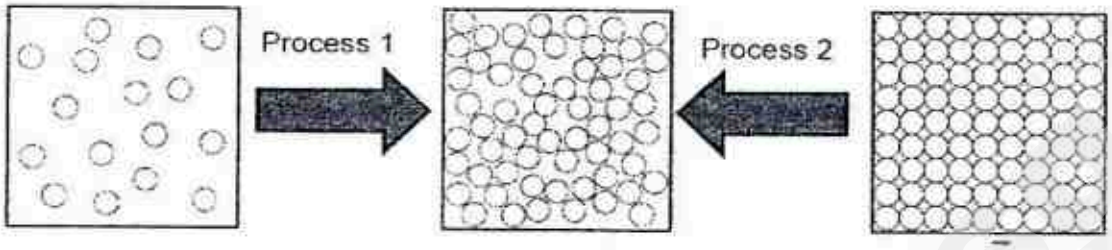
material	specific heat capacity / J/(kgK)
Aluminium	913
Lead	130
Steel	420
Water	4 200

Four samples of the above materials, of equal masses, were heated by an identical heat supply. The graph below shows how the energy of the four samples varies with their temperature.

Which graph best represents the energy-temperature graph of aluminium?



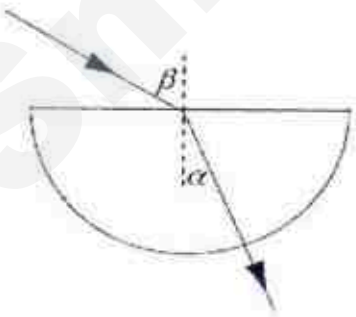
19 There is some energy transfer when a substance changes from one state to another. The diagram shows the arrangement of the particles between different states of matter.

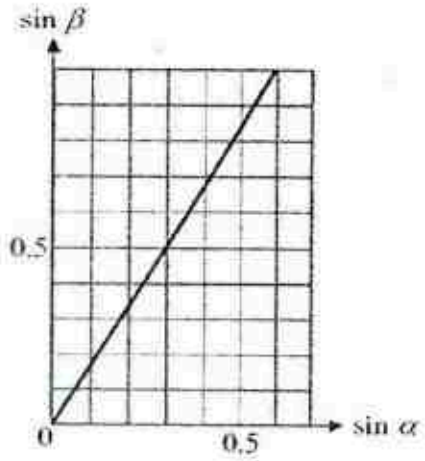


Which one of the following options gives the correct combination of the processes and the corresponding energy transfer in order to change from one state to another?

	Process 1	Process 2
A	vaporisation with energy absorbed	solidification with energy released
B	vaporisation with energy released	solidification with energy absorbed
C	condensation with energy absorbed	melting with energy released
D	condensation with energy released	melting with energy absorbed

20 A light beam is incident into a semi-circular glass block and refracted out as shown. A graph of sin β against sin α is plotted as shown.

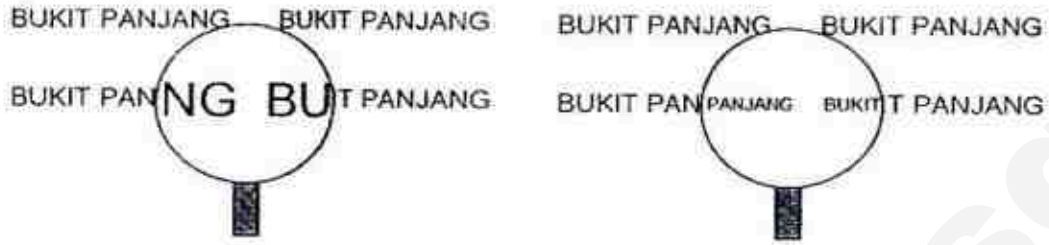




What is the critical angle of the glass?

A 30.0°
B 36.9°
C 44.4°
D 53.1°

21 The diagrams below show the images of the words "Bukit Panjang" seen through two types of lenses.



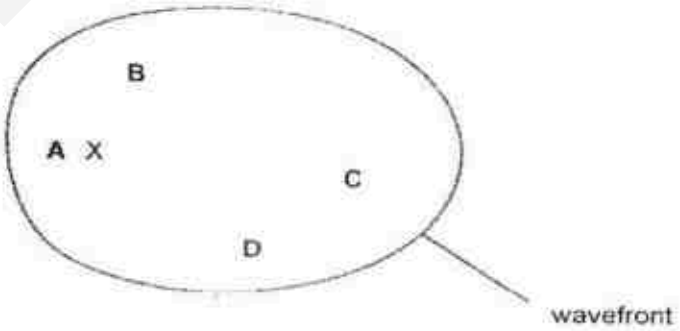
Which statement(s) about the lenses and the images is/are correct?

(I) Both images are virtual and upright images.
(II) Both images are real and upright images.
(III) Both lenses are converging lenses.
(IV) Both lenses are diverging lenses.

A I only
B II only
C I and III only
D II and IV only

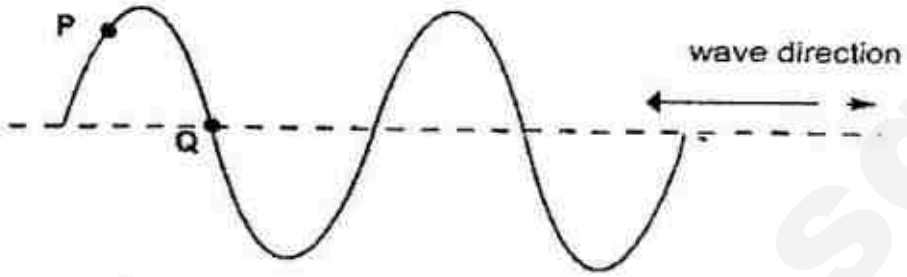
22 Waves travel slower on the surface of water when the water is shallow.

A person drops a stone into a pool at X. The diagram shows the first wavefront formed on the surface of the pool.



Which region of the pool is likely to be most shallow?

23 The diagram shows a wave on a rope with two points **P** and **Q** marked. The wave is moving the direction shown.



What will happen next?

A P will move to the left.

B P will move up.

C Q will not move.

D Q will move up.

24 A company which manufactures laser machines used to correct short-sightedness is intending to change the type of laser being used. The table below shows the various types of lasers that the company is interested in and their respective wavelengths.

If the visible light spectrum has a range of wavelength from 4.0×10^{-7} m to 7.0×10^{-7} m, which laser uses infra-red?

wavelength / m

A 3.4×10^{-7}

B 5.4×10^{-7}

C 5.9×10^{-7}

D 1.1×10^{-6}

25 Early in the morning, a student councillor made an announcement into the remote microphone in the school general office, which is connected to a 120 W amplifier. The announcement was instantaneously heard all over the school via wall speakers mounted in each classroom.

Which of the following statements is/are incorrect about the Physics of the announcement system?

(I) The remote microphone and wall speakers act as input transducers which convert sound energy to electrical energy.

(II) The remote microphone and wall speakers act as output transducers which convert electrical energy to sound energy.

(III) A longitudinal wave travels from the remote microphone to the amplifier to the speakers.

(IV) The amplitude of the sound wave transmitted by the wall speaker is greater than that produced by the student councillor.

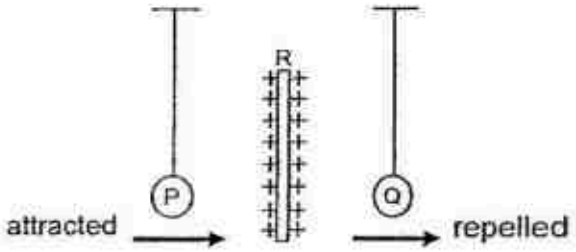
A I and IV only
B II and III only
C I, II and III only
D I, II and IV only

26 Ships use ultrasound waves to find the depth of the sea. Pulses of the ultrasound waves are sent out and echoes are detected. A ship emits a pulse of ultrasound waves lasting 0.50 s. The ultrasound waves have a frequency of 30 000 Hz.

How many complete ultrasound waves does the pulse contain? (Take the speed of sound in water to be 1500 m s^{-1}.)

A 15 000
B 30 000
C 70 000
D 140 000

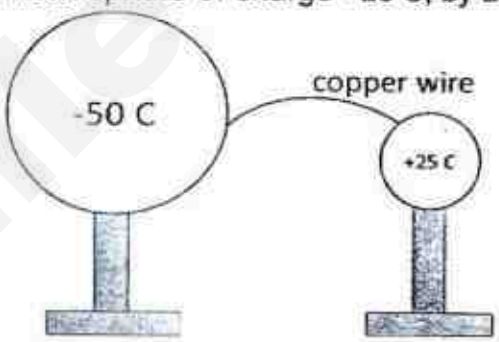
27 P and Q are two light conducting spheres suspended using nylon threads. When a positively charged rod R was placed between these two spheres, sphere P was attracted towards the charged rod but the sphere Q was repelled away from the rod.



Which of the following is the correct conclusion about the charge on each sphere?

	P	Q
A	negative	positive
B	negative	positive or neutral
C	negative or neutral	positive
D	negative or neutral	positive or neutral

28 A large negatively-charge metal sphere of charge -50 C is connected to a small positively-charged metal sphere of charge +25 C, by a piece of copper wire.



Which of the following statements is/are incorrect?

(I) A momentarily conventional current will flow from the small metal sphere.

(II) The small metal sphere will acquire an overall negative charge.

(III) Only the small metal sphere will be neutralised.

(IV) Both metal spheres will be neutralised after equilibrium is established.

(V) The electric force exerted by the larger metal sphere on the smaller metal sphere is greater than that exerted by the smaller metal sphere on the larger metal sphere.

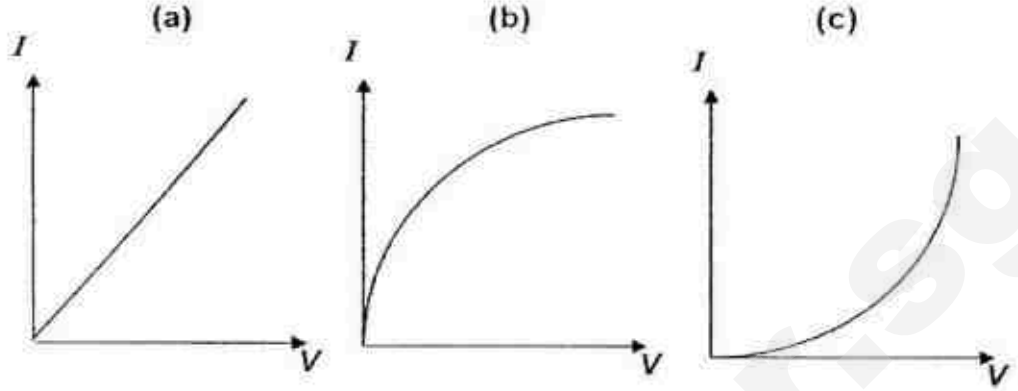
A I and III only

B III and IV only

C II, IV and V only

D III, IV and V only

29 The graphs below show how current *I* through different electronic components varies with the potential difference *V* across each component.



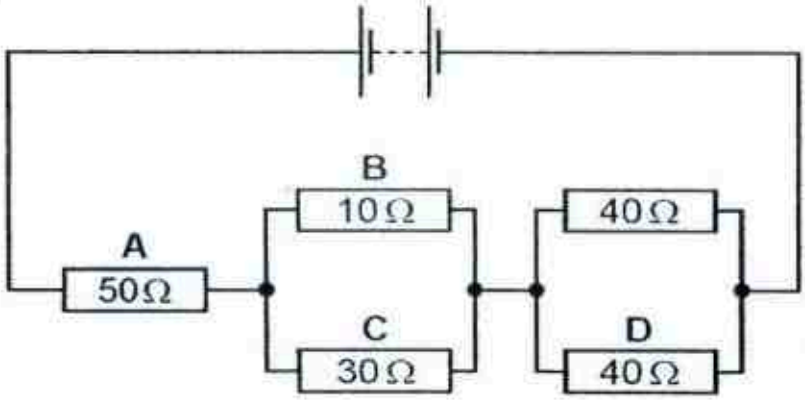
What are the components (a), (b) and (c)?

	(a)	(b)	(c)
A	fixed resistor	filament lamp	thermistor
B	fixed resistor	thermistor	filament lamp
C	filament lamp	thermistor	fixed resistor
D	thermistor	fixed resistor	filament lamp

30 Which of the following unit is also equivalent to the SI unit of potential difference?

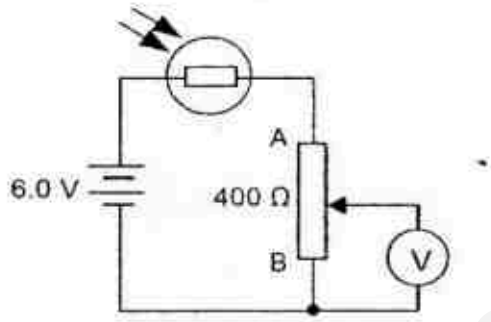
A A / s
B C / A
C C / J
D J / C

31 The diagram shows a circuit containing five resistors connected to a battery.



In which resistor is the current the smallest?

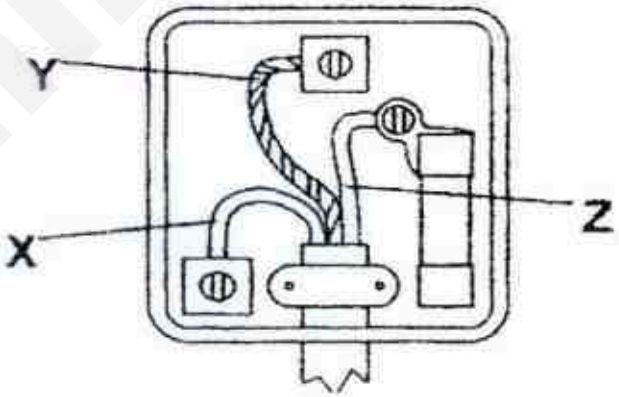
32 The diagram shows a circuit with a potential divider joined in series with a light-dependent resistor (LDR). The resistance of LDR varies from 600 Ω to 1200 Ω.



What are the minimum and maximum readings that can be obtained on the voltmeter when the potential divider is adjusted and light is shining on the LDR?

	minimum reading	maximum reading
A	0 V	1.5 V
B	0 V	2.4 V
C	1.5 V	4.5 V
D	2.4 V	3.6 V

33 The diagram shows an opened mains plug.



Which of the following statements is/are correct?

(I) Wire X is brown and wire Z is blue.

(II) No current will flow through Y when the appliance is operating normally.

(III) Wire X and wire Z are at the same potential.

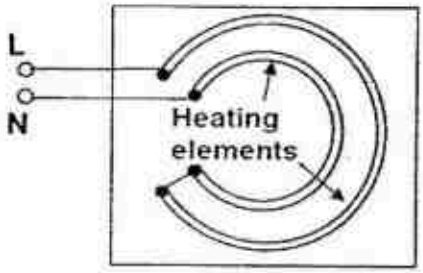
A II only

B III only

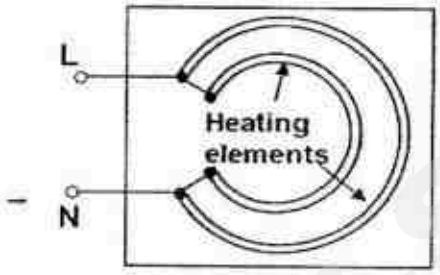
C I and II only

D II and III only

34 The diagrams show two electric cookers, **A** and **B**. Contained in each cooker are two heating elements, of resistances 100 Ω and 150 Ω respectively, connected to the live (**L**) and neutral (**N**) wires in different ways.



Cooker **A**

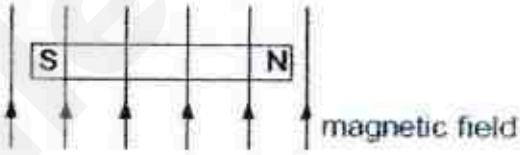


Cooker **B**

Given that the live wire is at a 240 V potential, calculate the maximum possible power dissipated by either cooker **A** or cooker **B**.

A 60 W
B 230 W
C 240 W
D 960 W

(For Questions 35 and 36, refer to the following description and diagram.)
The diagram shows a bar magnet placed in a uniform magnetic field.



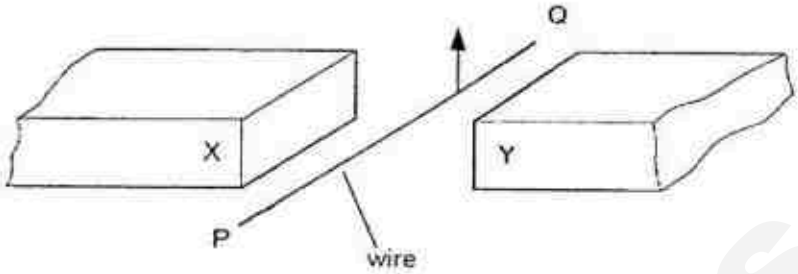
35 When the magnet is allowed to move freely, it will _____.

A remain stationary
B turn 90° clockwise
C turn 90° anticlockwise
D turn 180° clockwise

36 When the magnet is stationary, it is said to be _____.

A not in equilibrium
B in stable equilibrium
C in unstable equilibrium
D in neutral equilibrium

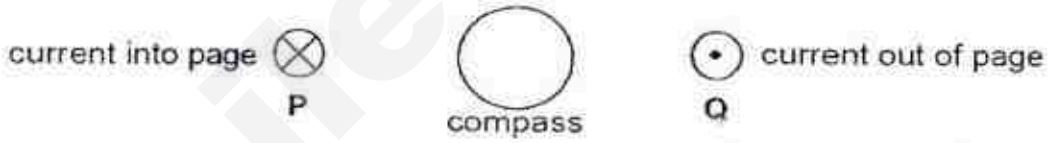
37 A student carries out an experiment to see the effect of a magnetic field on a wire carrying a current. The wire moves upwards as shown.



Which set-up is correct?

	polarity of X	polarity of Y	current direction
A	north	north	P to Q
B	north	north	Q to P
C	north	south	P to Q
D	north	south	Q to P

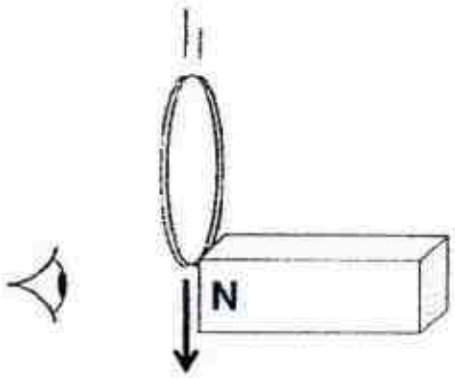
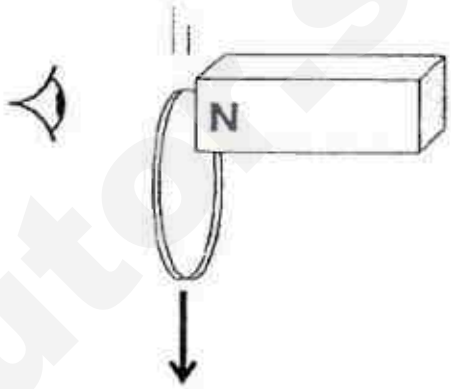
38 A compass is placed between two current-carrying conductors P and Q as shown. Conductor P carries current into the page while conductor Q carries the same amount of current out of the page.



Which of the following correctly shows the direction of the compass needle, and the direction of the force experienced by conductor P?

	Direction of compass needle	Direction of force experienced by P
A	↑	↑
B	↑	↓
C	↓	←
D	↓	→

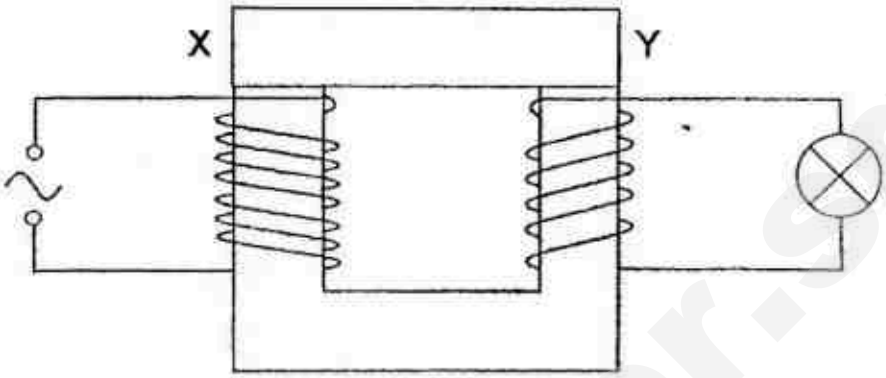
39 A copper ring is dropped next to a magnet. The diagrams below show their positions at two different instances, t_1 and t_2.

At time t_1	At time t_2
	

Determine the direction of the induced current in the ring as viewed from the left for the two instances shown.

	At time t_1	At time t_2
A	anticlockwise	anticlockwise
B	anticlockwise	clockwise
C	clockwise	anticlockwise
D	no induced current	no induced current

40 In the diagram below, the portion **XY** of the soft iron core of the transformer is removable.



Which of the following is correct when **XY** is removed?

A The brightness of the lamp decreases.

B The brightness of the lamp increases.

C The brightness of the lamp remains unchanged.

D The lamp stops lighting up.

END OF PAPER

1	C	11	D	21	A	31	C
2	A	12	B	22	A	32	B
3	A	13	B	23	B	33	A
4	D	14	C	24	D	34	D
5	B	15	D	25	C	35	C
6	D	16	D	26	A	36	B
7	C	17	D	27	C	37	D
8	B	18	B	28	D	38	C
9	C	19	D	29	A	39	C
10	D	20	B	30	D	40	A

For Examiner's Use

Section A

Answer all the questions in this section.

1 A space rocket is launched from a planet. The space rocket starts its engine from rest and rises vertically from the surface of the planet. After several seconds the engine is switch off. The graph in Fig. 1.1 shows how the velocity of the rocket varies with the time from the instant of launching.

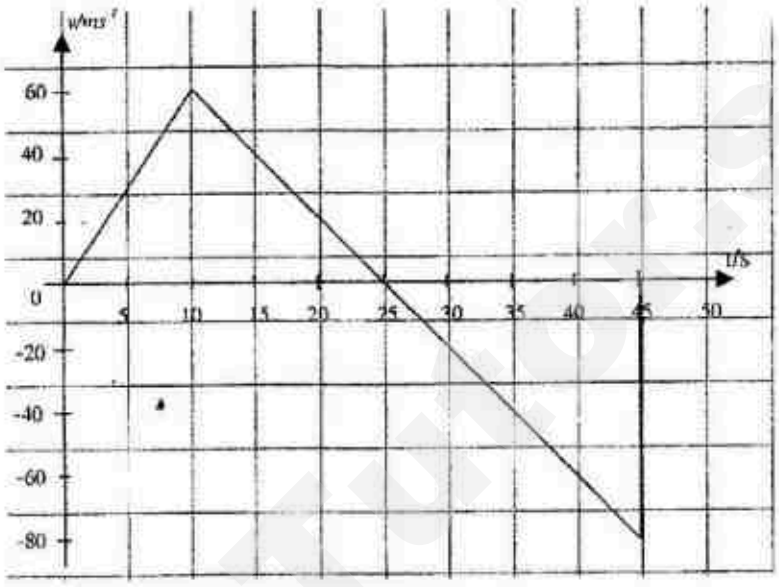


Fig. 1.1

(a) Determine the maximum height that the rocket reaches above the surface of the planet.

Maximum height = ...[1]

(b) Calculate the acceleration due to gravity on the planet.

Acceleration due to gravity = ...[1]

For Examiner's Use

(c) Sketch the displacement-time graph of the rocket for the 45 seconds. [2]

(d) Describe the motion of the rocket from 0 second to 45 seconds.

.....

.....

.....

.....[2]

2 A stone of mass 2.0 kg is thrown vertically upwards at the top of a cliff with a speed of 15 m/s. The cliff is 80 m above the sea. Take the gravitational potential energy at the sea level to be zero and the gravitational field strength to be 10 N/kg.

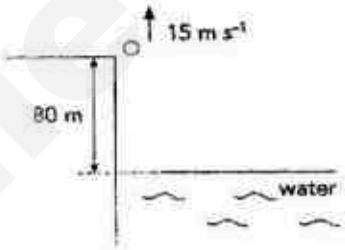


Fig. 2.1

(a) (i) By considering the Principal of Conservation of Energy, calculate the greatest height reached by the stone above the sea.

Greatest height = ... [2]

[Turn over

For Examiner's Use

(ii) Calculate the speed of the stone just before entering the sea.

Speed of stone = ...[1]

(b) When the stone enters the sea, it slows down. Fig. 2.2 shows the velocity-time graph of the stone from the time it enters the water till it reaches constant velocity at **C**.

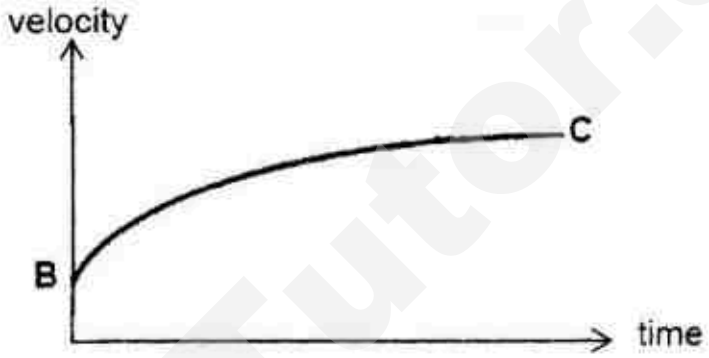


Fig. 2.2

(i) Explain the motion of stone from **B** to **C** in terms of the forces acting on it and with reference to the relevant Newton's Laws.

.....

.....

.....

.....

.....

.....

.....[4]

(ii) Describe the change in energy when the stone is falling with constant speed.

.....

.....[1]

For Examiner's Use

3 A student notices a large puddle of water on a road. Later in the day, he notices that some of the water has evaporated.

(a) State two changes in the atmospheric conditions that would cause the water to evaporate faster.

1.....

.....

2.....

.....[2]

(b) Explain, in terms of molecules, what happens during evaporation.

.....

.....

.....

.....[2]

4 Fig. 4.1 shows a non-uniform plank **XY** 2.50 m long and weighing 950 N. Spring balances A and B are attached to the plank at a distance of 0.40 m from each end, as shown.

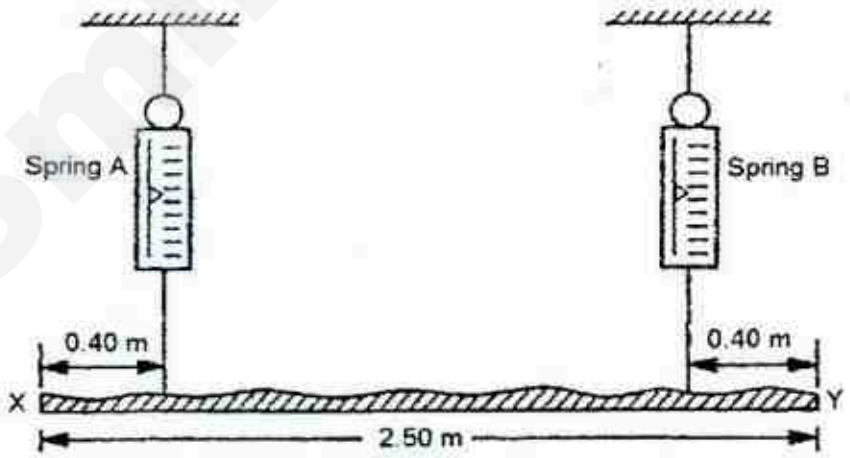


Fig. 4.1

When the plank is horizontal, spring balance A records 580 N.

[Turn over

For Examiner's Use

(a) On Fig 4.2 below, indicate all the forces and their magnitudes acting on the plank. [2]

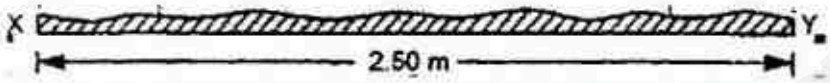


Fig. 4.2

(b) Define moment.

.....

.....[1]

(c) Determine the distance of the centre of gravity from the end X of the plank.

Distance of centre of gravity from end X = ...[2]

(d) Identify an action-reaction pair (according to Newton's Third Law) from the system shown in Fig. 4.1.

.....

.....[1]

5 (a) Fig. 5.1 below shows a thin converging lens used to form the image of a can as shown. The can with its light source is placed such that the object distance is more than twice the focal length of the converging lens. A screen is placed on the opposite side of the lens and moved until a sharp image of the can is captured on the screen.

For Examiner's Use

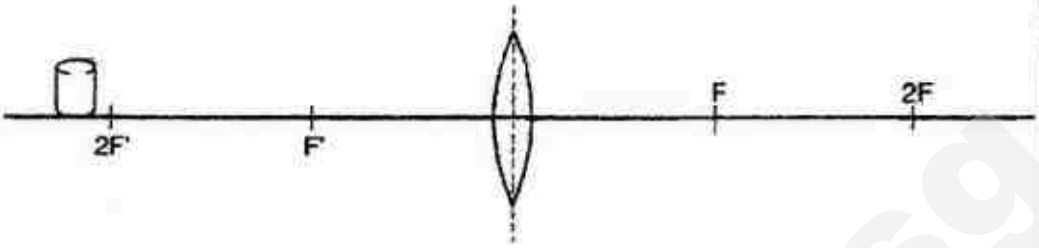


Fig. 5.1

(i) Define the focal length of a converging lens.

.....

.....[1]

(ii) State three characteristics of the image formed.

.....

.....[2]

(iii) The lens is replaced with another of the same focal length but one whose diameter is half the size of the original lens. State the change(s) if any, that would be observed in the image formed.

.....

..... [1]

(iv) The positions of the screen and can with light source are switched. State :

(1) if the image will still be sharp ;

(2) the change, if any, that would be observed in the size of the image.

(1) .....

(2) .....

.....[2]

[Turn over

For Examiner's Use

(b) Stars that are being formed emit infra-red radiation. Some of this radiation is received by a telescope that orbits the earth. Microwave signals from the telescope are sent to the Earth surface, as shown in Fig. 5.2.

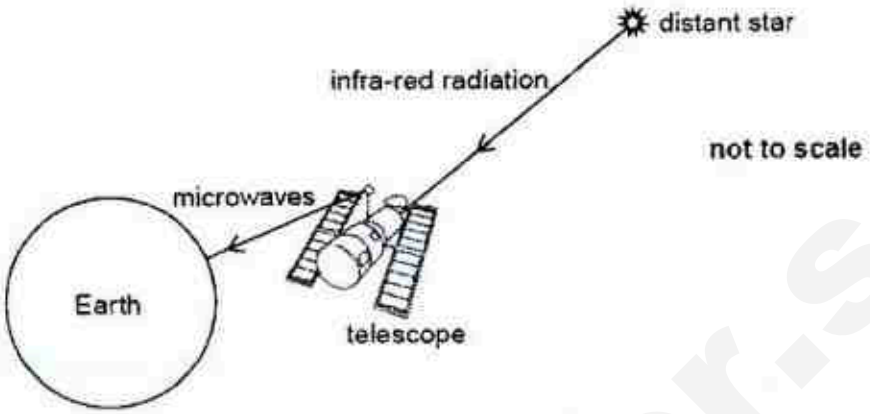


Fig. 5.2

(i) The telescope is 600 km above Earth's surface. Calculate the time for a microwave signal from the telescope to reach the Earth's surface.

Time = ... [1]

(ii) Infra-red and microwave radiation are both part of the electromagnetic spectrum. State two other similarities and give one difference between infra-red and microwave radiation.

.....

.....

.....

.....

.....[2]

(iii) State an effect of absorbing infra-red radiation by human.

.....

.....[1]

For Examiner's Use

6 Ultrasound is emitted from the rear of the car when the car is reversing. Objects behind the car reflect the ultrasound, which are detected by sensors that are fitted to the rear bumper of cars. The sensors will activate buzzer that emits audible beeps, which become more frequent as the car moves closer to the object as shown in Fig. 6.1. Assume speed of sound in air to be 330 m/s.

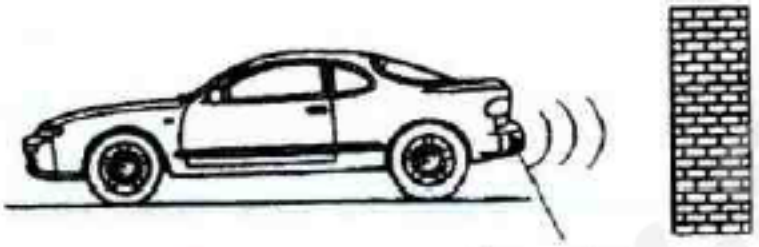


Fig. 6.1

(a) Define ultrasound.

.....

.....[1]

(b) Suggest two reasons why the amplitude of reflected ultrasound received by sensors is less than the amplitude of ultrasound emitted by the emitters.

1.....

.....

2.....

.....[2]

(c) The time taken between these pulses being sent and received is 4.0 ms. Calculate the distance between the object and the rear of the car.

Distance = ...[1]

[Turn over

For Examiner's Use

(d) When the distance between the object and the rear of the car reaches a certain distance, 1 pulse is sent out every 40 μs. Calculate the wavelength of the ultrasonic pulse that results in the beeps at that distance.

Wavelength = ...[2]

7 A student sets up a circuit as shown in Fig. 7.1.

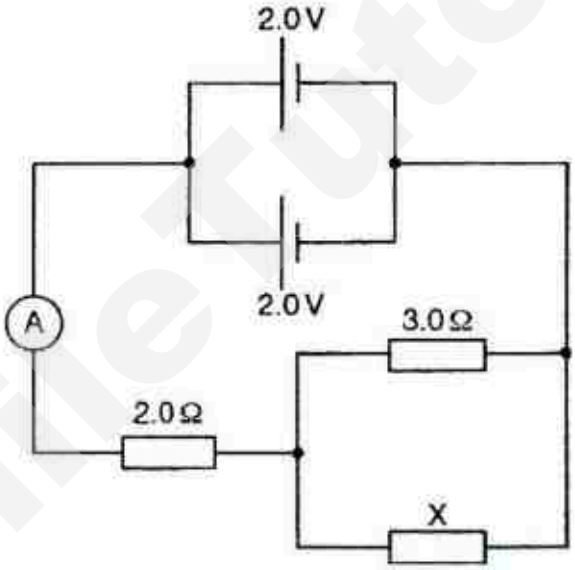


Fig. 7.1

(a) Resistor X and the 3.0 Ω resistor have a combined resistance that is equal to 2.0 Ω. Calculate the ammeter reading.

Ammeter reading = ...[2]

For Examiner's Use

(b) State an advantage of connecting the cells in parallel as shown.

.....

.....[1]

8 The generators at a power station produce a voltage of 25000 V. This voltage is stepped up to 400000 V by a transformer for long distance transmission on overhead power cable. A 20 km long transmission line has a resistance of 0.005 $\Omega\ m^{-1}$.

(a) Find the power wasted as thermal energy in the 20 km transmission line when 30 kW of electrical power is transmitted at 400000 V.

Power wasted as thermal energy = ...[2]

(b) State and explain why the voltage is stepped up for long distance transmission.

.....

.....

.....[2]

(c) Calculate the turn ratio of the step up transformer.

Turn ratio = ...[1]

(d) Compare the frequency of the alternating current in the power station and during transmission. Explain briefly.

.....

.....

.....[2]

[Turn over

Class	Name	Reg. No.

For Examiner's Use

Section B

Answer all the questions in this section.

Answer only **one** of the two alternative questions in **Question 11**.

9 Ray hears that the mean global temperature is going to rise due to greenhouse effect. He performs an experiment to study the absorption of solar energy by carbon dioxide. He uses identical flasks A and B filled with carbon dioxide and air respectively and puts them under sunlight as shown in Fig. 9.1.

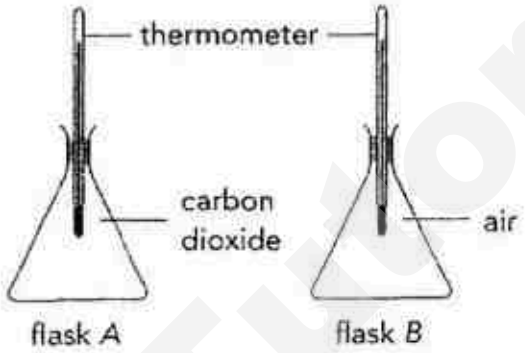


Fig. 9.1

Using thermometers, he records their temperatures at 3-minute intervals. Fig. 9.2 shows the result of his experiment.

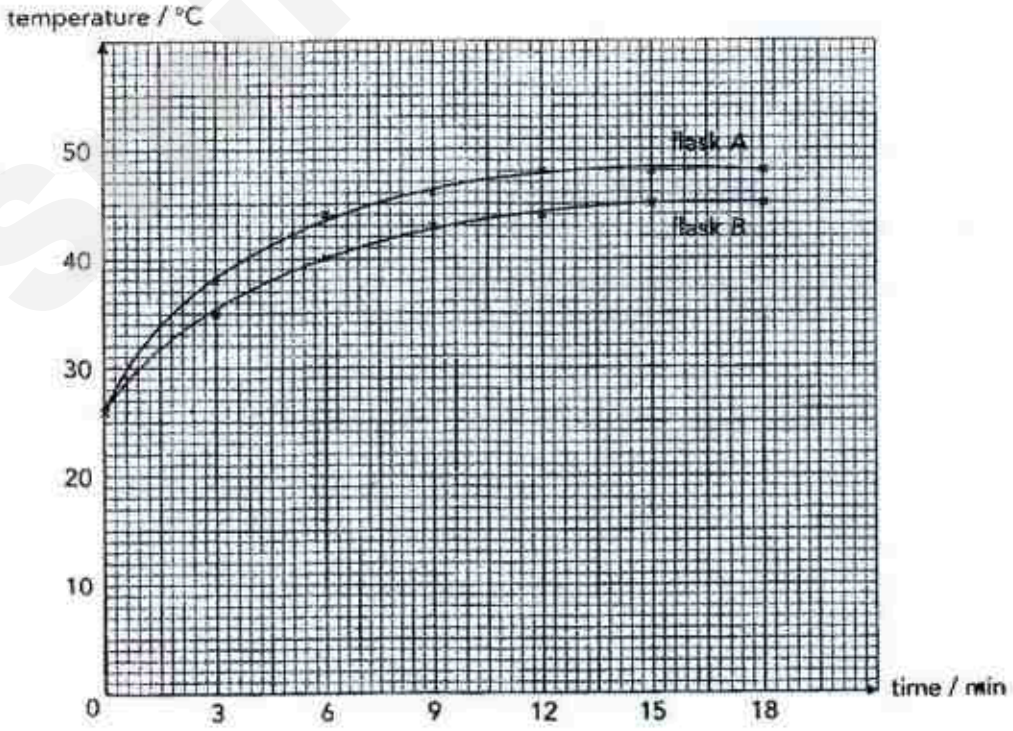


Fig. 9.2

For Examiner's Use

(a) Explain why each of the gases reaches a steady temperature after 15 minutes.

.....

.....[1]

(b) The volume of each flask is 0.0015 m^3. Ray gets the following data from a data book:

Density of air	= 0.0013 g/cm^3
Density of carbon dioxide	= 0.0020 g/cm^3
Specific heat capacity of air	= 740 J kg^{-1} °C^{-1}
Specific heat capacity of carbon dioxide	= 640 J kg^{-1} °C^{-1}

(i) Find the mass of gas in each flask.

Mass of carbon dioxide = ...[1]

Mass of air = ...[1]

(ii) Find the energy absorbed by each gas to reach its steady temperature.

Energy absorbed by carbon dioxide = ...

Energy absorbed by air = ...[2]

[Turn over]

For Examiner's Use

(c) Describe the mechanisms in which thermal energy is transferred from the sun through the wall of the flask and to the air inside the flask.

.....

.....

.....

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.....

.....

.....[3]

(d) Define renewable source of energy and state two sources of renewable energy that will not contribute to greenhouse gases.

.....

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.....[2]

10 The cathode-ray oscilloscope (CRO) in Fig. 10.1 is used in many applications. One of it is to measure the potential difference across an electrical component.

For Examiner's Use

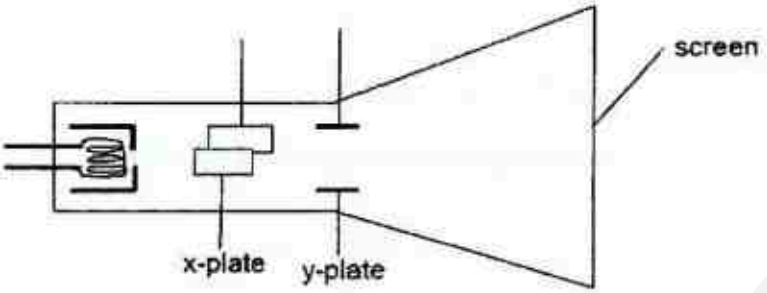

Fig. 10.1

The CRO is connected in parallel across a resistor that is connected to an a.c. generator as shown in Fig. 10.2.

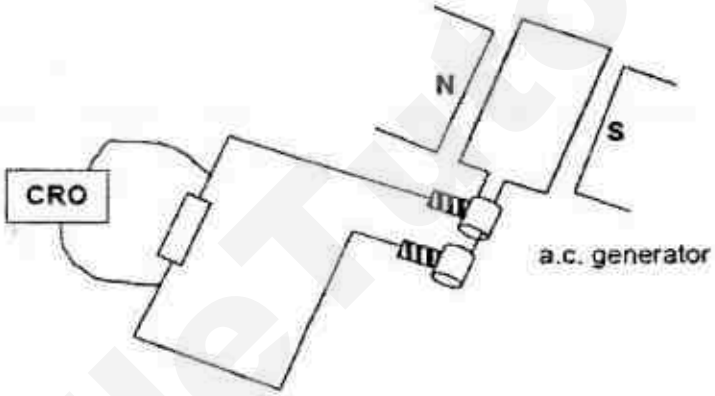

Fig. 10.2

(a) The voltage sensitivity of the CRO was set at 0.50 V per cm and the time-base was set at 5.0 ms per cm. If the peak value of voltage across resistor is 1.0 V and the frequency is 50 Hz, sketch the trace in Fig. 10.3 provided below. [2]

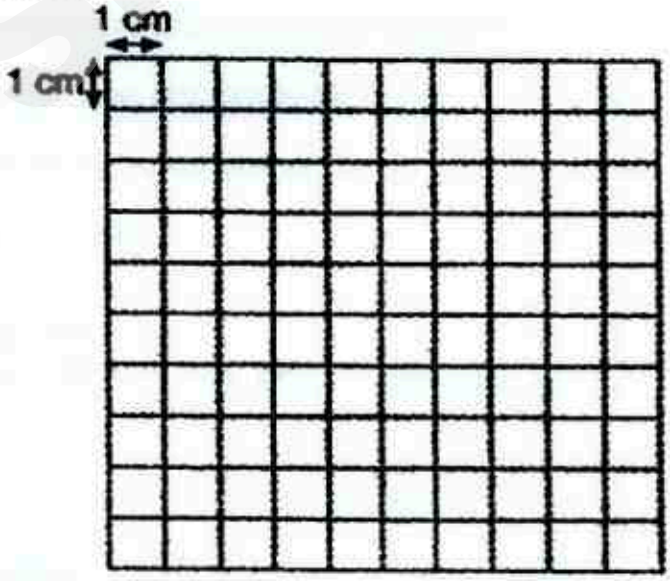

Fig. 10.3

For Examiner's Use

(b) Explain why the e.m.f. generated varies as the coil of generator rotates one complete revolution.

.....

.....

.....

.....

.....

.....

.....[3]

(c) Indicate with letter H on your answer for part **(a)** of Fig. 10.3 for the positions of the coil when it is horizontal (i.e. when the plane of the coil is parallel to the magnetic field) [1]

(d) Sketch the new trace that will be observed on the screen provided in Fig. 10.4 below when the rotation of the generator is increased to twice its original speed. [1]

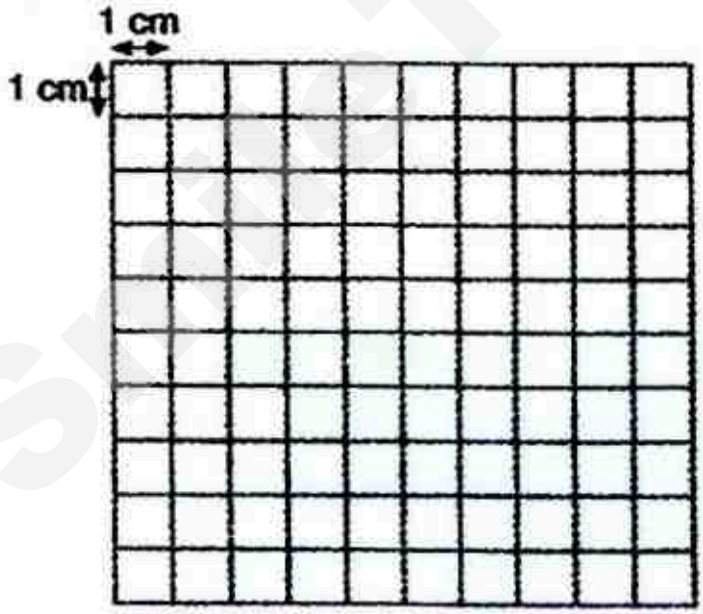

Fig. 10.4

(e) The a.c. supply is disconnected from the CRO and the time base turned off. The electron beam appears at the middle of the screen.
Two strong magnets are placed next to the CRO and perpendicular to the electron beam as shown below.
In Fig.10.5 below, mark the new position of the electron beam on the screen. [1]

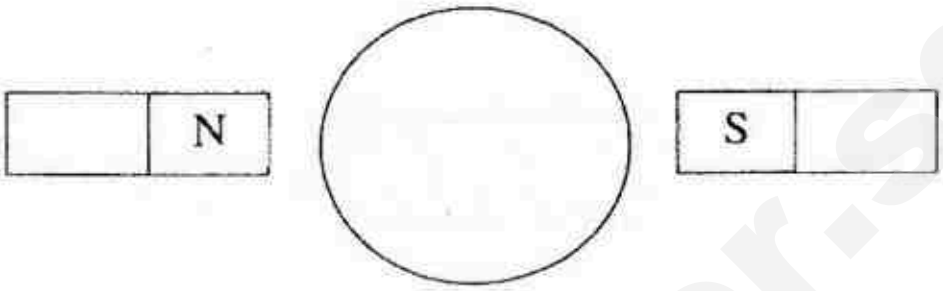

Fig. 10.5

(f) Explain how you derive the position of the electron beam in part **(e)** .

.....

.....

.....

.....

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.....[2]

For Examiner's Use

11 EITHER

Fig. 11.1 shows a simple type of motor. PQ and RS are hollow paper cones wound by wires. The cones and coil ABCD are connected in parallel to a battery.

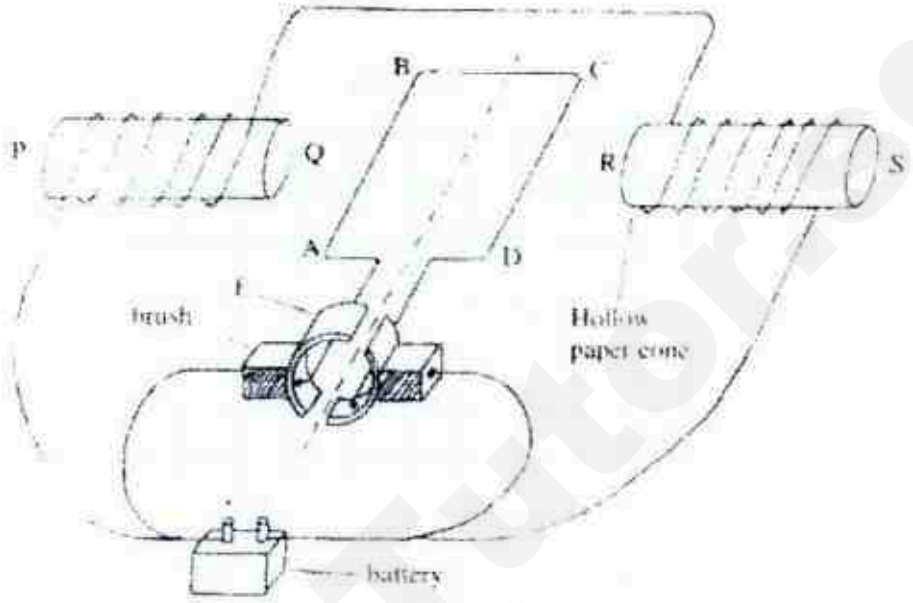


Fig. 11.1

(a) State

(i) the polarity at end Q of the left solenoid;

.....[1]

(ii) the direction of rotation of coil when viewed from the battery.

.....[1]

(b) Explain why the coil rotates in the same direction as stated in **(a)(ii)** continuously.

.....

.....

.....

.....

.....[2]

For Examiner's Use

(c) Suggest two ways of increasing the rotating speed of the coil.

.....

.....

.....[1]

(d) A student claims that if the battery in Fig. 11.1 is replaced by an a.c. of 50 Hz supply, the coil will only oscillate to and fro and hence the motor will not function properly.
Do you agree? State the reason.

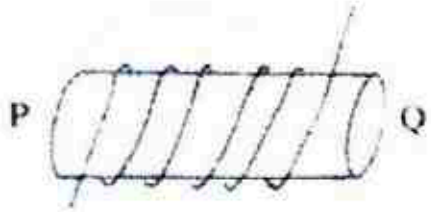
.....

.....

.....[2]

(e) In the space below, sketch the moment-time graph of the motor, starting with the position of coil as shown in Fig. 11.1. [2]

(f) In the space below, sketch the magnetic field pattern of solenoid with the direction of current as in Fig. 11.1. [1]



For Examiner's Use

OR

A student designs a simple apparatus to measure electrical current. The set-up is as shown in Fig. 11.2. The current to be measured is allowed to flow from terminal A to B through the solenoid.

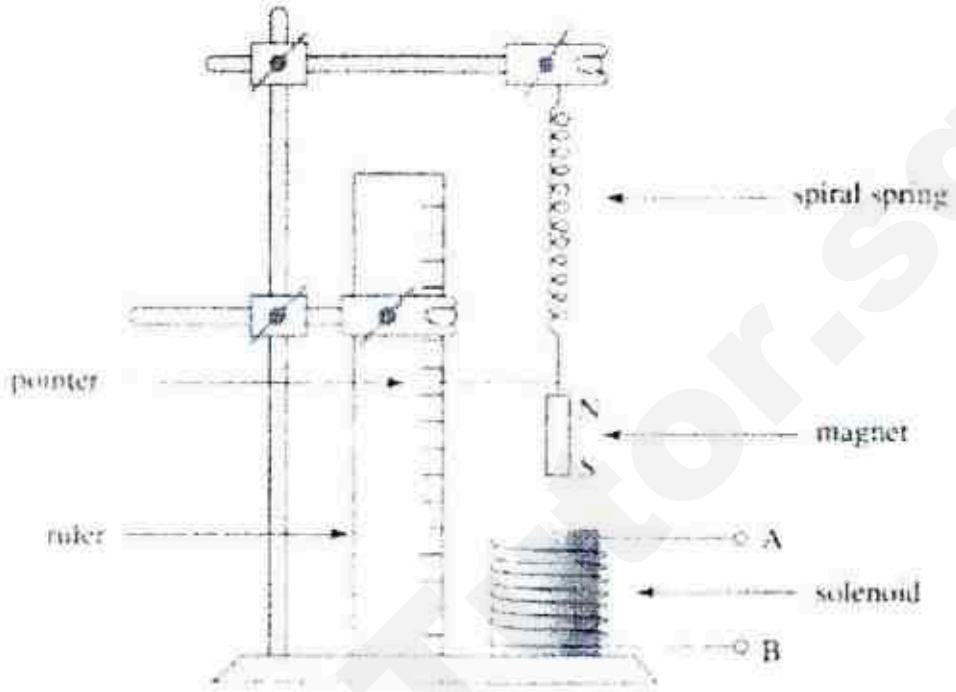


Fig 11 .2

(a) **(i)** Explain why this set-up can be used to measure current.

.....

.....

.....

.....

.....

.....[2]

(ii) Suggest two methods to increase the sensitivity of the set-up.

.....

.....

.....[2]

(iii) State and explain if the setup can still measure current if the magnet is replaced by soft iron bar.

For Examiner's Use

.....

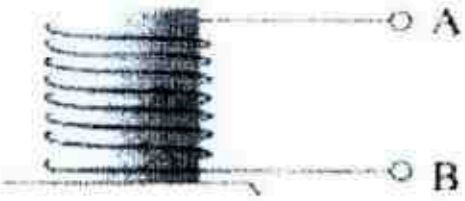
.....

.....[2]

(b) The student tries to calibrate the set-up by an external circuit connected across AB. The external circuit consists of four dry cells, an ammeter, a rheostat and a light dependent resistor.

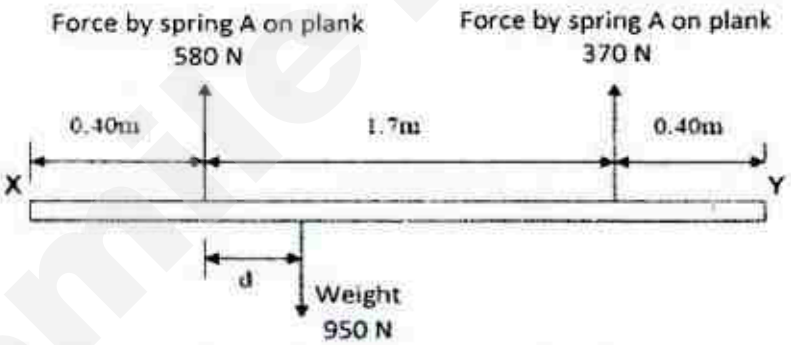
(i) Draw a circuit diagram to show one possible arrangement of the components of the external circuit. [2]

(ii) In the space below, sketch the magnetic field pattern of solenoid as shown in Fig. 11.2 [2]



END OF SECTION B

Qn No.	Suggested Solution	Marks
1(a)	Maximum height = area under the v-t graph = ½ x 60 x 25 = **750 m**	A1
(b)	Acceleration due to gravity on planet = (v-u) / t = (0-60) / (25-10) = **-4.0 m/s^2** or **4.0 m/s^2 downwards**	A1
(c)	0-10 s: increasing gradient 10-25s : decreasing gradient 25 s: zero gradient 25-45 s: increasing negative gradient Include max displacement value of 750 m, deduct one mark if max displacement value is not included in graph	B1 B1
(d)	From 0-10 s, rocket **moves upwards** from rest to 60 m/s with **constant acceleration.** From 10-25 s, rocket **moves upwards** from 60 m/s to 0 m/s with **constant deceleration.** From 25-45 s, rocket **moves downwards** from 0 m/s to 80 m/s with **constant acceleration**.	B1 B1
2(a)(i)	Total mechanical energy of stone = mgh + ½ mv^2 = 2 x 10 x 80 + ½ x 2 x 15^2 = = **1825 J** At highest point , mgh = 1825 2 x 10 x h = 1825 h = 91.25 m = **91 m** (2sf)	A1 A1
(ii)	At sea level, ½ mv^2 = 1825 ½ x 2 x v^2 = 1825 v = 42.72 m/s = **42.7 m/s**	A1
(b)(i)	The velocity increases at a decreasing rate (decreasing acceleration). The resultant force, F = W - upthrust - water resistance. **F decreases as water resistance increases with speed of stone.** By **Newton's 2nd Law**, F = ma, **acceleration decreases as resultant force, F, decreases.** When **weight equals upward forces** (F = 0 N), the stone travels with constant velocity	B1 B1 B1

	By **Newton's 1st Law, stone continues with uniform motion as there are no unbalanced forces** (also accepted if Newton's 2nd Law was used to explain this part).	B1
(ii)	The **loss in gravitational potential energy** is used to **do work in overcoming the water resistance / changes into internal energy of the water molecules / changes to thermal energy of the stone and water** due to water resistance opposing the motion.	B1
3(a)	Any 2 of the following: 1. Increase in wind speed/ wind flow above the puddle 2. Decrease in atmospheric pressure 3. Decrease in humidity 4. Increase in temperature	 B1 B1
(b)	Liquid molecules **near the surface** that have **enough energy to overcome** the **attractive forces of the other liquid molecules** and **atmospheric pressure** escape into the atmosphere. **Less energetic molecules are left behind.** Therefore average kinetic energy of the molecules decreases.	B1 B1
4(a)	 (deduct one mark for each missing or wrong force)	B1 B1
(b)	Moment is the product of force and the perpendicular distance from the pivot to the line of action of the force.	B1
(c)	Taking moment about spring A, at equilibrium, Clockwise moment = anti clockwise moment $950 \times d = 370 \times 1.7$ $d = 0.662m$ Distance of the centre of gravity from X = 0.662 + 0.4 = **1.06 m**	 C1 A1
(d)	Upward force on plank by spring and downward force on spring by plank Or Gravitational force on plank by earth and gravitational force on earth by plank	B1

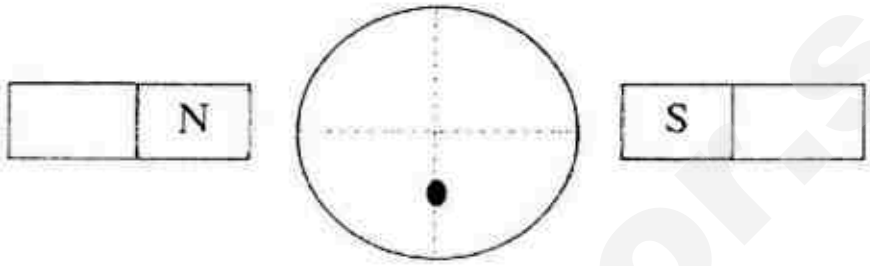
5(a)(i)	Focal length of a converging lens is the distance between the optical centre of the lens and the focal point.	B1
(ii)	Any three: **Real, inverted, diminished and on opposite side of the lens.** (deduct one mark for each wrong or missing characteristic)	B1 B1
(iii)	The image would be **dimmer**.	B1
(iv)	(1) The **image would still be as sharp**. The light rays would still converge on the screen as the light rays behave the same when they enter the lens from either side (due to the principle of reversibility of light). (2) The image would now be **magnified** instead.	B1 B1
(b)(i)	Speed of EM wave = 3 00000000 m/s Time = Distance / speed = **600000 / 300000000 = 0.0020 s**	 A1
(ii)	Both are transverse waves Both can travel in vacuum at 3×10^8 m/s Both do not require a medium Infrared has a higher frequency than microwaves. Microwave has a longer wavelength than infrared. (deduct one mark for each mistake)	B1 B1
(iii)	Infra-red radiation **increases temperature** of object	B1
6(a)	Ultrasound is **sound with frequencies above the upper limit of the human range of audibility.** (above 20000 Hz)	B1
(b)	Any one of the following: 1. Some ultrasound is absorbed by the wall. 2. Some sound energy is lost to the surrounding or the wall (accept only if the 1. was not given). 3. Some sound energy is converted to other forms of energy (accept only if the 1 or 2 was not given). 4. Friction between the air particles result in the air particles losing energy. 5. Ultrasound moves in all direction, only some of the sound gets to be reflected back to the direction of the receiver. 6. Ultrasound that hits the wall reflects in all directions, and not all is picked up by the receiver.	 B1 B1
(c)	Distance = **speed x time / 2** $= 330 \times 4.0 \times 10^{-3} / 2$ = **0.66 m** ***(Marker's comments:** Well done.)*	 A1

(d)	Frequency = 1/T = $(40\times10^{-6})^{-1}$ Hz = **25000 Hz** V = $f\lambda$ λ = V/ f = 330 / 25000 = **0.0132 m**	C1 A1
7(a)	Reff = 2 + 2 = **4 Ω** I = $\frac{V}{R} = \frac{2}{2+2}$ = **0.50 A**	C1 A1
(b)	Cells can **last longer** when they are connected in parallel. or Circuit will still be given the have the same e.m.f. when one cell is damaged or depleted.	B1
8(a)	Total resistance = 20000 m × 0.005 Ω m^{-1} = 100 Ω Using $P = IV$, 30 000 = I × 400000 I = **0.075 A** Power loss = I^2R = $(0.075)^2 \times 100$ = **0.563 W** (3 sf)	 A1 A1
(b)	Transmit power at high voltage (V) so that **current (I) is low when power (P) is constant because I = P /V** **Less joule heating occur during transmission (P = I^2R where R is resistance)** and **less heat/power/energy loss**	B1 B1
(c)	**16 : 1**	A1
(d)	Frequency of a.c. in power station is **same** as frequency of a.c. during transmission because **current in the transmission circuit is induced by current in the power station.**	B1 B1

Section B

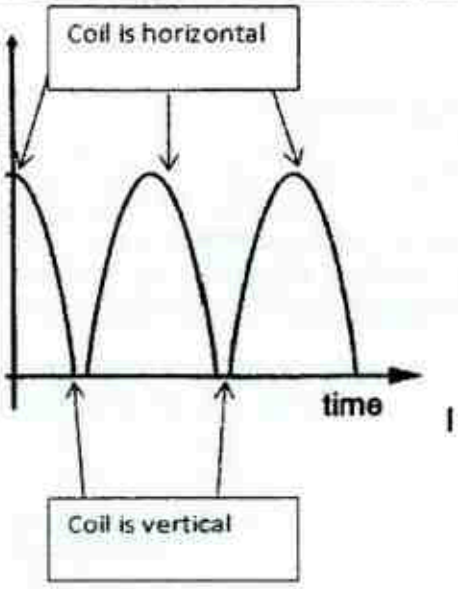
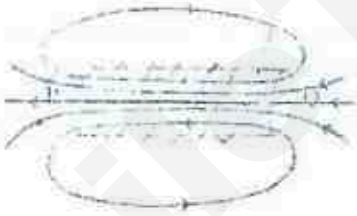
9(a)	A steady temperature is reached when the **rate of energy lost** by the gas is equal to **the rate of absorption of energy** from the sun/surroundings.	B1
(b) (i)	Mass of carbon dioxide = density x vol = 2.0 x 0.0015 = **0.0030 kg** Mass of air = density x vol = 1.3 x 0.0015 = **0.00195 kg**	A1 A1
(b) (ii)	Energy absorbed by carbon dioxide = mcθ = 0.003 x 640 x (48-26) = 42.24 J = **42.2 J** (3 s.f.) Energy absorbed by air = mcθ = 0.00195 X 740 x (45-26) = 27.417 J = **27.4 J** (3 s.f.) Accept Energy absorbed by carbon dioxide =**36.5 J** (3 s.f.) Energy absorbed by air = **31.7 J** (3 s.f.)	 A1 A1
(c)	Solar energy from the sun travel to earth by **infra-red radiation** which **does not require a medium**. Particles on outer surface of flask **gain kinetic energy** from the solar energy and **vibrate vigorously about their fixed positions**. They **collide with neighbouring particles** and **transfer kinetic energy** to the **neighbouring particles**. Process repeat itself and thermal energy is **transferred mainly by conduction through the walls of flask**. **Air particles near to wall of flask and gain kinetic energy** and move further apart from each other, results in increase in volume of the air near to the wall. Air becomes less dense and rises. Cooler air sinks in to replace the warmer air. **Convection currents** are form and thermal energy is transferred to air in flask. **Maximum : 3 marks**	B1 B1 B1 B1
(d)	Renewable energy is defined as energy from sources that can be **replenish naturally.** Any two of the following: **Solar Power** **Hydroelectric power** **Wind power** **Geothermal power**	B1 B1

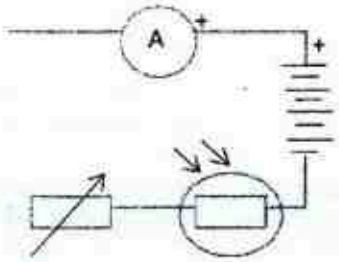
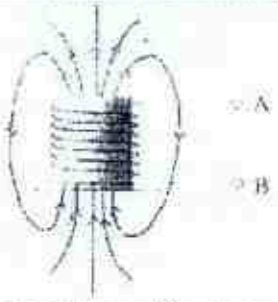
10 (a)	Period = 4 cm (1 mark) Peak voltage = 2cm (1 mark)	B1 B1
(b)	When the **plane of coil is rotate to parallel to the magnetic field** , the **coil will cut across the magnetic field lines at the greatest rate,** according to **Faraday's Law**, the **magnitude of e.m.f. induced increases to maximum** When **plane of coil rotates to perpendicular to the magnetic field** , **the coil do not cut across the magnetic field lines** and the **magnitude of e.m.f. induced reduces to zero.**	B1 B1

	After half a rotation, induced e.m.f. is maximum as plane of coil is parallel to the field again. But **direction of motion of coil is opposite to first half and e.m.f. induced will be opposite in direction**.	B1
(d)	Period = 2 cm Peak voltage = 4 cm ECF from 10(a)	B1
(e)		A1
(f)	Using Fleming's Left Hand rule, with the thumb, index and middle finger **mutually perpendicular** to each other. Point the **index finger, which represents the magnetic field to the right**, the **middle finger away from you into the paper**, and the thumb which represents **the force acting on the beam will be pointing downwards**, which indicates a **downward force** pushing the beam downwards.	B1 B1

Either

11(a)(i)	Q : South pole	A1
(ii)	Clockwise	A1
(b)	Because the contacts of carbon brushes and commutators switch over after the coil passes through vertical position, **direction of current in the coil reverses**. The force **on the side of the coil next to the N-pole continued to be downwards direction** and the **force for the side next to S-pole continue to be upward direction** when the current reverses after the vertical position.	B1 B1
(c)	Any two of the following: 1) Place soft iron cores inside the solenoids to concentrate the magnetic field lines 2) Increase the number of turns of the coil PQRS 3) Increase the current	B1 B1
(d)	The **polarities of the solenoids** and the **current passing through the coil are reversed simultaneously** if the terminals of the battery are reversed. Therefore **the rotating direction of the coil remains unchanged**, the motor still work correctly	B1 B1

(e)	 Moment graph must start from peak moment because moment is maximum when coil is horizontal - 1 mark Correct Shape of graph – 1 mark *Markers' comments:* *Most students drew a sine graph as they seem to confuse with AC generator.*	
(f)		B1
Or		
11(a)(i)	Solenoid becomes an **electromagnet** when current flows through it from A to B. The upper end of the solenoid becomes an north pole and attracts the magnet as **unlike pole attract** The **downward displacement of the magnet increases** with the current and **therefore is a measure of the current.** *Markers' comments:* *Second point on how set up is used to measure current is often missing in students' answer or not properly stated.*	B1 B1
(ii)	Any 2 of the following: Use a stronger magnet Use a solenoid with more turns per unit length Use a less stiff spring	B1 B1
(iii)	Yes, The lower end of the iron will be **induced with unlike poles** and becomes **a south pole** by the magnetic field of the electromagnet.	B1

	Unlike poles attract and **soft iron** will be **attracted towards the electromagnet.**	B1
(b)(i)	 Deduct 1 mark for 1 wrong symbol or missing symbol	B1 B1
(b)(ii)	 Correct field lines direction – one mark Correct shape – one mark Deduct one mark for any intersection of lines	B1 B1

NCHS P1-17

This paper consists of **15** printed pages including the cover page.

1. Which of the following pairs of physical quantities have the same unit?

A weight and mass

B force and acceleration due to gravity

C moment and torque

D terminal velocity and acceleration

2. Fig. 2.1 shows part of the vernier scale on a pair of vernier calipers when no object was placed between the jaws. Fig.2.2 shows the same vernier calipers when the diameter of a rod was measured.

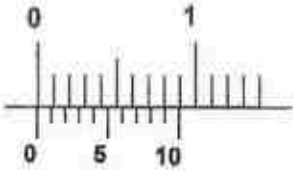


Fig. 2.1

Fig. 2.2

Which is the correct reading of the diameter of the rod?

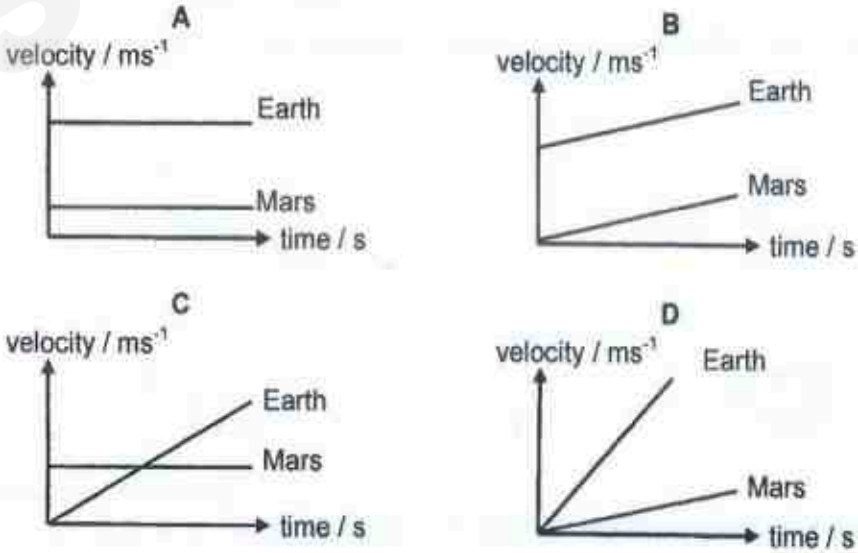
A 3.35 cm

B 3.27 cm

C 3.28 cm

D 3.29 cm

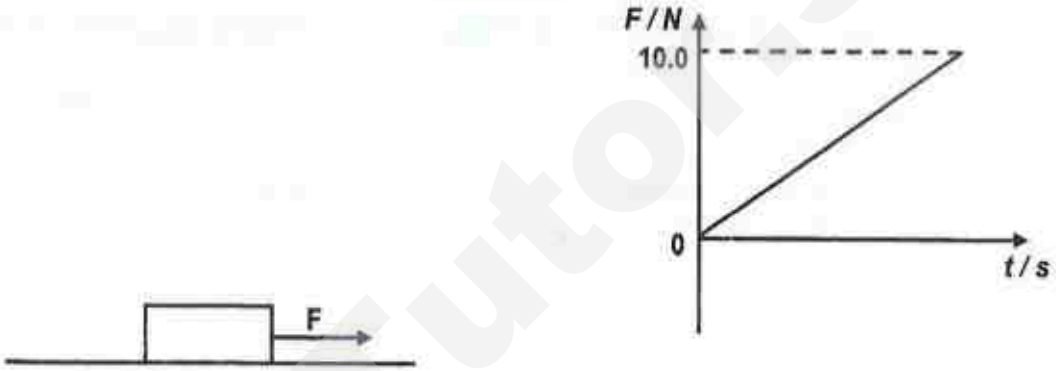
3. When a stone is dropped on Earth, it accelerates constantly at about 10 m/s^2. When the same stone drops on Mars, it accelerates constantly at about 2.0 m/s^2. Which graph best describes the rock motion?



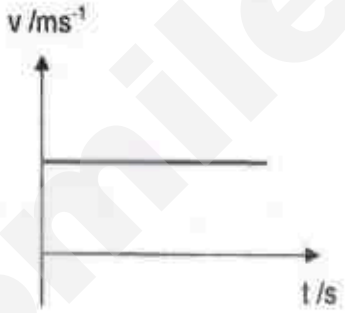
4. A car of mass 700 kg is capable of exerting a maximum engine force of 5000 N. When travelling along a typical road, it has a maximum acceleration of 5.0 m/s^2. What is the total resistive force acting on the car?

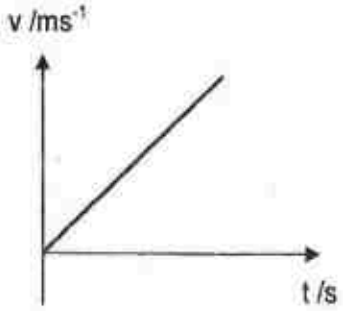
A	36 N	B	1500 N
C	3500 N	D	5000 N

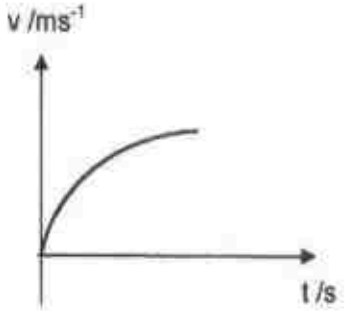
5. The diagram below shows a wooden block initially at rest on a smooth horizontal surface. A pulling force F acting on the wooden block varies as shown in the graph.

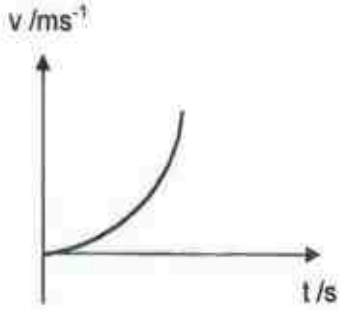


Which graph best describes the motion of the wooden block?

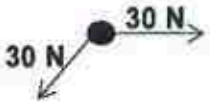
A


B


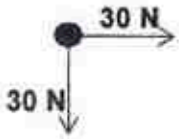
C


D


6. Two forces of 30 N act simultaneously on a body. Which of the following would produce the smallest resultant force?

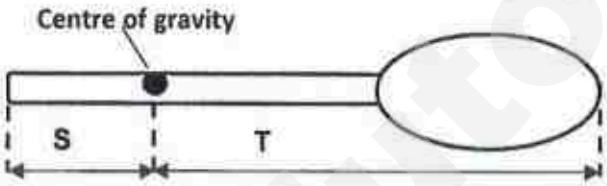
A


B


C


D


7. The diagram below shows the position of the centre of gravity of an object made of different material.



Which of the following statements about the object is ***not* correct**?

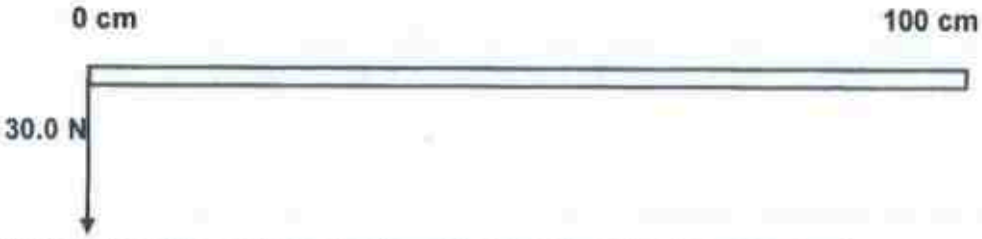
A The weight of the object acts through the centre of gravity.

B The spoon can be balanced by placing a knife edge at the centre of gravity.

C The mass of part **S** of the spoon is more than that of part **T**.

D The mass part **S** of the spoon is equal to that of part **T**.

8. The diagram below shows a uniform metre ruler with a weight of 10 N, under the action of a vertical force of 30.0 N.

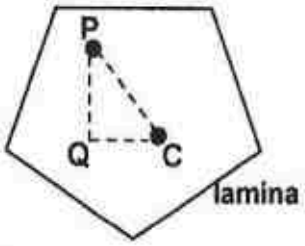


At what mark must a fulcrum be placed to hold the ruler in equilibrium?

A 12.5 cm B 16.7 cm

C 25.0 cm D 37.5 cm

9. A flat lamina is freely suspended from point **P**.
The weight of the lamina is 4.0 N and the centre of mass is at **Q**.

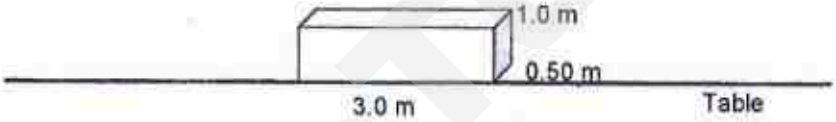


PC = 0.50 m
PQ = 0.40 m
QC = 0.30 m

What is the moment due to the weight of lamina that will cause the lamina to swing?

A 0 N m
B 1.2 N m
C 1.6 N m
D 2.0 N m

10. An object of mass 4.0 kg with a length of 3.0 m, width of 0.50 m and height of 1.0 m is placed on a table as shown in the diagram below.



What is the pressure exerted by this object on the table?

A 0.33 Pa
B 2.7 Pa
C 1.3 Pa
D 27 Pa

11. Which of the following **incorrectly** shows the thermometric property of the thermometer?

	Thermometer	Thermometric property
A	Mercury-in-glass thermometer	Volume of a fixed mass of liquid varies with temperature.
B	Thermocouple	Electromotive force between two junctions at different temperature varies with the temperature difference across the junctions.
C	Constant-volume gas thermometer	Volume of a fixed mass of gas varies with temperature.
D	Resistance thermometer	Resistance of a piece of conducting wire varies with temperature.

12. Illuminated smoke particles, suspended in air, are viewed under a microscope. They are seen to move randomly. Which of the following best describes the movement of the smoke particles?

A The smoke particles are moving due to the energy gained from the illuminated light.

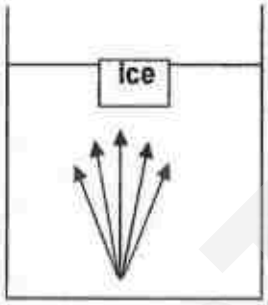
B The smoke particles are moving about due to convection currents.

C The smoke particles are bombarded continuously by the air molecules.

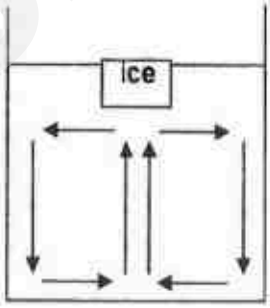
D The smoke particles are moving due to bombardment by other smoke particles.

13. An ice cube is placed in a beaker of water at the top of the surface. Which figure below best shows the convection currents form in the water?

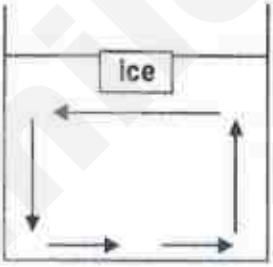
A



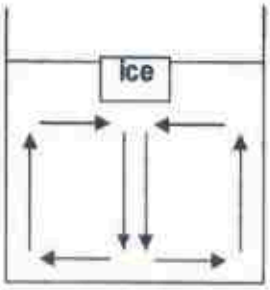
B



C



D



14. Which of the following in the table correctly shows examples of transverse and longitudinal waves?

	Transverse	Longitudinal
A	Gamma-rays	Sound
B	Infra-red	Water waves
C	Radio	Light
D	Sound	X-rays

15. Which of the following statement(s) about electromagnetic waves is/are *correct*?

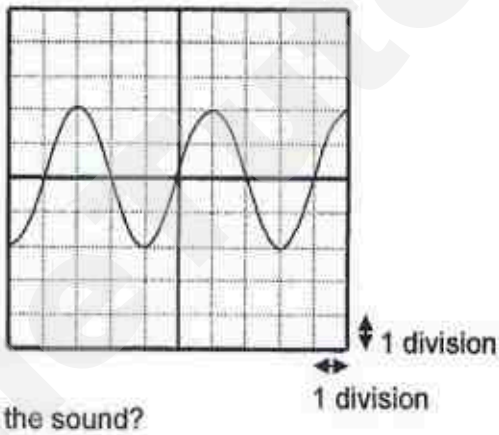
I All electromagnetic waves travel at 3.0×10^8 m/s in vacuum.

II All electromagnetic waves travel faster in air than in water.

III All electromagnetic waves have magnetic field around them.

A II only
B I and II only
C II and III only
D I, II and III

16. The diagram below shows oscilloscope trace of sound picked up by the microphone. The Y-gain is set at 2 V per division and the time base is set at 50 ms per division.



What is the frequency of the sound?

A 0.040 Hz
B 0.13 Hz
C 5.0 Hz
D 10 Hz

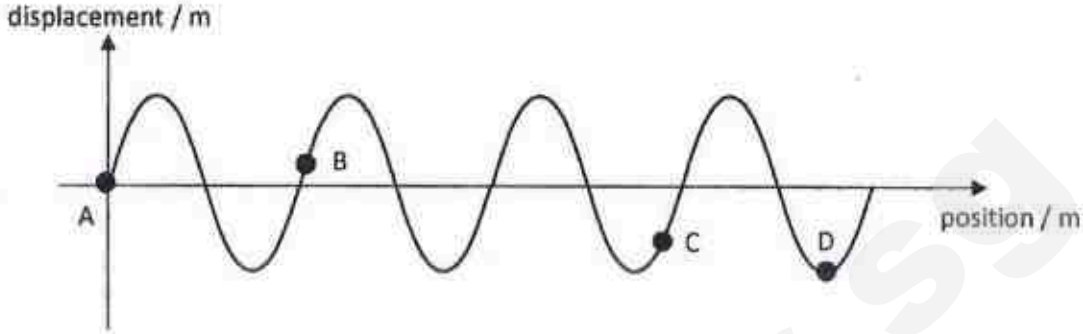
17. Two notes of different pitch but the same loudness are played on a musical instrument. The two sound waves produced will have

A same frequency and different speed.
B different frequency and different speed.
C different frequency and same speed.
D different speed and same amplitude.

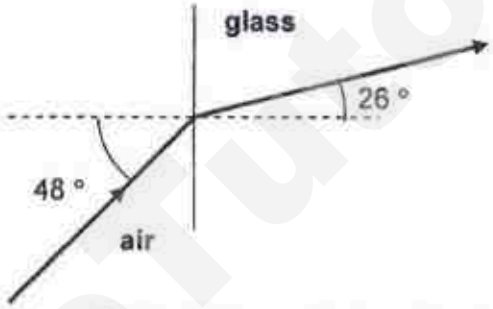
18. Which of the following is the approximate range of audible frequency for human?

A 1 Hz to 20 Hz
B 20 Hz to 20 kHz
C 20 kHz to 200 kHz
D 1000 kHz to 20 000 kHz

19. The graph below shows the displacement of particles on the wave against position. Which particle has the highest speed?



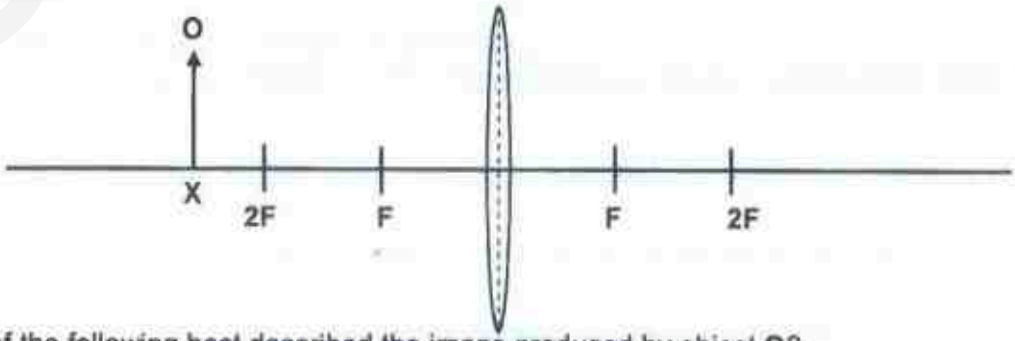
20. A ray of light travels from air into glass as shown below.



Given that the refractive index of air is 1.00, what is the refractive index of glass?

A	1.21	**B**	1.34
C	1.53	**D**	1.70

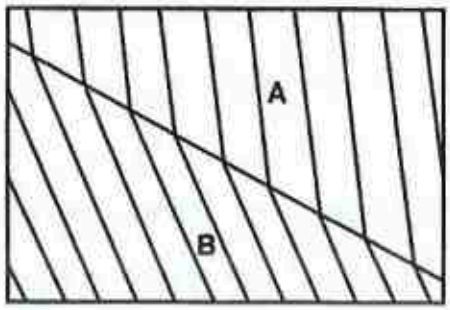
21. The diagram below shows a convex lens used to produce an image of an object **O** when it is placed at X.



What of the following best described the image produced by object **O**?

A	real and diminished	**B**	real and magnified
C	virtual and diminished	**D**	real and same size as object

22. The diagram below shows water waves travelling from region **B** to region **A**.



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

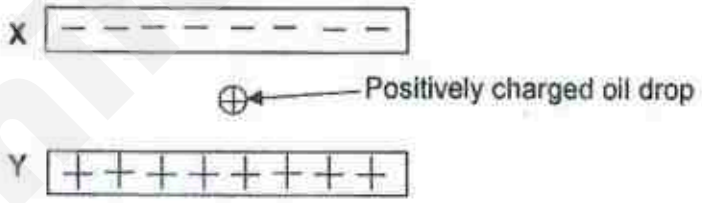
A The frequency of the waves in region **A** is smaller than in region **B**.

B The direction of the waves has changed because of the change in speed.

C Region **B** is deeper than region **A**.

D The speed of the waves in region A is slower than in region **B**.

23. A positively charged oil drop stays stationary between two charged metal plates **X** and **Y** as shown in the diagram.



What happen if the potential of plate Y is increased?

A The oil drop will remain stationary.

B The oil drop will move downwards.

C The oil drop will move upwards.

D The oil drop will move in circular motion.

24. A lightning strike was discharged in 1.2×10^{-4} s with a charge of 700 C that travels from the cloud to a building.

What is the number of electrons that travels from the cloud to the building?
(Each electron carries 1.6×10^{-19} C)

A 4.1×10^{6}

B 6.3×10^{18}

C 4.4×10^{21}

D 2.7×10^{25}

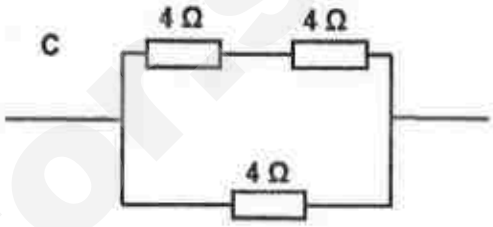
25. A current of 2.0 A passes through a cell of e.m.f 6.0 V.
What is the electrical energy supplied by the cell in 3.0 s?

A	1.0 J	**B**	4.0 J
C	9.0 J	**D**	36 J

26. Three 4.0 Ω resistors are connected as shown below. Which of the following connections gives the lowest effective resistance?

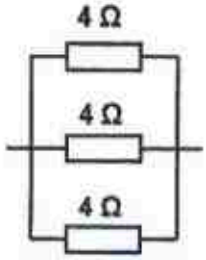
A

C

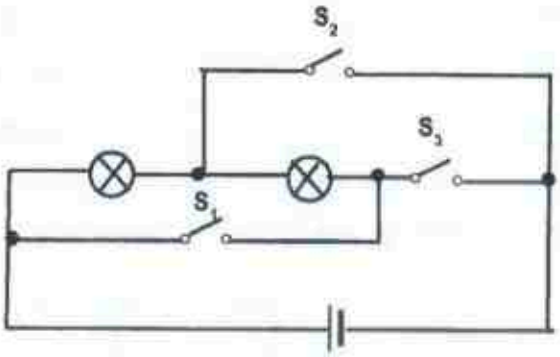


B

D



27. Two identical light bulbs and three switches S_1, S_2, and S_3 are connected together to a battery in the circuit shown below.



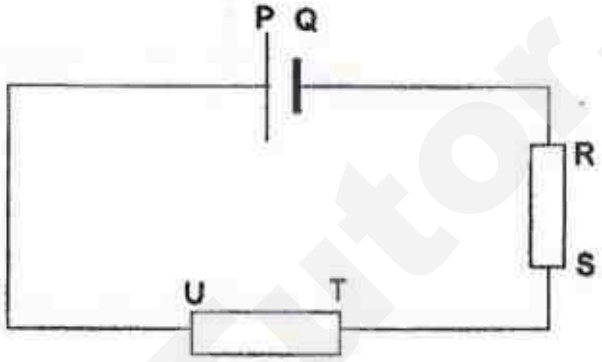
To connect the two bulbs together in parallel, which switch/es should be closed?

A	S_1	**B**	S_1, S_2
C	S_2	**D**	S_2, S_3

28. A piece of wire **X** that is made of a certain material has a resistance of 16 Ω. What is the resistance of another piece of wire **Y** of the same material with half the diameter and twice the length of wire **X**?

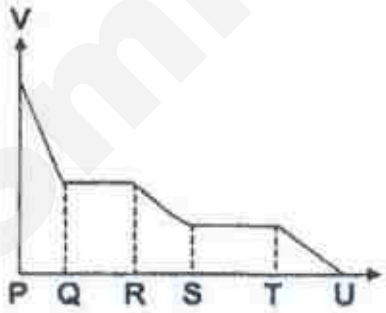
A	2.0 Ω	**B**	12 Ω
C	32 Ω	**D**	128 Ω

29. The diagram shows two resistors connected in series to a cell with wires of negligible resistance. The ends of the cell and resistors are marked **P**, **Q**, **R**, **S**, **T** and **U** correspondingly.

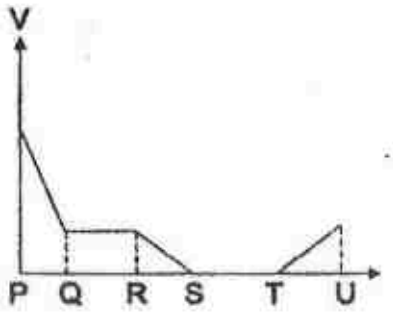


Which of the following graphs correctly shows how the potential, *V*, vary in the regions **PQRSTU**?

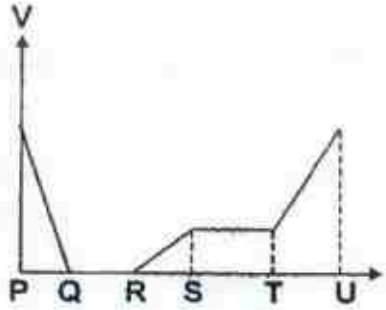
A



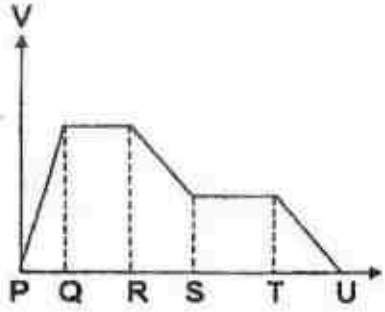
B



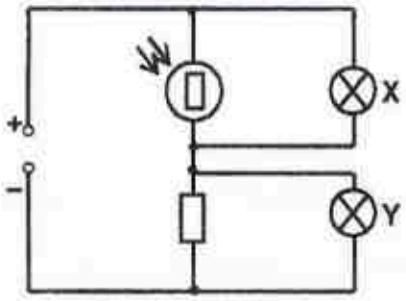
C



D



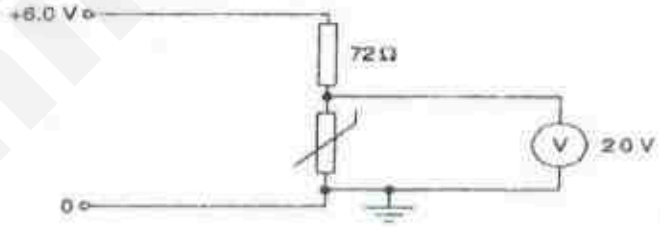
30. The diagram below shows an electrical circuit consisting of an **LDR**, a fixed resistor and two identical light bulbs connected to a power supply.



What will happen to the brightness of bulb **X** and **Y** when the light incident on the LDR decreases?

	Bulb X	Bulb Y
A	brighter	dimmer
B	brighter	brighter
C	dimmer	brighter
D	dimmer	same

31. A thermistor is connected in series with a 72 Ω resistor across a constant 6.0 V power supply. When the temperature of the thermistor is 30 °C, the potential difference across it is 2.0 V.



What is the resistance of the thermistor at 30 °C?

A	28 Ω	B	36 Ω
C	108 Ω	D	148 Ω

32. Four 200 W lamps and two 120 W fans are switched on for 8 hours.

What is the total cost if the energy consumption is 15 cents per kWh?

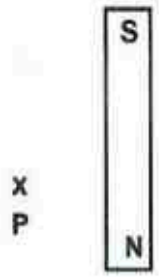
A	$ 0.15	B	$ 1.25
C	$ 3.84	D	$ 12.48

33. Two identical lamp each is labelled 230 V, 100 W are connected to a 230 V mains supply in series.

What is the current flowing through each lamp?

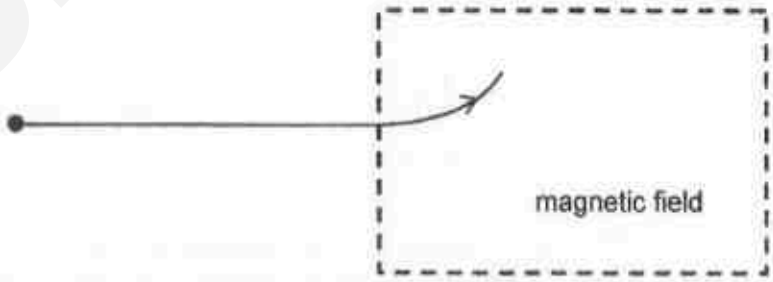
A	0.22 A	**B**	0.43 A
C	0.87 A	**D**	2.3 A

34. The diagram below shows a bar magnet.



Which of the following best represents the orientation of the compass at **P** if the magnetic field of the Earth is neglected?

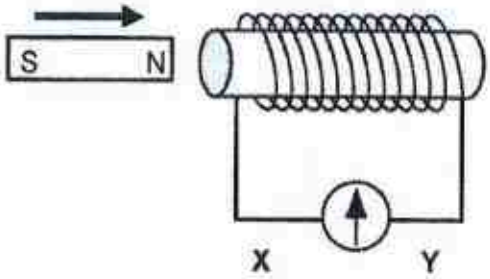
35. An electron enters a region with a magnetic field. It is deflected upwards as shown in the diagram below.



What is the direction of the magnetic field in the region?

A	into the plane of paper	**B**	out of the plane of paper
C	upwards	**D**	downwards

36. A small coil is connected to a galvanometer as shown below.

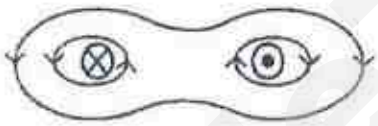


When the magnet is allowed to move towards the coil, the current flows

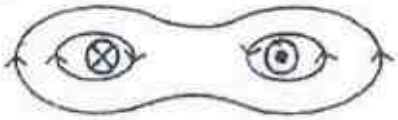
A	momentarily from X to Y	**B**	continuously from X to Y
C	momentarily from Y to X	**D**	continuously from Y to X

37. Each of the diagrams below is a cross-section through two parallel current-carrying conductors. Which diagram correctly shows the magnetic field pattern formed by the currents in the two conductors?

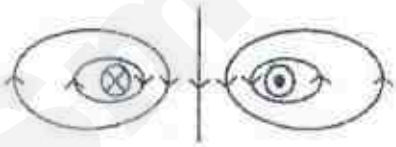
A



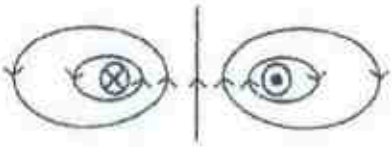
B



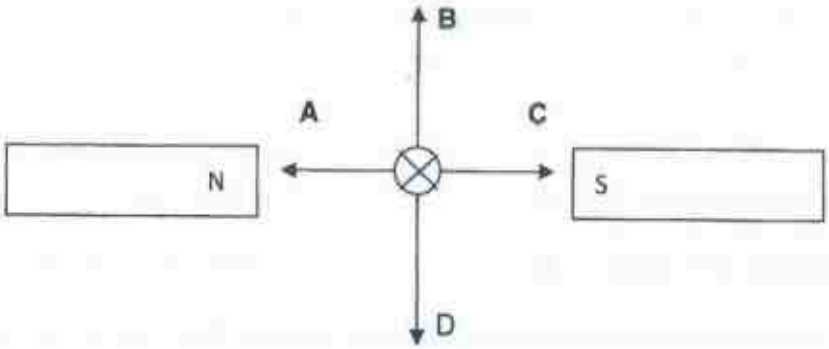
C



D



38. The diagram below shows an induced current flowing through a conductor while it is moving between two magnets. Which arrow indicates the direction of movement of the conductor?



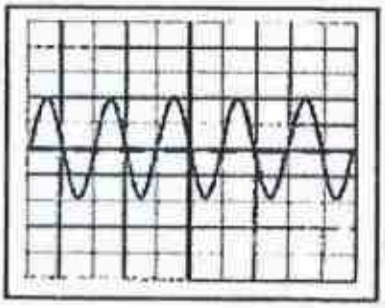
39. In the primary coil of a transformer, the current flowing through it is 2.5 A. The turn ratio of the transformer is 2.0 and the voltage in the secondary coil is given to be 100 V.
What is the power in the secondary coil if this is an ideal transformer?

A	50 W	**B**	125 W
C	250 W	**D**	500 W

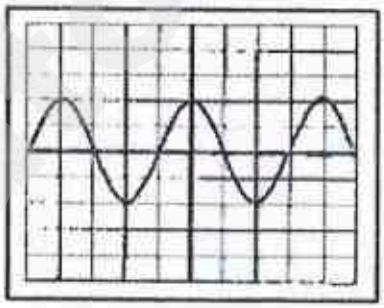
40. A cathode-ray oscilloscope (c.r.o.) is connected to a supply of amplitude 4.0 V and frequency 25 Hz. The time-base on the horizontal axis is set at 10 ms per division and the Y-gain on the vertical axis is set at 1.0 V per division.

Which of the following traces is obtained from the supply?

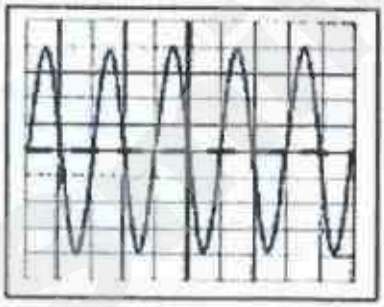
A



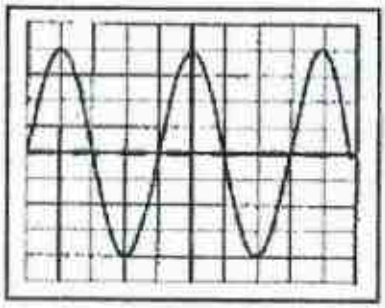
B



C



D



Answers to Sec 4 Prelim 2 2017 (NCHS)

MC Q								
	1.	C	11.	C	21.	A	31.	B
	2.	C	12.	C	22.	B	32.	B
	3.	D	13.	D	23.	C	33.	A
	4.	B	14.	A	24.	C	34.	C
	5.	D	15.	D	25.	D	35.	B
	6.	A	16.	C	26.	D	36.	A
	7.	D	17.	C	27.	B	37.	C
	8.	A	18.	B	28.	D	38.	B
	9.	A	19.	A	29	C	39.	B
	10.	D	20.	D	30.	A	40.	D

NCHS P2 17

Section A

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

1. Fig. 1.1 shows a light bulb of weight 15.0 N suspended at rest by two wires **X** and **Y** from the ceiling in a radio studio.

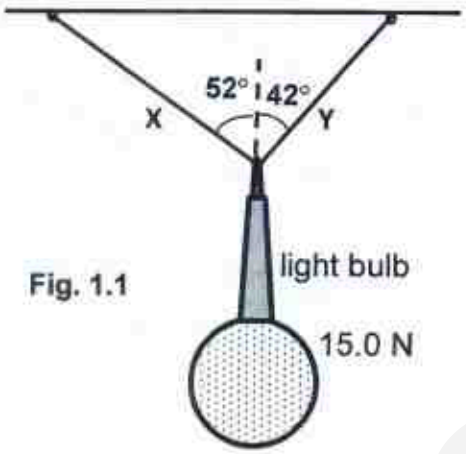


Fig. 1.1

Use an appropriate scale vector diagram to determine the magnitude of the tension of wire **X** and tension of wire **Y**. **[3]**

2. Fig. 2.1 shows an object of mass 500 g moving up a rough inclined plane. The object moves from **A** with an initial velocity of 9.00 m/s up the inclined plane to **B** and comes to a rest in 1.2 s. The horizontal distance between point **A** and **B** is 3.9 m.

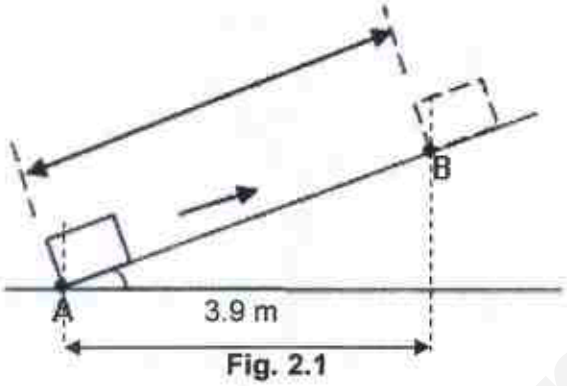


Fig. 2.1

(a) Calculate the distance **AB** along the inclined plane. **[1]**

(b) Calculate the

(i) gain in gravitational potential energy of object at **B**. **[2]**

(ii) loss in kinetic energy as it travels from **A** to **B**. **[1]**

(c) Suggest why the gain in gravitational potential energy is not equal in magnitude as the loss in kinetic energy of the object when moving the distance **AB**. **[1]**

_____

_____

_____

3. **(a)** Fig 3.1 shows a stone drop at a certain height freely from rest near the surface of Earth. (Neglecting air resistance)

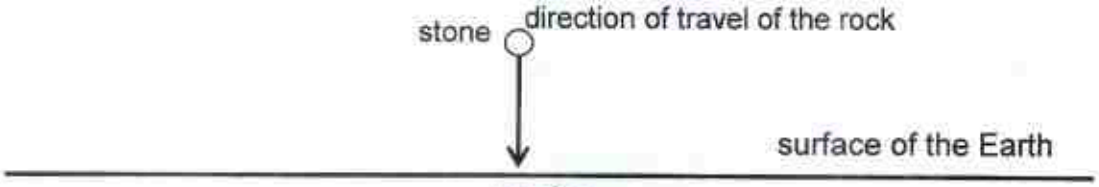


Fig. 3.1

On the axes given in Fig. 3.2, sketch the

(i) graph of the gravitational potential energy, label it as **P**, of the stone against time, t, just before it hits the ground. **[1]**

(ii) graph of the kinetic energy, label it as **K**, of the stone against time, t, just before it hits the ground. **[1]**

The graphs drawn should clearly show the relationship between them.
[no numerical value is required for the graphs]

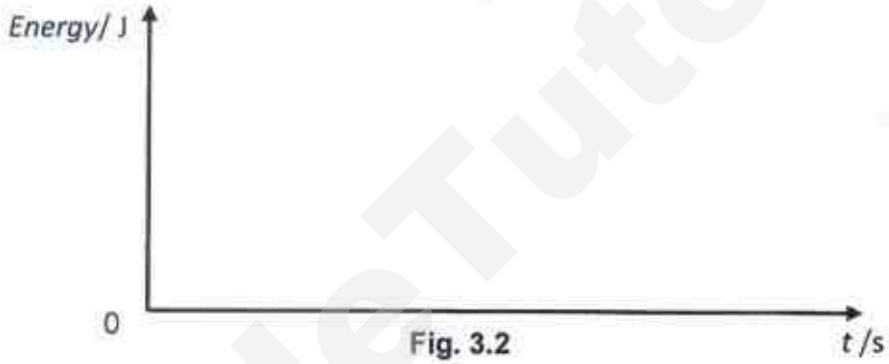


Fig. 3.2

(b) Fig. 3.3 shows a person hitting a billiard ball **X** on a smooth table. The billiard ball **X** will move straight and hit another ball **Y** at a velocity **v** m/s and come to a stop instantaneously while the ball **Y** will move forward at a certain velocity.

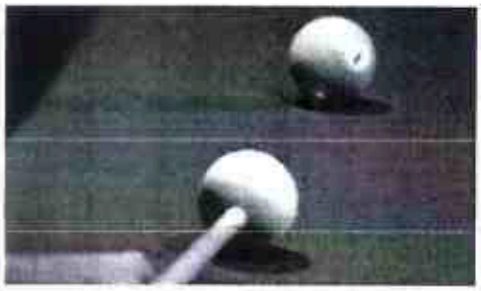


Fig. 3.3

Given that the mass of the ball **X** is larger than ball **Y**, state and explain if the velocity of ball **Y** be greater than, equal or less than **v** m/s. **[2]**

_____

_____

_____

4 (a) Fig. 4.1 shows a simplified form of the hydraulic press, also known as a force multiplier. The small piston has a cross-sectional area of 30.0 cm^2 and the large piston has a cross-sectional area of 0.15 m^2. An applied force, 4.0 N, is acting on the small piston to maintain the position of the load shown.

(Neglect the weight of the pistons and the hydrostatic pressure variation.)

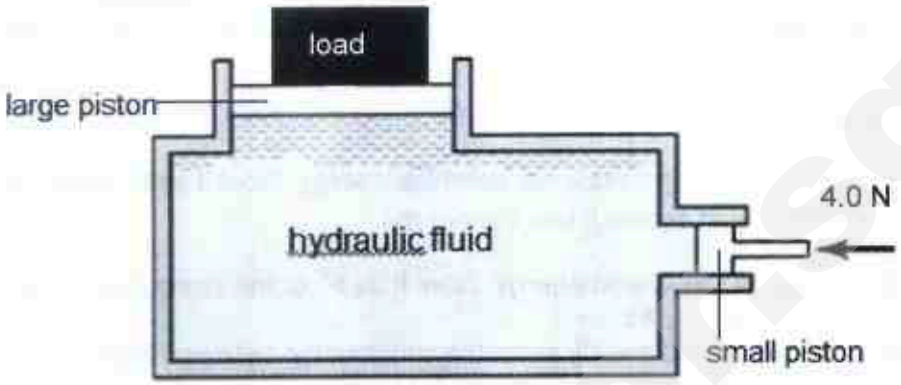


Fig. 4.1

(i) Calculate the weight of the load. **[2]**

(ii) State, if any, to the motion of the large piston is the cross-sectional area of large piston is increased while the weight is still as what is calculated in (i). **[1]**

_____

(iii) Suggest why the hydraulic press will not function well if the fluid is changed into air. **[1]**

_____

_____

(b) Fig 4.2 shows the landscape of a mountain. The reading of a mercury barometer at the foot of the mountain is 76.0 cmHg.

On point **P** of the mountain, its reading drops to 70.0 cmHg. The density of mercury is 13 600 kg/m^3 and the density of air is 1.23 kg/m^3.

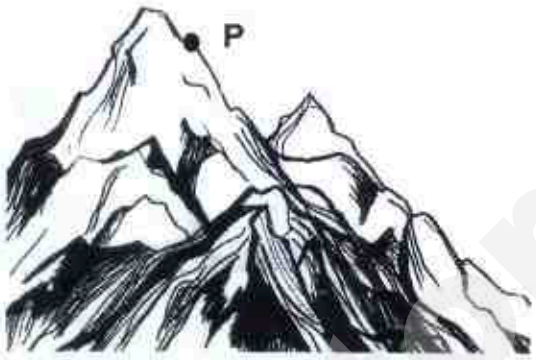


Fig. 4.2

(i) Calculate the height of the mountain. **[3]**

(ii) Water is heated up at point **P**. State and explain if the water is able to boil at 100 °C. **[2]**

_____

_____

_____

_____

5. A student used the set-up as shown in Fig. 5.1 to study the pressure ***P*** and volume **V** of a fixed mass of gas inside an elastic flask **A** at various thermodynamic temperatures ***T***.

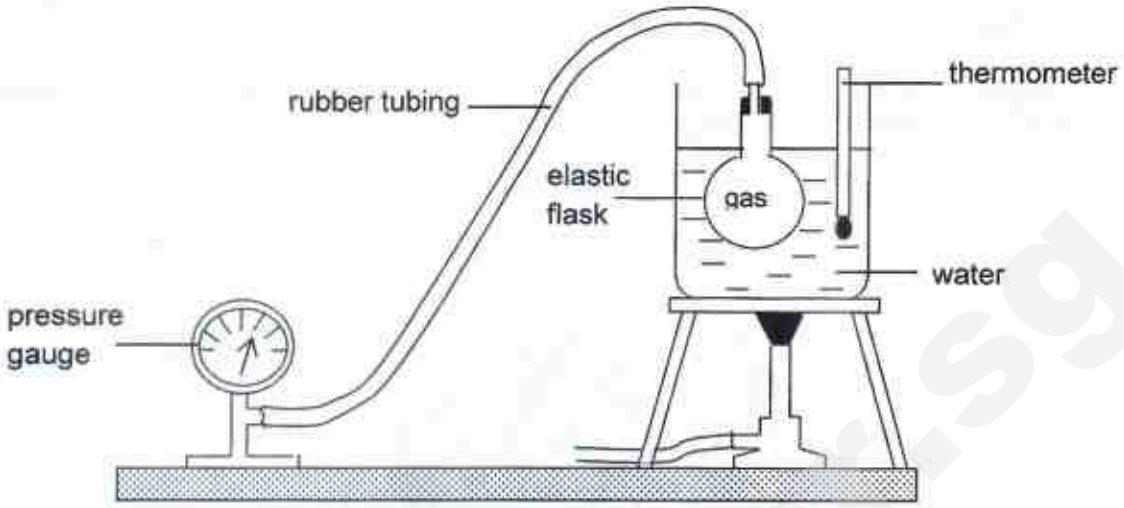


Fig. 5.1

The student's tabulated readings of ***P*** and ***T*** are shown in Fig. 5.2 below.

***T* / K**	293	323	337	371
***P* / kPa**	90	85	80	78
***V* / cm^3**	40	42	45	47

Fig. 5.2

(a) Explain why the relationship between the pressure and volume of the gas is inverse when the temperature of the gas increases. **[2]**

_____

_____

_____

(b) If the elastic flask is changed into a glass flask, state and explain, in terms of the kinetic theory of particles, what happens to the pressure of gas when the temperature of the gas increases. **[3]**

_____

_____

_____

_____

_____

6. Fig. 6.1 shows a transverse wave on a rope that travels from right to left at a frequency of 5.0 Hz. The instance shown is taken to be at time t = 0 s. Particles **A**, **B** and **C** are found on the rope as shown. The horizontal distance between particle **A** and **B** is 5.5 cm.

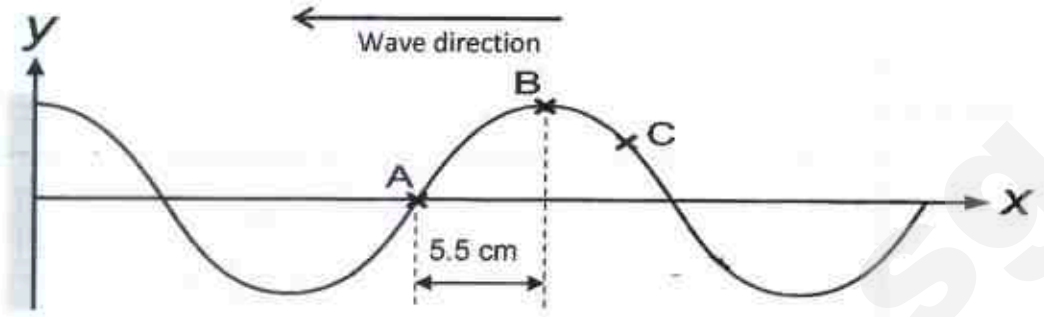


Fig. 6.1

(a) State what is a transverse wave. **[1]**

_____

_____

_____

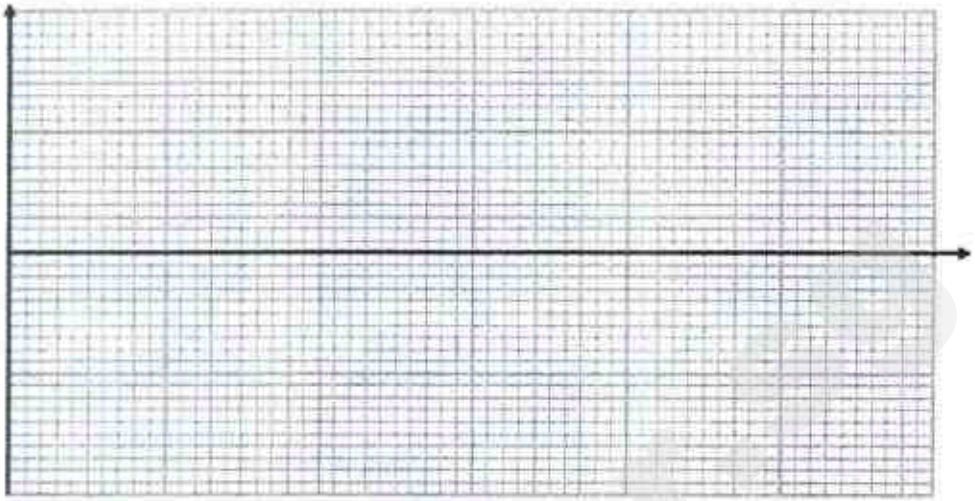
(b) In Fig. 6.1, indicate with arrow, to show the direction of the motion of the particle **C** at the next instant. **[1]**

(c) **(i)** Calculate the period of the wave. **[1]**

(ii) Calculate the speed of the wave. **[1]**

(d) Sketch on Fig. 6.2 the displacement against time graph of particle **A** for one complete oscillation. **[2]**

Fig. 6.2



7 A diamond, refractive index of 2.4, has an excellent cut where it has the shape shown at the sectional view in Fig. 7.1 with a certain percentage of the build to be the crown and pavilion. This cut allows light rays falling on the diamond to be reflected multiple times inside the diamond. A light ray is also shown emitting from the diamond at an angle 50° about the surface of the diamond.

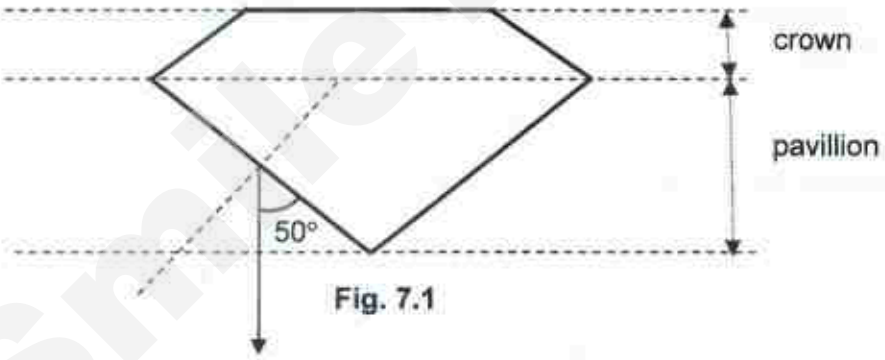


Fig. 7.1

(a) Suggest how does the cut of diamond allow light rays to be reflected multiple times. **[2]**

_____

_____

_____

_____

(b) **(i)** Calculate the critical angle of the diamond. **[2]**

(ii) Calculate the angle of incidence for the light ray that emits from the diamond shown in Fig. 7.1. **[2]**

8. Fig.8.1 shows a negative charged metal plate **X**, an uncharged metal plate **Y** and a connection to earth. Plate **X** and Plate **Y** are on insulating stands.

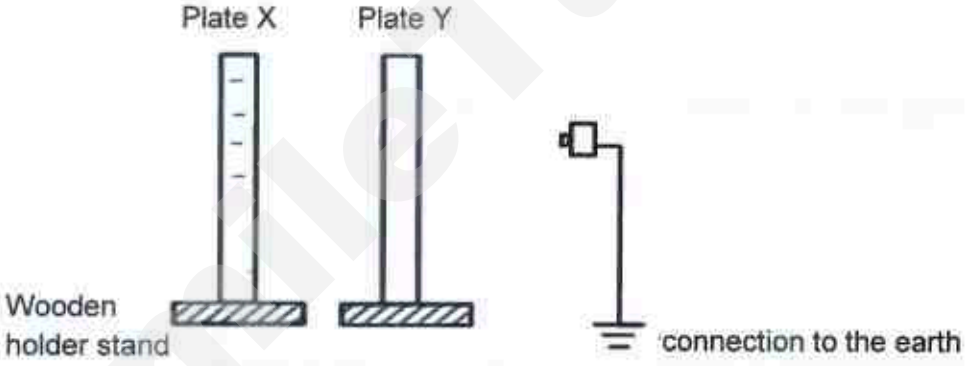


Fig. 8.1

(a) Define electrostatic induction. **[1]**

_____

_____

(b) With the aid of the items shown in Fig. 8.1, describe clearly the steps to attain a positive charged plate **Y**. **[3]**

_____

_____

_____

_____

(c) Suggest the need for the holder stand to be wooden. **[1]**

_____

_____

9. Fig. 9.1 shows a circuit with an e.m.f supply of 15.0 V. All the resistors in the circuit are identical with resistance of 10.0 Ω each.

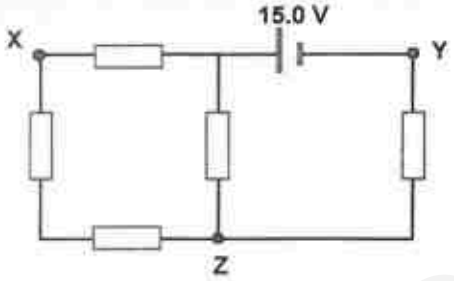


Fig. 9.1

(a) **(i)** Calculate the effective resistance of the whole circuit shown in Fig. 9.1. **[2]**

(ii) Calculate the current supplied by the battery. **[2]**

(iii) Determine the potential difference between point **X** and **Y**. **[2]**

(b) Determine the effective resistance of the whole circuit if a wire is used to connect point **X** and **Z**. **[1]**

Section B

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

Answer only one of the two alternative questions in **Question 12.**

10. Fig. 10.1 shows a space rocket being launch from a lunch pad at sea level. The space rocket has rocket boosters and main engines that helped the shutter to blast off from the Earth. It is said that a rocket must reach a breaking speed in order to escape from Earth. Fig. 10.2 shows information on the data about the launch. In the space after the rocket escapes, the rocket exhaust is propelling the rocket forward

Fig. 10.1

Altitude (height) of the rocket at the escape speed just before it hit the outer space (assuming uniform acceleration)	825 000 m
Mass of space shuttle	22 700 kg
Breaking speed	11 000 m/s

Fig. 10.2

(a) Assumptions:

1) the mass of the space rocket is the same throughout the launch.
2) uniform acceleration

(i) Determine the time taken for the rocket to reach breaking speed. **[2]**

(ii) Determine the vertical acceleration of the rocket. [2]

(iii) Calculate the upward thrust of the rocket. [2]

(b) "In the space after the rocket escapes, the rocket exhaust is propelling the rocket forward. " Explain, using the concept of forces, what this sentence means. [2]

(c) In reality, during launching, the space rocket will burn solid fuel that is inside the fuel compartment. Once the compartment is empty, the compartment will be detached from the main body. State how this affects the acceleration and the velocity of the rocket. [2]

11 Cappuchino is an Italian, coffee-based drink prepared with espresso (a type of coffee), steam milk and milk foam. To make steamed milk, hot steam is passed into the cold milk to heat up the milk. Fig. 11.1 shows a machine where hot steam is passed into the milk.

Fig. 11.1

Table 11.1 and 11.2 shows some of the specific heat capacities for different substances. You may assume that milk and water have the same specific heat capacity.

Substances	Specific heat capacity / J kg $^{-1}$ °C $^{-1}$
Glass	837
Ice	2090
Water	4200
Steam	2010

Table 11.1

Substance	Melting point / °C	Specific latent heat of fusion / J kg $^{-1}$	Boiling point / °C	Specific latent heat of vaporization /J kg $^{-1}$
Water	0.0	3.3×10^5	100	2.26×10^6

Table 11.2

(a) Define the term specific heat capacity of a substance. **[1]**

_____

_____

_____

(b) Suggest why the value of the specific latent heat of vaporisation is higher than the specific latent heat of fusion of water. **[1]**

_____

_____

_____

(c) 300 g of milk is poured into a 100 g of glass container. With the aid of the information from Table 11.1 and 11.2,

(i) calculate the thermal energy required to warm the 300 g of milk in a 100 g of glass container from 20 °C to 55 °C. **[2]**

(ii) if hot steam of initial temperature 120 °C is used to warm the 300 g of milk in a 100 g of glass container instead, calculate the minimum mass of steam required to heat the milk and the container from 20 °C to 55 °C. **[2]**

(d) A person suggested to use a 10.0 kW heating lamp to heat up a cup of milk as shown in Fig. 11.2. However, he found that this process of heating up 250 g of milk in the 150 g of glass container from 20 °C to 40 °C is only 5.0 % efficient.

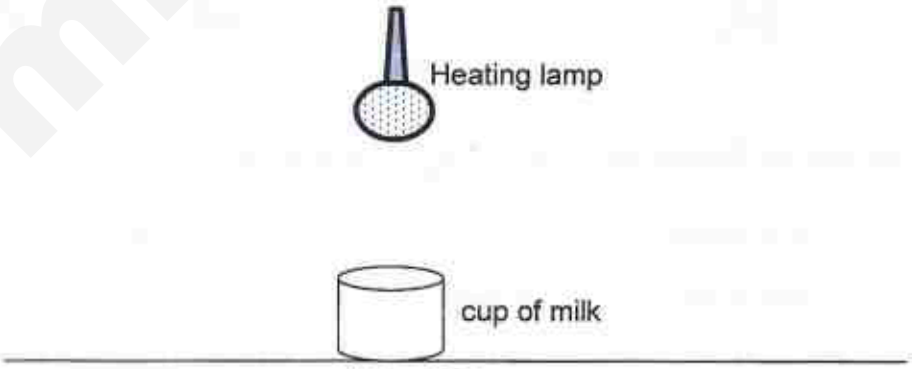


Fig. 11.2

(i) State the main mode of thermal transfer from the heating lamp to the cup of milk. **[1]**

_____

(ii) Suggest a reason for the low efficiency. [1]

_____

_____

_____

(iii) Calculate the time required to warm the milk in (d) using the heating lamp. [2]

12. EITHER

A student builds a motor which consists of a coil **ABCD**, two metal rings and two magnets. The two ends of the coil are soldered to the two metal rings as shown in Fig. 12.1.

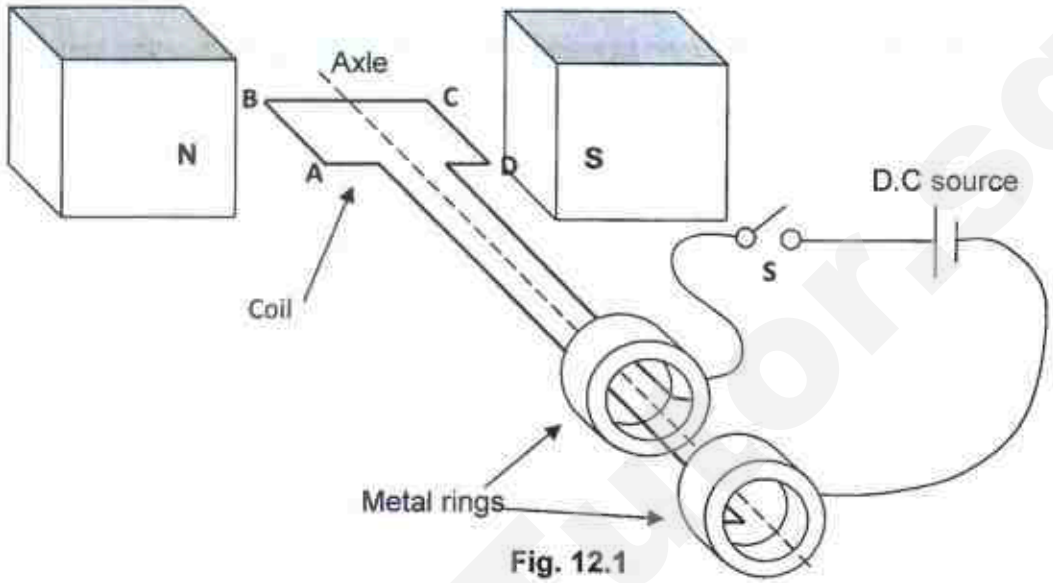


Fig. 12.1

(a) **(i)** Fig. 12. 1 shows the front view of the design of the motor. On Fig.12.1, draw the direction of the force acting on wire parts **AB** and **CD** when switch **S** is closed. **[1]**

Fig. 12.2

(ii) Hence, state the direction in which the motor turns when switch **S** is closed. **[1]**

_____

(iii) It is observed that due to momentum, the coil moves to the position as shown in Fig. 12.3. On Fig. 12.3, draw the direction of the force acting on wire parts **AB** and **CD**. **[1]**

Fig. 12.3

(iv) There is a fault with the design of this motor set up by the student. Explain what is wrong with the set up. [1]

(v) State a solution and explain briefly how it can help to rectify the motor's design. [2]

(b) Fig. 12.4 shows two towers that support a single cable of total length 20.0 km, which links a factory to the electrical grid. The voltage at the tower A is at 6000 V while the voltage at the factory is at 5500 V.

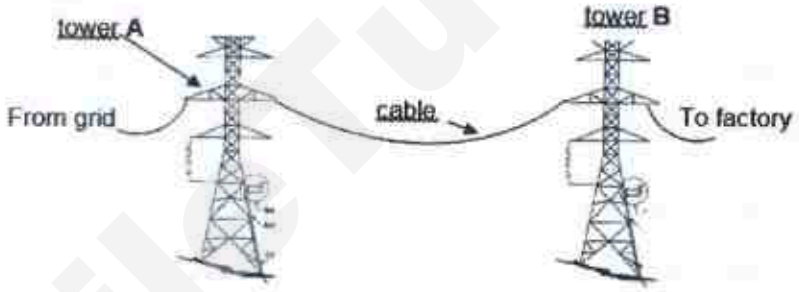


Fig. 12.4

The cable used is made from aluminium which has a resistance of 3.6 Ω per 1.0 km.
Calculate the

(i) power loss in the cable. [2]

(ii) cost of the power loss for a day given that 1 kWh costs $0.15. [2]

OR

(a) Fig. 12.5 shows an experimental set-up where a copper ring is fitted loosely over an iron core that has been placed inside a solenoid that is connected to a D.C supply.

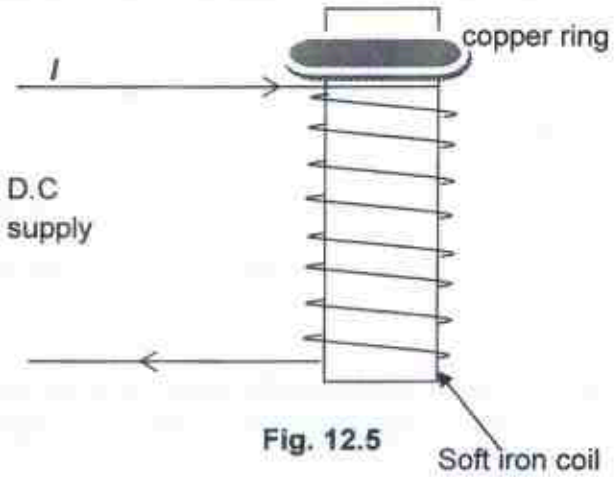


Fig. 12.5

Fig. 12.6

(i) At the instant when the switch is closed, state what happen to the ring. **[1]**

_____

(ii) Explain the observation stated in (a)(i). **[3]**

_____

_____

_____

_____

_____

_____

(iii) State what will happen to the copper ring at the instant when the switch is closed if the current flows in the opposite direction in the coil. **[1]**

_____

(iv) State what will happen if the solid copper ring is now replaced with a slit copper ring as shown in Fig.12.6 at the instant the switch is closed. **[1]**

_____

(b) Fig 12.7 shows an ideal transformer connected to an a.c. input voltage of 240 V. The transformer has 2000 turns in Primary coil and 100 turns in Secondary coil. A current of 8.0 A flows in the secondary coil.

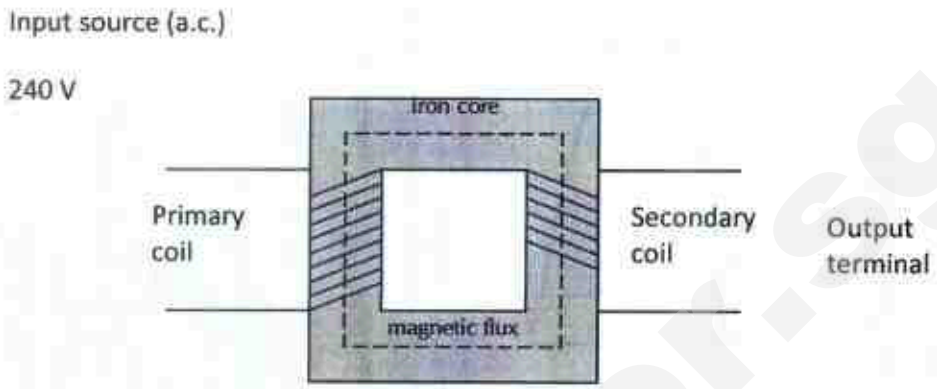


Fig. 12.7

(i) State what is meant by an ideal transformer. **[1]**

_____

_____

(ii) Calculate the output voltage and input current. **[2]**

(iii) It is recommended to have laminated iron sheets instead of iron core. Suggest a reason why is this so. **[1]**

_____

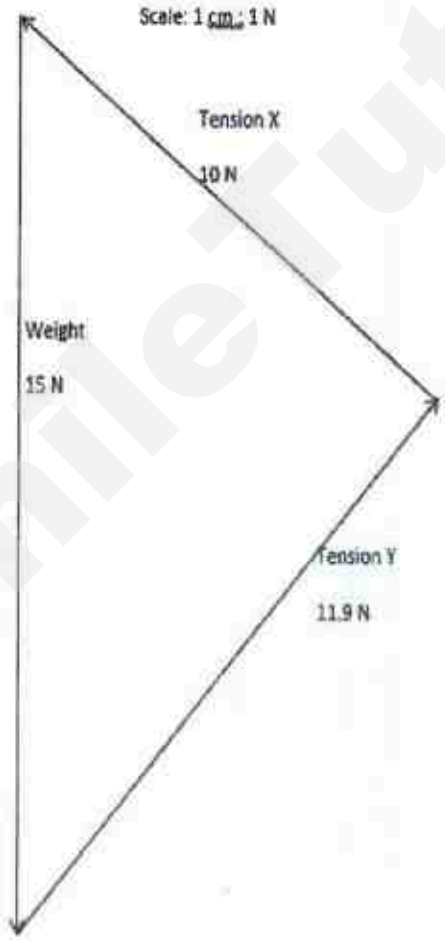
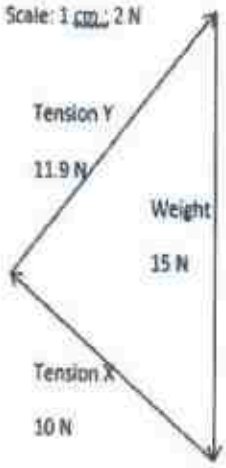
_____

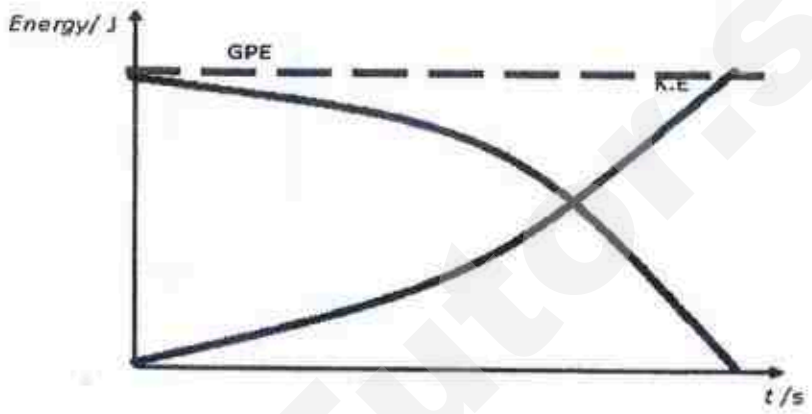
_____

END OF PAPER

Answers to Sec 4 Prelim 2 2017 (NCHS)

MCQ								
	1.	C	11.	C	21.	A	31.	B
	2.	C	12.	C	22.	B	32.	B
	3.	D	13.	D	23.	C	33.	A
	4.	B	14.	A	24.	C	34.	C
	5.	D	15.	D	25.	D	35.	B
	6.	A	16.	C	26.	D	36.	A
	7.	D	17.	C	27.	B	37.	C
	8.	A	18.	B	28.	D	38.	B
	9.	A	19.	A	29	C	39.	B
	10.	D	20.	D	30.	A	40.	D

1.	(a)	 Marking scheme All arrows in closed loop (no resultant vectors), B1 Tension X = 10.0 N Tension Y = 11.9 N Correct tension within +/- 0.5 N Deduct 1 m for odd scale eg 1 cm: 3 N or 1 cm: 1.5 N 	
2	(a)	Distance AB along the inclined plane = 0.5 x 9.0 x 1.2 = 5.4m	B1

	(b)(i)	5.4^2 = vertical distance – 3.9^2 Vertical distance = 3.735 m Gain in G.P.E = 0.5 x 10 x 3.735 =18.67 J =18.7 J	M1 A1
	(ii)	Loss in K.E = 0.5 x 0.5 x $(9.0)^2$ = 20.25 J = 20.3 J	A1
	(c)	Loss in K.E is the sum of the gain in GPE and work done against friction	A1
3	(a)		Shape 1 Inverse proportional 1
.	(b)	Velocity of ball Y is higher. Conservation of energy, T.E changed in X is equal to T.E changed in Y. Given no change in GPE, change in K.E of X is equal to change in K.E of Y. $\frac{1}{2} m_x v^2 = \frac{1}{2} m_y v$ Since a larger m_x than m_y, v will be greater than v Wrong concept RESULTANT FORCE = m X a a higher, v higher.	[1] [1]
4	(a)(i)	**Pressure** = $\frac{force}{area}$ $F_{on\ load} = F_{applied} \times (A_{applied} / A_{on\ load})$ $F_{on\ load}$ = 4.0 x (0.15 x [30 / 10 000] = 200 N	M1 A1
	(ii)	It will move upwards. Answers not accepted • It move lesser / move more • Motion that direction is not stated	B1
	(iii)	Air can be compressed and the pressure exerted at a piston will not be transmitted to the other piston. or Additional work done against compressing the air. Wrong concept Force exerted will not be accepted. The correct concept is the	A1

		pressure is consistently transmitted through throughout a incompressible fluid.	
	(b)(i)	76-70 = 6.0 cm Hg Pressure difference in Pa = 0.06 x 10 x 13600 = 8160Pa 8160 = 1.23 x 10 x h Height = 663.4 m = 663 m (3sf)	C1 C1 A1
	(ii)	No. Atmospheric pressure is lower than at sea level and at lower atmospheric pressure boiling point will be lower. Alternatively, students can explain that latent heat is lesser as there is lesser atmospheric pressure acting on the surface of the liquid.	B1 B1
5.	(a)	As the temperature increases, **the pressure will increase**. However, as the **flask is able to expand,** the volume **of the flask will increase**, thus allow the drop in the pressure,	B1 B1
	(b)	As the temperature of the gas increases, **the average speed of the molecules will increase**, there will **be an increase in the force exerted per unit area** of the surface of the flask, as **P = F / A,** the pressure per unit area will increase.	B1 B1 B1
6	(a)	A transverse wave oscillates perpendicular to the direction of wave travel .OR It is a wave in which particles in the medium travel perpendicular to the direction of wave motion.	M1
	(b)	Down	A1
	(c)(i)	F = 1 / T 5.0 = 1 / T , T = 0.20 s	 A1
	(c)(ii)	V= 5.0 x 0.22 = 1.1 m s^{-1} or 110 cm/s	A1
	(c) (ii)	Sine wave starting from origin position. Period 0.20 s for one complete oscillation.	B1 B1
7	(a)	The cut allows **the angle of incidence in the diamond to be greater than the critical angle** thus allowing the light to experience **total internal reflection** multiple times.	B1 B1
	(b)(i)	Sin c = 1 / 2.4 C = 24.6 °	

	(ii)	sin i / sin r = 1/2.4 sin i / 40 = 1/2.4 Angle of incidence = 15.5 °	M1 A1
8	(a)	**Electrostatic Induction is a process of causing charges to move in conductors without contact between the conductor and the charging body.**	B1
	(b)	1) Place plate X close to plate Y. 2) connect the contact of the wire that link to Earth to plate Y 3) remove the connect of the contact of the wire from plate Y. 4) move plate X away from Y	B1 B1 B1
	(c)	Stand needs to be wooden so that charges will not flow away or to the plate	B1
9	(a) (i)	Effective resistance = $(1/30 + 1/10)^{-1} + 10$ = 17.5 Ω	M1 A1
	(ii)	V = R I 15.0 = 17.5 x I I = 0.85714 = 0.857 A	 M1 A1
	(iii)	Potential method Potential at Z = $\frac{10.0}{17.5} \times 15.0 = 8.5714\ V$ Potential across XY= $\frac{2}{3} \times (15.0 - 8.5714) + 8.5714 = 12.857$ = 12.9 V (note that potential at Y = 0 V) Current divider method $I_{30\Omega} = \frac{10.0}{40.0} \times 0.85714 = 0.21429 = 0.214\ A$ V = R I P.D across first 10 Ω resistor, between the cell and X = 10.0 X 0.21429 = 2.1429V Potential at X is 15.0 - 2.1429 = 12.857 V = 12.9 V. As potential at Y is 0 V, hence potential difference between X and Y = 12.9 - 0.0 = 12.9 V	M1 A1
	(b)	Effective resistance = $(1/10 + 1/10)^{-1} + 10$ = 15.0 Ω	A1

Section B (30 marks)

Qn.	Answer	Remarks
10 (a)(i)	>Distance under v-t = 0.5 x 11000 x t 825 000 = 0.5 x 11000 x t >t = 150 s or s=[(u+v)/2]t 825 000 =[(0 + 11 000)/2]t	M1 A1

	t= 150 s or Fd=KE + GPE = ½mv^2 + mgh F=[0.5 x 22 700 x 11 000 x 11 000 + 22 700 x 10 x 825 000] / 825 000 F =15.60625 x 10^{11}/ 825 000 = 1 891 666.667 a = F/m = 1 891 666.667 / 22 700 = 83.333 t = (v – u) / a = (11 000 – 0) / 83.33 = 132 s	
(ii)	a = (v-u) / t = (11 000 – 0) / 150 = 73.3 m/s	M1 A1 (allow ecf)
(iii)	Resultant force = m a Upward thrust – W = ma Upward thrust = W + mA = (22 700 x10) + (22700 x 73.3) = 1890910 N = 1.89 x 10^6 N	M1 A1 (allow ecf)
(b)	>The rocket is exerting a force on the rocket exhaust in a backward direction. From Newton's third law, the exhaust gases is exerting a force on the rocket in the forward direction. >In space with no resistive force, the force of exhaust gases on the rocket is the net force which causes acceleration in the forward direction in accordance to Newton's second law. Note: No marks are given when using N1L to explain as it is not answering the question.	B1 B1
(c)	Assuming the breakup of the fuel compartment is in space which has no air resistance and the main engine thrust remains constant, the total mass of the rocket decreases and from N2L, F=ma, the acceleration will increases and consequently its velocity as a=(v-u)/t OR Assuming the breakup of the fuel compartment is in space which has no air resistance and there is no more fuel in the rocket, the engine thrust becomes zero and from N2L, acceleration becomes zero and the velocity of the rocket remains constant. OR Assuming the breakup of the fuel compartment is in the atmosphere which has air resistance. When there is no more fuel in the rocker, the engine thrust becomes zero and from N2L, acceleration and velocity decreases due to the net opposing force of its weight and air resistance.	B1 B1
11(a)	Specific heat capacity is the amount of thermal energy required to raise the temperature of 1K per unit mass of an object.	B1
(b)	Specific latent heat of vaporisation is higher than the specific latent heat of fusion of water because for water to change state to gas, it requires more energy per unit mass **as the distance between each molecule is much further from water to gas than from solid to water.**	B1
I(i)	Thermal energy gained = mc Δ θ (milk) + mc Δ θ (glass) = Δ θ [mc (milk) + mc (glass)] = 35 [(0.3)(4200) + 0.1 x837] = 47029.5 J = 47.0 kJ	M1 A1
(ii)	mc Δ θ (Steam 120 °C to 100 °C)+ m lv + mc Δ θ (water 100 °C to 55 °C) = T.E gained by the milk and glass m (2010 x 20 + 2.26 x 10^6 + 4200 x 45) = 47029.5 J mass of steam = 0.0189 kg	M1 A1

	= 18.9 g	
(d) (i)	Thermal radiation.	B1
(ii)	Thermal energy from the heating lamp will be transferred to the surrounding air as well hence it explains the low efficiency of this method.	B1
(iii)	E = P x t 5% efficiency 0.05 x(P x t)= mc Δ θ (milk) + mc Δ θ (glass) 0.05 x 10 000 x t = 0.25 x 4200 x 20 + 0.15 x 837 x 20 t = 47 s	 M1 A1
Either		
12 (a) (i)	Use ruler to draw arrow to indicate AB up and CD down	B1
(ii)	Clockwise direction	B1
(iii)	Use ruler to draw arrow to indicate AB up and CD down	B1
(iv)	The rectangular coil will only swing in a clockwise manner and turn anticlockwise after passing through the vertical position. It will oscillate about the vertical position. (not the question is about the fault and not what should be done)	B1
(v)	The ends of coil **ABCD** should be connected to a **split ring commutator. Each half of the** commutator presses against a **carbon brush in good contact.** The **commutator reverses the direction of the current in the coil every half a revolution whenever the split ring changes contact from one carbon brush to the other brush.**	B1 B1
(b) (i)	Resistance of the wire = 1000 x 3.6 = 3600 Ω Power loss = p.d. ^{2} / R =500^2/ 3600 =69.4 W Note that the power loss is related to the drop in potential across the length of wire. In other words, the difference in potential between the 2 points.	 M1 A1
(ii)	$\frac{69.4}{1000} \times 0.15 \times 24$ = $ 0.249 = $ 0.25	M1 A1
OR		
(i)	The copper ring will jump upwards	B1
(ii)	At the instant when the switch is closed, current starts to flow through the solenoid, causing a magnetic field to be build up in the solenoid forming a North pole adjacent to the copper ring. During the building up of magnetism in the solenoid, an increase in the rate of change of magnetic flux linkage occurs thus inducing an electromotive force (e.m.f.) in the copper ring according to Faraday's law. According to Lenz's Law, as the copper ring has a closed loop, an induced current will flow to form a North pole in the lower half of the copper ring to oppose the change in magnetic flux in it. Thus the copper ring is repelled and moves upwards. Note that copper is not a magnetic object but a good electrical conductor.	B1 B1 B1
(iii)	The copper ring will still do the same as (i) (note that this time a South pole is formed at the lower half o the copper ring to oppose the South pole formed in the solenoid nearer to the copper ring)	B1
(iv)	It will not move from this position or there is no change from its rest position.	B1

	(as it is impossible to have an induced current flowing across the broken ring to form a magnetic pole)	
(b) (i)	In an ideal transformer, there will be no power loss between the primary and the secondary coil	B1
(ii).	2000 / 100 = 240 / output voltage Output voltage = 12 V 8.0 x 12 V = 240 x I I = 0.40 A	A1 A1
(iii)	To reduce formation of eddy currents so that there will be minimum power lose due to eddy current.... (note: there is no way to <u>prevent</u> formation of eddy currents in the soft iron core)	B1

1 The diameter and the length of a thin wire, approximately 1m in length, are measured as accurately as possible. What are the best instruments to use?

	Diameter	Length
A	Micrometer	Metre Rule
B	Micrometer	Vernier Caliper
C	Metre Rule	Measuring Tape
D	Vernier Caliper	Metre Rule

2 Which list contains only scalar quantities?

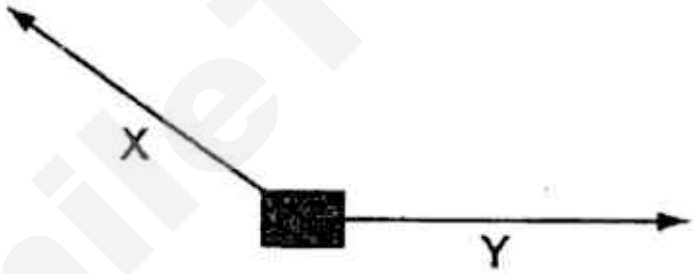
A acceleration, displacement, velocity

B acceleration, work, power

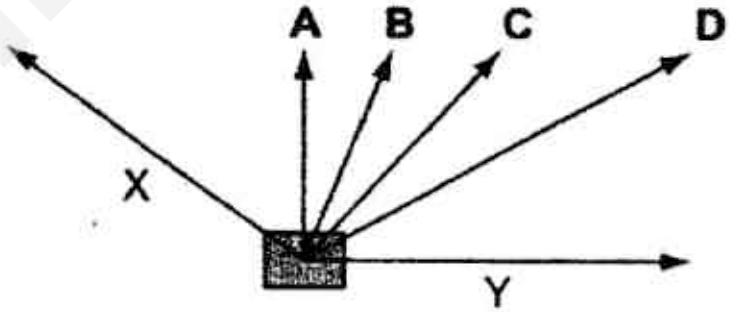
C pressure, force, time

D pressure, energy, distance

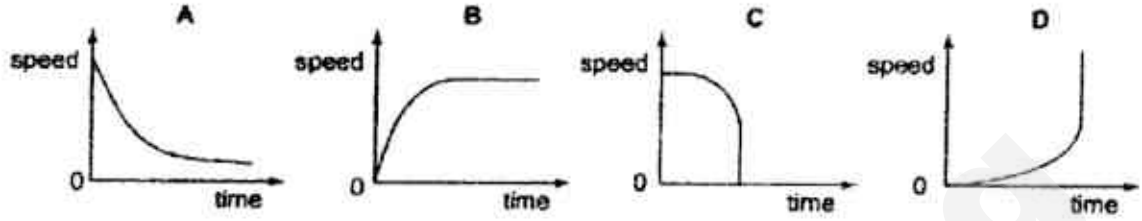
3 Forces X and Y act on a block in the directions shown on the scale diagram.



In which direction is the resultant force acting?



4 Which graph represents the motion of an athlete accelerating to a point when his force forward is equal to the total resistive force acting against him?



5 A car is travelling at constant speed along a road and drives over a large patch of oil. The driver applies the brakes to stop the car.

Compared to braking on a dry road, what may happen?

A The car takes longer to slow down because the thinking distance of the driver is greater.
B The car takes longer to slow down because of the reduced friction between the tyres and the road.
C The car speeds up at first because of the reduced friction between the tyres and the road.
D The car slows down more quickly because of the greater friction between the tyres and the road.

6 A ferry stops to pick up 200 more passengers from a port. Which of the following best describe the ferry's ability to change its state of motion or rest after it picks up more passengers?

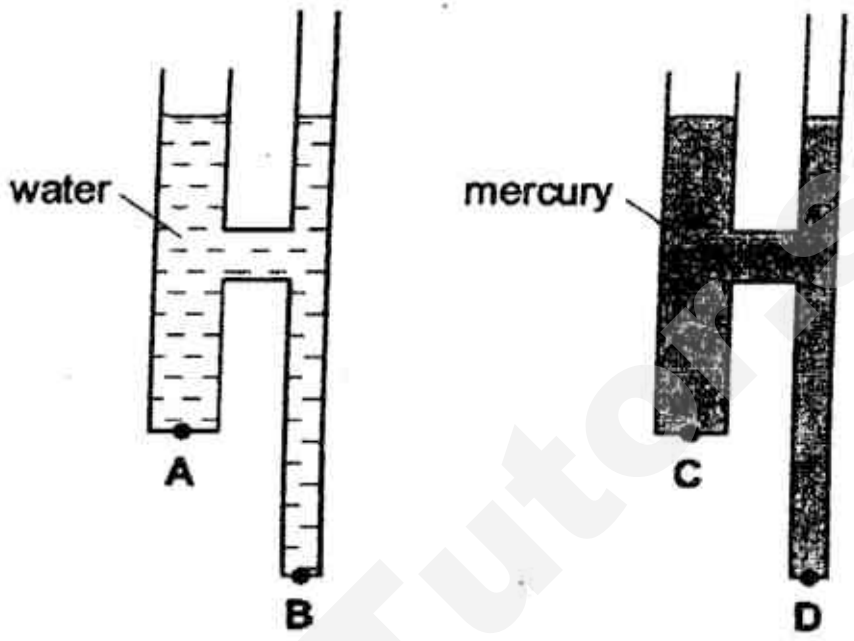
	Start moving	Stop moving
A	easier	easier
B	easier	harder
C	harder	easier
D	harder	harder

7 The weight of a cylinder on Venus is less than its weight on the Earth.

How do the gravitational field strength and the mass of the cylinder on Venus compare with their values on the Earth?

	Gravitational field strength	Mass of cylinder
A	zero	zero
B	less	the same
C	the same	less
D	less	less

8 The diagram shows two identical pieces of apparatus. One is filled with water and the other is filled with mercury. Water is less dense than mercury. At which point is the liquid pressure lowest?



9 A car accelerates up a slope. Which of the following describes how the gravitational potential and kinetic energies change?

	Gravitational Potential Energy	Kinetic Energy
A	increases	decreases
B	increases	increases
C	decreases	unchanged
D	unchanged	increases

10 A rock climber of weight 700 N climbs up a hill of vertical height 270 m along a slope of 400 m in 3600 s. What is the average power she generates during this time?

A 130 W B 77.8 W C 52.5 W D 40.0 W

11 Some gas is trapped in a closed container. The gas is cooled and the volume of the container is kept constant. What happens to the gas molecules?

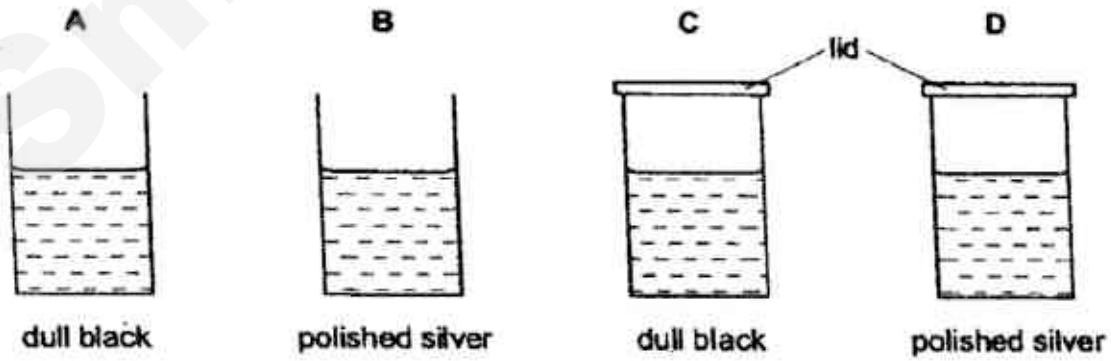
	Frequency of collision with wall of container	Speed of molecules	Pressure of gas
A	unchanged	decreases	unchanged
B	increases	increases	increases
C	unchanged	increases	unchanged
D	decreases	decreases	decreases

12 According to the kinetic theory, matter is made up of very small particles in a constant state of motion.

Which row best describes the particle behaviour in the liquid state?

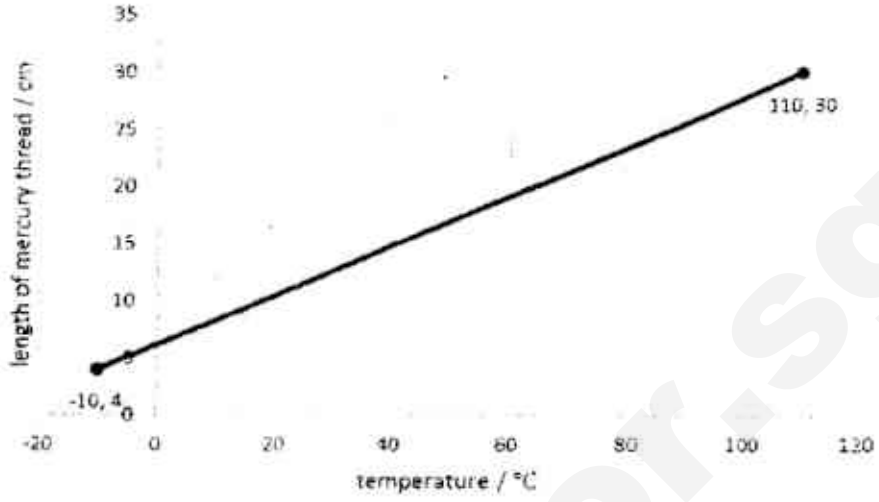
	Forces between particles	Motion
A	weak	move randomly at high speed
B	weak	vibrate but are free to move position
C	strong	vibrate to and fro around a fixed position
D	strong	move randomly at high speed

13 The diagrams show four identical cans with their outside surfaces painted either dull black or polished silver. Each can contains the same volume of water, initially at 90 °C. After five minutes in a cool room, which can contains the warmest water?



14 A liquid-in-glass thermometer is newly calibrated using fixed points of -10 °C and 110 °C. Their respective lengths of mercury thread are 4 cm and 30 cm. The graph below shows

their plot.

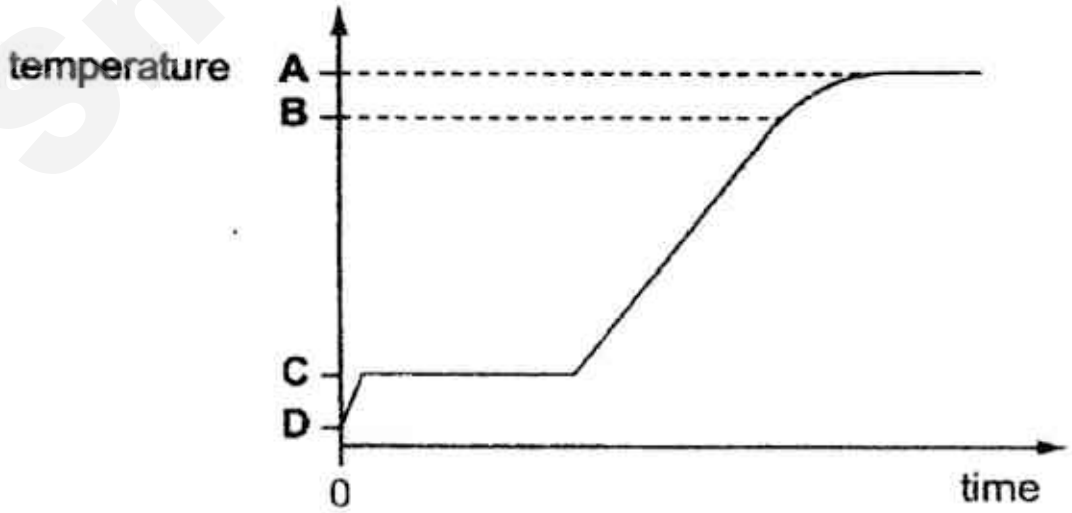


Determine the length of the mercury thread when the thermometer is dipped into a liquid of 40 °C.

A 10.8 cm **B** 12.6 cm **C** 15.0 cm **D** 17.5 cm

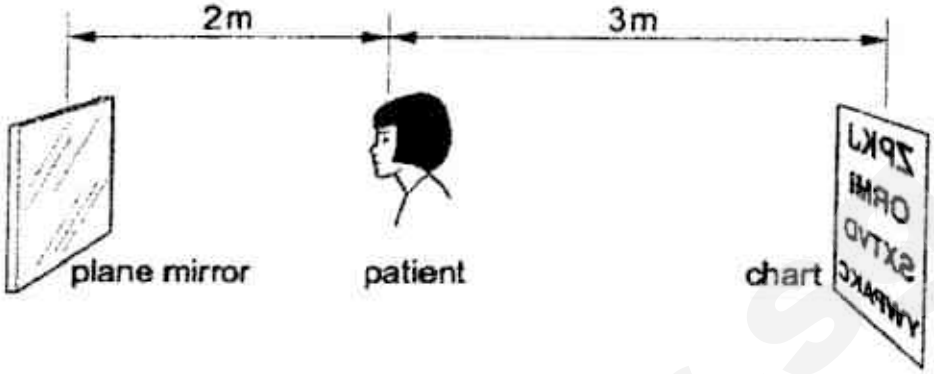
15 Some ice cubes are taken from deep-freeze and placed in a metal container. The container is heated at a constant rate and readings of temperature and time are taken. The results are recorded on a graph.

Which temperature corresponds to freezing point of ice?



16 The diagram shows a patient having her eyes tested. A chart with letters on it is placed

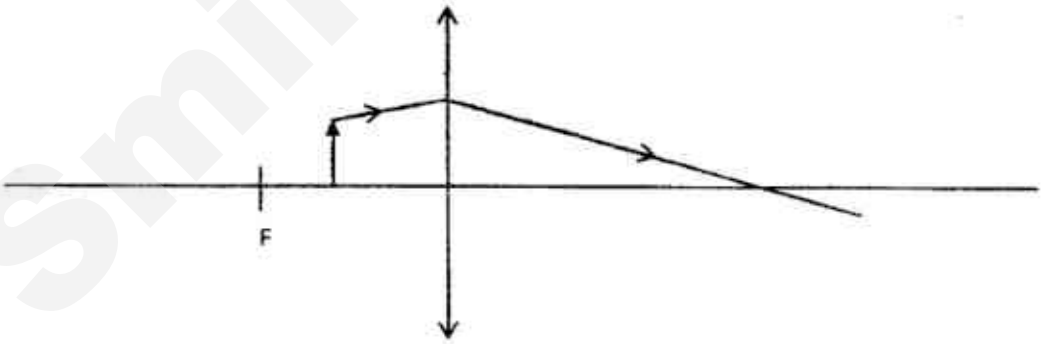
behind her and she sees the chart reflected in a plane mirror.



If the mirror is moved 1 m towards the patient, how far would the image of the chart has moved with respect to the patient?

	Distance moved by image	Direction of movement
A	7 cm	away from patient
B	5 cm	towards patient
C	5 cm	away from patient
D	2 cm	towards patient

17 An incomplete ray diagram shows light rays from an object passing through a convex lens.



If F is the focal point of the lens, which of the following is correct about the image formed?

	Characteristics of image	Position of image
A	real	on the left of F
B	real	on the right of F
C	virtual	exactly on F
D	Virtual	on the left of F

18 Which application uses microwaves?

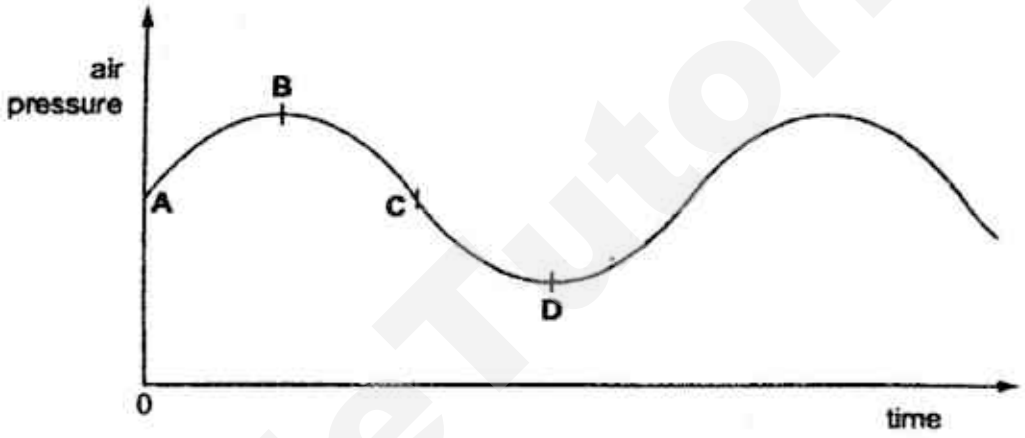
A mobile phones

B burglar alarm system

C remote control

D radio

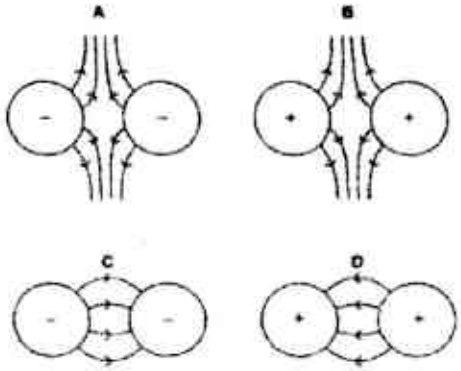
19 The graph shows how the pressure varies as a sound wave passes through air. Which point represents a rarefaction?



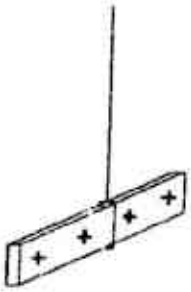
20 A camper is woken up in the middle of the night by a thunderstorm. A flash of lightning at his West lights up his tent. He hears the first thunderclap 5.0 s later and its echo from a distant mountain on his East another 8.0 s later. The speed of sound is 340 m/s. How far away from the tent is the mountain?

A 1360 m B 1700 m C 2380 m D 3060 m

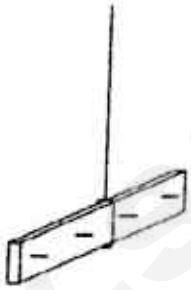
21 Which diagram correctly shows the electric field between two charged spheres?



22 The diagram shows a positively charged acetate strip and a negatively charged polythene strip that are freely suspended.



acetate strip



polythene strip

Two rods X and Y are brought up in turn to these two strips. Rod X repels the acetate strip but attracts the polythene strip. Rod Y does not repel either the acetate strip or the polythene strip.

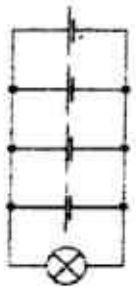
Which type of charge is on each rod?

	Rod X	Rod Y
A	no charge	no charge
B	no charge	opposite charge as acetate and polythene strips
C	same charge as acetate strip	opposite charge as polythene strip
D	same charge as acetate strip	no charge

23 A lamp is rated at 10 V, 600 mW. What is the current in the lamp?

A 17 mA B 60 mA C 1.7 A D 60 A

24 A lamp designed to work at 1.5 V is connected in series to a dry cell of 1.5 V. The lamp lights at normal brightness. The lamp is now connected in parallel to 4 identical dry cells.



What effect does connecting the dry cells in this manner on the lamp?

A Lamp will become brighter.

B Lamp will blow.

C Lamp will produce light for a longer period of time.

D Lamp will produce light for a shorter period of time.

25 Which of the following would cost the **most** if operated from the same voltage supply?

A A 100 W lamp used for 2 hours

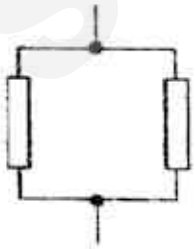
B A 500 W electric iron used for 1 hour

C A 1000 W electric fire used for 10 minutes

D A 5000 W electric cooker used for 1 minute

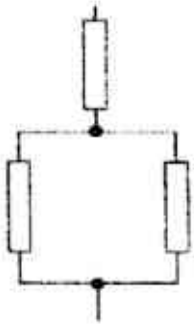
26 Which combination of identical resistors gives the **highest** total resistance?

A

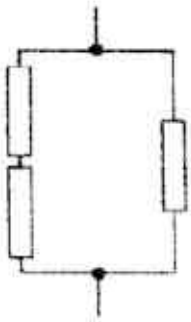


B

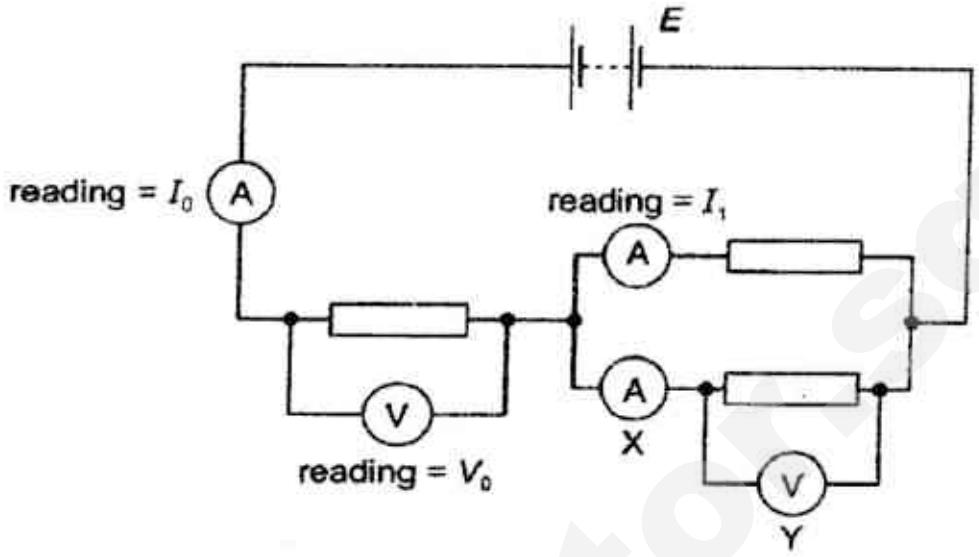
C



D



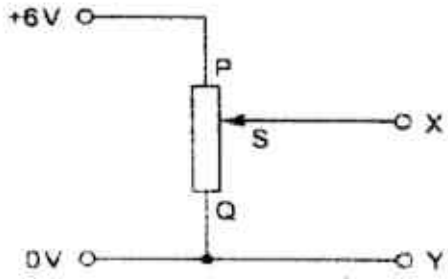
27 A battery of e.m.f. E is connected in a circuit as shown in the diagram below.



Which readings will ammeter X and voltmeter Y show?

	Reading of ammeter X	Reading of voltmeter Y
A	$I_0 + I_1$	$E - V_0$
B	$I_0 + I_1$	$\frac{E - V_0}{2}$
C	$I_0 - I_1$	$E - V_0$
D	$I_0 - I_1$	$\frac{E - V_0}{2}$

28 A variable potential divider has a sliding contact S that can be moved between P and Q.



What happens to the potential difference between X and Y as S moves from Q to P?

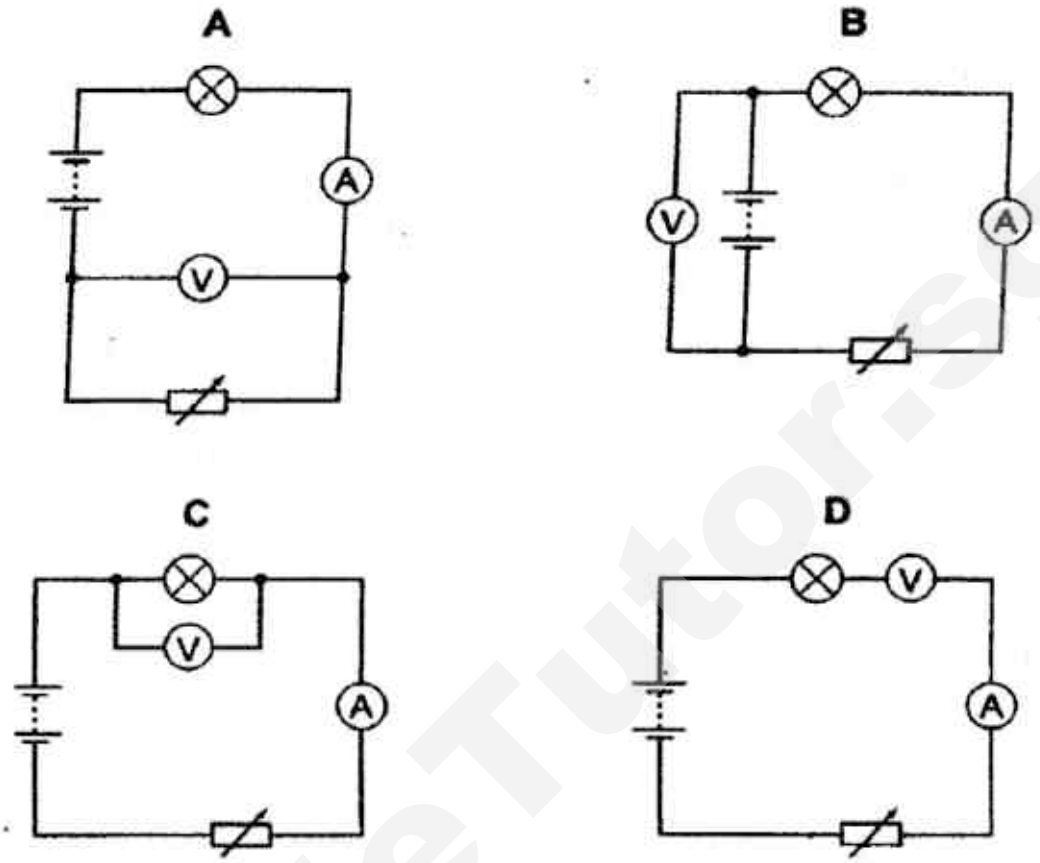
A It stays constant at 6.0 V.

B It stays constant at 0 V.

C It increases from 0 to 6 V.

D It decreases from 6 to 0 V.

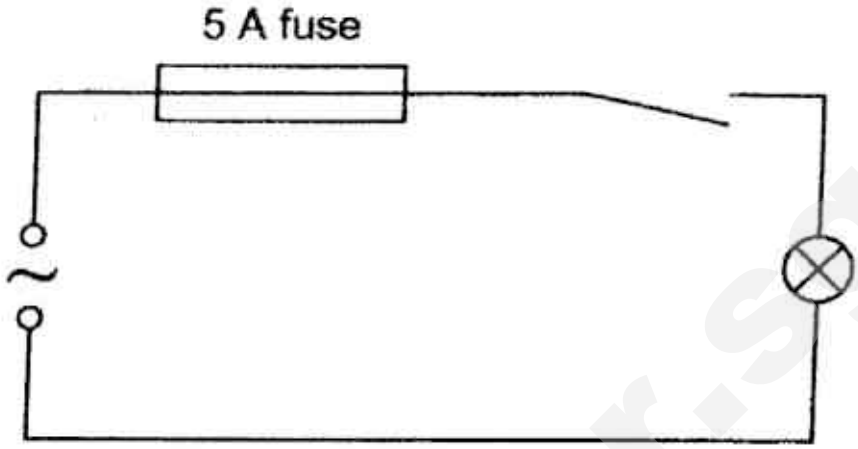
29 Which circuit should be used to show that the lamp does not obey Ohm's Law?



30 The heating element of an electric kettle with a resistance of 38.4 Ω is connected to a 240 V power supply. Calculate the amount of thermal energy produced in 1 minute. You can assume that the resistance of the heating element remains constant as temperature increases.

A 0.375 kJ B 1.5 kJ C 37.5 kJ D 90 kJ

31 A student makes the circuit shown.



The lamp blows but not the 5 A fuse. What could have caused this?

A The fuse rating is too high for the lamp.

B The fuse rating is too low for the lamp.

C Alternating current is used to power the lamp.

D The lamp is not earthed.

32 Which of the following about the live and neutral wires in a plug is correct?

A The live wire has a potential of 240 V while neutral wire is 0 V. A person touching the neutral wire will get an electric shock.

B The live wire has a potential of 240 V while neutral wire is 0 V. A person touching the neutral wire will not get an electric shock.

C The live wire has a potential of 0 V while neutral wire is 240 V. A person touching the neutral wire will not get an electric shock.

D The live and the neutral wire have the same potential of 240 V. A person touching any of the wire will get an electric shock.

33 An electromagnet is used to separate magnetic metals from non-magnetic metals. Why is steel unsuitable as the core of the electromagnet?

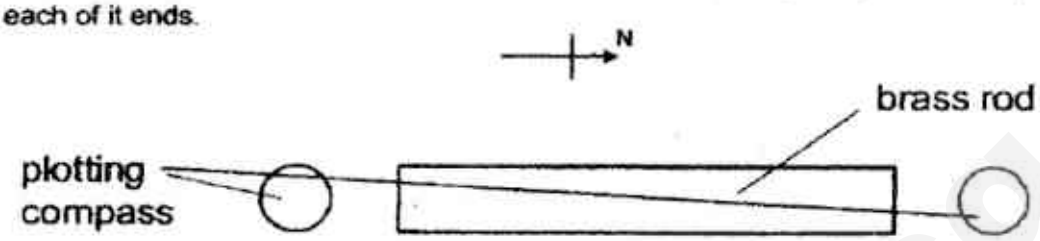
A It has high heat capacity.

B It has a high density.

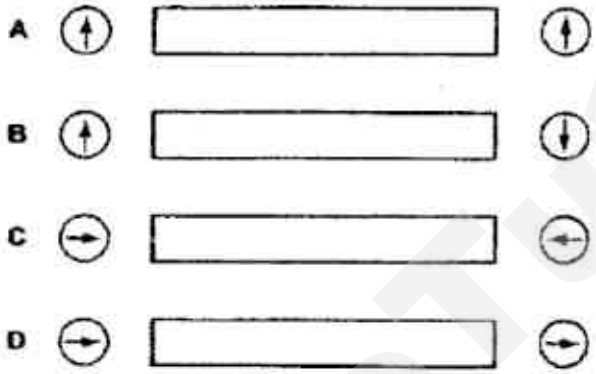
C It becomes a permanent magnet.

D It is a good conductor of electricity.

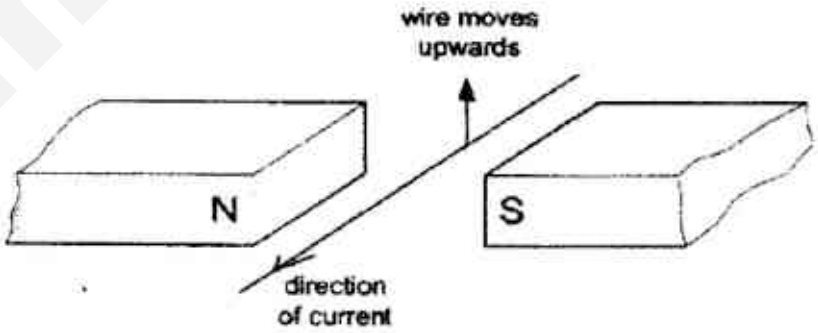
34 A brass rod is arranged in a north-south direction and plotting compasses are placed at each of it ends.



Which diagram shows the positions of the needles of the plotting compasses?



35 An experiment is carried out to investigate the effect of a magnetic field on a current-carrying conductor.



What can be done to make the wire move downwards?

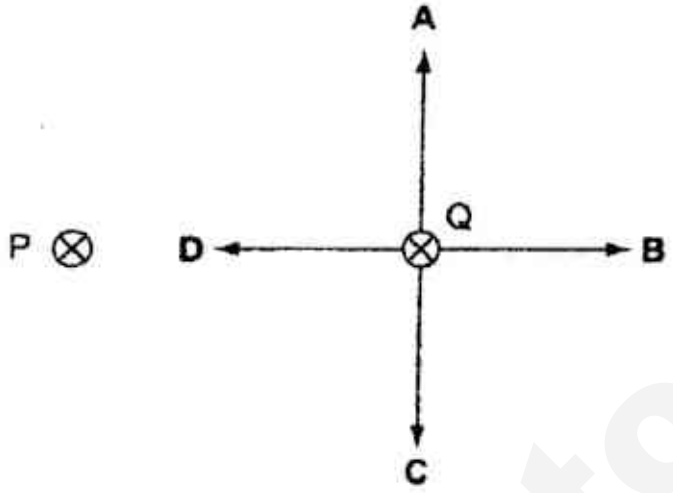
A use a stronger magnet

B increase the current flowing in the conductor

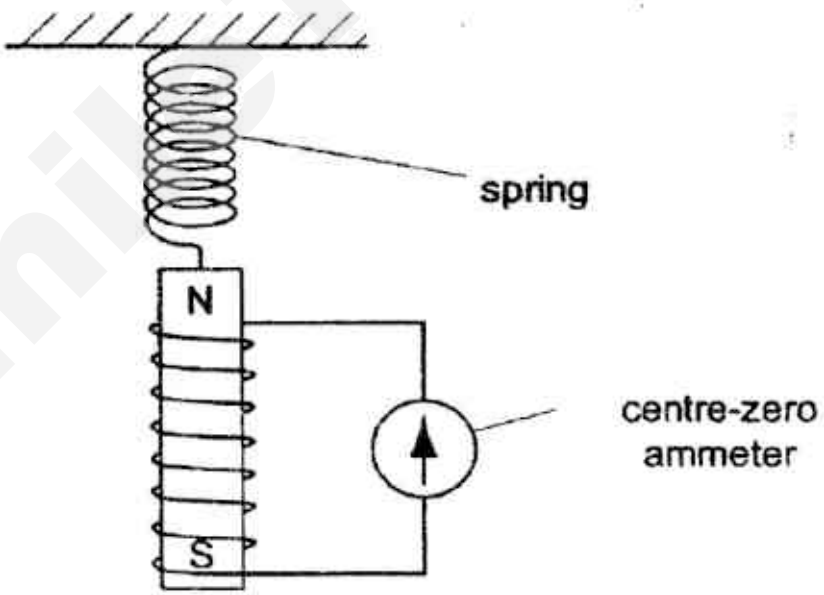
C move the magnets closer to the conductor

D reverse the polarities of the two magnets

36 P and Q represents two parallel, straight, wires carrying currents. P and Q exert force on each other. Which arrow shows the force on Q?



37 A magnet is suspended from a spring so that it can move freely inside a coil which is connected to a sensitive centre-zero ammeter.



What does the ammeter show when the magnet vibrates slowly up and down?

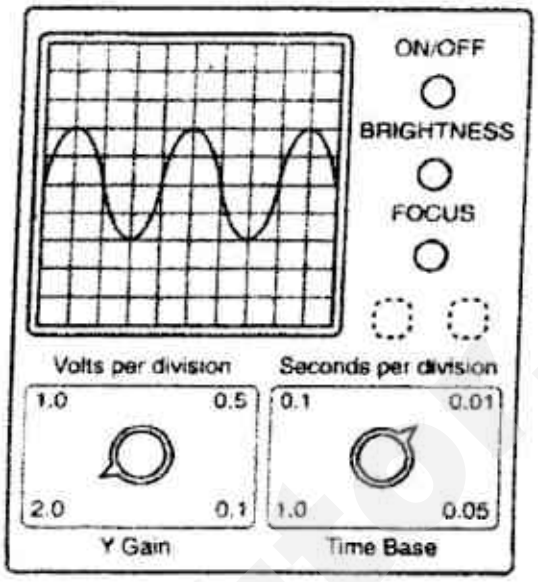
A Constant 0 reading.

B A steady reading to the right.

C A steady reading to the left.

D A reading changing from left to right and then right to left.

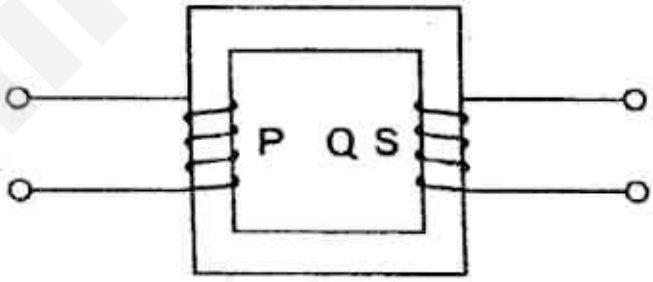
38 The diagram below shows a cathode-ray oscilloscope with the y-gain set to 2.0 V/division and time-base 0.01 s/division.



What is the period of the wave?

A 0.04 s **B** 0.08 s **C** 4.0 s **D** 8.0 s

39 The diagram represents a transformer.



Which arrangement could be used to make the output voltage **lower** than the input voltage?

	Number of turns in P	Number of turns in Q	Type of Input
A	50	100	d.c. at P
B	50	100	a.c. at Q
C	100	50	d.c. at P
D	100	50	a.c. at Q

40 Electric power cables transmit electrical energy over large distances using high-voltage, alternating current.

What the advantages for using a high-voltage and an alternating current?

	Advantage of using high-voltage	Advantage of using alternating current
A	lesser energy is lost through heat	voltages can be changed using a transformer
B	lesser energy is lost through heat	resistance of the cable is reduced
C	high current is produced in the cable	voltages can be changed using a transformer
D	high current is produced in the cable	resistance of the cable is reduced

1) A
2) D
3) B
4) B
5) B
6) D
7) B
8) A
9) B
10) C
11) D
12) D
13) D
14) C
15) C
16) D
17) D
18) A
19) D
20) A
21) B
22) D
23) B
24) C
25) B
26) B
27) C
28) C
29) C
30) D
31) A
32) B
33) C
34) D
35) D
36) D
37) D
38) A
39) B
40) A

Multiple Choice Questions [40 marks]
Answer **all** questions and shade your answers on the OMR sheet provided.

1 Fig. 1.1 shows the zero error of a pair of vernier calipers and Fig. 1.2 shows the measurement of the diameter of a copper rod.

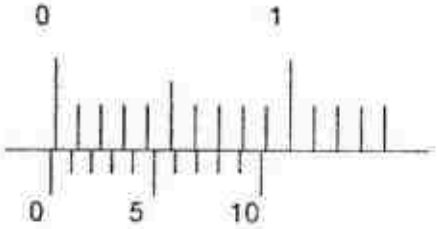


Fig. 1.1

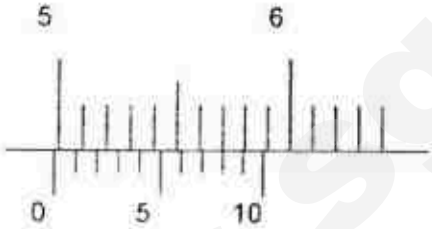


Fig. 1.2

Which of the following sets of data is correct?

	zero error / cm	observed reading / cm	actual diameter / cm
A	-0.02	4.98	4.96
B	-0.02	4.98	5.00
C	+0.08	5.58	5.50
D	-0.08	5.08	5.16

2 Which of the following represents the shortest length?

A 1.5×10^{12} nm B 1.5×10^{6} μm C 1.5×10^{-6} km D 1.5×10^{-10} Gm

3 A ticker tape timer is used to investigate the speed of a remote control car. The ticker tape timer is set to frequency of 10 Hz and a portion of the tape obtained is as shown in Fig. 3.1.

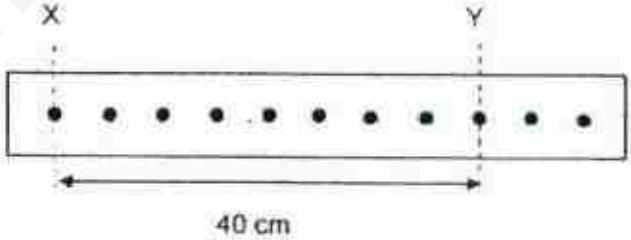


Fig. 3.1

Which of the following statements are correct?

(i) The average speed is 50 cm/s.
(ii) The car moves at a constant speed.
(iii) The car has a uniform acceleration.

A (i) and (ii) only
B (ii) and (iii) only
C (i) and (iii) only
D (i), (ii) and (iii)

4 Fig. 4.1 describes the motion of three cars.

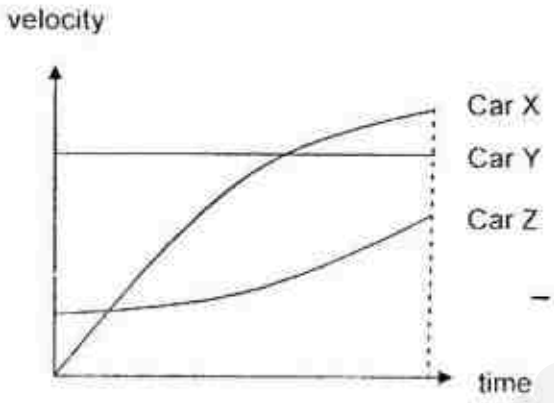


Fig. 4.1

Which of the following sets is correct?

	greatest average velocity	increasing acceleration
A	X	Z
B	X	Y
C	Y	Z
D	Z	X

5 A man applied a force, F, to pull a box across the floor at a constant speed. If the man now uses twice the amount of the force to pull the box across the same floor, the box will move

A at the same constant speed.
B at a higher constant speed.
C with a uniform acceleration.
D with an increasing acceleration.

6 An object weighing W is hung from ceiling by a light string. A horizontal constant force F is applied to the object as shown in Fig. 6.1. If T is the tension in the string, which of the following diagrams shows the three forces T, W and F in equilibrium?

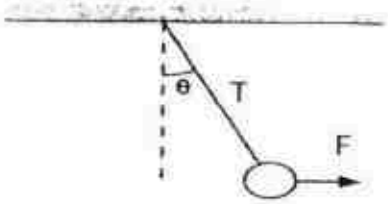
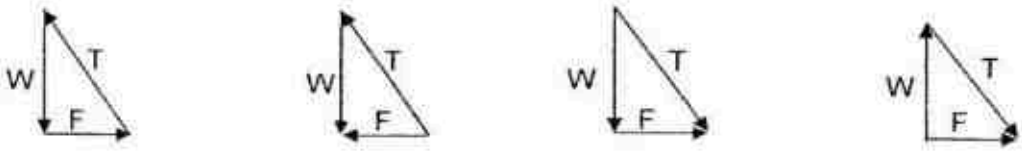


Fig. 6.1



A B C D

7 The weight of an inflated balloon is 200 N. The balloon rises at a constant speed of 2.0 m/s. What is the resultant force acting on the balloon while it is rising?

A 0 N B 100 N C 200 N D 400 N

8 A big cube is formed by 27 identical small cubes. The small cubes are made of the same material and the density of each cube is 2.0 g/cm^3. Fig. 8.1 shows a new arrangement when one small cube is removed from the big cube.

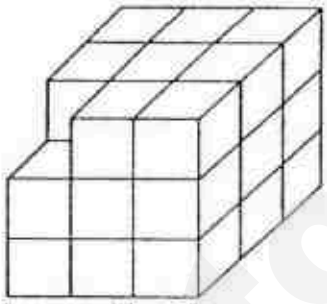


Fig. 8.1

What will be the change(s) to its density and inertia as compared to the original big cube (if any)?

	density of the new arrangement	inertia of the new arrangement
A	remains unchanged	decreases
B	increases	remains unchanged
C	remains unchanged	remains unchanged
D	decreases	decreases

9 Three identical hollow pipes X, Y and Z have one or two identical weights attached to their inner surfaces as shown in Fig. 9.1.

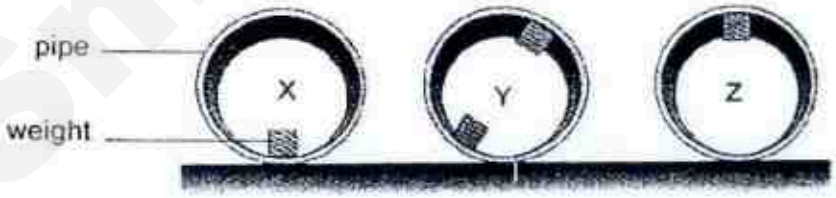


Fig. 9.1

Which of the following sets best describes the state of equilibrium of each pipe?

	X	Y	Z
A	neutral	unstable	stable
B	unstable	neutral	stable
C	neutral	stable	unstable
D	stable	neutral	unstable

10 Fig. 10.1 shows four identical heavy bells balancing on light strings and horizontal bars of negligible mass.

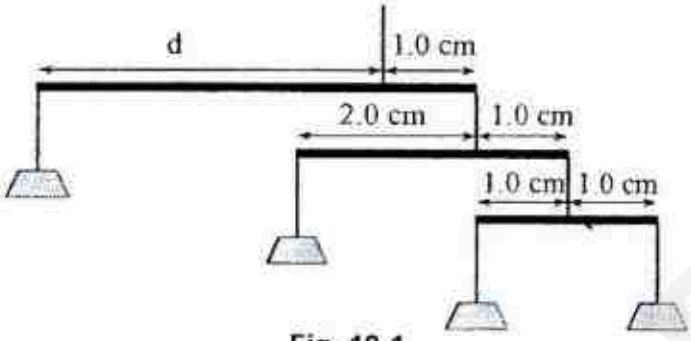


Fig. 10.1

What is the length d?

A 3.0 cm **B** 4.0 cm **C** 5.0 cm **D** 6.0 cm

11 Fig. 11.1 shows a simple hydraulic jack. Which of the following alterations will enable heavier loads to be lifted?

Fig. 11.1

(i) decrease the cross-sectional area of piston W
(ii) increase the cross-sectional area of piston Z
(iii) use a denser hydraulic fluid

A (i) and (ii) only
B (ii) and (iii) only
C (i) and (iii) only
D (i), (ii) and (iii)

12 Fig. 12.1 shows a U-tube containing oil and water. The density of water is 1.0 g/cm^3.

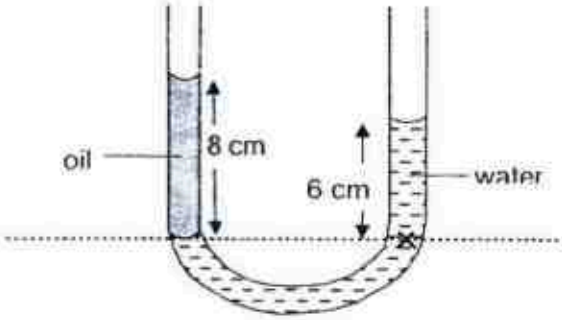


Fig. 12.1

What is the density of the oil?

A 0.25 g/cm^3 **B** 0.50 g/cm^3 **C** 0.75 g/cm^3 **D** 0.90 g/cm^3

13 A 2.0 kg box moves at a constant speed of 7.2 km/h. What is the kinetic energy of the box?

A 1.0 J B 2.0 J C 4.0 J D 8.0 J

14 The power of an electric motor is 20 W. How long does it take to lift a 2.0 kg box through a height of 5.0 m? The gravitational field strength g is 10 N/kg.

A 5.0 s B 10 s C 15 s D 20 s

15 The Brownian motion of fine pollen grains suspended in water occurs because of the

A convection currents in the water.
B constant random motion of the pollen grains.
C water molecules colliding with each other.
D water molecules colliding with the pollen grains.

16 Fig. 16.1 shows bubbles of gas, escaping from the mud at the bottom of a deep lake, rise to the surface.

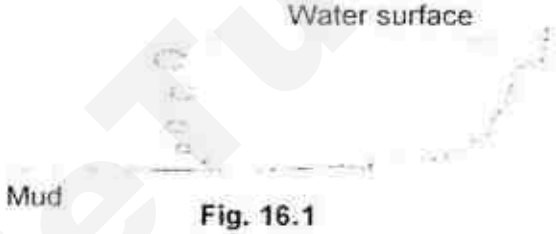


Fig. 16.1

As the bubbles rise, they get bigger. This is due to _____.

A the formation of convection currents.
B the evaporation at the water surface.
C the colder water at the bottom of the lake.
D the decrease in the water pressure acting on the bubbles.

17 Fig. 17.1 shows a piece of paper wrapped tightly around a copper rod and placed above a candle flame. It was observed that the paper did **not** catch fire even when it was placed above the flame for some time.

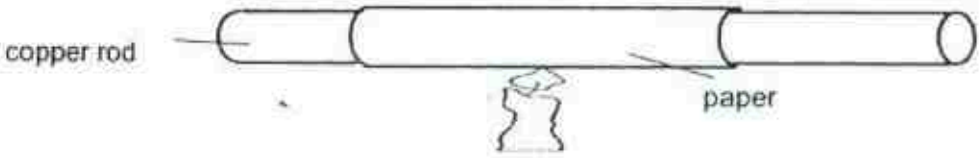


Fig. 17.1

Which of the following statements provides the best explanation?

A The flame from the candle is too weak to heat up the paper.
B The copper rod, being a good thermal conductor, conducts heat quickly away.
C The paper is a poor conductor of thermal energy.
D The paper is a poor absorber of radiant heat.

18 A piece of kitchen aluminium foil is used to wrap around food to be cooked in a barbeque fire. The foil has a shiny and a dull side. Which side should be on the outside and why?

	outside surface	explanation
A	shiny	better heat absorber
B	shiny	better heat conductor
C	dull	better heat absorber
D	dull	better heat conductor

19 When one junction of a thermocouple is placed in pure melting ice at 0 °C and the other junction in steam at 100 °C, the e.m.f. is 8.0 mV. The cold junction is then removed from melting ice and placed in a liquid at constant temperature. The e.m.f. is now 2.0 mV.

What is the temperature of the liquid?

A 20 °C B 25 °C C 55 °C D 75 °C

20 Fig. 20.1 shows the rise in temperature of 2.0 kg of a substance, X. The substance is initially in solid state and it was heated uniformly at the rate of 2000 J/min.

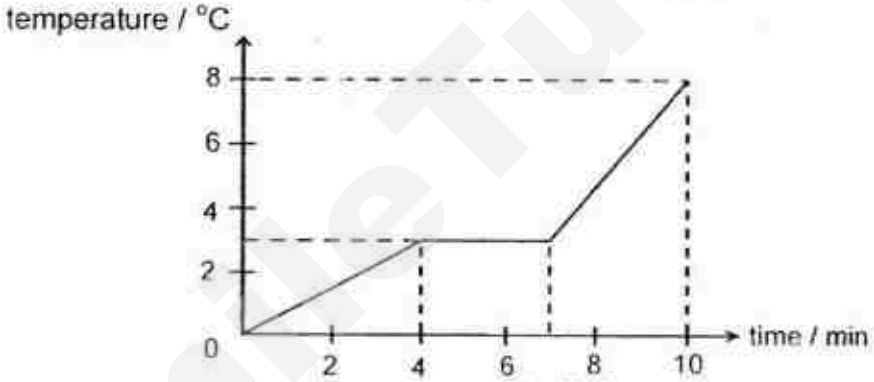


Fig. 20.1

Which of the following sets of data about X is correct?

	specific heat capacity of solid X / J kg^{-1} °C^{-1}	specific latent heat of fusion of X / J kg^{-1}	specific heat capacity of liquid X / J kg^{-1} °C^{-1}
A	8000	6000	3000
B	1330	6000	600
C	4000	3000	1200
D	1330	3000	600

21 A fixed mass of gas is cooled down while its volume is kept constant. How do the properties of the molecules of the gas change?

	average speed	frequency of collisions with walls	average distance apart
A	decreases	increases	unchanged
B	decreases	decreases	unchanged
C	decreases	unchanged	increases
D	unchanged	decreases	decreases

22 Fig. 22.1 shows a ripple tank. The dipper vibrates up and down at a constant frequency.

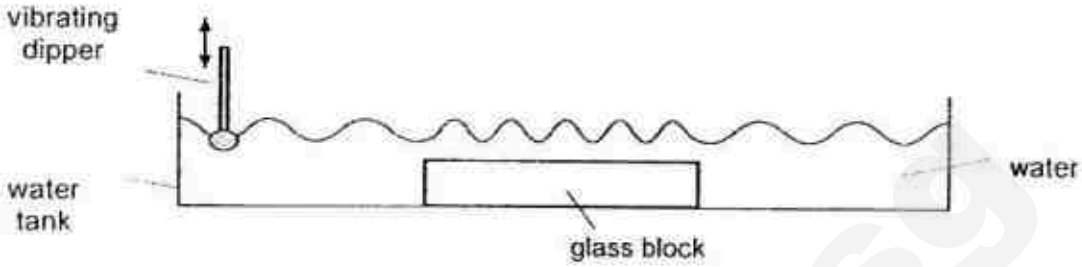


Fig. 22.1

What happens to the wavelength, frequency and speed of the wave as it reaches the glass block?

	wavelength	frequency	speed
A	increases	remains unchanged	increases
B	decreases	increases	increases
C	decreases	remains unchanged	decreases
D	increases	increases	decreases

23 Fig. 23.1 shows the cross-section of a water wave.

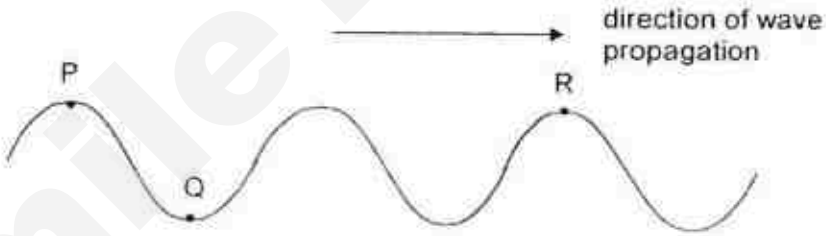


Fig. 23.1

A student made the following statements.

- The particle moves from P to Q after ½ T.
- Q is in the same phase as R.
- Wave energy is transferred from position P to R.
- Fig. 23.1 shows a transverse wave.

How many of the above statements is/are correct?

A 1 **B** 2 **C** 3 **D** 4

24 Fig. 24.1 shows a person X standing 1.0 m in front of a plane mirror while observer O stands 2.5 m behind X.

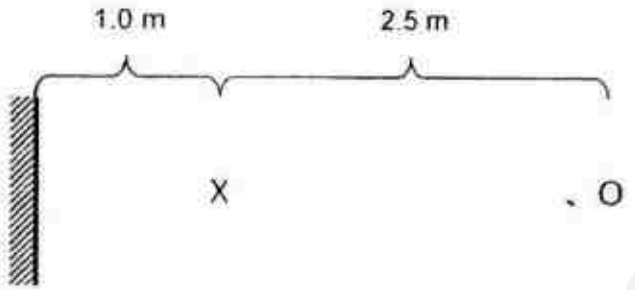


Fig. 24.1

Determine the distance between observer O and the image of X.

A 2.0 m **B** 3.5 m **C** 4.5 m **D** 7.0 m

25 Fig. 25.1 shows the path of a ray of light as it strikes the water-to-air boundary.

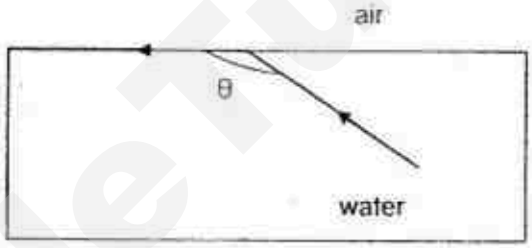
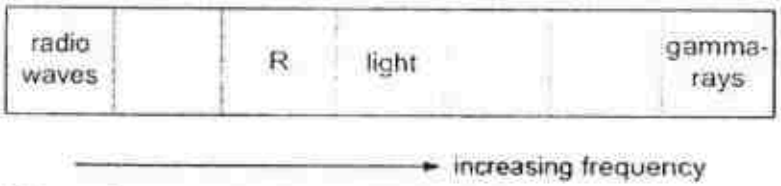


Fig. 25.1

If the speed of the light in the water is 2.3×10^8 m/s and its speed in air is 3.0×10^8 m/s, determine the angle θ.

A 100 °
B 120 °
C 130 °
D 140 °

26 The diagram shows the main sections of the electromagnetic spectrum in order of increasing frequency. Some of the sections are labelled.



The section R has a frequency just below that of light.
Which application uses the section R?

A Sterilisation
B Satellite television
C Sunbed
D Television remote controller

27 The speed of the radio waves in air is 3.0×10^8 m/s and the wavelength is about 5.0 m. What is the frequency of the waves broadcast by the radio station?

A 60 MHz **B** 60 GHz **C** 150 MHz **D** 150 kHz

28 Fig. 28.1 shows a man standing between two cliffs. He claps his hands once.

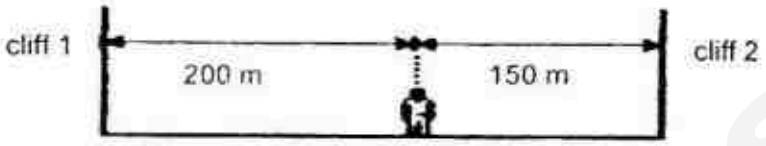


Fig. 28.1

If the speed of sound in air is 300 m/s, determine the time interval between the two loudest echoes.

A 0.33 s **B** 0.83 s **C** 1.2 s **D** 1.3 s

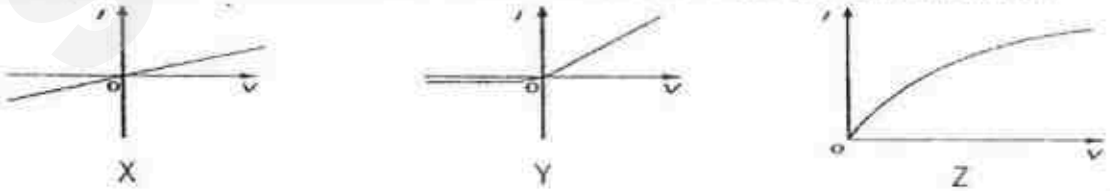
29 An insulating rod carries a positive charge after it is rubbed with a woollen cloth. Which of the following statements correctly explains the transfer of charges?

A Friction causes the negative charges on the rod to become positive.
B Positive charges are transferred from the cloth to the rod.
C Electrons are transferred from the rod to the cloth.
D Electrons are transferred from the cloth to the rod.

30 During a thunderstorm, a bolt of lightning sends out an electric charge of 20 C from a thundercloud to the earth. If the energy produced by the lightning is about 500 MJ, determine the potential difference between the thundercloud and the earth.

A 25 MV **B** 500 MV **C** 10000 MV **D** 40000 MV

31 Three graphs X, Y and Z show the I-V characteristics for three different components.



A student made the following statements:

- X is an ohmic device whereas Y and Z are non-ohmic devices.
- Gradient of graph X gives the resistance of X.
- Y is a semiconductor diode and Z is a thermistor.

How many of the above statements is/are correct?

A 0 **B** 1 **C** 2 **D** 3

32 In Fig. 32.1, the current that flows through the point X is 0.50 A.

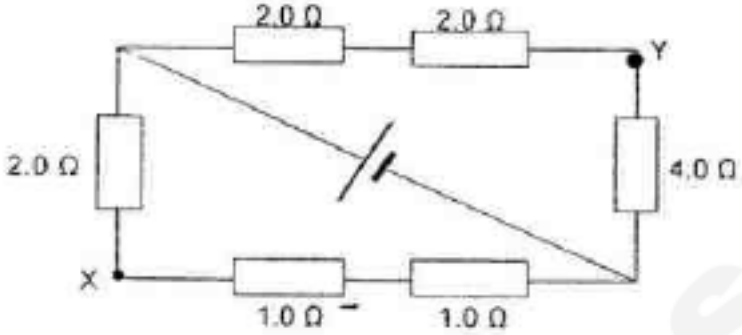


Fig. 32.1

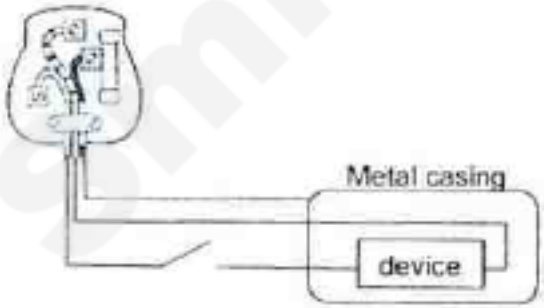
Determine the current that flows through Y.

A 0.25 A **B** 0.50 A **C** 1.0 A **D** 1.3 A

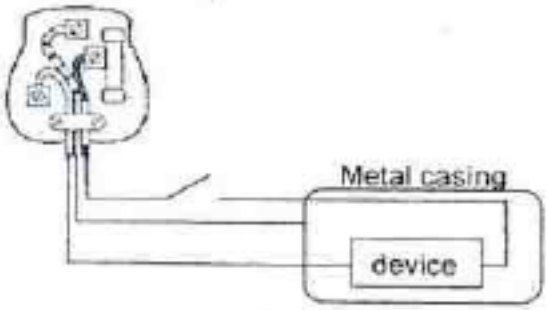
33 An electrical household appliance uses 43.2 MJ of electrical energy after 4 hours of operation. If it costs 25 cents/kWh, find the electrical power of the appliance and the cost of energy usage.

	electrical power / kW	cost / $
A	3	0.75
B	3	3.00
C	12	3.00
D	12	0.75

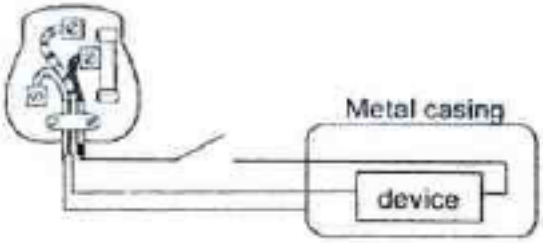
34 Which of the following is correctly wired?



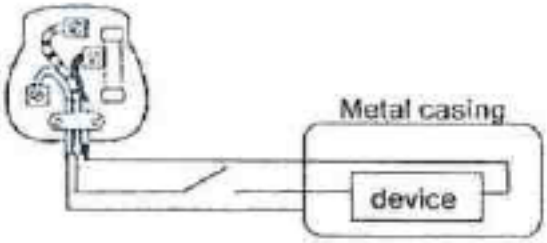
A



C



B



D

35 Fig. 35.1 shows a small compass placed between two bar magnets with the ends X and Y nearest to the compass.

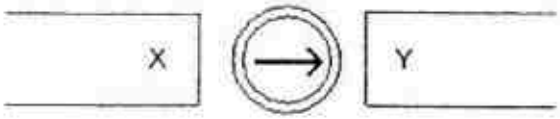


Fig. 35.1

What are the polarities of ends X and Y?

	X	Y
A	North pole	South Pole
B	South Pole	North pole
C	South Pole	South Pole
D	North pole	North pole

36 Equal amount of current is flowing in two insulated wires, perpendicular to each other as shown in Fig. 36.1.

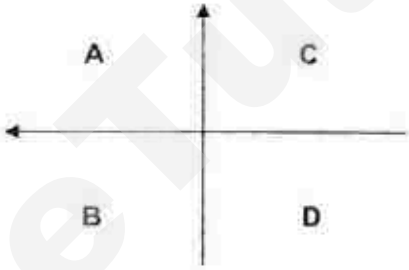


Fig. 36.1

Which segment, **A**, **B**, **C** or **D** has the strongest magnetic field flowing into the paper?

37 Fig. 37.1 shows a transformer. The number of turns between each pair of output terminals of a transformer is shown in the diagram.

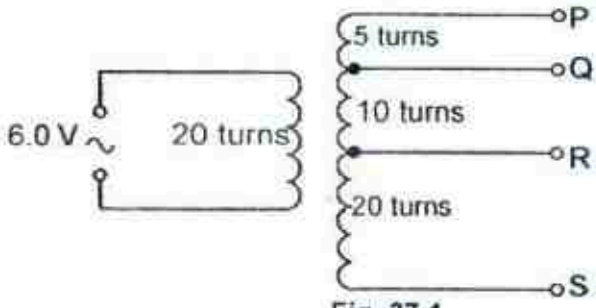


Fig. 37.1

Which pair of terminals should be connected such that the output will be 4.5 V?

A PQ **B** QR **C** PR **D** QS

38 Fig. 38.1(a) shows a simple alternating current (a.c.) generator and Fig. 38.1(b) shows the initial voltage produced against time.

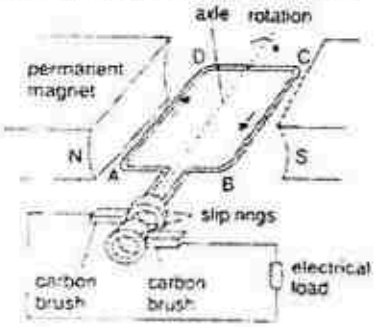


Fig. 38.1(a)

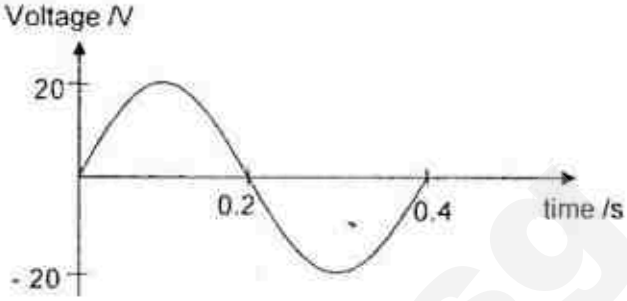


Fig. 38.1(b)

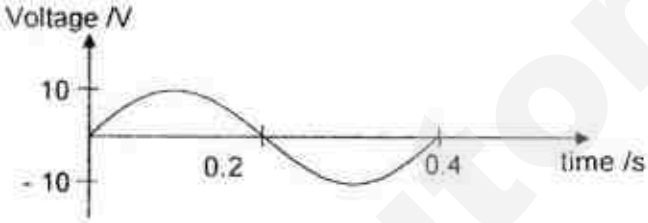


Fig. 38.2

After a certain change was made to the a.c. generator, the voltage against time waveform is as shown in Fig. 38.2. What is likely to be the change?

A Reduce the rotating speed.
B Use a magnet that has a weaker strength.
C Increase the number of turns of the coil in the generator.
D Place a soft iron core in the centre of the coil.

39 Fig. 39.1 shows a trace on the cathode ray oscilloscope (CRO) when a source is connected to it. The amplitude of the input source is 10.0 V and the time-base of the CRO is 5.0 ms/div. Find the voltage gain of the CRO display and the frequency of the input source.

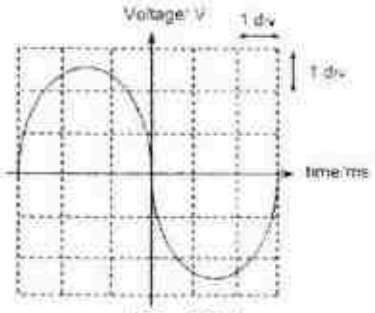


Fig. 39.1

Determine the voltage gain and the frequency of the trace.

	voltage gain / V div^{-1}	Frequency / Hz
A	2.5	30
B	2.5	33
C	4.0	30
D	4.0	33

40 Fig. 40.1 shows a magnet moving up and down (between P and R) above a coil of copper wire.

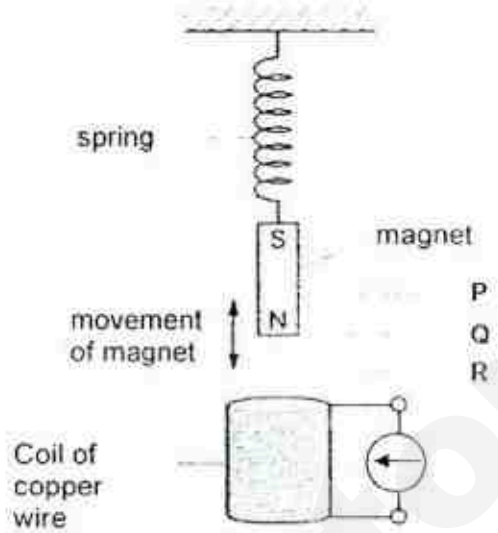


Fig. 40.1

Which of the following statements are true?

(i) An induced alternating current is formed in the coil as the magnet moves up and down.
(ii) When the N-pole of the magnet is at P or R, the galvanometer does not show any deflection.
(iii) The galvanometer will show bigger deflections when more turns are made to the coil of copper wire.

A (i) and (ii) only
B (ii) and (iii) only
C (i) and (iii) only
D (i), (ii) and (iii)

End of Paper

Marking Scheme

1	2	3	4	5	6	7	8	9	10
B	C	A	C	C	A	A	A	D	A

11	12	13	14	15	16	17	18	19	20
A	C	C	A	D	D	B	C	D	D

21	22	23	24	25	26	27	28	29	30
B	C	B	C	D	D	A	A	C	A

31	32	33	34	35	36	37	38	39	40
B	A	B	C	A	C	C	B	D	D

Answer all questions.

1 The figures below show the reading on a vernier caliper when it is used to measure the thickness of a book. Figure 1.1 shows the reading when the jaws are closed. Figure 1.2 shows the reading when the book is placed in between the jaws.

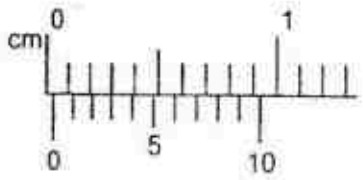


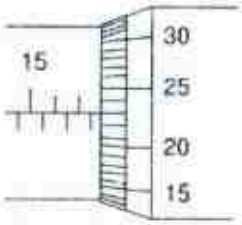
Figure 1.1

Figure 1.2

What is the actual thickness of the book?

A 4.32 cm
B 4.35 cm
C 4.38 cm
D 4.80 cm

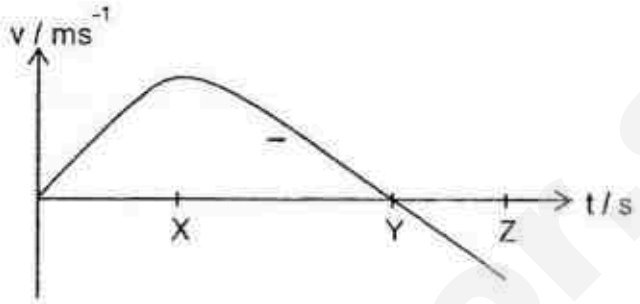
2 The diagram shows part of a micrometer screw gauge.



What is the reading shown?

A 15.23 mm
B 15.73 mm
C 17.23 mm
D 17.73 mm

3 A water rocket is accelerated vertically upwards. The velocity-time graph below shows the relationship between the velocity of the rocket and time.

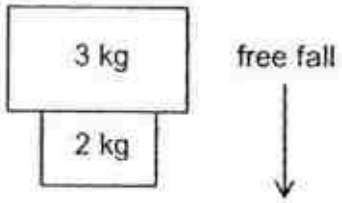


Which of the following statements is/are correct?

(1) The rocket reaches the highest position at instant X.
(2) The resultant force acting on the rocket is zero at instant Y.
(3) The rocket is still in the air at instant Z.

A (1) only
B (3) only
C (1) and (2) only
D (2) and (3) only

4 Two different concrete blocks, in contact with each other, are falling freely from a building under construction.



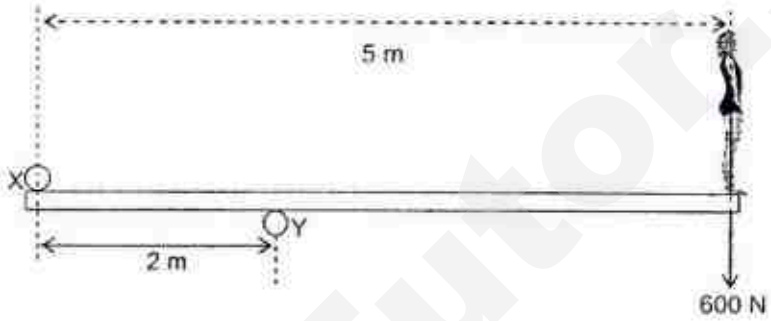
What is the net force acting on the 2 kg block?

A 10 N
B 20 N
C 30 N
D 50 N

5 A mass of liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. There is no change in the total volume. What is the density of the mixture?

A $4/3\ \rho$ B $3/2\ \rho$ C $5/3\ \rho$ D $3\ \rho$

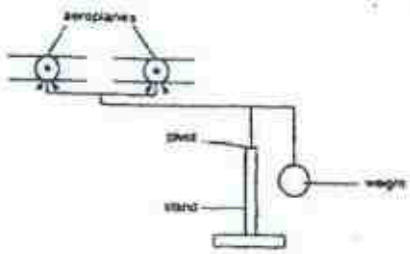
6 The diagram shows a diving-board of negligible weight held in position by two rods X and Y.



What additional forces do these rods need to exert on the board when a diver of weight 600 N stands on the right-hand end?

	At X (downwards)	At Y (upwards)
A	400 N	1000 N
B	600 N	1200 N
C	900 N	600 N
D	900 N	1500 N

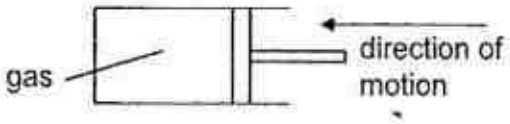
7 The diagram shows a balancing toy pivoted on a stand. If the toy is tilted slightly, it does not overbalance but returns to its original position.



This is because the centre of gravity of the toy is

A between the aeroplanes.
B below the pivot.
C exactly at the pivot.
D inside the weight.

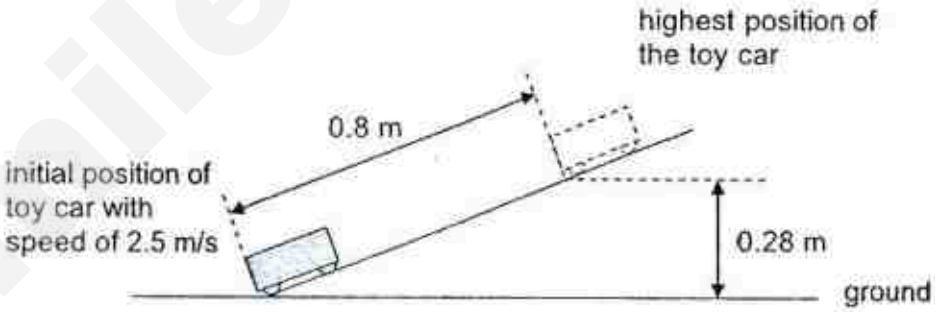
8 Gas inside a cylinder is cooled slowly to a lower temperature. The pressure inside the cylinder remains constant as the piston moves inwards.



How do the speed of the particles and their rate of collisions with the cylinder and piston compare with their initial values at the higher temperature?

	average speed	rate of collision
A	lower	reduced
B	lower	increased
C	same	same
D	same	reduced

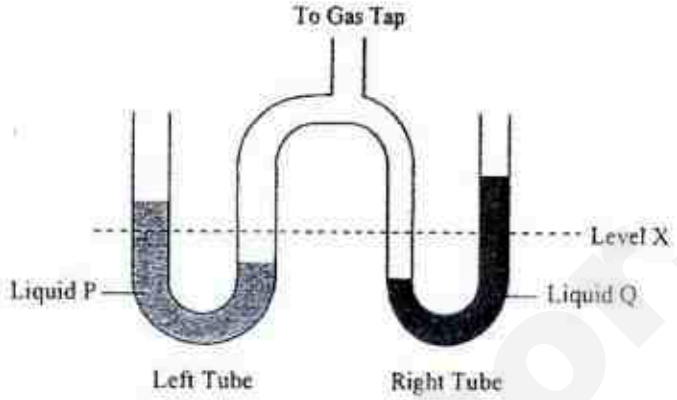
9 The diagram below shows a 0.50 kg toy car being pushed from the base of a slope with an initial speed of 2.5 m/s. It is able to move a distance of 0.80 m up the slope to its highest point 0.28 m above the ground.



What would be the average frictional force acting on the toy car as it moves up the slope?

A 0.203 N
B 1.400 N
C 1.560 N
D 1.950 N

10 The apparatus shown is connected to a gas tap in order to measure the pressure of the gas. The left tube contains liquid P whereas the right tube contains liquid Q. The levels in the tube were originally at X.



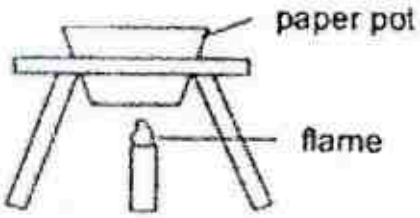
When the gas tap is turned on, liquid Q in the open limb of the right tube rises to a higher level than liquid P in the open limb of the left tube as shown. Why does this happen?

A Liquid P has a higher density than liquid Q.
B The right tube has a smaller cross-sectional area than the left tube.
C There is more liquid Q in the right tube than liquid P in the left tube.
D The gas exerts a greater pressure on the right tube as it is nearer to the gas inlet.

11 Some gas is heated in a sealed container. Which of the following **does not** increase?

A The force due to the collisions between the gas molecules and the container walls.
B The number of collisions per second by the gas molecules on the container walls.
C The average distance between the gas molecules.
D The average kinetic energy of the gas molecules.

12 Some Japanese restaurants use paper pots for their customers to boil the food.



What are the reasons for the paper pot not catching fire when in contact with the flame?

(1) Water has a boiling point lower than the burning temperature of the paper.
(2) The paper is thin and therefore heat is conducted quickly to the water in the paper pot.
(3) The paper is thick enough to withstand the high temperature of the flame.

A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

13 A thermocouple indicates 0.1 mV at ice point and 2.6 mV at 500 °C. What will be the temperature when the thermocouple indicates 3.0 mV?

A 80 °C B 560 °C C 580 °C D 600 °C

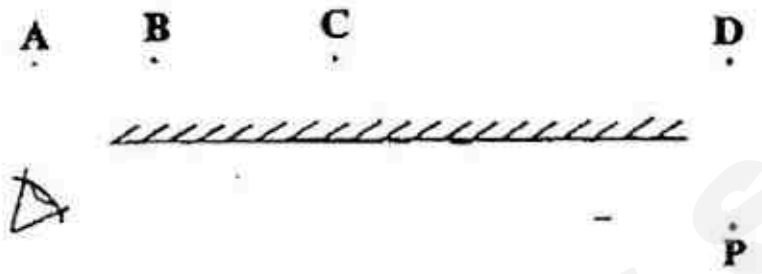
14 A piece of aluminium of mass *m* has a specific heat capacity of *c*. A piece of copper of mass *2m* has a specific heat capacity of *2c*. Both of these metals receive the same quantity of heat and the temperature of the copper rises by 10 °C. How much will the temperature of the aluminium rise?

A 5.0 °C B 10 °C C 20 °C D 40 °C

15 A heater is used to heat a 300 g piece of tin at 323 K. The specific heat capacity of tin is 210 J/kg K. How long will it take the heater to heat the tin to 388 K if the heater supplies 500 W of power?

A 8.19 s B 40.7 s C 48.9 s D 8190 s

16 A pin labelled P is placed to the right of a plane mirror. It is viewed from the left-hand side by the eye. At which position can the image of the pin be seen?

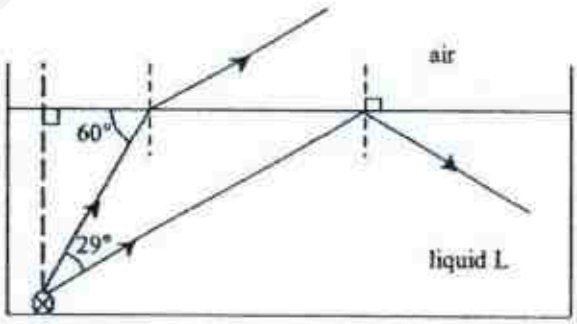


17 When an object is placed 20 cm from a thin converging lens, a real image equal in size to the object is formed. The object is then moved 5 cm towards the lens.

Which of the following describes the new image formed?

	Image distance	Image size
A	more than 20 cm	magnified
B	more than 20 cm	diminished
C	less than 20 cm	magnified
D	less than 20 cm	diminished

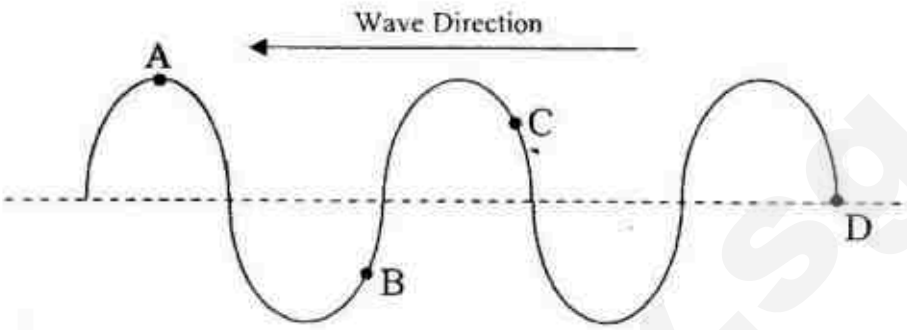
18 A lamp is placed at the bottom of a tank of a liquid L. The direction of two light rays from the lamp is shown.



What could be the refractive index of liquid L?

A 2.90 B 1.30 C 1.13 D 1.00

19 The diagram shows a water wave. At the instant shown, which particle is moving upward?



20 A place where sound waves cannot travel would be

A through a balloon filled with helium.
B from one spaceship to another one, in space.
C from a surface ship to a submarine.
D through liquid nitrogen.

21 The frequencies of note C and note E are 256 Hz and 320 Hz respectively. Which of the following statements are correct?

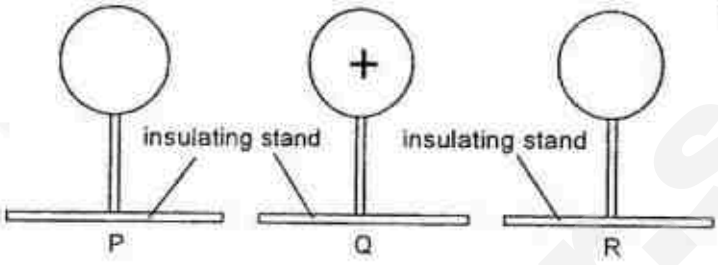
I Note E is louder than note C.
II Note E has a higher pitch than note C.
III Note E has a shorter wavelength than note C.
IV Note E travels faster than note C.

A I and IV
B II and III
C I and III
D II and IV

22 One of the following devices does not make use of electromagnetic waves in its operation. Which one is it?

A remote controller
B camera
C loudspeaker
D radio

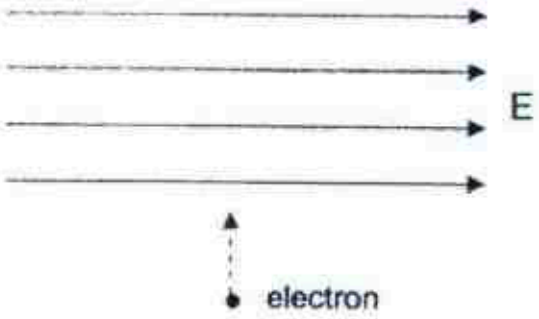
23 Three metal spheres held on insulating stands are placed closed to each other. Sphere Q is positively charged while spheres P and R are neutral.



What will be the charges in spheres P and R after sphere R is earthed momentarily?

	sphere P	sphere R
A	neutral	negative
B	neutral	neutral
C	neutral	positive
D	positive	negative

24 An electron is projected at right angles to a uniform electric field E as shown in the diagram.



In the absence of other fields, in which direction is the electron deflected?

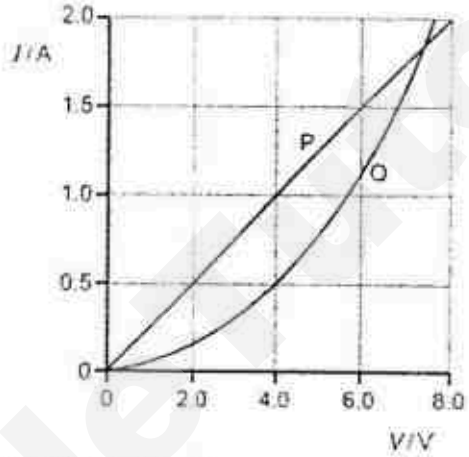
A to the left
B to the right
C into the plane of the paper
D out of the plane of the paper

25 A charged cloud carrying a charge of 180 C passes over a building and transfers its charge to the ground in 0.40 ms in a flash of lightning.

What is the current flowing to the ground?

A 0.45 A
B 450 A
C 45000 A
D 450 000 A

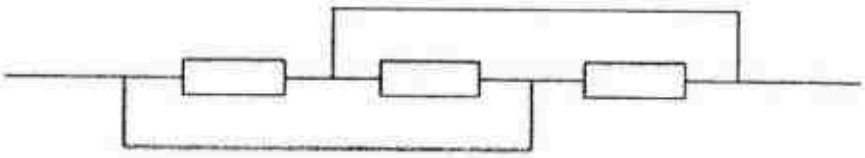
26 The I-V characteristics of two electrical components P and Q are shown below.



Which statement is correct?

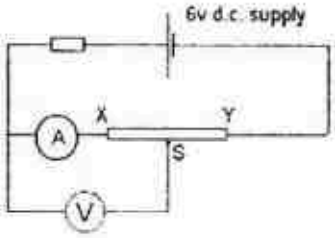
A P is a resistor and Q is a filament lamp.
B The resistance of Q increases as the current in it increases.
C For a current of 1.9 A, the resistance of Q is approximately half that of P.
D For a current of 0.5 A, the power dissipated in Q is double that in P.

27 What is the effective resistance of the diagram below if each resistor has a resistance of 12 Ω?



A 0 Ω B 3 Ω C 4 Ω D 12 Ω

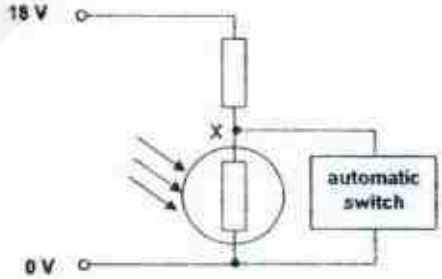
28 The following experimental setup shows a jockey that can be placed at any point **S** between a high resistance wire **XY**.



Which of the following describes what happens to the ammeter and voltmeter readings when the jockey is shifted from **X** to **Y**?

	ammeter reading	voltmeter reading
A	remains constant	increases
B	remains constant	decreases
C	decreases	increases
D	increases	decreases

29 The circuit shown below is connected to an automatic switch for the lights in the garden. The automatic switch needs a voltage at **X** of 12 V or higher for the lights to be on. The lights are to come on at sunset and the value of the fixed resistor is 400 Ω.



What must be the minimum resistance of the light-dependent resistor in order for the lights to come on at sunset?

A 400 Ω
B 800 Ω
C 1200 Ω
D 1600 Ω

30 Which of the following is/are done to minimise power loss in industrial power transmission cables?

(1) use shorter wires
(2) step up the voltage in the transmission cables
(3) decrease the cross-sectional area of the wires

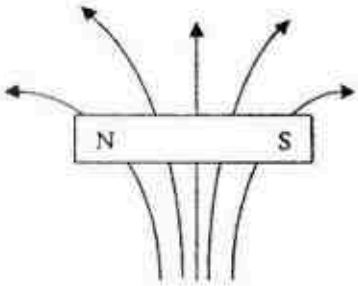
A (1) only
B (1) and (2) only
C (2) and (3) only
D (1), (2) and (3)

31 An electric oven is connected to the mains supply using insulated copper wires. The wires become very warm.

What can be done to prevent so much heat being produced in the connecting wires?

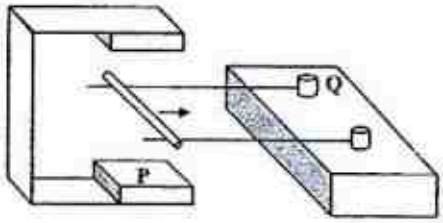
A Use thicker copper wires.
B Use thinner copper wires.
C Use thicker insulation.
D Use thinner insulation.

32 The diagram below shows the top view of a magnet suspended in a magnetic field.



The magnet will
A move to the right.
B move to the left.
C rotate clockwise.
D rotate anti-clockwise.

33 A bare conducting rod is being placed on top of two similar wires connected to a d.c. power supply. The bare conducting rod jerks to the right when the current is switched on.

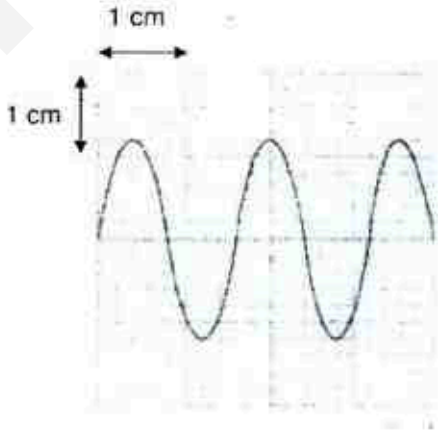


Which of the following statements are correct?

I P is a North pole and Q is a negative terminal.
II P is a North pole and Q is a positive terminal.
III P is a South pole and Q is a negative terminal.
IV P is a South pole and Q is a positive terminal.

A I and IV **B** II and III **C** I and III **D** II and IV

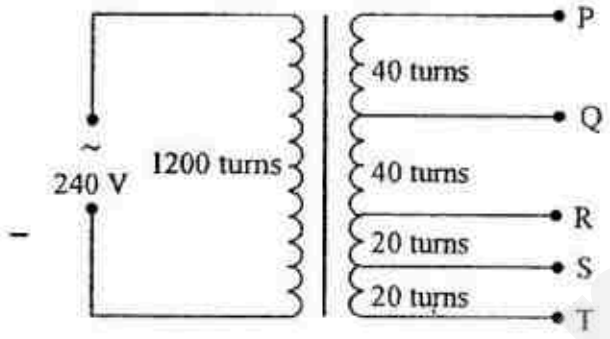
34 The figure shows the screen display of a CRO when a 25 Hz a.c. of peak voltage 6 V signal is connected to the Y-plates.



What is the voltage gain and time-base of the CRO?

	Voltage gain	Time base
A	5.0 V/cm	25 ms/cm
B	5.0 V/cm	50 ms/cm
C	10 V/cm	25 ms/cm
D	10 V/cm	50 ms/cm

35 A transformer consists of one coil with 1200 turns and a second coil, with a total of 120 turns, which can be tapped at various points as shown.

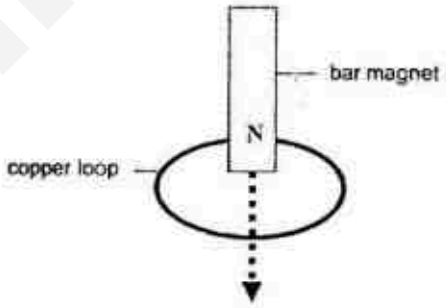


Which pair of terminals should be connected to a 12 V, 24 W lamp for it to be lit normally?

A PS B QS

C RT D PT

36 A bar magnet is dropped through a loop of copper wire as shown.



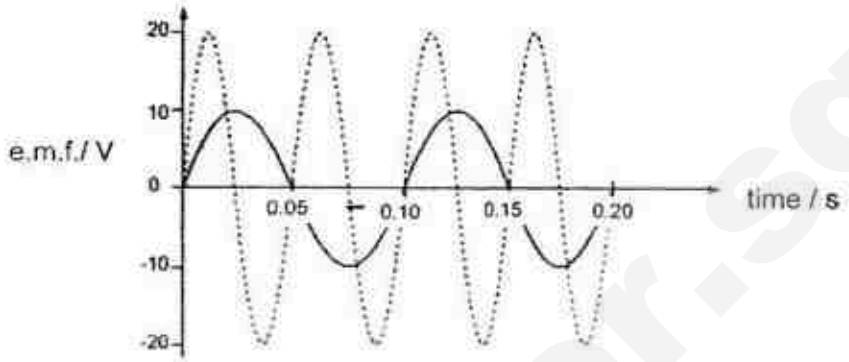
Which of the following statement(s) is/are correct?

(1) When the magnet approaches the copper loop, a current is induced in the loop that flows in clockwise as seen by the observer from the top of the loop.
(2) When the magnet moves through the copper loop, the current induced in the copper loop sets up a magnetic field that always repel the magnet.
(3) Heat is produced in the copper loop.
(4) The magnet falls through the copper loop with an acceleration that is lower than the acceleration of free fall due to gravity.

A (2) only B (1) and (3) only

C (2) and (3) only D (3) and (4) only

37 In the graph shown, the solid curve shows how the e.m.f. produced by a simple generator varies with time. The dashed curve is the output from the same generator after a modification has been made to the generator.



Which modification was made to produce the result shown?

A The area of the coil was doubled.
B A split-ring commutator was added.
C The number of turns in the coil was doubled.
D The speed of rotation of the coil was doubled.

38 Which part of a simple d.c. motor reverses the direction of current through the coil every half-cycle?

A the armature
B the brushes
C the commutator
D the slip-rings

39 In some countries, electricity is transmitted at a very high voltage over large distances using overhead cables.
Why is this voltage an advantage?

A Electricity can travel faster along the cables.
B It makes the cables stronger.
C There is less energy loss from the cables.
D The current will be of a higher magnitude.

40 Why is the core of a transformer made of iron?

A Iron is a good electrical conductor.
B Iron is cheaper than copper.
C Iron is easily magnetised and demagnetised.
D Iron makes a good permanent magnet.

----End of Paper----

Answer for MCQ Paper 1 Prelim 2 2017(updated v1)

Qn	1	2	3	4	5	6	7	8	9	10
Ans	A	D	B	B	A	D	B	B	A	A

Qn	11	12	13	14	15	16	17	18	19	20
Ans	C	A	D	D	A	D	A	B	B	B

Qn	21	22	23	24	25	26	27	28	29	30
Ans	B	C	A	A	D	D	C	A	B	B

Qn	31	32	33	34	35	36	37	38	39	40
Ans	A	C	A	A	B	D	D	C	C	C

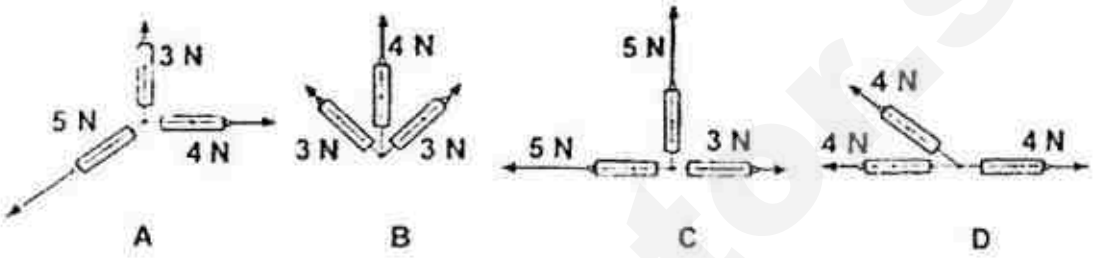
Answer all questions using the OAS provided (40 Marks)

1. Which of the following shows the correct order of the diameter of the Earth?

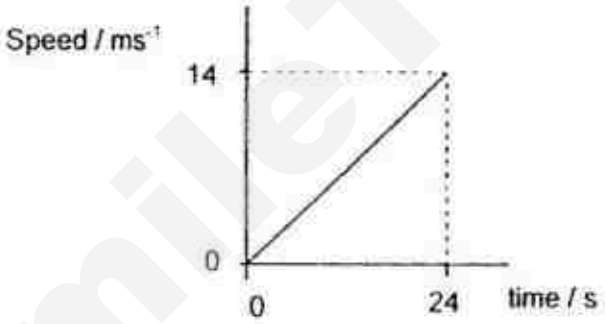
A 10^5 m B 10^6 m C 10^7 m D 10^8 m

2. The diagrams show spring balances joined to demonstrate a system of three forces acting at a point. The readings represent the magnitude of the forces.

Which system of forces could be in equilibrium?



3. The graph shows how the speed of a car changes with time.



Which calculation gives the distance travelled by the car in 24 seconds?

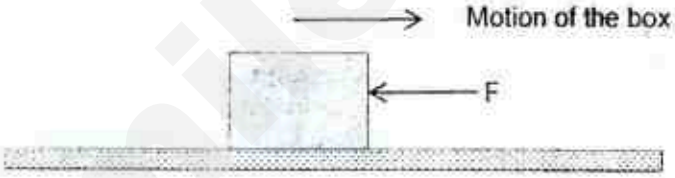
A $\left(\frac{14}{24}\right)$ m B $\left(\frac{24}{14}\right)$ m C $\left(\frac{24 \times 14}{2}\right)$ m D (24×14) m

4. A lady is sitting on a swing.

Which of the following is **not** a correct action-reaction pair of forces?

	Action	Reaction
A	The gravitational force of Earth acting on the lady.	The gravitational force of the lady acting on the Earth.
B	The contact force of the lady on the wooden plank.	The contact force of the wooden plank on the lady.
C	The gravitational force of the lady on the wooden plank.	The contact force of the wooden plank on the lady.
D	The pull of the ropes on the wooden plank.	The pull of the wooden plank on the rope.

5. A box is moving to the right with constant speed.



A force, F, acting to the left is exerted on it.

Which of the following statement about the box will be true?

A The box will move to the left with increasing speed.
B The box will move to the right with decreasing speed.
C The box will stop moving immediately.
D The box will move to the left with constant speed.

6. A scooter rider is moving down a gentle slope at a constant speed.

I There is no resultant force on the rider because her speed is steady.
II There must be a resultant force on the rider because she is moving.
III The greater the mass of the rider, the harder it is for the rider to come to a stop.
IV There is no resultant force on the rider because the force of the road acting on the wheels is equal to the force of the wheels acting on the road.

Which of the following is correct?

A I only B II and III C I and III D I & IV

7. A person throws a volley ball straight up into the air.

If the volley ball is on the way up, which of the following statement is true?

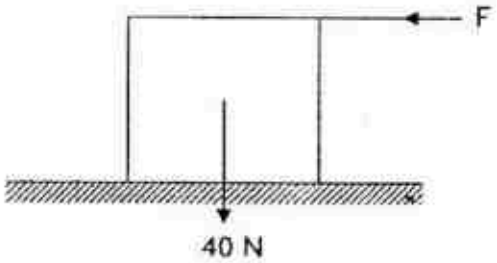
	Forces acting on the ball	Direction of the resultant force acting on the ball
A	Force of gravity only	downward
B	Force of gravity and air resistance	downward
C	Force of gravity and force of the throw	upward
D	Force of gravity, force of the throw and air resistance	upward

8. A small steel ball is being thrown upwards and it reaches its highest point.

Which statement describes its motion?

A The acceleration of the steel ball is zero.
B The acceleration of the steel ball is 10 m/s^2.
C The acceleration of the steel ball is increasing.
D There is no force acting on the steel ball since the steel ball is momentarily at rest.

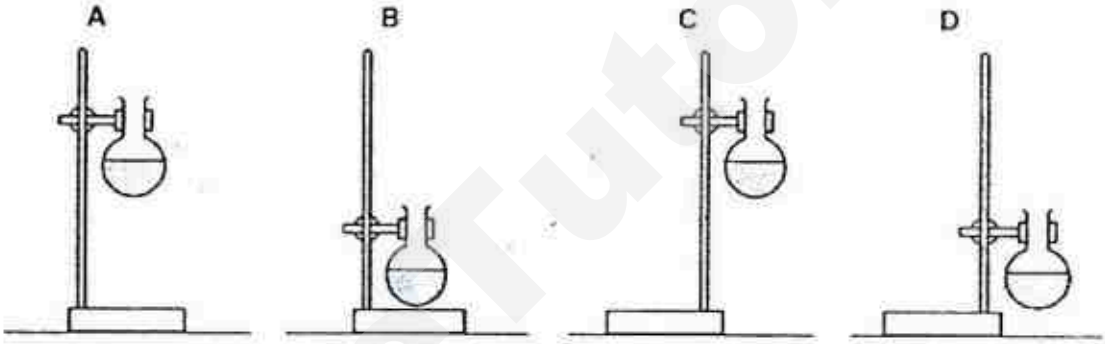
9. What is the force F needed to just tilt the cube with weight 40 N?



A 10 N B 20 N C 40 N D None of the above

10. A student uses a stand and clamp to hold a flask of liquid.

Which diagram shows the most stable arrangement?



11. A labourer on a building site lifts heavy concrete blocks onto a lorry. Lighter blocks are now lifted the same distance in the same time.

What happens to the work done in lifting each block and the power exerted by the labourer?

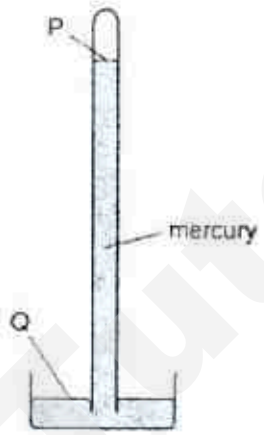
	work done in lifting each block	power exerted by labourer
A	decreases	decreases
B	decreases	remains the same
C	increases	increases
D	remains the same	increases

12. A certain machine is very efficient.

What does this mean?

A It produces a large amount of power.
B It uses very little energy.
C It wastes very little energy.
D It works very quickly.

13. The diagram shows a simple mercury barometer.

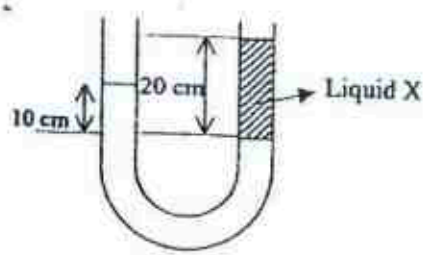


Atmospheric pressure decreases.

What happens to the level of the mercury at P and what happens to the level of the mercury at Q?

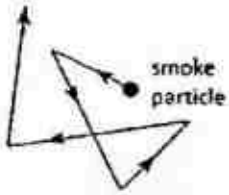
	P	Q
A	falls	falls
B	falls	rises
C	rises	falls
D	rises	rises

14. A column of liquid X, floats on water in a U-tube of uniform cross-section area. If the density of water is 1000 kg/m^3, find the density of liquid X.



A 1500 kg/m^3 B 1000 kg/m^3 C 800 kg/m^3 D 500 kg/m^3

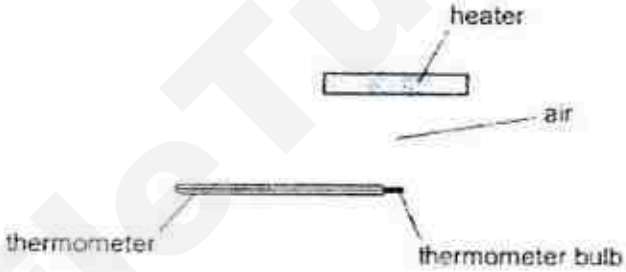
15. In Brownian motion, some smoke particles are seen moving in a haphazard motion in an enclosed glass cell when light is shone in them.



Which of the following statement is the correct explanation for the motion of the smoke particles?

A The smoke particles are knocking unto each other.
B The smoke particles are hit by air molecules that are in constant random motion.
C According to kinetic theory of matter, smoke particles are in constant random motion.
D The smoke particles gain energy from the light and they start to move in a haphazard motion.

16. The diagram shows a heater above a thermometer. The thermometer bulb is in the position shown.



Which row shows how the heat energy from the heater reaches the thermometer bulb?

	conduction	convection	radiation
A	yes	yes	no
B	yes	no	yes
C	no	yes	no
C	no	no	yes

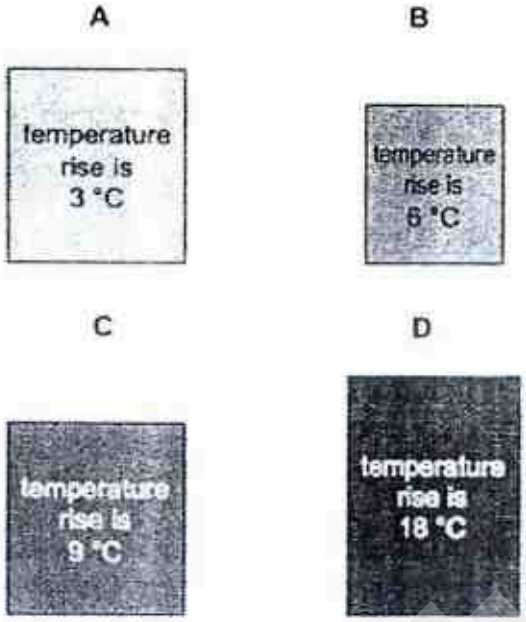
17. A balloon is inflated in a cold room. When the room becomes much warmer, the balloon becomes larger.

How does the behaviour of the air molecules in the balloon explain this?

A The molecules expands.
B The molecules evaporate.
C The molecules move more quickly.
D The molecules repel each other.

18. The same quantity of heat energy is applied to four different blocks. The temperature rise produced is shown on each block.

Which block has the highest heat capacity?



19. A wave on a string is produced by a vibrator.

The waveforms at **t** = 0 s and **t** = 0.03 s are as shown in the diagrams.

soup because

A oil is a bad conductor of thermal energy.
B oil has a smaller latent heat of vaporisation than water.
C the layer of oil prevents thermal energy transfer by convection.
D the layer of oil reduce the rate of evaporation of the soup.

A musician plays a violin. The string of the violin vibrates and sound transmits through the air.

Which of the following correctly describes the waves produced?

A Longitudinal waves are produced in the string and in the air.
B Longitudinal waves are produced in the string and transverse waves are produced in the air.

Which of the following statements about the wave is/are correct?

I The amplitude of the wave is 1 cm.
II The wavelength of the wave is 2 cm.
III The period of the wave is 0.04 s.

A I only B II only C I and III only D II and III only

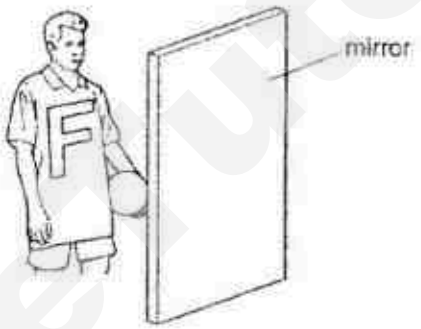
20. When sound waves travel from one medium to another, the wavelength changes because

A the speed changes.
B the frequency changes.
C different media have different temperatures.
D the attraction between the molecules of the medium changes.

21. Which list shows electromagnetic waves in order of increasing frequency?

A visible light, X-rays, gamma-rays
B visible light, gamma-rays, X-rays
C X-rays, gamma-rays, visible light
D gamma-rays, X-rays, visible light

22. A boy wears a shirt with a letter F on the front. He stands in front of a plane mirror.



What does he see in the mirror?

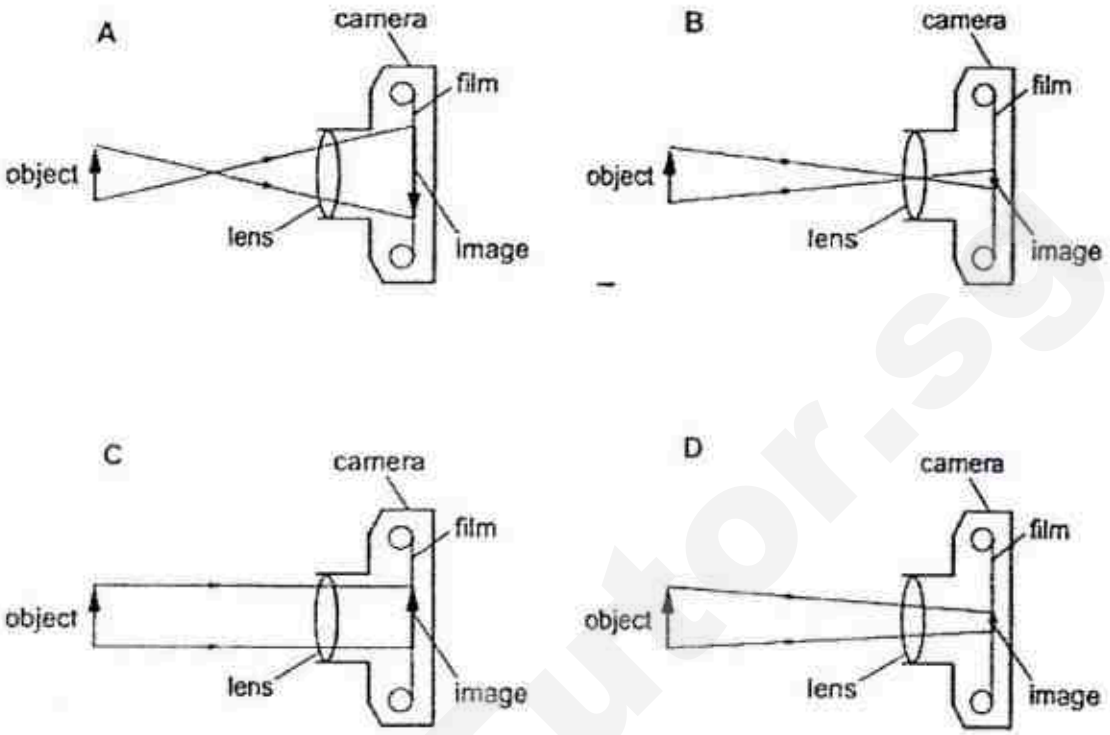
A

B

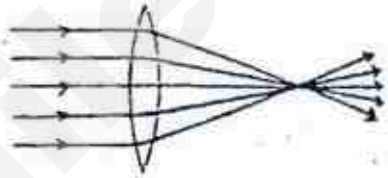
C

D

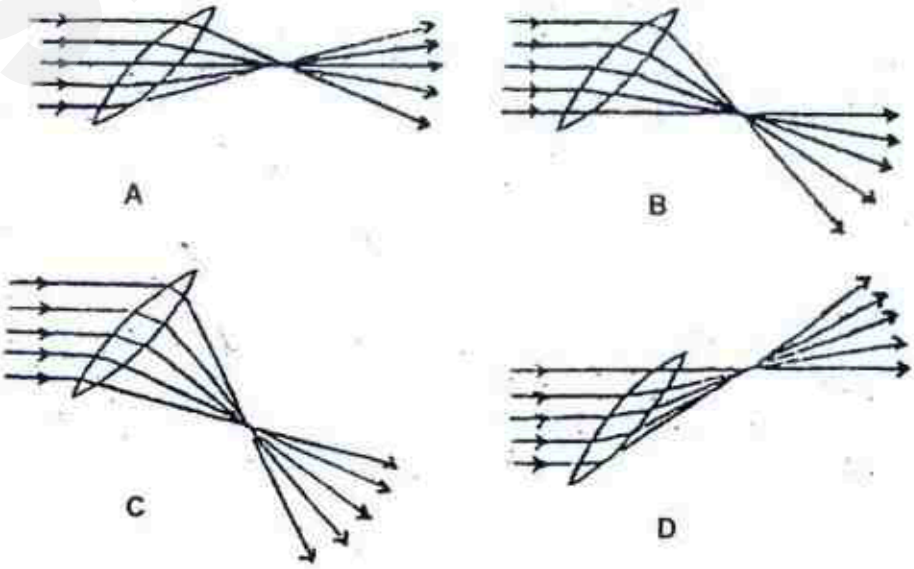
23. Which diagram correctly shows rays passing through a camera lens?



24. A converging lens focuses a parallel set of rays as indicated in the figure below.

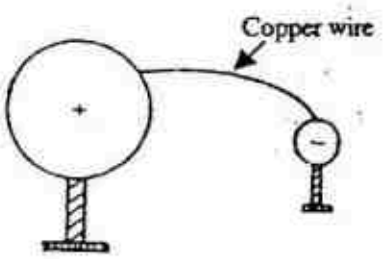


If the lens is tilted to one side as shown, which is the MOST likely way in which the rays will behave?



25. A large positively charged metal sphere is connected to a small negatively charged metal sphere by a piece of copper wire as shown below.

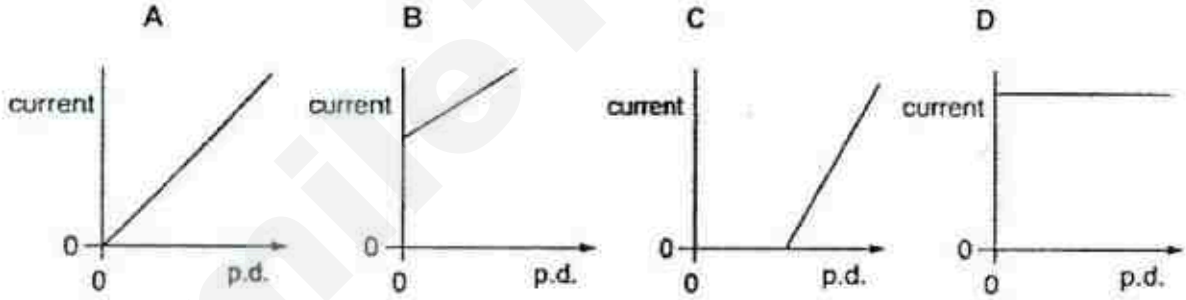
Which of the following statements is correct?



A The large sphere will acquire a net negative charge.
B The charges on the small sphere will be neutralized.
C A momentary conventional current will flow from the small sphere.
D Both spheres are at the same potential after equilibrium is established.

26. When the potential difference (p.d.) across a piece of resistance wire is changed, the current through the wire also changes. The temperature of the wire is kept the same.

Which graph shows how the p.d. and current are related?



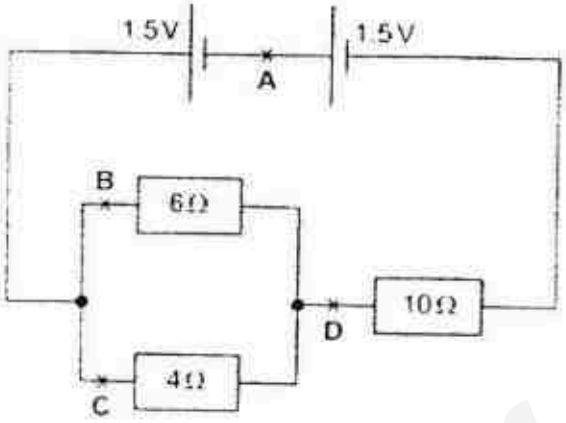
27. The resistance of a piece of constantan wire P is 5.0 Ω.

What is the resistance of another piece of constantan wire of twice the length and twice the cross sectional area of P?

A 2.5 Ω B 5.0 Ω C 10 Ω D 20 Ω

[Turn over]

28. In the circuit shown, at which point is the current the smallest?

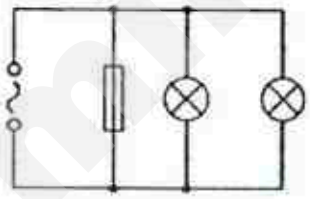


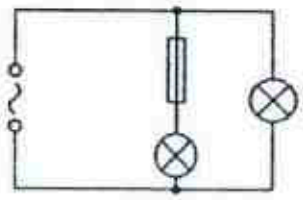
29. Which statement is not correct for lamps connected in parallel?

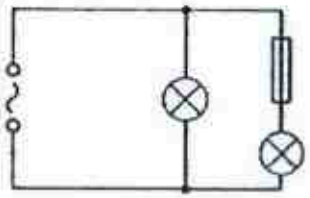
A They can be switched on and off separately.
B They will remain as bright as before if another lamp is connected in parallel.
C They share the supply voltage equally between them.
D They still operate if one lamp is removed.

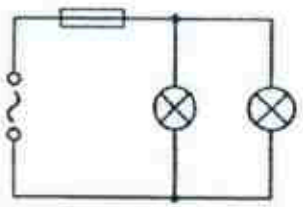
30. A student makes four circuits.

In which circuit are both lamps protected by the fuse?

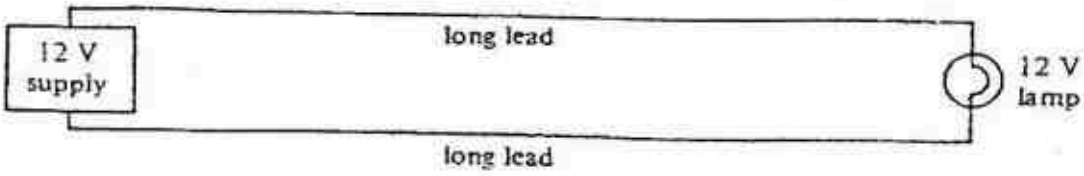
A


B


C


D


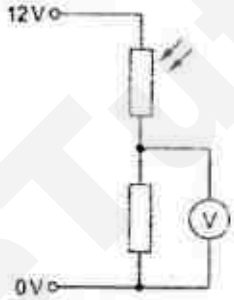
31. A 12 V lamp is connected to a 12 V supply with very long leads as shown.



Why does the lamp glow dimly?

A The current through the lamp is less than the current from the supply.
B The p.d. across each lead will be half the supply voltage.
C Electrical energy is converted to heat in the long leads.
D A d.c. supply is being used rather than an a.c. supply.

32. The diagram shows part of an electric circuit.

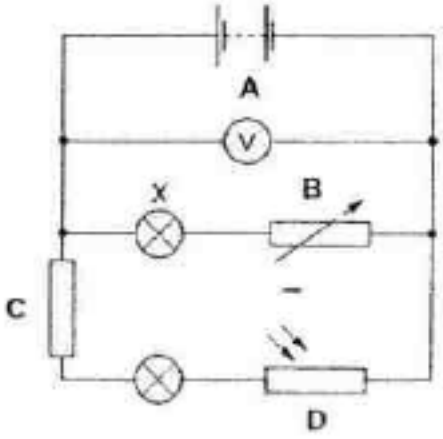


The light falling on the light-dependent resistor (LDR) increases in brightness.

What happens to the resistance of the LDR and what happens to the reading on the voltmeter?

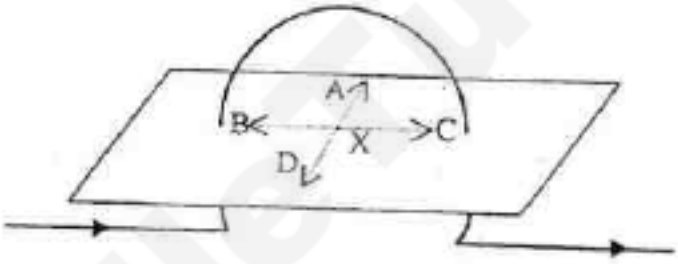
	resistance of LDR	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

33. Which labelled component in the circuit shown controls the brightness of lamp X?

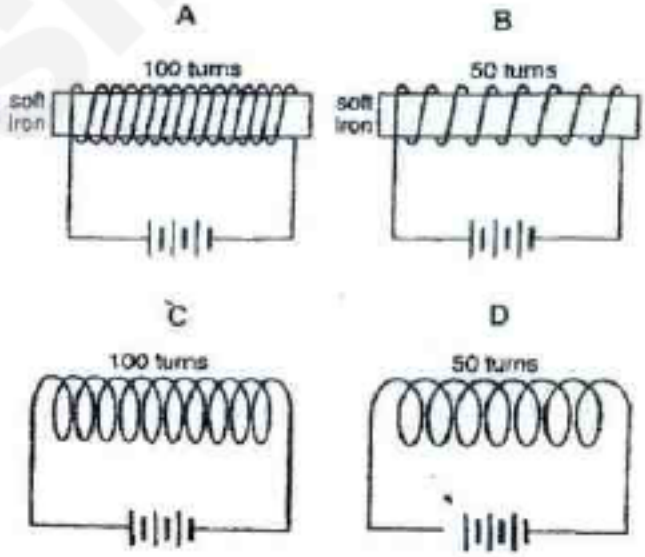


34. A compass is placed at point X on the cardboard as shown in the diagram.

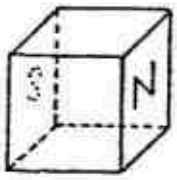
Which direction will the north pole of the compass needle point towards?



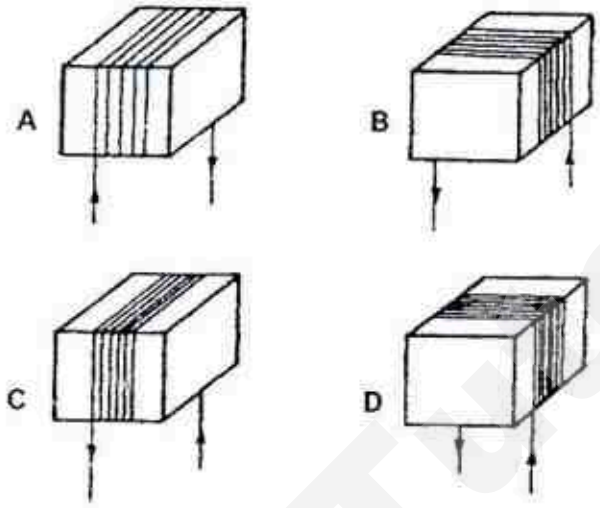
35. Given that the voltage of the battery in each case is the same, which of the following electromagnets has the strongest magnetic field?



36. John wants to produce a steel bar with its polarity as shown in the figure below.

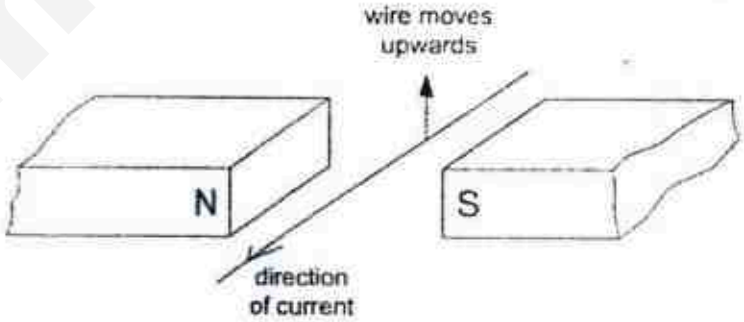


Which of the following windings and direction of currents will give rise to such a magnet?



37. A student carries out an experiment to see the effect of a magnetic field on a wire carrying a current.

The wire moves upwards as shown.

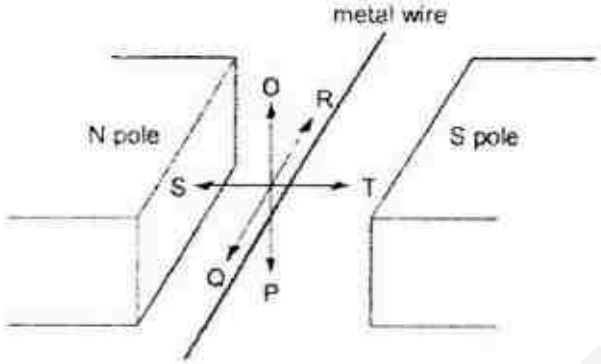


What should the student do to make the wire move downwards?

A change the direction of the current
B move the poles of the magnet closer together
C send a smaller current through the wire
D use a stronger magnet

38. A metal wire is placed between the poles of a magnet.

The wire can be moved in each of three directions OP, QR and ST.



In which direction or directions must the wire be moved to induce an e.m.f. across the ends of the wire?

A OP only **B** OP or ST **C** QR **D** ST only

39. A beam of cathode rays passes through an electric field between two parallel plates.

In which direction is the beam deflected?

A into the page
B out of the page
C towards the bottom of the page
D towards the top of the page

40. An input voltage of 10 V is supplied to the primary coil of a transformer. An output voltage of 40 V is produced across the secondary coil.
The 10 V supply at the primary coil is now replaced with a 40 V supply.

What is the new output voltage across the secondary coil?

A 10V **B** 40V **C** 70V **D** 160V

END

Answers to 2017 Prelim 5059 Paper 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	A	C	C	B	C	B	B	B	B	A	C	B	D	B	B	C	A	C	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	A	B	A	D	A	B	B	C	D	C	B	B	A	A	~~B~~ C	A	A	D	D

Name: _____ Class: _____ Index No. : _____

ST JOSEPH'S INSTITUTION

PRELIMINARY EXAMINATION 2017
SECONDARY 4 (O-LEVEL PROGRAMME)

PHYSICS

5059/01

Paper 1 Multiple Choice

22 August 2017
1 hour
(1130 – 1230)

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper.

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

There are **forty** 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.
Unless otherwise stated, take gravitational field strength, g, to be **10 N/kg**.

At the end of the examination, submit the Question Paper and Answer Sheet SEPARATELY.

For Examiner's Use	
Total	40

This Question Paper consists of 19 printed pages.

1 A car with an initial speed of 2.0 m/s accelerates uniformly for 5.0 s and travels a distance of 24 m during this period. Determine its acceleration.

A 0.40 m/s^2
B 1.1 m/s^2
C 1.5 m/s^2
D 7.6 m/s^2

2 A car, which was travelling due east at a speed of 3.6 m/s initially, changes direction and travels due west at a speed of 6.2 m/s. Taking the direction to the east as positive, determine the change in speed and velocity.

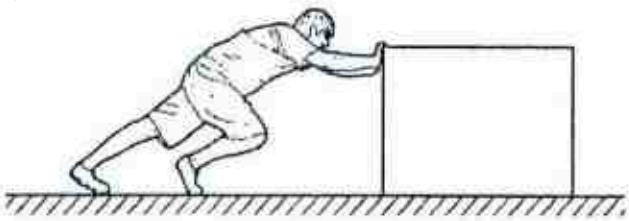
	Change in speed (m/s)	Change in velocity (m/s)
A	2.6	-2.6
B	9.8	2.6
C	2.6	9.8
D	2.6	-9.8

3 A student drops, from rest, a table-tennis ball in air.

What happens to the velocity and to the acceleration of the ball during the first few seconds after release?

	velocity	acceleration
A	decreases	stays constant
B	decreases	increases
C	increases	decreases
D	increases	increases

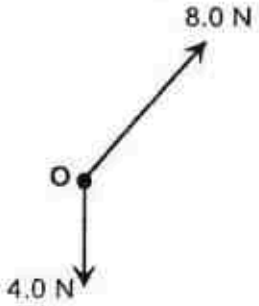
4 A boy pushes a heavy box along the ground.



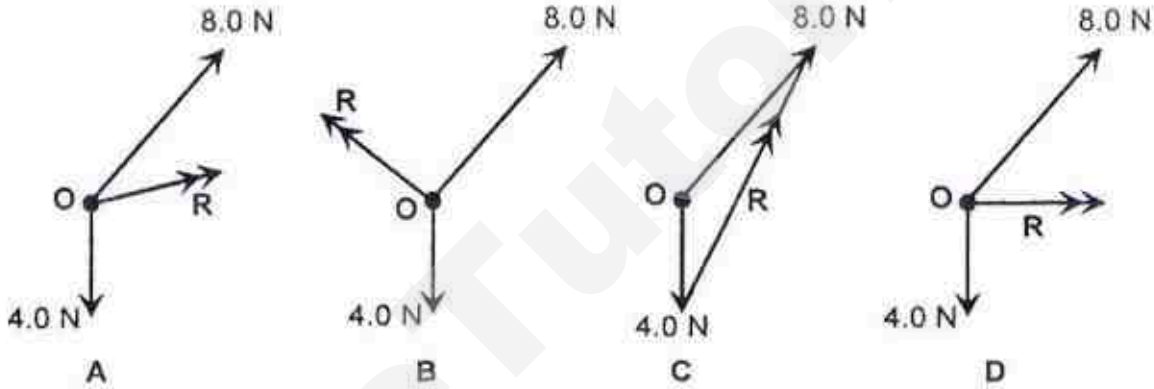
There is a force acting between the boy's hands and the box, and another acting between his feet and the floor. In which direction do these forces act on the boy?

	force on boy's hands	force on boy's feet
A	towards the left	towards the left
B	towards the left	towards the right
C	towards the right	towards the left
D	towards the right	towards the right

5 Two forces, 8.0 N and 4.0 N, act on an object **O** as shown.

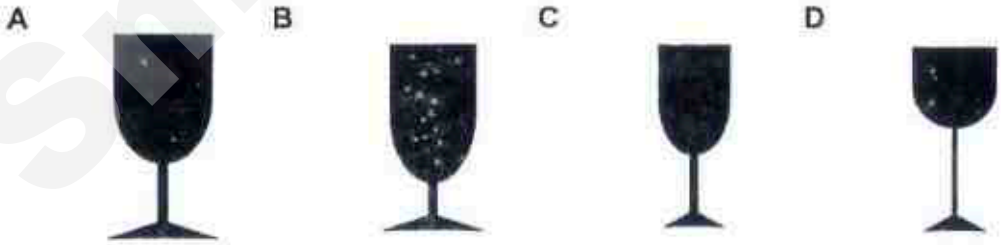


Which of the following shows the resultant force **R** acting on the object **O**?

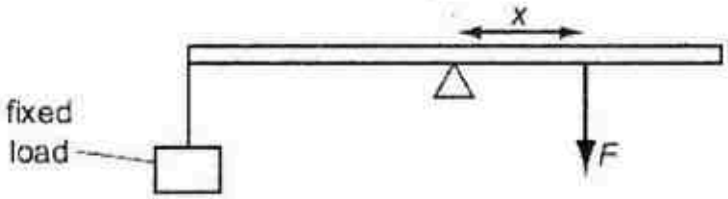


6 The side view silhouette of four wine glasses are shown.

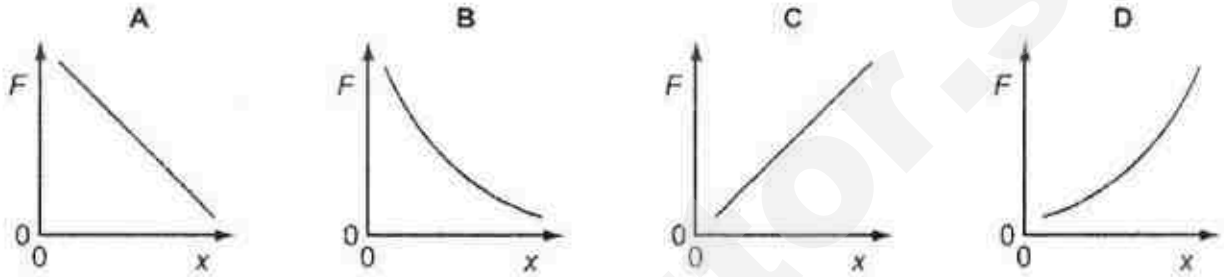
When filled with the same liquid to the brim, which glass is the *least* stable?



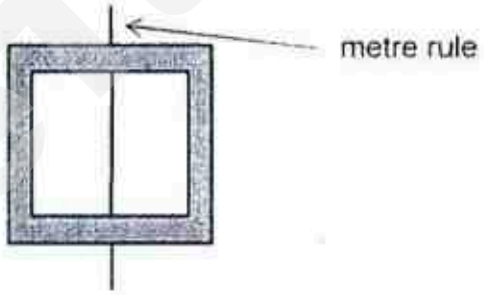
7 A horizontal bar is pivoted at its centre of gravity. A fixed load is attached at one end of the bar. To keep the bar in equilibrium, a force F is applied at a distance x from the pivot.



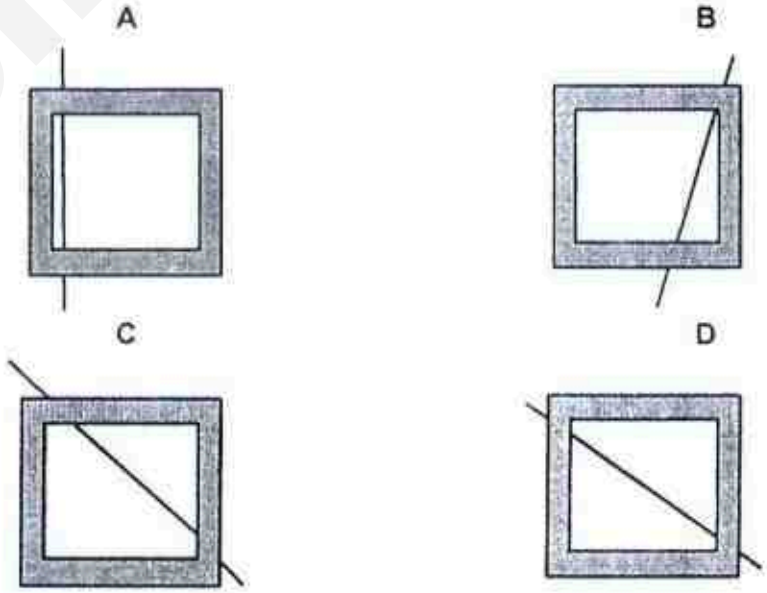
How does F vary with x?



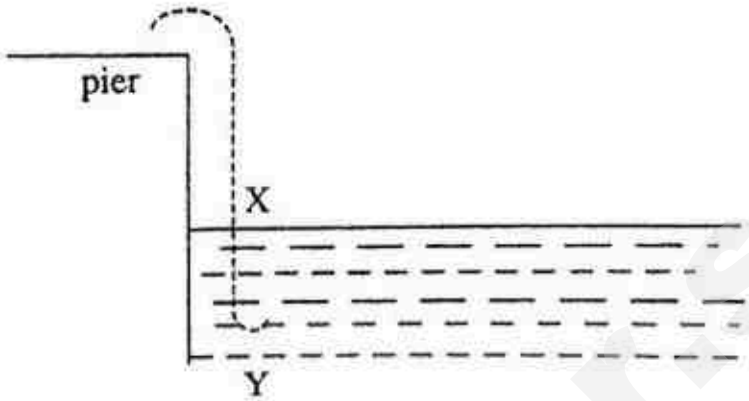
8 A square lamina of uniform thickness and with a square hole is balanced horizontally on the edge of a metre rule as shown.



Which of the following positions will the lamina also balance on the metre rule?



9 A log thrown from a pier into water enters the water at point **X** as shown in the figure. The log descends to point **Y** and then floats up the surface. Taking the gravitational potential energy at point **X** to be zero, which of the following statements is/are correct?



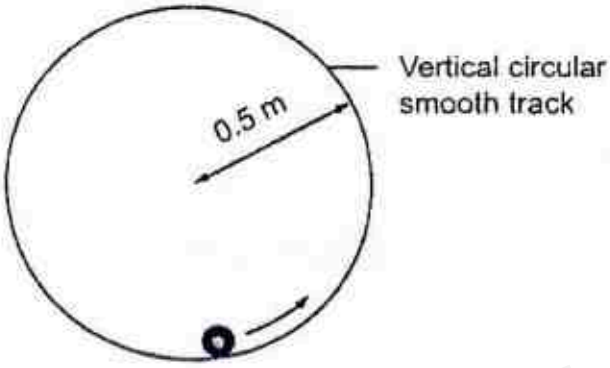
(1) The kinetic energy of the log at point **Y** is maximum.
(2) The sum of the gravitational potential energy and kinetic energy of the log at point **Y** is zero.
(3) The kinetic energy of the log at point **Y** is a minimum.

A (1) only
B (3) only
C (1) and (2) only
D (2) and (3) only

10 A toy rocket moves upwards so that it can reach a maximum height of 45 m in 0.050 s. If the mass of the toy rocket is 0.20 kg, find its average output power.

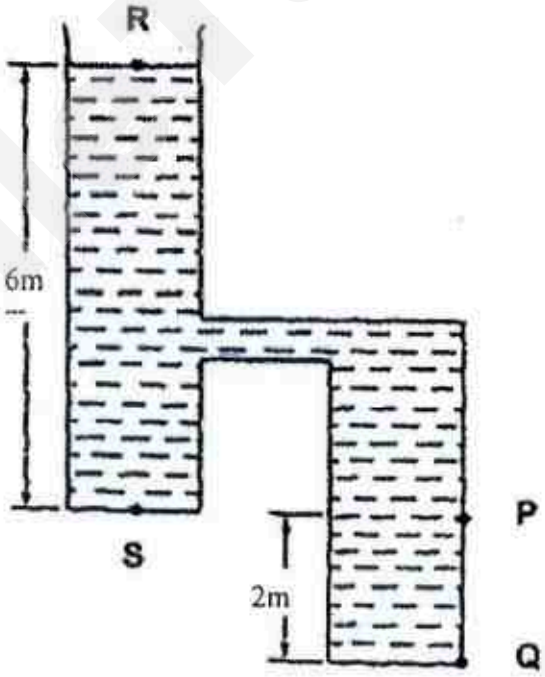
A 1800 W
B 900 W
C 450 W
D 30 W

11 A ball is moving along a smooth circular vertical track with a radius of 0.50 m as shown in the figure. Determine the speed of the ball at the lowest point if it has a speed of 4.0 m/s at the highest point.



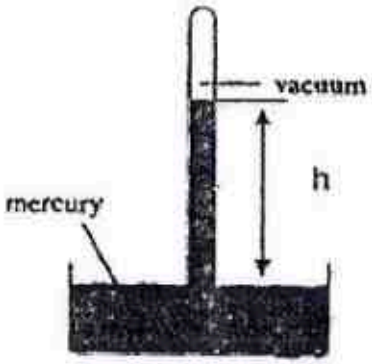
A 4.0 m/s
B 4.5 m/s
C 5.1 m/s
D 6.0 m/s

12 The following figure shows a container of liquid. The pressure at R is 1×10^5 N/m^2 and the pressure at S is 1.6×10^5 N/m^2. What is the pressure (in N/m^2) at P and Q?



	P	Q
A	1.6×10^5	1.8×10^5
B	6.0×10^5	8.0×10^5
C	1.6×10^5	3.6×10^5
D	1.0×10^5	3.0×10^5

13 The figure below shows the height h of the mercury in the barometer on Earth.

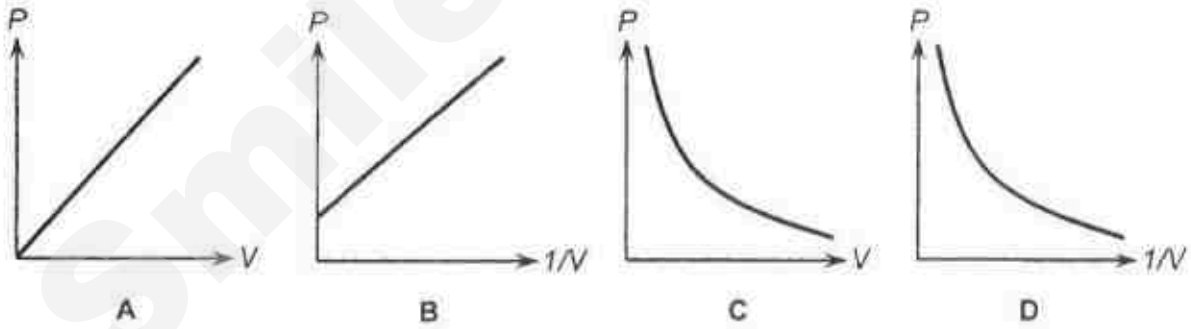


The barometer is taken to another planet where the atmospheric pressure is half that on Earth and the acceleration due to gravity is double that on Earth.

What height of mercury is recorded on the planet?

A h/4
B h/2
C h
D 2h

14 Which of the following shows the relationship between pressure (P) and volume (V) of a gas at constant temperature?



15 A boy sits on the floor, a few metres in front of a heater in a room as shown below.

The following statements comment on how fast thermal energy from the heater reaches the boy via radiation.

(I) The hotter the heater, the faster the thermal energy reaches the boy

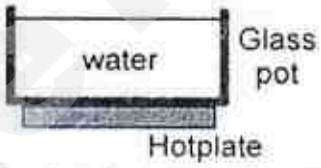
(II) How fast the thermal energy reaches the boy depends on how fast the air molecules between him and the heater transfer the energy

(III) The speed of the thermal energy is approximately equal to the speed of light in air

Which of the statement(s) is/are correct?

A I & II
B I & III
C II & III
D Only III

16 The figure below shows a glass pot filled with water, placed on a hotplate.



How is thermal energy from the hotplate transferred to the surface of the water?

A Conduction only
B Convection only
C Conduction and Convection
D Conduction, Convection and Radiation

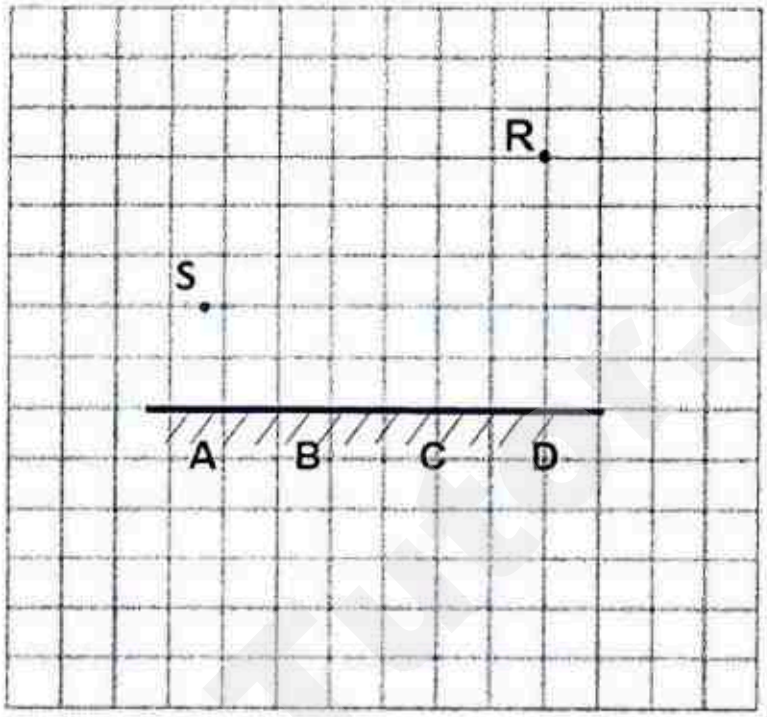
17 A solid of mass m and specific heat capacity c is placed in a liquid which has a mass of $2m$. The heat capacity of the liquid is twice that of the solid. Given that the initial temperatures of the solid and liquid are 30°C and 80°C respectively, what is the final temperature of the liquid, assuming no heat is lost to the surroundings?

A 63.3°C
B 65.0°C
C 70.0°C
D 72.5°C

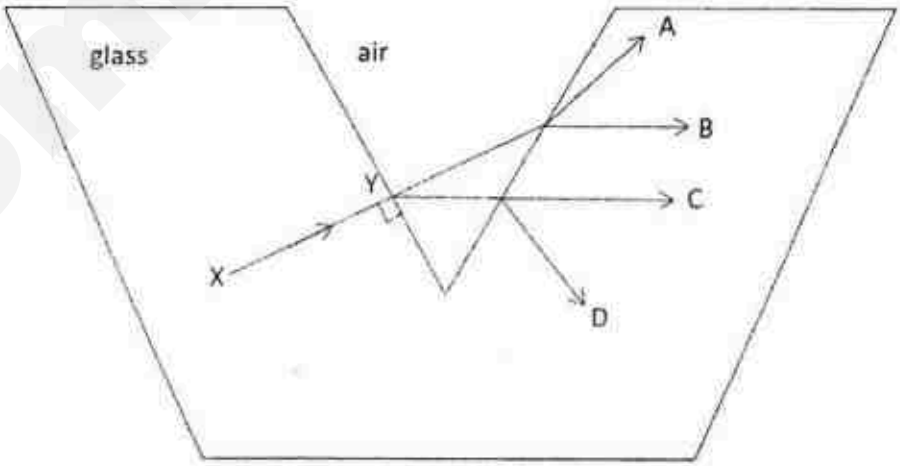
18 When a liquid evaporates, its temperature is lowered. Which of the following is the correct explanation for this observation?

A The liquid lost heat to the surroundings
B The average kinetic energy of the molecules in the liquid decreased
C The total internal energy of the liquid decreased
D The total kinetic energy of the molecules in the liquid decreased

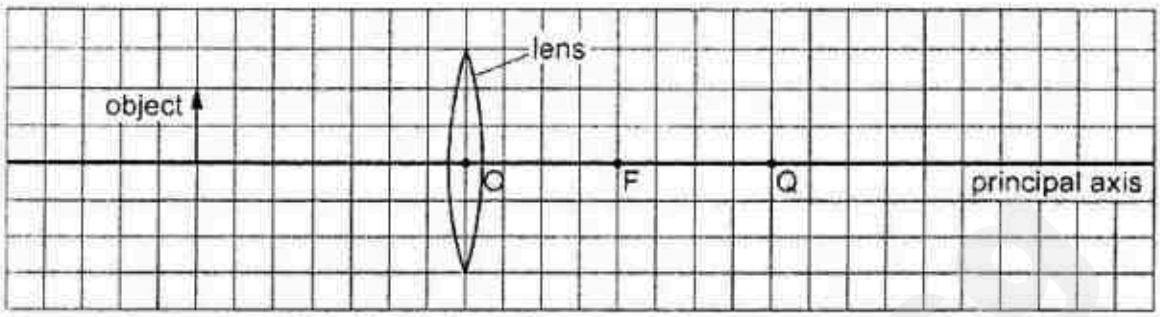
19 A lamp is placed at point **R** in front of a mirror as shown in the diagram. A boy stands in front of the mirror and the position of his eye is indicated by point **S** in the diagram. Locate the point (**A**, **B**, **C** or **D**) on the mirror where an incident ray of light from the lamp would reflect into the boy's eye.



20 A light ray **XY** is incident at a glass-air boundary as shown in the diagram. Which direction, **A**, **B**, **C** or **D**, shows the path that **XY** will take after leaving the glass-air boundary?



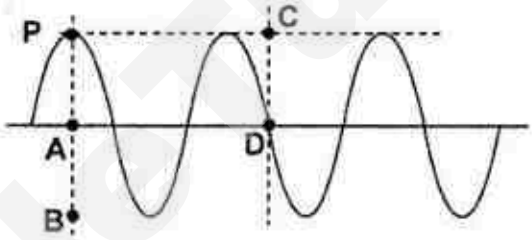
21 The diagram shows an object on the principal axis of a converging (convex) lens. A principal focus of the lens is at F.



Where is the image formed by the lens?

A Between O and F
B Between F and Q
C At Q
D To the right of Q

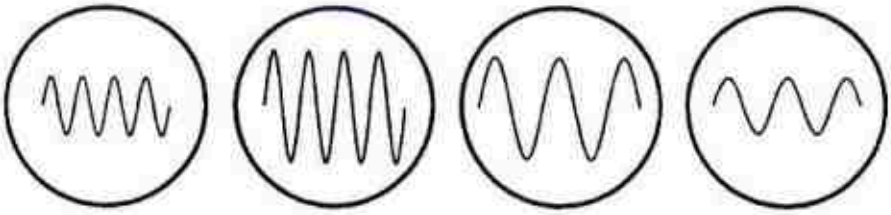
22 The figure below shows the position of a point **P** on a wave at t = 0 s. Given that T is the period of the wave, what would be the position of **P** at t = 1.25 T?



23 Which of the following correctly shows electromagnetic waves arranged in order of increasing wavelength?

A microwave, visible light, gamma rays
B x-ray, infra-red radiation, visible light
C x-ray, visible light, microwave
D radio waves, ultraviolet, visible light

24 The diagrams show the oscilloscope traces produced by different sounds. Which diagram corresponds to the loudest sound of the lowest pitch?

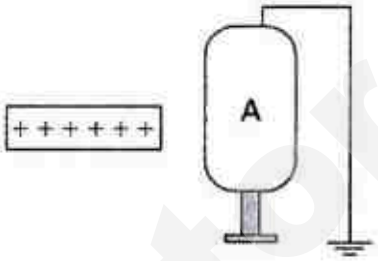


A B C D

25 Which of the following represents the correct order of the speed of sound in solids, liquids and gases?

	Increasing speed of sound →		
A	solid	liquid	gas
B	liquid	solid	gas
C	liquid	gas	solid
D	gas	liquid	solid

26 The figure below shows a positively charged rod brought near a conductor **A**, which is mounted on an insulating stand. What happens in conductor **A** when it is earthed as shown in the diagram?



A Protons in conductor **A** are repelled into the earth, giving **A** a net negative charge

B The earth connection does not have any effect because it is connected to the top of the conductor

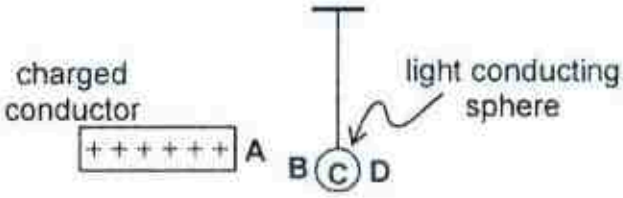
C Protons in **A** are repelled by the positively charged rod, making the left side of **A** negatively charged and its right side positively charged

D Electrons are attracted from the earth into conductor **A**, giving it a net negative charge

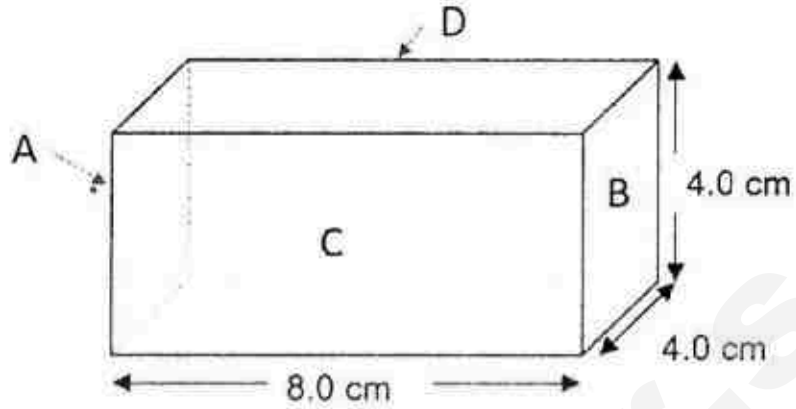
27 The figure below shows a light and neutral conducting sphere suspended by an insulated thread near a charged conductor.

The sphere moves towards and touches the charged conductor.

In which position will the light conducting sphere come to rest?



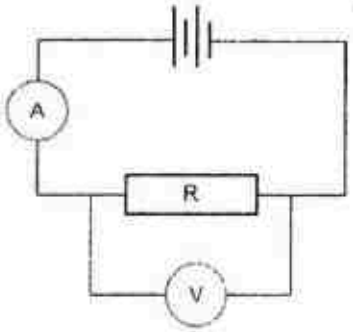
28 A section of a rectangular conductor is shown in the figure below.
Face A is directly opposite face B and face C is directly opposite face D.



A potential difference applied across the faces **A** and **B**, which are 8.0 cm apart results in a current of magnitude **I** flowing from **A** to **B**. What is the corresponding current when the same potential difference is applied across the faces **C** and **D**, which are 4.0 cm apart?

A I/2
B 2I
C 4I
D 5I

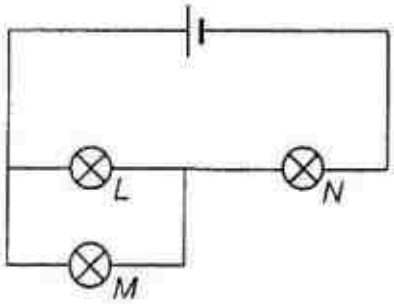
29 In the circuit shown below, a voltmeter of resistance R_V and an ammeter of resistance R_A are used to measure the resistance R of a fixed resistor.



Which condition is necessary for an accurate value to be obtained for **R**?

A **R** is much smaller than R_V.
B **R** is much smaller than R_A.
C **R** is much greater than R_V.
D **R** is much greater than R_A.

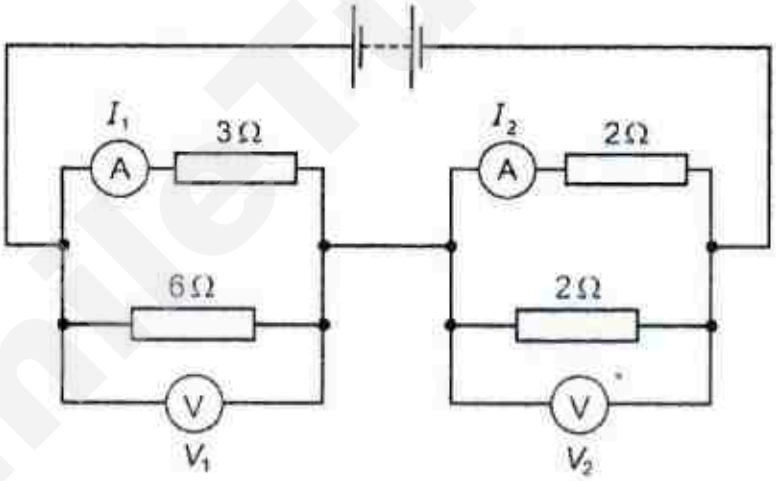
30 In the circuit shown, a battery is connected to three identical bulbs (*L*, *M*, and *N*).



The filament in bulb *M* breaks. Which of the following correctly states the *change* in brightness of bulbs *L* and *N*?

	Bulb *L*	Bulb *N*
A	Increases	Stays the same
B	Stays the same	Decreases
C	Decreases	Increases
D	Increases	Decreases

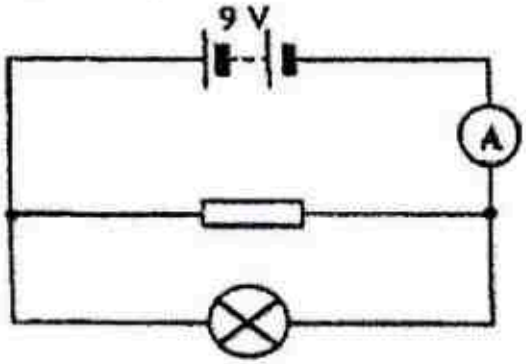
31 In the circuit shown, two ammeters and two voltmeters record the currents I_1, and I_2, and p.d., V_1, and V_2.



Which statement is correct?

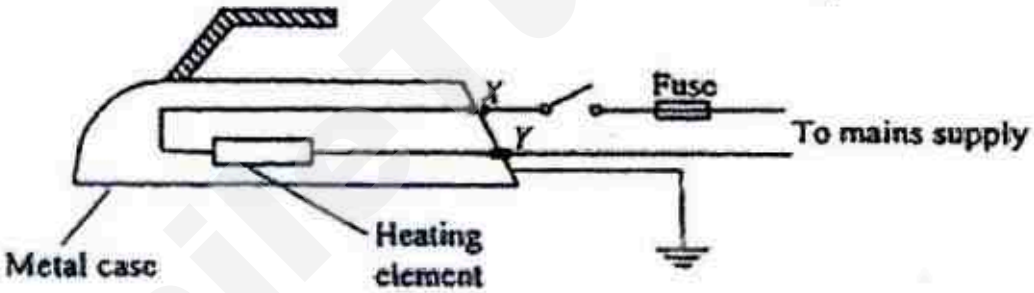
A $I_1 > I_2$ and $V_1 > V_2$
B $I_1 > I_2$ and $V_1 < V_2$
C $I_1 < I_2$ and $V_1 > V_2$
D $I_1 < I_2$ and $V_1 < V_2$

32 A resistor and a bulb are connected in parallel to a 9.0V battery as shown below. The reading of the ammeter is 5A. If the power dissipated by the resistor is 18W, what is the power dissipated by the bulb?



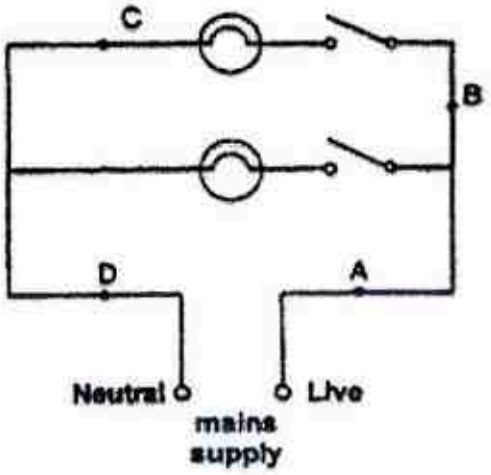
A 9.0 W
B 18 W
C 23 W
D 27 W

33 The diagram below shows the main parts of an electric iron. In which of the following situations will the fuse blow when the switch is closed?



A The insulation at contact point X is worn out so that the wire touches the metal case.
B The insulation at contact point Y is worn out so that the wire touches the metal case.
C The heating element is broken.
D The Earth wire is removed from the electric iron.

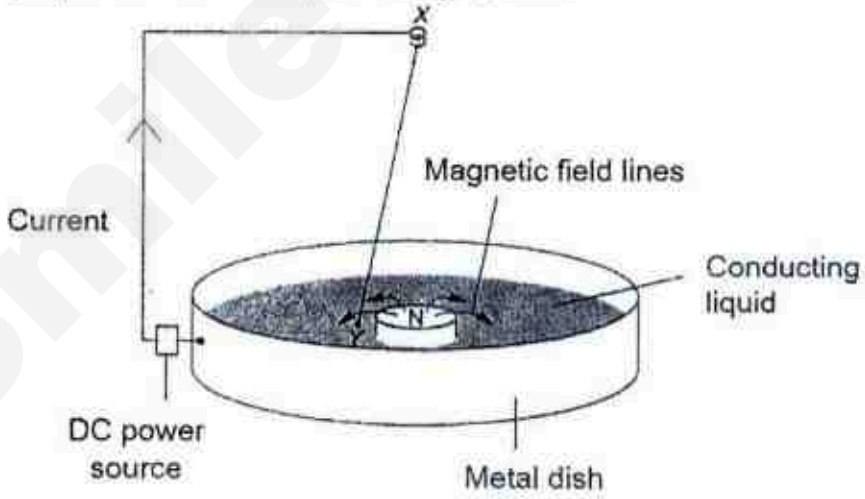
34 The diagram shows two lamps in a lighting circuit. At which location, A, B, C or D, should a fuse be placed?



35 Which of the following is the best choice for the material of a compass needle?

A Iron
B Steel
C Copper
D Plastic

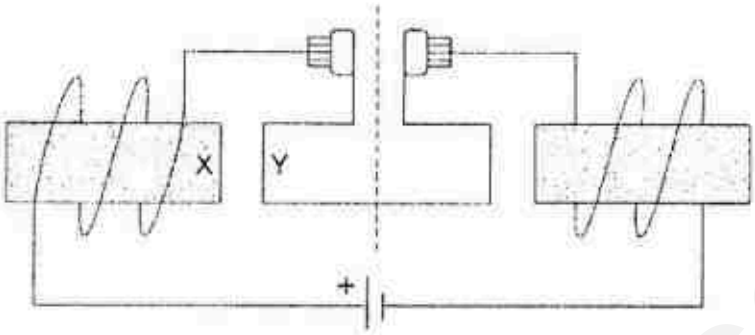
36 In the figure below, one end of a wire **Y** is immersed in a conducting liquid while the other end **X** which is connected to a battery, is free to rotate. The direction of the current in the circuit is indicated. A cylindrical magnet is placed in the centre of the conducting liquid with the North pole facing upwards.



In which direction will the wire **XY** move?

A Clockwise
B Anticlockwise
C Towards the magnet
D Away from the magnet

37 The figure shows a DC motor with the parts indicated in the key beside it.



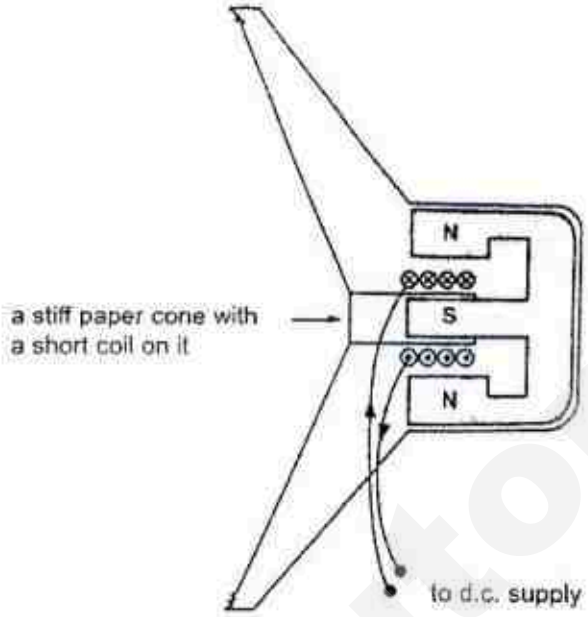
Key

- Iron core
- Split-ring commutator
- Brush
- Axis of rotation

What is the polarity of the magnetic pole at **X**, and the direction of the motion of wire **Y**?

	Polarity of magnetic pole at X	Direction of motion of wire Y
A	South	Into the page
B	South	Out of the page
C	North	Into the page
D	North	Out of the page

38 The figure shows the side view of a loudspeaker with a direct current flowing in the coil. The coil is wound around a cardboard cylinder, which is attached to the middle of a stiff paper cone. Determine the direction of motion of the stiff paper cone when the current flows in the direction shown.



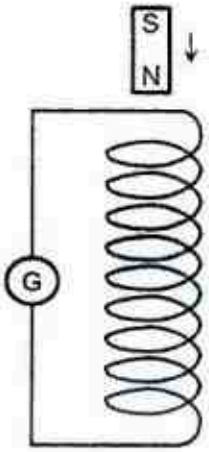
A Upwards

B Move downwards

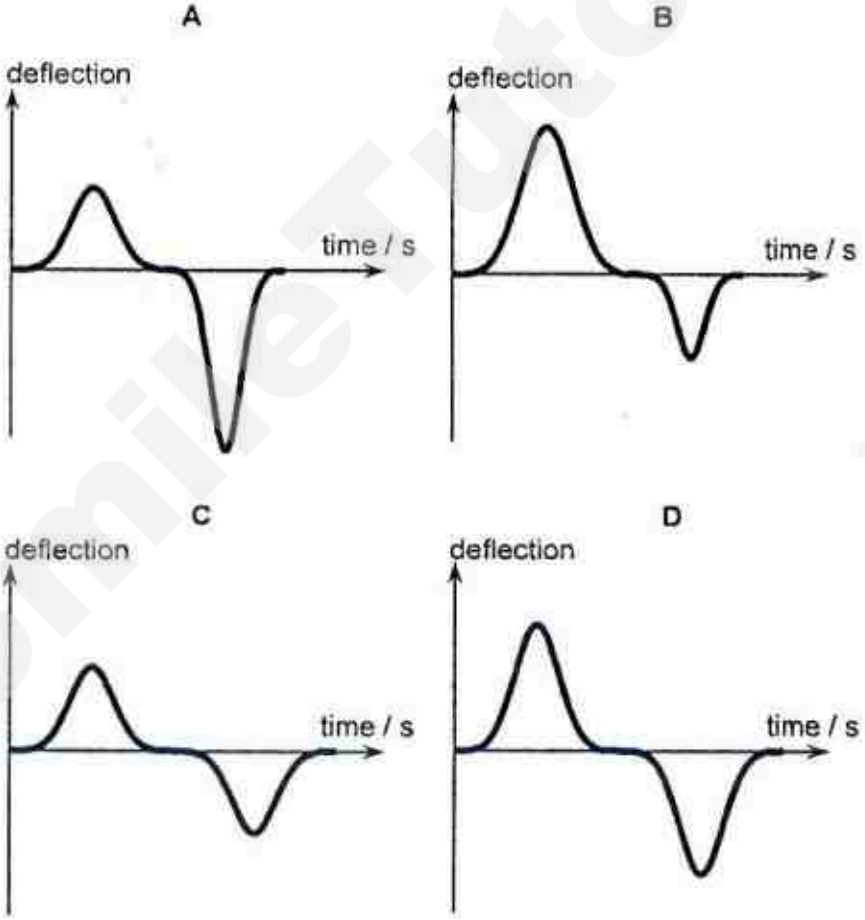
C To the left

D To the right

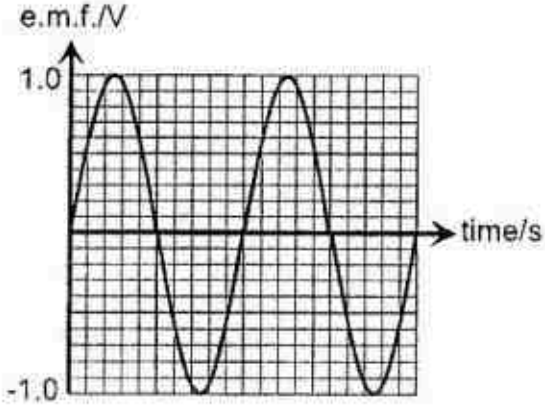
39 A permanent magnet falls freely through a solenoid, that is connected to a galvanometer, G.



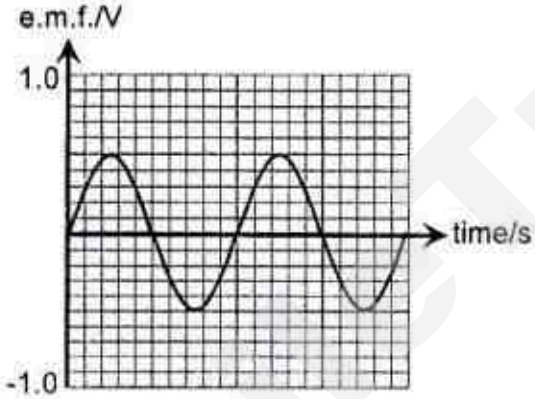
Which of the following shows the amount of deflection recorded by the galvanometer?



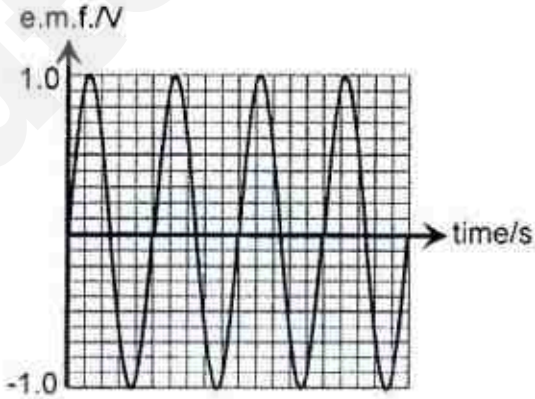
40 A simple a.c. generator is connected to a C.R.O. The coil rotates at a constant speed, and induced e.m.f. is recorded as shown.



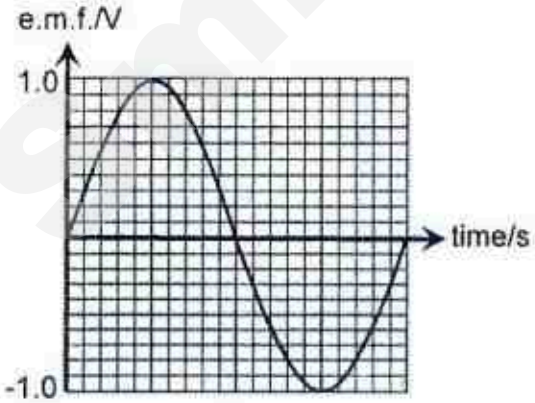
Which of the following will show on the C.R.O. when the speed of the coil rotation is halved?



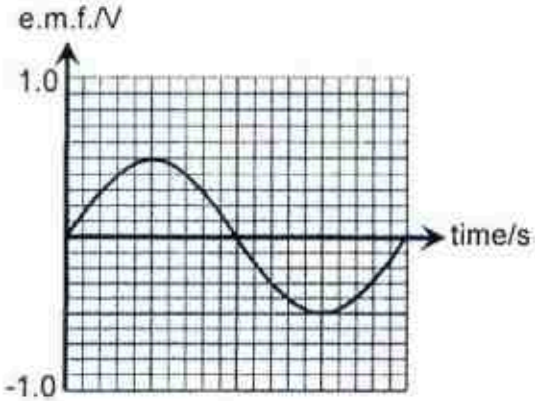
A



B



C



D

Answers

Paper 1

1	B		21	D
2	D		22	A
3	C		23	C
4	B		24	C
5	A		25	D
6	D		26	D
7	B		27	D
8	D		28	C
9	B		29	A
10	A		30	D
11	D		31	A
12	A		32	D
13	A		33	A
14	C		34	A
15	D		35	B
16	D		36	A
17	A		37	A
18	B C D		38	C
19	B		39	A
20	B		40	D

ST. MARGARET'S SECONDARY SCHOOL

Preliminary Examinations 2017

CANDIDATE NAME

CLASS REGISTER NUMBER

PHYSICS **5059/01**

Paper 1 Multiple Choice **24 August 2017**

Secondary 4 Express **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 register number on the cover page and on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** 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 19 printed pages.

1 **Fig. 1.1** shows the readings on a pair of vernier calipers when its jaws are closed and there is nothing clamped in between its jaws. **Fig 1.2** shows the length of a block being measured by the same pair of vernier calipers.

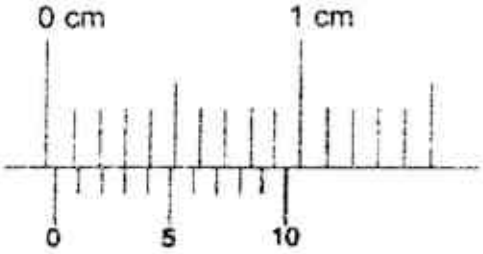


Fig. 1.1

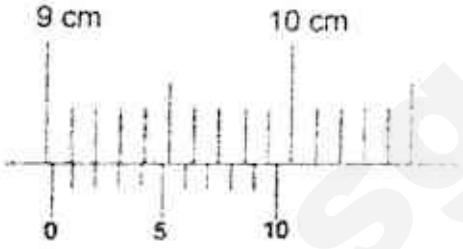


Fig. 1.2

What is the actual length of this block?

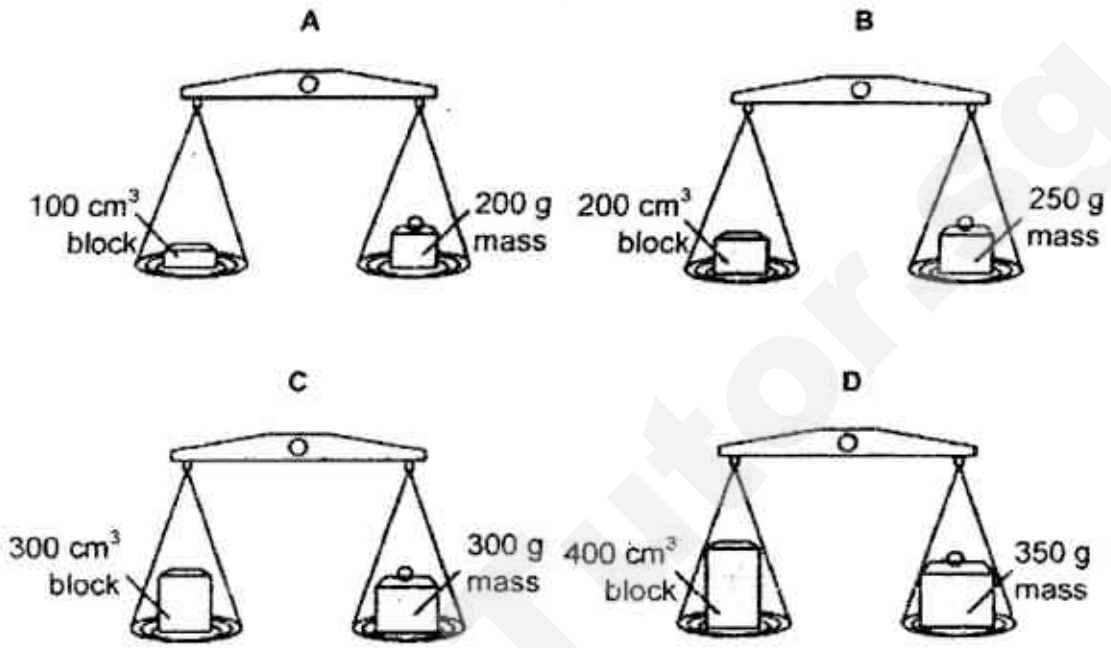
A 8.95 cm **B** 8.99 cm **C** 9.05 cm **D** 9.09 cm

2 Which pair shows the correct scalar and vector quantities?

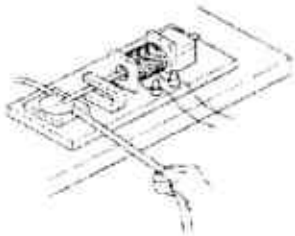
	scalar	vector
A	displacement	acceleration
B	force	kinetic energy
C	moment	speed
D	power	velocity

3 Four blocks, each made from a different material, are placed on the left side of a scale and balanced as shown in the diagrams below.

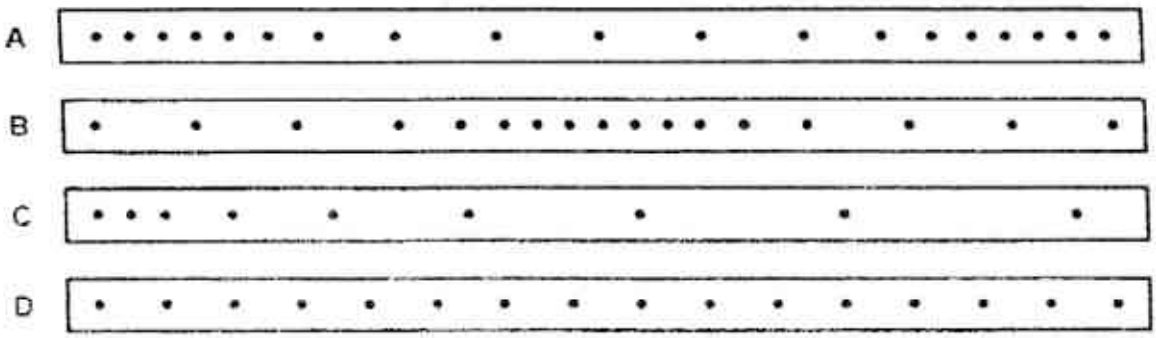
In which diagram does the block have the lowest density?



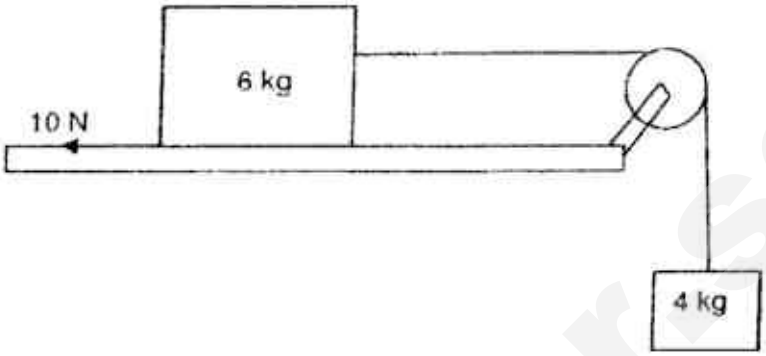
4 A student pulls a piece of tape through a ticker-tape timer. Every 0.02 s, the timer prints a dot on the tape. First the tape is pulled quickly, then slowly, then quickly again.



Which piece of tape does the student obtain?



5 The figure below shows a box of 6 kg sliding along a rough surface. A smaller box of 4 kg is pulling on the box of 6 kg. There is a friction of 10 N acting on the box. Take gravitational field strength to be 10 N/kg.



What is the tension in the string?

A 8 N B 28 N C 30 N D 40 N

6 Object X has a mass of 10 kg and object Y has a mass of 60 kg. The gravitational field strength on the Earth and on the Moon are 10 N/kg and 1.6 N/kg respectively.

Which statement about objects X and Y is correct?

A The inertia of X on the Earth is greater than its inertia on the Moon.

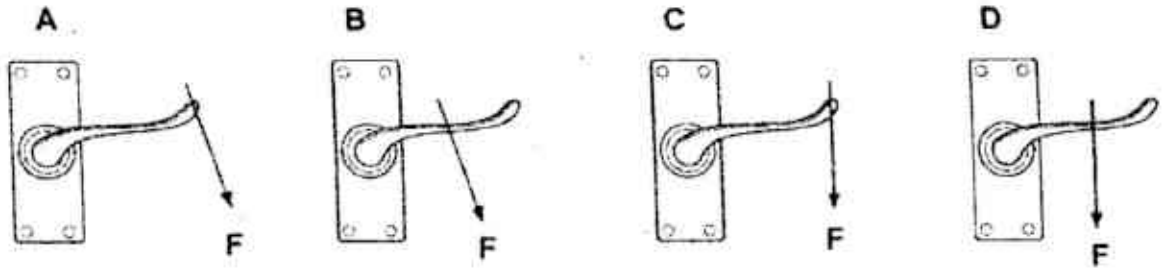
B The weights of X and Y do not change when they are taken from the Earth to the Moon.

C X experiences the same gravitational field strength as Y on the Moon.

D X has about the same weight on the Moon as Y has on the Earth.

7 The diagrams show a force of magnitude F being applied to the same door handle.

Which diagram shows the greatest moment?



8 Which of the following objects is in neutral equilibrium?

A A balancing toy which returns to its original position when displaced.

B A cone resting on its circular base.

C A cylinder resting on its curved surface.

D A heavy circular disc resting on its circular base.

9 Car X is travelling at half the speed of car Y and has twice the mass of car Y.

Which statement is correct?

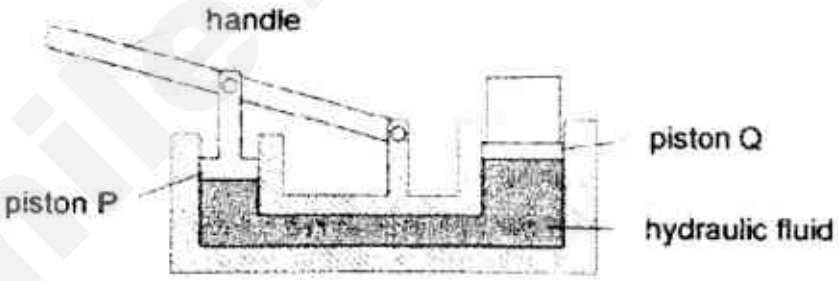
A Car X has half the kinetic energy of car Y.

B Car X has one quarter of the kinetic energy of car Y.

C Car X has twice the kinetic energy of car Y.

D The two cars have the same kinetic energy.

10 The diagram below shows a simple hydraulic jack used to lift heavy objects. The diameter of piston P is 2.0 cm and that of piston Q is 10.0 cm. A load of mass 55 kg is placed on piston Q.



What force is required at the handle to lift the load?

A 2.8 N B 18 N C 22 N D 28 N

11 **Fig. 11.1** shows an open-ended capillary tube in horizontal position with air trapped by a small, stationary column of mercury 12 cm in length.

Fig. 11.2 shows the same capillary tube in an upright position.
The atmospheric pressure is 75 cm Hg.

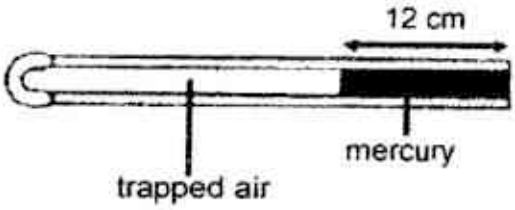


Fig. 11.1

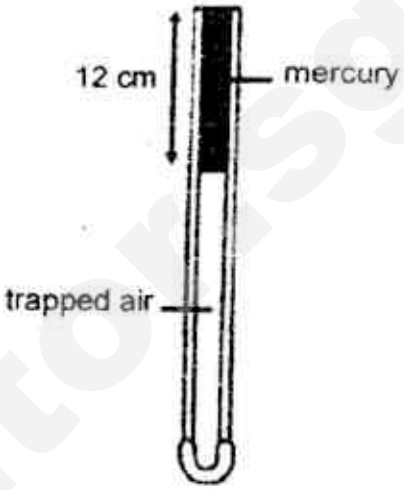
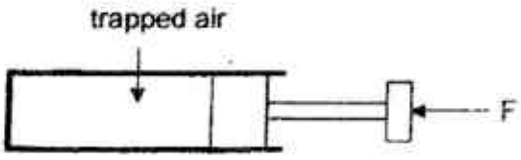


Fig. 11.2

What is the pressure of the trapped column of air in **Fig. 11.1** and **11.2**?

	Fig 11.1	**Fig. 11.2**
A	63 cm Hg	75 cm Hg
B	63 cm Hg	87 cm Hg
C	75 cm Hg	63 cm Hg
D	75 cm Hg	87 cm Hg

12 A tube with a movable piston is shown in the figure below. The piston is pushed in slowly by a constant force F.



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

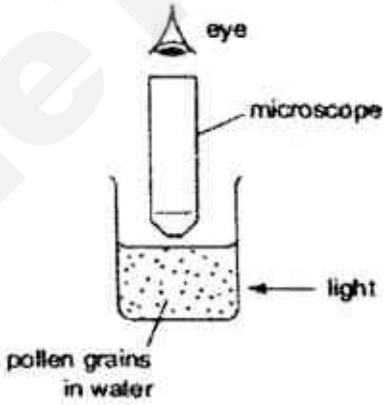
A The air pressure inside the tube increases.

B The frequency of collision between the air particles and the tube increases.

C The spacing between the air particles decreases.

D The volume of the air particles decreases.

13 Very small pollen grains are suspended in a beaker of water. A bright light is shone from the side. Small, bright dots of light are seen through a microscope. The dots move in rapidly changing, random directions.



What are the bright dots?

A pollen grains being hit by other pollen grains

B pollen grains being hit by water molecules

C water molecules being hit by other water molecules

D water molecules being hit by pollen grains

14 A faulty thermometer reads 10 °C and 90 °C when placed in melting ice and steam respectively. If this thermometer is uniformly graduated, what is the true

temperature when the thermometer reads 40 °C?

A 24.0 °C
B 34.0 °C
C 37.5 °C
D 47.5 °C

15 Which one of the following is **not** suitable for use as a temperature scale?

A e.m.f. produced by junctions formed with wires of two different metals

B the pressure of a fixed mass of gas at constant volume

C the resistance of a metal wire

D the volume of a column of water

16 In the process of convection, energy is transferred

A because of density differences in a fluid.

B because of temperature differences in a solid.

C by the diffusion of molecules through a fluid.

D by the vibration of molecules about a fixed position .

17 Certain physical characteristics of a polar bear help it to reduce heat loss in winter. Which of the following characteristics are correct?

1 Its white coat reduces heat loss through radiation.
2 A layer of fat under its skin reduces heat loss through conduction.
3 The thick fur reduces heat loss through convection.

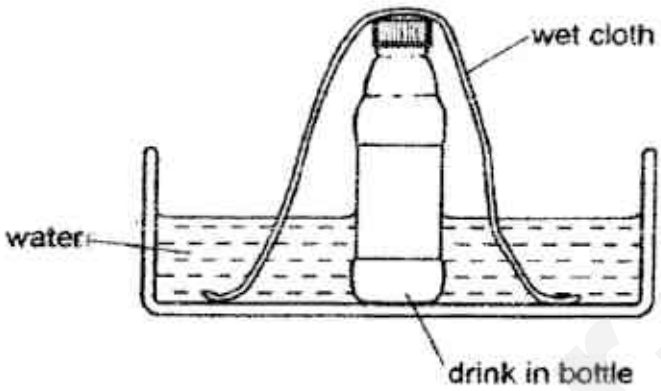
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D All of the above

18 On a hot day, the drink in a bottle can be kept cool by standing the bottle in a bowl of water and placing a wet cloth over it.



How is the drink kept cool?

A Cold air cannot escape from the bottle.

B The cloth conducts heat from the bottle into the water.

C The drink cannot evaporate from the bottle.

D Water evaporating from the cloth cools the drink.

19 A 200 W heater is immersed in a filter funnel of crushed ice.

The table below shows the mass of water collected from the melting ice 1.0 minute before and after the heater is switched on.

Before heater is switched on	10 g
After heater is switched on	50 g

What is the specific latent heat of fusion of ice?

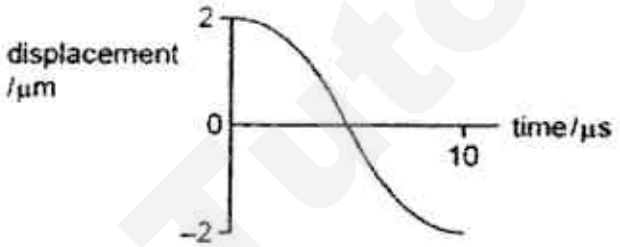
A 5.00 J/g B 240 J/g C 300 J/g D 1200 J/g

20 A sound wave is traveling from air to glass.

How will the speed, frequency and wavelength change as it enters glass?

	Speed of wave	Frequency	Wavelength
A	decrease	increase	decrease
B	decrease	no change	decrease
C	increase	no change	increase
D	no change	decrease	increase

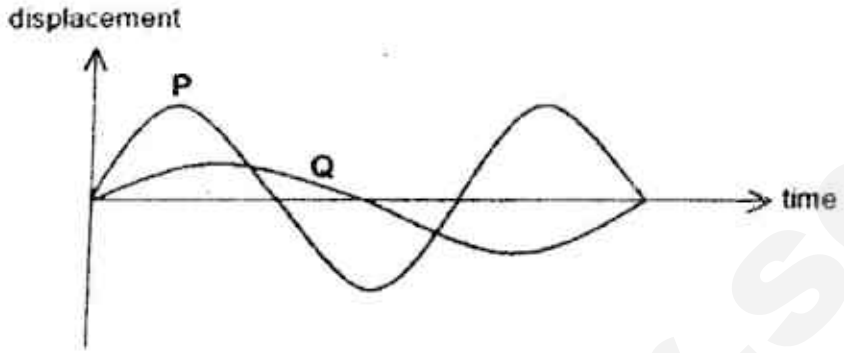
21 The graph shows the variation in the displacement of a particle in a progressive wave with respect to time.



Which row gives the correct values of the frequency and amplitude of the particle?

	frequency/kHz	amplitude/μm
A	25	2.0
B	25	4.0
C	50	2.0
D	50	4.0

22 The diagram below shows two notes **P** and **Q** produced by two different instruments.



Which of the following statements about notes **P** and **Q** is correct?

A **P** has a higher pitch than **Q**, and is softer than **Q**.

B **P** has a higher pitch than **Q**, and is louder than **Q**.

C **P** has a lower pitch than **Q**, and is softer than **Q**.

D **P** has a lower pitch than **Q**, and is louder than **Q**.

23 The diagram represents some of the main parts of the electromagnetic spectrum.

P	Infrared	Q	R	S	Gamma ray

What are P, Q, R and S?

	P	Q	R	S
A	radio wave	ultraviolet	visible light	x-ray
B	radio wave	visible light	ultraviolet	x-ray
C	visible light	ultraviolet	x-ray	radio wave
D	visible light	ultraviolet	radio wave	x-ray

24 Which of the following is **not** true about electromagnetic waves?

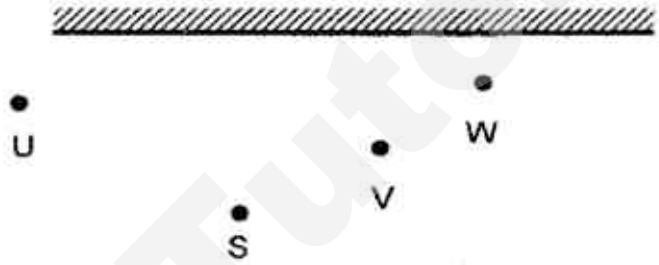
A Gamma rays are more harmful than radio waves.

B Infrared radiation is transverse in nature.

C Microwaves can travel through vacuum.

D Ultraviolet radiation travels faster than infrared radiation in air.

25 The diagram below shows a mirror. Four students stand at positions S, U, V and W respectively.



Which student images can S see in the mirror?

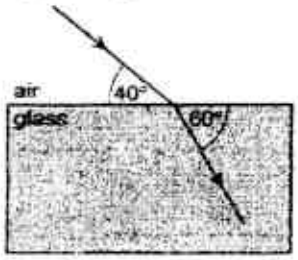
A U only

B V only

C V and W only

D U, V and W

26 The diagram shows a ray of light passing from air into a glass block.



The angle between the ray and the edge of the glass block is 40° in the air and 60° in the glass. The speed of light in air is 3.0×10^8 m/s.

What is the speed of light in the glass block?

A 2.0×10^8 m/s

B 2.2×10^8 m/s

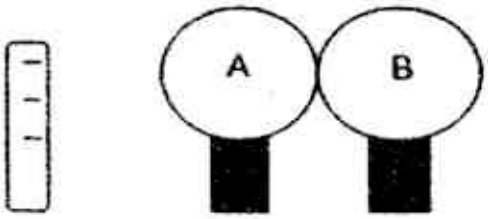
C 4.0×10^8 m/s

D 4.6×10^8 m/s

27 The number of wavelengths of visible light in one metre is of the order of

A 10^4. B 10^6. C 10^8. D 10^{10}.

28 Two insulated and uncharged metal spheres, A and B, are touching each other as shown below.



A negatively-charged rod is placed near sphere A, and sphere A becomes positively charged.

What will the charge on B be?

A Positive, and equal in magnitude to that on sphere A

B Negative, and equal in magnitude to that on sphere A

C Positive, but smaller in magnitude than that on sphere A

D Negative, but smaller in magnitude than that on sphere A

29 A conductor carries a current of 2.0 A.

Given that each electron carries a charge of -1.6×10^{-19} C, what is the number of electrons that flow through a point in the conductor in 0.20 s?

A 1.6×10^{18} **B** 2.5×10^{18} **C** 1.6×10^{19} **D** 2.0×10^{19}

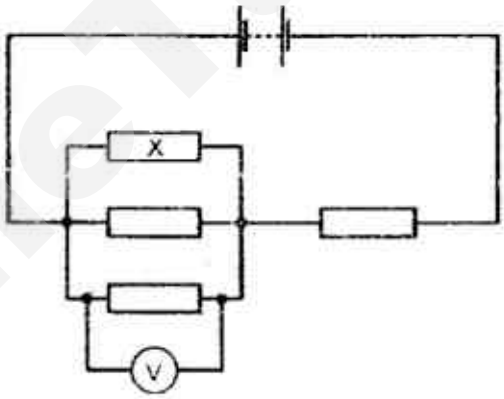
30 Wires A and B have the following ratios.

$$\frac{\text{length } L_A}{\text{length } L_B} = \frac{1}{3} \; ; \quad \frac{\text{diameter } D_A}{\text{diameter } D_B} = \frac{2}{3} \; ; \quad \frac{\text{resistivity } \rho_A}{\text{resistivity } \rho_B} = \frac{4}{9}$$

What is the ratio of the resistance of wire A to wire B?

A 1 : 3 **B** 2 : 9 **C** 8 : 81 **D** 16 : 243

31 Four identical resistors are connected in a circuit as shown.

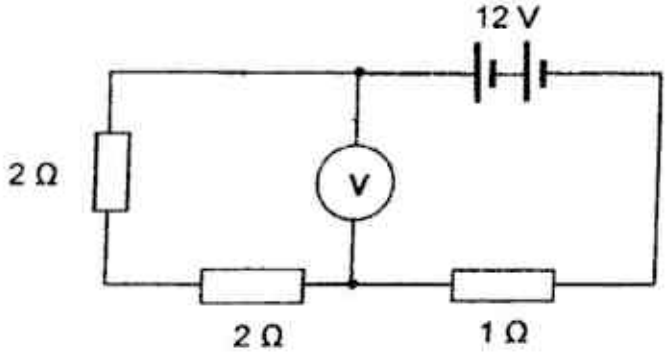


The voltmeter reads 6.0. The battery has negligible internal resistance.

What can be correct values for the potential difference across resistor X and the e.m.f. of the battery?

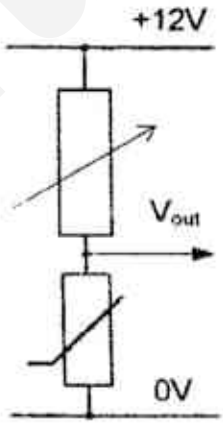
	potential difference across X / V	e.m.f. of battery / V
A	2.0	6.0
B	6.0	6.0
C	6.0	12.0
D	6.0	24.0

32 What will the voltmeter reading in the circuit shown be?



A 0 V
B 6 V
C 9.6 V
D 12 V

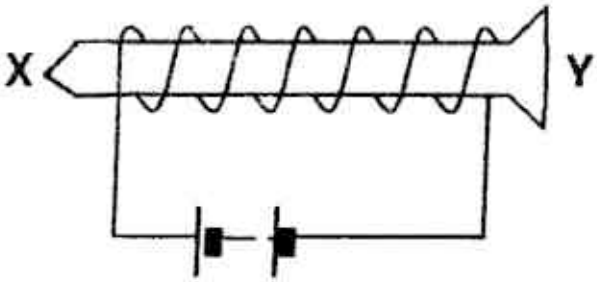
33 The circuit below shows a thermistor that is connected to a power supply of 12 V and a rheostat. The resistance of a thermistor will increase when the surrounding temperature decreases, and vice versa.



If the resistance of the rheostat is increased, which statement explains how the surrounding temperature near the thermistor should change so that the V_{out} remains unchanged?

	temperature	reason
A	decreases	resistance of thermistor increases
B	decreases	resistance of thermistor decreases
C	increases	resistance of thermistor increases
D	increases	resistance of thermistor decreases

34 A soft iron nail, XY, is placed within a current-carrying solenoid for a shorwhile as shown below.



Which of the following is true?

A End X will be able to repel a copper nail placed in current-carrying solenoid.

B End X will be attracted to the north-seeking pole of a bar magnet.

C End Y will be repelled by the south-seeking pole of a bar magnet.

D End Y will point to the North Pole of the earth when freely suspended.

35 The figure shows a bar magnet resting on a turn-table. A plotting compass is placed in front of the magnet as shown.

When the turn-table starts to rotate in an anti-clockwise direction, the compass needle will

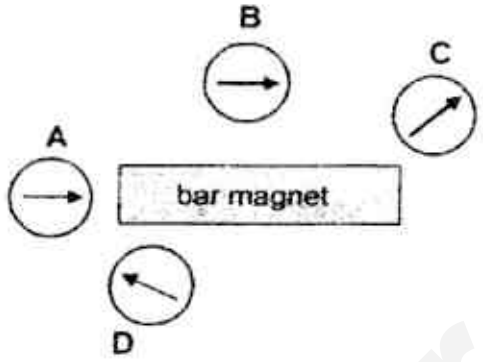
A rotate anti-clockwise.

B rotate clockwise.

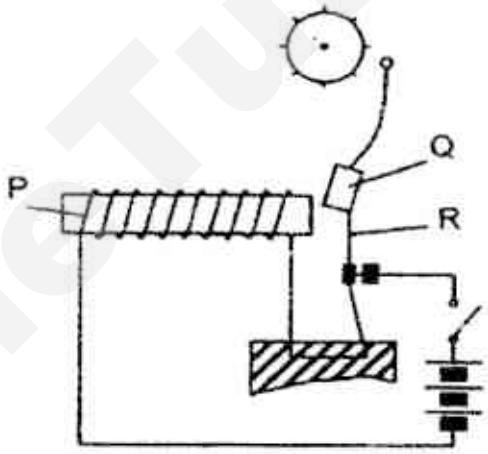
C oscillate.

D remain stationary.

36 Four magnetic compasses are placed near a bar magnet as shown in the figure below. Which compass is faulty?

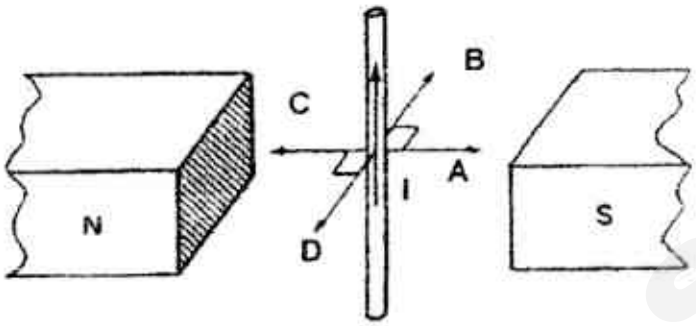


37 In an electric bell, what are parts P, Q and R made of?



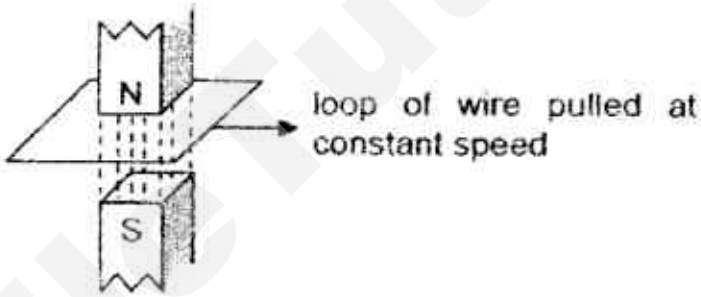
	P	Q	R
A	copper	soft-iron	spring steel
B	copper	steel	spring steel
C	steel	soft-iron	copper
D	steel	steel	copper

38 A current carrying conductor (carrying a current, **I**) is placed between two magnetic poles as shown.

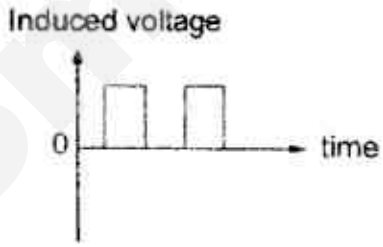


Along which direction (**A**, **B**, **C** or **D**) is a force acting on the wire?

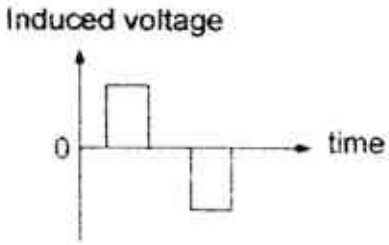
39 The diagram shows a rectangular loop of wire being pulled to the right through a magnetic field at constant speed.



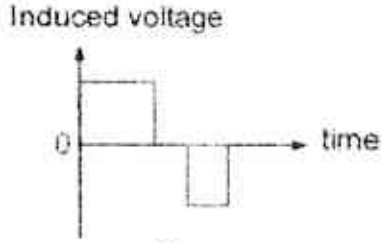
Which of the following graphs shows how the induced voltage in the loop of wire varies with time?



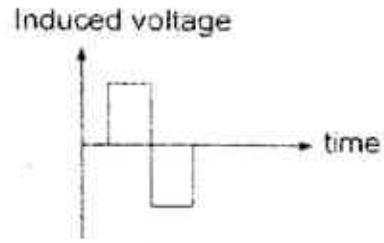
A



B

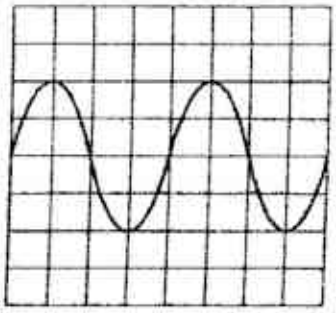


C



D

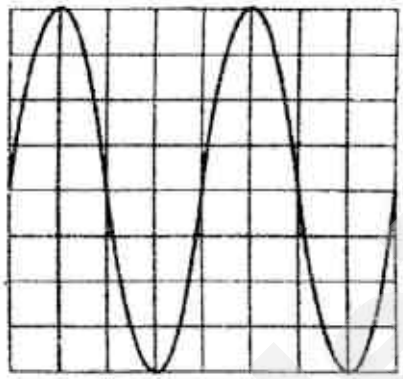
40 The following trace is seen on the screen of a cathode-ray oscilloscope.



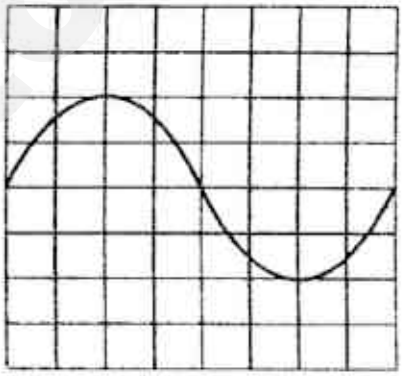
The setting of the time base is then changed from 10 ms/cm to 20 ms/cm and the Y-sensitivity is unaltered.

Which trace is now seen on the screen?

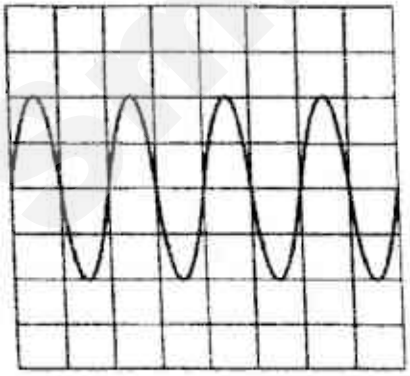
A



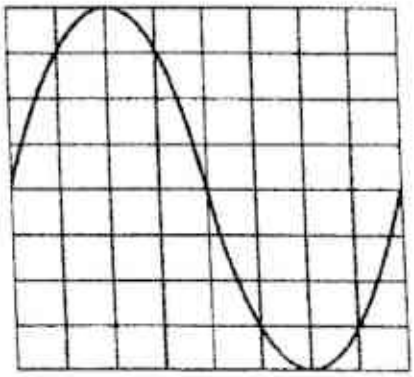
B



C



D



1) B
2) D
3) D
4) B
5) B
6) C
7) A
8) C
9) A
10) C
11) D
12) D
13) B
14) C
15) D
16) A
17) A
18) D
19) C
20) C
21) C
22) B
23) B
24) D
25) D
26) A
27) B
28) B
29) B
30) A
31) D
32) C
33) A
34) C
35) B
36) B
37) A
38) B
39) B
40) C

Section A

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

1 Fig. 1.1 shows the horizontal forces acting on a car moving on a straight level road. You may assume that the friction between the car and the road is constant.

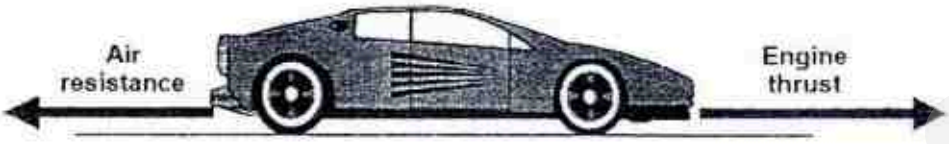


Fig. 1.1

Fig. 1.2 shows the speed-time graph for the first 24 s of the motion of the car along the straight level road.

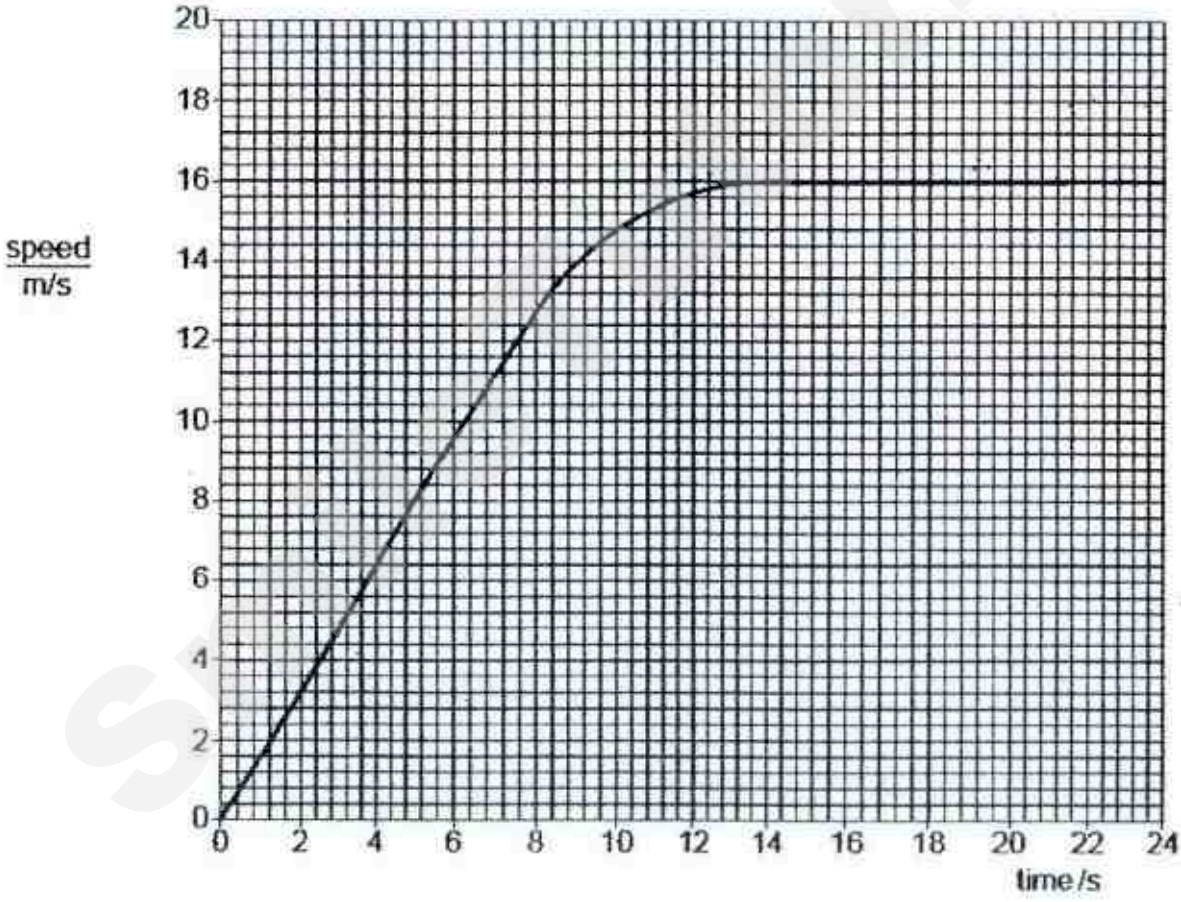


Fig. 1.2

(a) Determine the acceleration of the car during the first 8 s.

acceleration = ... [1]

(b) Determine the distance travelled by the car in the first 6 s.

distance travelled = ... [1]

(c) Use Newton's laws to explain why the acceleration of the car decreases to zero eventually.

.....

.....

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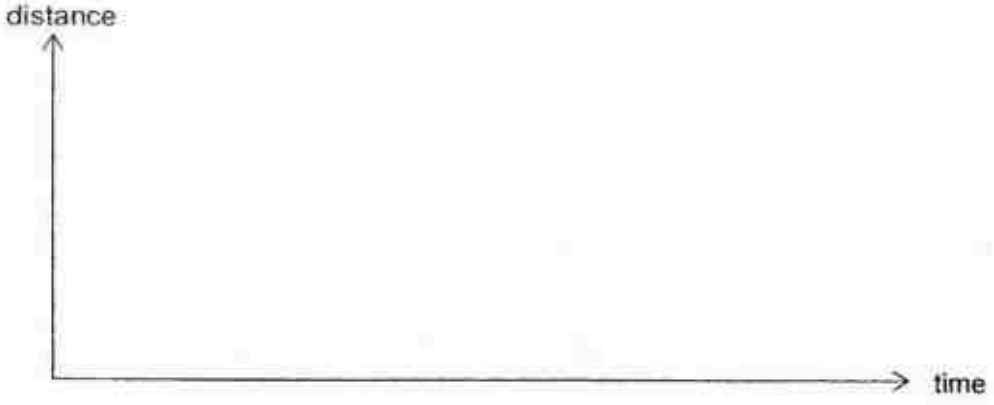
.....

.....

..... [3]

(d) In the axes below, sketch the distance-time graph of the car for the first 24 s. You do not need to give any details on both axes. [2]



2 In a space mission to the Moon, a spacecraft enters the Moon's gravitational field and descends towards the Moon's surface. Halfway through the descent, a piece of equipment became detached from the spacecraft and descends towards the Moon's surface on its own. There is no atmosphere present on the Moon, and the gravitational field strength of the Moon is one-sixth of that on Earth.

(a) Define the terms **(i)** *gravitational field* and **(ii)** *gravitational field strength*.

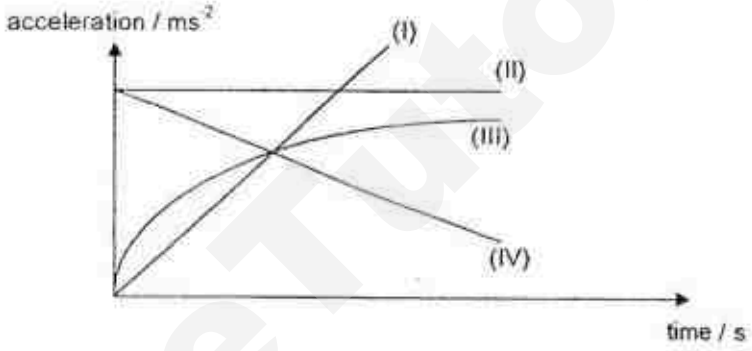
.....

.....

.....

..... [2]

(b) Which acceleration-time graph below – (I), (II), (III) and (IV) – best represents the motion of the spacecraft and the detached piece of equipment?



Spacecraft : acceleration-time graph ..... [1]

Detached equipment : acceleration-time graph ..... [1]

3 Fig. 3.1 shows a firefighter of total weight 840 N in equilibrium at the top of a ladder that is pivoted at point P.

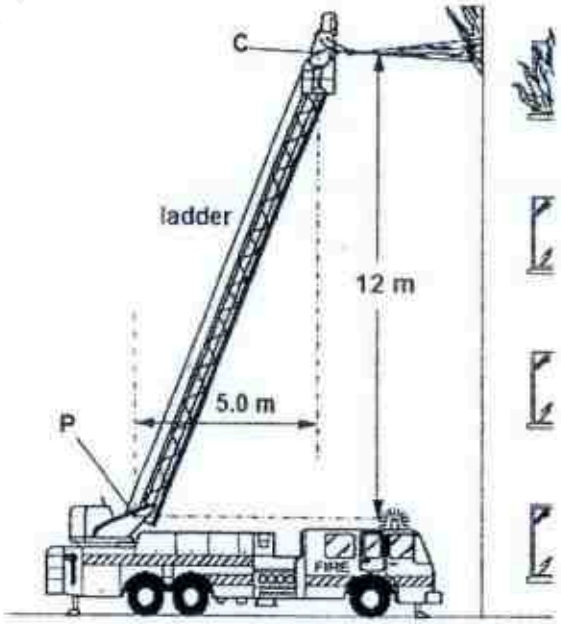


Fig. 3.1

Question continues on next page...

The ladder leans towards a burning building at an angle such that the centre of gravity **C** of the firefighter is 12 m above and 5.0 m to the right of **P**. The firefighter holds a hose that directs a high-speed jet of water horizontally into a burning building.

(a) Calculate the moment *M* of the firefighter's weight about **P**.

moment *M* = ... [2]

(b) The jet of water causes a horizontal force *R* on the firefighter that acts towards the left, through **C**. This opposes the turning effect of his weight. Calculate the magnitude of force *R* that, on its own, ensures that *M* is exactly cancelled.

force *R* = ... [2]

(c) Suggest a third force that has a clockwise turning effect about **P** on the ladder.

..... [1]

4 500 g of water at a temperature of 16°C enters an ice-making machine and emerges as ice cubes at a temperature of −5°C. The freezing point of water is 0°C. Given that:

- specific heat capacity of water = 4.2 J/(g°C)
- specific latent heat of fusion of water = 336 J/g
- specific latent heat of vaporization of water = 2260 J/g
- specific heat capacity of ice = 2.1 J/(g°C)

Calculate the thermal energy removed from

(a) the water during freezing,

thermal energy = ... [2]

(b) the frozen water as it cools further.

thermal energy = ... [2]

(c) Using ideas about molecules, suggest why more energy is needed to change water into steam than to change the same mass of water into ice.

.....

..... [1]

5 In cold countries, people wear coats that are designed to reduce the rate at which thermal energy is lost from their bodies.
The material for some coats is made from a layer of thin strips of silver-coloured plastic between two layers of fabric, as shown in Fig. 5.1.

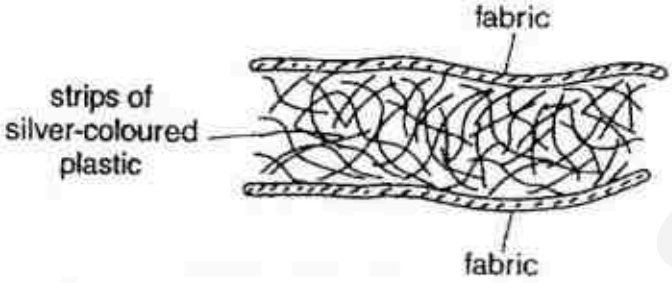


Fig. 5.1

The plastic strips trap small pockets of air between them.
Explain why the layer of silver-coloured plastic strips reduces loss of thermal energy by

(a) conduction,

.....

.....

.....

..... [2]

(b) convection,

.....

..... [1]

(c) radiation.

.....

..... [1]

6 Fig. 6.1 shows a ray of light passing through a semi-circular plastic block.
Q is the centre of the straight side of the block.

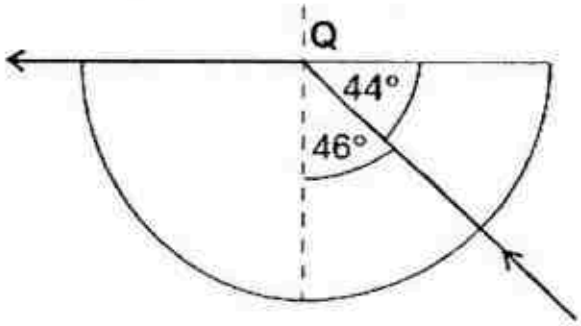


Fig. 6.1

(a) State the value of the critical angle in the plastic.

critical angle = ... [1]

(b) Define what is meant by *critical angle*.

.....

.....

..... [1]

(c) Calculate the refractive index of the plastic.

refractive index = ... [2]

(d) Another semi-circular block of identical dimensions as that shown in Fig. 6.1 is made of diamond.
Diamond has a refractive index of 2.13.
Suggest why more internal reflections occur inside this semi-circular diamond block than inside the piece of semi-circular plastic block shown in Fig. 6.1.

.....

.....

.....

.....

.....

..... [3]

7 Fig. 7.1 shows how ultrasound is used to produce an image of the heart.

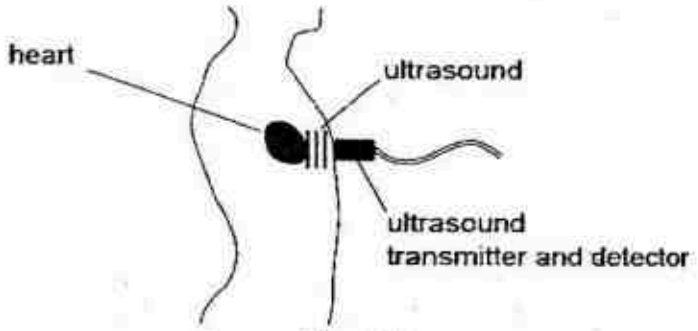


Fig. 7.1

(a) Define *ultrasound*.

.....

..... [1]

(b) The ultrasound has a wavelength of 1.2 mm. The speed of the ultrasound in the human body is 1500 m/s.
Calculate the frequency of the ultrasound.

frequency = ... [2]

(c) Explain how the vibrations of the transmitter produce waves of ultrasound between the transmitter and the heart.

.....

.....

..... [2]

8 Fig. 8.1 shows a mains extension lead. The six sockets allow several electrical appliances to be connected to the mains supply through one cable.
The cable connects the sockets to the mains supply.

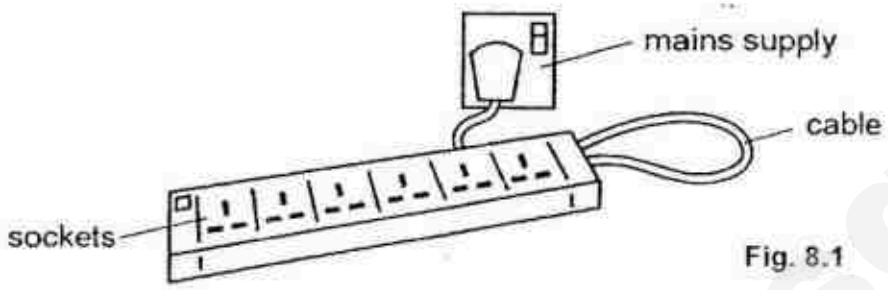


Fig. 8.1

(a) Explain why such a mains extension lead may pose an electrical hazard in the house.

.....

.....

..... [2]

Fig. 8.2 shows the wiring inside the mains plug of an electric kettle that is plugged into the extension lead.

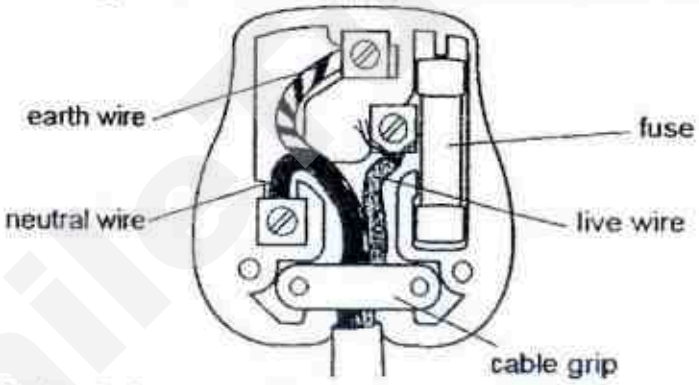


Fig. 8.2

(b) State two mistakes in the wiring of the plug.

1. .....

.....

2. .....

.....

[2]

(c) Explain why it is dangerous to handle the plug with wet hands.

.....

.....

..... [2]

9 Fig. 9.1 shows a magnet, two compasses and two steel nails J and K.
For this question, you may ignore any effects due to the Earth's magnetic field.

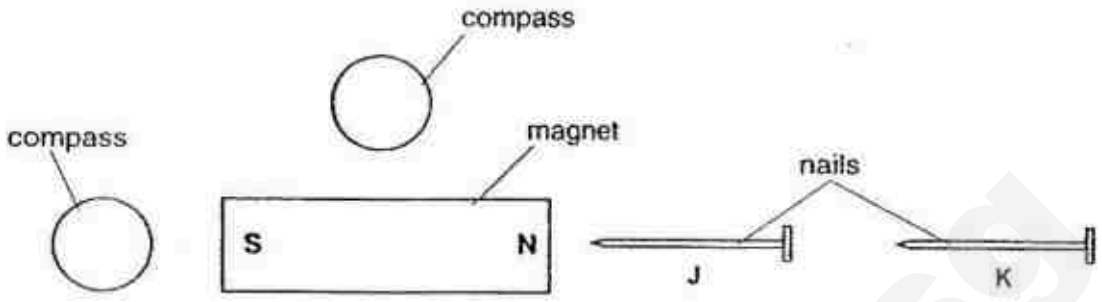


Fig. 9.1

(a) On Fig. 9.1, draw an arrow in each compass to show the direction of the magnetic field of the magnet at the two positions. [1]

(b) When nail J is brought near the magnet, it is attracted to the magnet.
Explain why this attraction occurs.

.....

.....

..... [2]

(c) When the magnet is removed, the nails are still magnetised.

(i) Describe how to test whether the nails are still magnetised when they are away from the magnet.

.....

..... [1]

(ii) Describe, with the aid of a labelled diagram, how the nails are demagnetised.

.....

.....

.....

..... [3]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12**.

10 In an experiment to investigate Bernoulli's Principle on a wing of an aircraft, the effects of air velocity and pressure are recorded as the aircraft moves through air.

Fig. 10.1 shows how the air flow passes the wing. The velocity of air above the wing is higher than the velocity of air below the wing.

The pressure and velocity data of the aircraft and air (above and below the wing) are recorded in Fig. 10.3.

Bernoulli's Principle explains why there is a pressure difference above and below the wings (see Fig. 10.2), which produces lift.
Lift is an upward force produced on the wings of an aircraft, allowing it to take off from a runway.

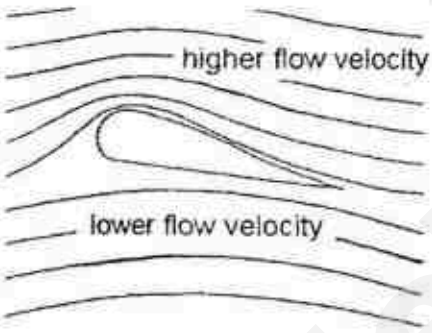


Fig. 10.1

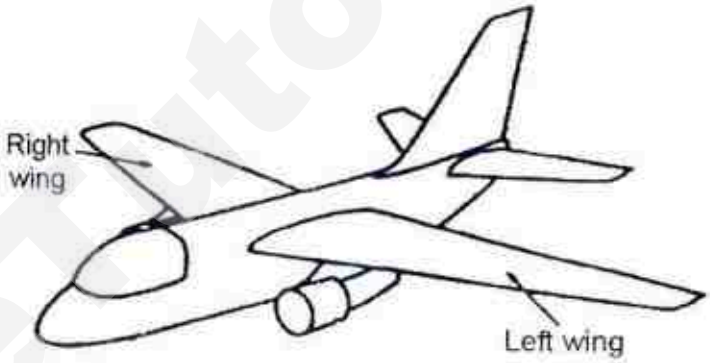


Fig. 10.2
(Image from Google)

	Aircraft Speed / ms^{-1}	30.0	40.0	50.0	60.0	70.0	80.0
Above both wings	**Air Velocity / ms^{-1}**	36.0	48.0	60.0	72.0	84.0	96.0
	Air Pressure / Pa	551	980	1531	2205	3001	3920
Below both wings	**Air Velocity / ms^{-1}**	30.0	40.0	50.0	60.0	70.0	80.0
	Air Pressure / Pa	794	1411	2205	3175	4322	5645

Fig. 10.3

Question continues on next page...

(a) Based on the data provided above, state the relationship between the speed of the aircraft and the air pressure difference above and below the wing.

..... [1]

(b) Bernoulli's Principle is essential for the production of the lift force.
Based on Fig. 10.3, explain how the lift force is produced and how this force is able to cause the aircraft to take off.

.....

.....

.....

.....

.....

..... [3]

(c) Given that the area of the underside (bottom) of all wings of the aircraft is 25 m^2, determine the lift force produced when the aircraft is moving at 30 m/s.

lift force = ... [2]

(d) Given that the weight of the aircraft is 25 kN, estimate the speed of the aircraft necessary for it to take off from a runway.

speed = ... [2]

Question continues on next page...

(e) Before platform doors were installed on all above-ground MRT stations in Singapore, all commuters waiting for trains at such MRT stations are told to stand behind the yellow line for their own safety (see Fig. 10.4)

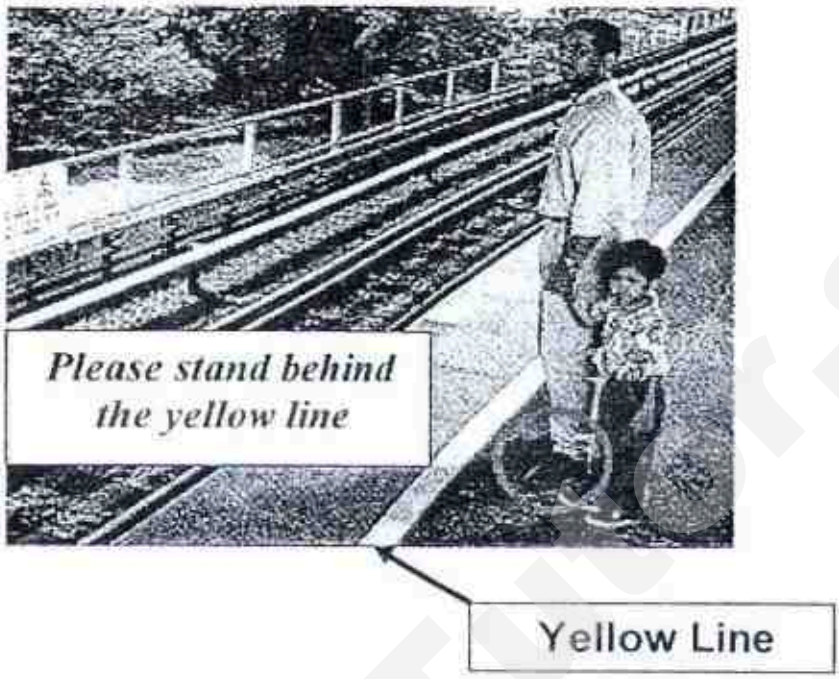


Fig. 10.4

(Reference: http://i.colnect.net/l/1467/907/Stand-behind-yellow-line.jpg)

By referring to your responses to the earlier parts of the question, explain why it is dangerous for commuters to stand on the yellow line, or too close to the rail tracks, when a train is entering the MRT station.

.....

.....

.....

..... [2]

11 Fig. 11.1 shows the top view of a simple physics demonstration, which comprises of a plotting compass being placed above a copper wire.

When there is no current flowing through the wire, the plotting compass points towards the North.

A large direct current then flows through the wire from point **J** to point **K**.

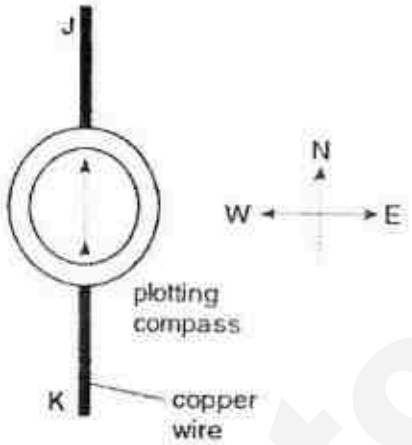


Fig. 11.1

(a) **(i)** State what happens to the compass needle.

..... [1]

(ii) State what happens to the compass needle if the compass were placed under the wire.

..... [1]

(iii) State and explain what is observed if there were a 50 Hz alternating current flowing through the wire.

.....

.....

..... [2]

Question continues on next page...

(b) Fig. 11.2 shows a coil in a magnetic field. The coil is able to rotate about the axis. The ends **X** and **Y** of the coil are connected directly to a d.c. power supply. The arrows on the sides of the coil show the direction of the current in the coil.

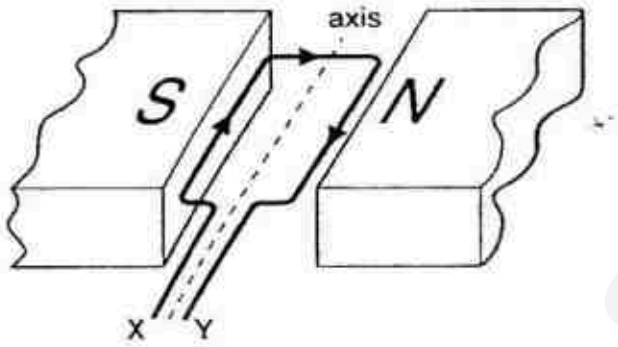


Fig. 11.2

(i) On Fig. 11.2, draw arrows to show the directions of the forces acting on the sides of the coil. [1]

(ii) Explain why the forces act on the sides of the coil.

.....

.....

.....

.....

.....

..... [3]

(iii) An observer (not shown in Fig. 11.2) looks at the coil while standing at point **X**. Describe the motion of the coil as viewed by the observer.

.....

.....

.....

..... [2]

12 **EITHER**

(a) Fig. 12.1 shows a variable potential divider (potentiometer), a power supply and a lamp.

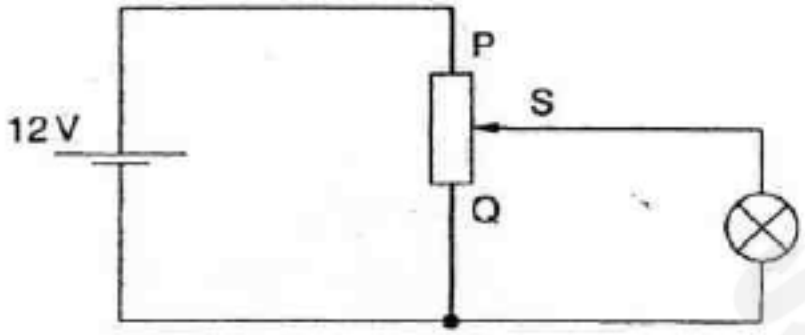


Fig. 12.1

(i) On Fig. 12.1,

1. mark with a letter **X** the position of an ammeter to measure the current in the lamp,
2. add a voltmeter to measure the potential difference (p.d.) across the lamp. [2]

(ii) The sliding contact **S** moves from **P** to **Q**. Describe what happens to the brightness of the lamp.

..... [1]

(b) The lamp is marked 12 V, 200 mA.
When the potential difference across the lamp is in the range 0 to 1.0 V, the resistance of the lamp has a constant value of 11 Ω.

(i) Calculate the current in the lamp when the potential difference across it is 1.0 V.

current = ... [2]

(ii) Calculate the power dissipated by the lamp when the potential difference across it is 1.0 V.

power = ... [2]

Question continues on next page...

(iii) On Fig. 12.2, sketch a graph to show how the current in the lamp changes with the p.d. across it. [3]

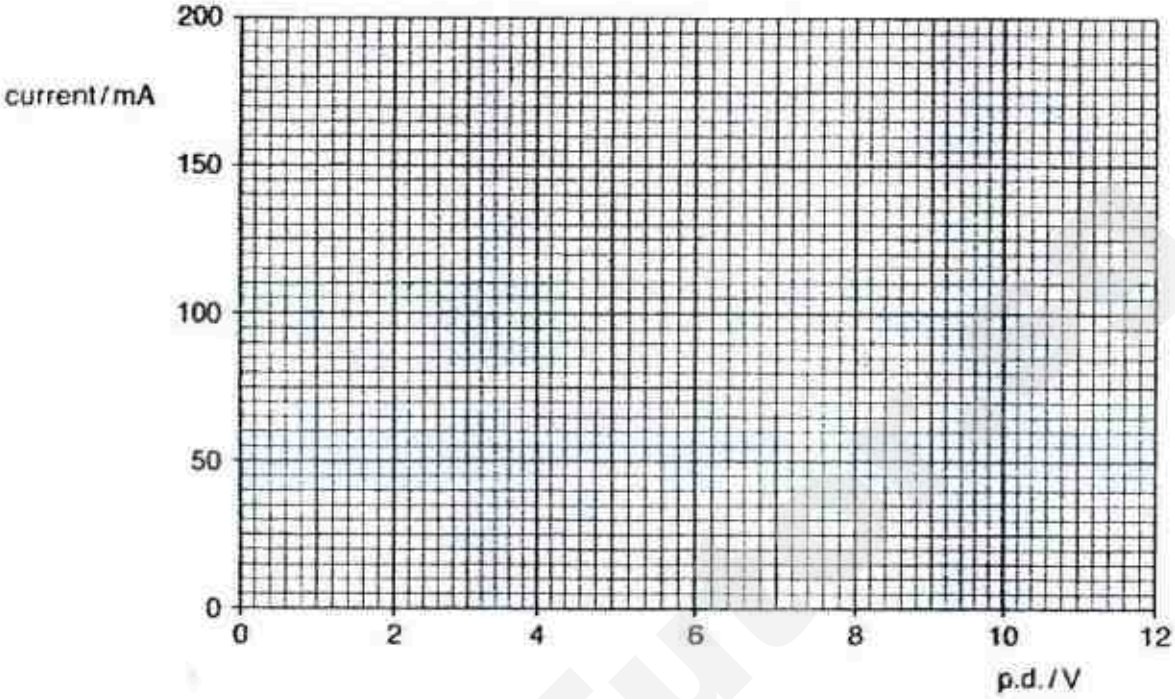


Fig. 12.2

12 OR

(a) Fig. 12.3 shows a device used to measure the flow of air. The turbine is made to rotate by the air that flows through it.

When viewed from **X**, the turbine is rotating in an anticlockwise direction.

The rim of the turbine contains small magnets.

When a small magnet goes near and then away from the coil (wound on a soft-iron core), a trace (which looks like a sine curve) is formed on the graph of induced e.m.f. against time (see Fig. 12.4). This trace is due to an alternating e.m.f. being induced in the coil.

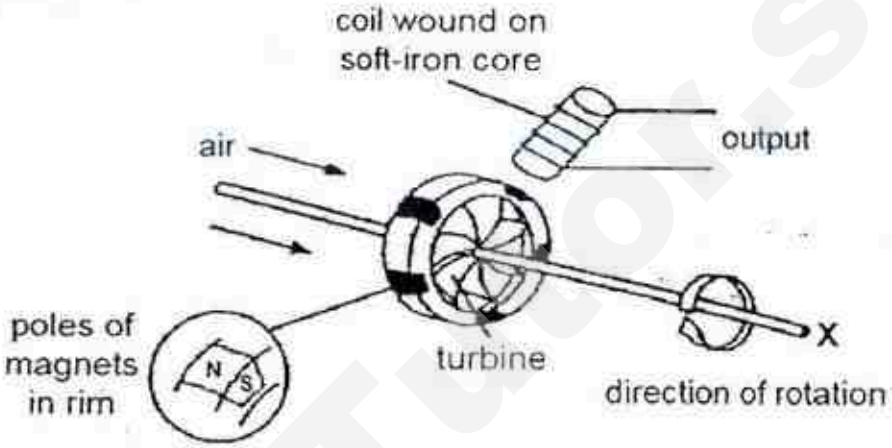


Fig. 12.3

(i) Explain why an alternating e.m.f. is induced in the coil.

.....

.....

.....

.....

.....

.....

..... [3]

Question continues on next page...

(ii) The traces (two separate sine curves) on Fig. 12.4 show how the induced e.m.f. varies with time when the turbine rotates at a steady speed.

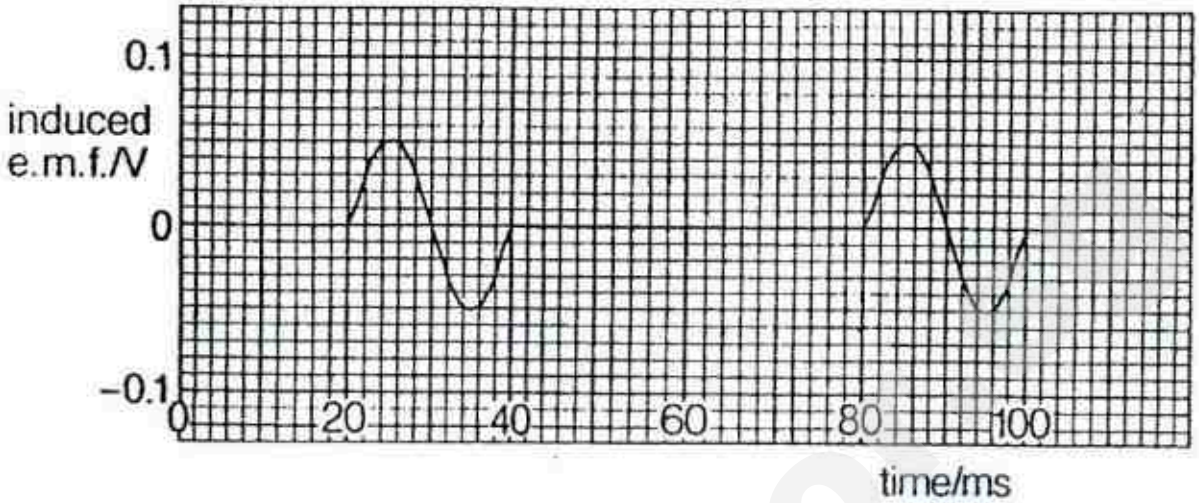


Fig. 12.4

The turbine now rotates twice as fast.

Draw on Fig. 12.4 the new traces to show how the induced e.m.f. varies with time. [3]

(b) Fig. 12.5 shows high voltage cables used to transmit electrical energy.

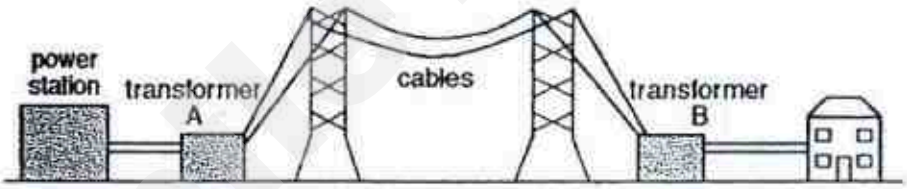


Fig. 12.5

(i) State the purpose of transformer B.

..... [1]

(ii) Explain why high voltages are used to transmit electrical power.

.....

..... [1]

Question continues on next page...

(iii) Fig. 12.6 shows how the loss of thermal energy from a cable varies with the thickness of the cable.

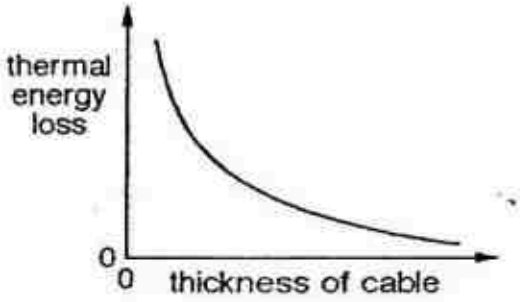


Fig. 12.6

Explain why the loss of thermal energy is less if the cable is thicker.

.....

.....

.....

..... [2]

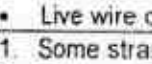
*** END OF PAPER ***

2017 BBSS SEC 4E PHYSICS (5059) O PRELIM EXAM
MARK SCHEME

PAPER 2: (W = working), (C/F = concept / formula), (A & U = answer & unit)

- **Penalize** 1 mark **per question** for no / wrong unit.
- **Penalize** 1 mark **per question** for failure to show concept / formula clearly **and explicitly** at the beginning of each mathematical working.
- Mark for 2 / 3 s.f. in **Q10(c) only**.

Q	Suggested Answer	Remarks
1(a)	When t = 8s, v = 12.8 m/s acceleration = gradient of v-t graph = (12.8 – 0) / (8 – 0) = **1.6 m/s²**	[1]: W, C/F, A & U
1(b)	When t = 6s, v = 9.6 m/s Distance = area under v-t graph (1st 6 s) = ½(6)(9.6) = **28.8 m**	[1]: W, C/F, A & U
1(c)	• Constant engine thrust & increasing air resistance leads to • decreasing net force acting on car (and acceleration decreases). • Eventually, engine thrust and air resistance are equal in magnitude and opposite in direction / balanced, leads to zero net force (and zero acceleration)	[1] [1] [1]
1(d)	• Curve of positive increasing gradient • Straight line of positive gradient	[1] [1]
2(a)	(i) *Gravitational field*: region in which a mass experiences a gravitational force. (ii) *Gravitational field strength*: gravitational force acting on unit mass (of body).	[1] [1]
2(b)	Spacecraft : graph (II) Equipment : graph (II)	[1] [1]
3(a)	Moments (M) = F × d = (840N)(5.0m) = **4200 Nm**	[1]: W & C/F [1]: A & U
3(b)	Apply principle of moments about P: (R)(12) = (840)(5.0) Force R = **350 N**	[1]: W & C/F [1]: A & U
3(c)	weight of ladder / hose / fire engine	[1]
4(a)	Q = ml_f = (500)(336) = **168 000 J**	[1]: W & C/F [1]: A & U
4(b)	Q = mcΔθ = (500)(2.1)(5 – 0) = **5250 J**	[1]: W & C/F [1]: A & U
4(c)	Any **one** of the following: More energy needed to completely break intermolecular forces (during vaporization) than to strengthen it (during freezing) / incomplete breaking of intermolecular forces during melting but complete breaking of such forces during boiling / work is done to push back atmosphere during boiling but not so during melting	[1]
5(a)	• Fabric and plastic are good thermal insulators. • Trapped air (between fabric) is a good thermal insulator.	[1] [1]
5(b)	Trapped air prevents formation of convection currents	[1]
5(c)	Silver-coloured plastic are good reflectors of radiant heat (reflects radiant heat back to the human body)	[1]
6(a)	46°	[1]
6(b)	Angle of incidence in optically denser medium where the corresponding angle of refraction in optically less dense medium is 90°.	[1]
6(c)	sin c = 1/n sin 46 = 1/n ⇒ n ≐ 1.39 (to 3 s.f.) or 1.4 (to 2 s.f.)	[1]: W & C/F [1]: A & U
6(d)	• Critical angle for diamond = $\sin^{-1}$(1/n) = $\sin^{-1}$(1/2.13) = **28°** (to 2 s.f.) • Critical angle for diamond < critical angle for plastic (46° – allow for ecf) • Higher chance of incident light ray in diamond (with an incident angle above 28°) to undergo internal reflection in diamond than in plastic.	[1] [1] [1]

Q	Suggested Answer	Remarks
7(a)	Sound with frequencies above / beyond the upper limit of the human range of audibility / 20 kHz.	[1]
7(b)	$v = f\lambda \Rightarrow f = v/\lambda = 1500 / 1.2 \times 10^{-3}$ = 1 250 000 Hz (or **1.25 MHz**)	[1]: W & C/F [1]: A & U
7(c)	• (Vibration of transmitter causes) body cells / tissues to vibrate parallel to direction of travel of sound wave • Forming regions of compressions and rarefactions	[1] [1]
8(a)	• Total current drawn by all appliances may exceed the maximum current that the mains supply can conduct safely. • Live wire of mains supply will overheat (and may start a fire)	[1] [1]
8(b)	1. Some strands of live wire were not connected properly to the live pin. 2. Cable grip should grip the outer insulation and not the inner (live, neutral & earth) wires.	[1] [1]
8(c)	• Water is a conductor of electricity. • Resistance of wet skin / hand is reduced and a larger electric current could flow through the body.	[1] [1]
9(a)		[1]: compass above magnet points to the left **AND** compass next to S-pole points to the right
9(b)	• LHS / tip of nail J magnetically induced to be S-pole. • Like poles repel and unlike poles attract (law must be stated in full).	[1] [1]
9(c)(i)	Bring both ends of permanent magnet near one end of nail and repulsion observed (at one instance).	[1]
9(c)(ii)	• Correct diagram with key parts (solenoid, nail and a.c. supply) labelled. • While a.c. still flows through solenoid, pull nail out of solenoid • in east-west direction till some distance away (from solenoid).	[1] [1] [1]
10(a)	The faster the aircraft, the greater the pressure difference	[1]
10(b)	• Air velocity above wings > air velocity below wings will cause air pressure above wings < air pressure below wings. • Upward net force acts on unit area of the wings. • Once upward net force > weight of aircraft, the aircraft takes off. (NOTE: students can repeat the point "the faster the aircraft, the greater the pressure difference" here, as part of their answer. But this point should not earn any credit in this part of the question – as it is a repetition of 10(a))	[1] [1] [1]
10(c)	(At 30m/s), pressure difference = 794 – 551 = 243 Pa (Lift)force = pressure × area = 243 × 25 = 6075 N = **6080 N** (3 s.f.) or **6100 N** (2 s.f.)	[1] [1]
10(d)	Pressure difference = F/A = 25000 / 25 = 1000 Pa From the table, minimum aircraft speed = **70 m/s**	[1] [1]
10(e)	• (Due to approaching train) air between commuter and train will have high speed, resulting in lower pressure of air (between commuter and train). • Air behind commuter at relatively higher pressure than air between commuter and train. Net force acts on commuter, pushing him towards the train.	[1] [1]
11(a)(i)	Needle points to west / left	[1]
11(a)(ii)	Needle points to east / right	
11(a)(iii)	• Needle will remain stationary / point to north / neither deflect left nor right / neither deflect east nor west / vibrates slightly about vertical axis. • (50 Hz a.c. causes) magnetic field around wire to reverse its direction 50 times per second / rapidly. Inertia of needle prevents it from deflecting / causes it to vibrate slightly about its vertical axis.	[1] [1]

Q	Suggested Answer	Remarks
11(b) (i)	Coil nearer to S-pole experiences vertically upward force AND Coil nearer to N-pole experiences vertically downward force.	[1]
11(b) (ii)	• Both the permanent magnet and the current carrying coil produce separate magnetic fields and they interact with each other. • Where the fields act in the same direction, they reinforce each other and create a stronger resultant field. Where the fields act in opposite directions, they create a weaker resultant field. • Difference in magnetic field strength results a net force to act from stronger field to weaker field.	[1] [1] [1]
11(b) (iii)	• Coil rotates clockwise • For quarter of a rotation before it oscillates back and forth with decreasing amplitude, and then comes to rest in a vertical position.	[1] [1]
12(E) (a)(i)	1. Ammeter must be connected in series with the lamp. 2. Voltmeter must be connected in parallel to the lamp.	[1] [1]
(a)(ii)	Brightness of lamp decreases.	[1]
12(E) (b)(i)	Current (I) = V / R = 1.0 / 11 = **0.091A** (to 2 s.f.) or **0.0909A** (to 3 s.f.)	[1]: W & C/F [1]: A & U
12(E) (b)(ii)	Power = $V^2/R = 1^2 / 11$ = **0.0909W** (to 3 s.f.)	[1]: W & C/F [1]: A & U
12(E) (b)(iii)	• Graph is a straight line from the origin to (1,91) ← accept **(1,90)** • and then a smooth curve of decreasing gradient after that • and pass through the point (12,200)	[1] [1] [1]
12(O) (a)(i)	• Relative motion between magnet(ic field) and (conducting) coil leads to a change in magnetic flux linking the coil per second (or: rate of change of magnetic flux linking the coil) and this induces an e.m.f. • As magnetic field is brought near the coil, there is an increase in magnetic flux linking the coil per second. This causes a peak in the alternating signal. • As magnetic field is brought away from the coil, there is a decrease in magnetic flux linking the coil per second. By Lenz's Law, this causes a trough in the alternating signal.	[1] [1] [1]
12(O) (a)(ii)	• Each new signal has twice the amplitude (0.1V) and • half the period (10 ms) as old signal • Start of new signals at t = 20 ms, 50 ms and 80 ms	[1] [1] [1]
12(O) (b)(i)	Transformer B is used to step down voltage.	[1]
12(O) (b)(ii)	Electric current flowing in the cables will be low (when high voltages are used). Hence the power loss (I^2R) would then be minimised.	[1]
12(O) (b)(iii)	• Thick wires have large cross-sectional areas A, and thus low resistance because resistance R inversely proportional to cross-sectional area A. • Since power loss (P) = I^2R, less resistance would mean less power loss.	[1] [1]

PAPER 1:

Q	1	2	3	4	5	6	7	8	9	10
A	B	B	D	A	B	D	D	C	B	C
Q	11	12	13	14	15	16	17	18	19	20
A	B	D	A	D	C	A	A	B	C	A
Q	21	22	23	24	25	26	27	28	29	30
A	C	A	A	D	A	A	A	B	A	B
Q	31	32	33	34	35	36	37	38	39	40
A	B	B	D	A	D	B	C	A	C	D

XINMIN SECONDARY SCHOOL
新民中学
SEKOLAH MENENGAH XINMIN

Preliminary Examination 2017

For Examiner's Use

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS **5059/02**

Paper 2 Theory **21 August 2017**

Secondary 4 Express **1 hour 45 minutes**

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

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer all questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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		50
Section B		30
Total		80
Parent's Signature		

Section A

Answer **all** questions in this section.

For Examiner's Use

1 Tej Deep claims that the following equations that involve physical quantities are valid.

Given that:

F = force x = distance v = velocity a = acceleration t = time m = mass

Show, by *considering the S.I. units of the physical quantities involved*, with *clear* working whether each of the following equations is **valid** or **invalid**.

(a) $v = at$

Answer = ... [2]

(b) $t = \sqrt{2x/a}$

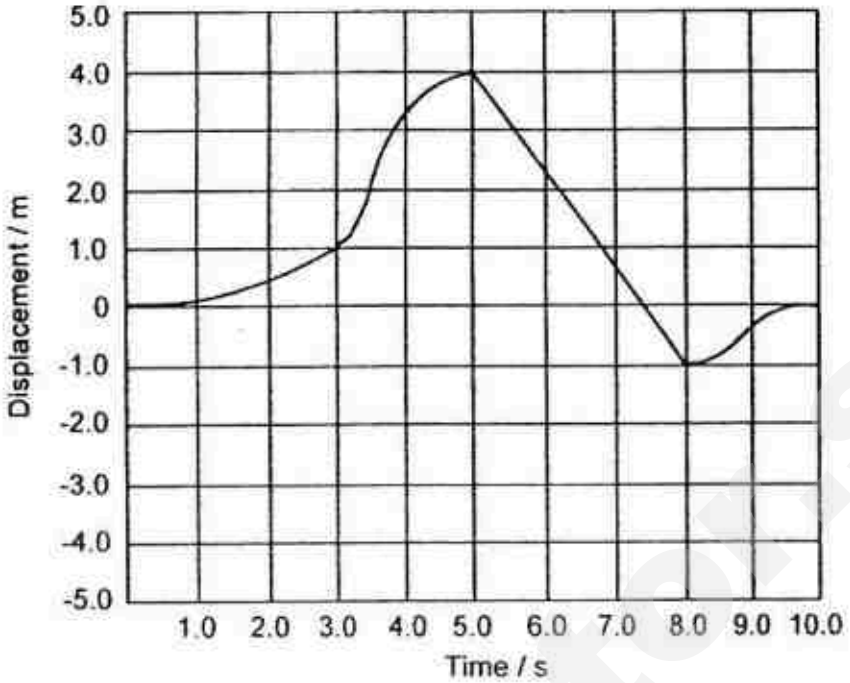
Answer = ... [2]

(c) $F = mvx$

Answer = ... [2]

2 A displacement-time graph of a part[illegible] motion is shown below.

For Examiner's Use



(a) How many time(s) is the particle instantaneously at rest?

..... [1]

(b) Write down the total distance travelled by the particle.

..... [1]

(c) When was the particle moving the fastest?

..... [1]

(d) How many time(s) is the particle at the starting point?

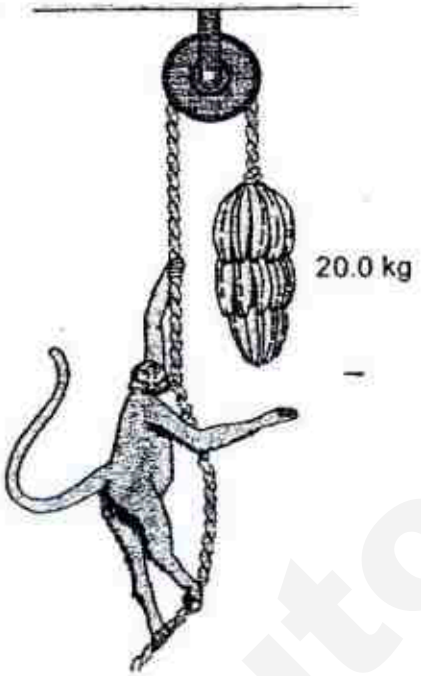
..... [1]

(e) Calculate the velocity of the particle at 7.0 s.

Velocity = ... [2]

3 A monkey has a firm hold on a light rope that passes over a frictionless pulley and is attached to a 20.0 kg bunch of bananas as shown below.

For Examiner's Use



The monkey and the bananas are balanced.

(a) Write down the weight of the monkey.

..... [1]

(b) Upon seeing the delicious bananas, the monkey starts to climb the rope to get them. The monkey applied a force on the rope that caused itself to accelerate at 0.50 m s^{-2} upwards, all the while hanging on to the rope.

(i) Calculate the magnitude of the force that the monkey applied on the rope.

Force = ... [2]

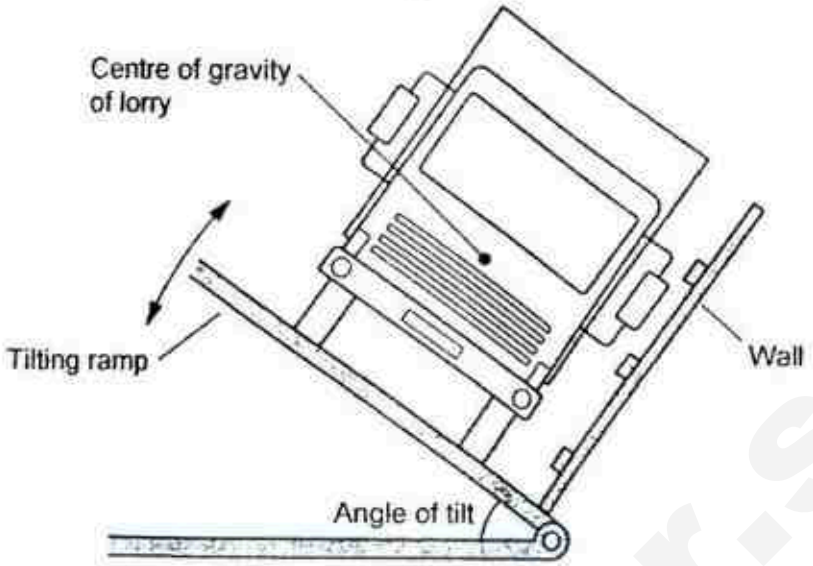
(ii) Describe the motion of the bunch of bananas.

.....

..... [2]

4 The stability of a lorry of weight 50 000 N is tested as shown below.

For Examiner's Use



The ramp is titled as much as possible without the lorry falling over. The ramp is then fixed and the lorry remains at rest in the position as shown above.

(a) Explain why the lorry falls over if the ramp is tilted any further.

.....

.....

.....

..... [2]

(b) State how the position of the centre of gravity of the lorry affects the angle of tilt of the ramp.

.....

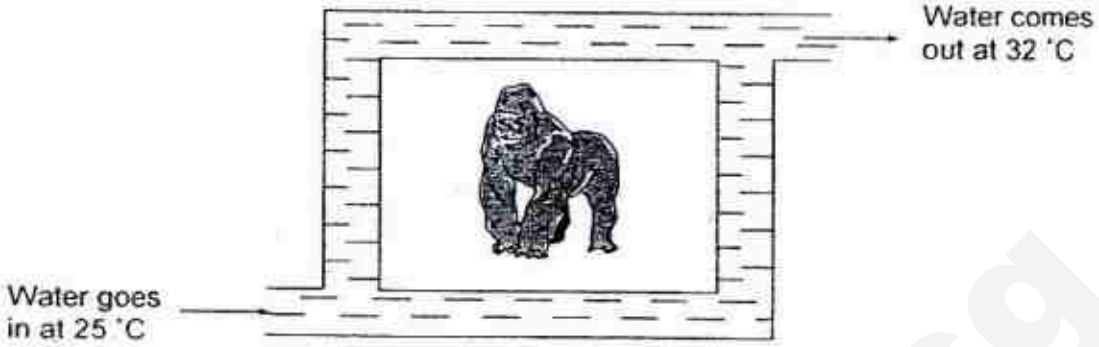
..... [1]

(c) Given that the lorry has six wheels and each wheel has a contact area of 0.058 m^2 with the ground, calculate the contact pressure of each wheel assuming the weight of the lorry is evenly distributed among the wheels.

Contact pressure of a wheel = ... [2]

5 In order to determine the rate at which a monkey loses thermal energy, it is placed in a chamber through which water is circulated as shown.

For Examiner's Use



The steady outlet temperature was recorded as 32 °C when the rate of flow of water was 3.0 kg h^{-1} and the inlet temperature was 25 °C.

When another monkey was added to the same chamber, the rate of flow of water had to increase to 7.0 kg h^{-1}, in order to achieve the same inlet and outlet temperatures.

Assume that each monkey lost thermal energy at the same constant rate, and the rate of loss of thermal energy from the chamber by other means remains constant.

(a) Define *temperature*.

..... [1]

(b) The main process of heat transfer from the monkey is thermal radiation. Describe **two** factors, in general, that could increase the rate of thermal radiation from an object.

1. .....

.....

2. .....

..... [2]

(c) Calculate the rate of loss of thermal energy of the second monkey.
(Specific heat capacity of water = 4 200 J kg^{-1} K^{-1})

Rate of loss of thermal energy of the second monkey = ... [4]

6 Joanne observes the Brownian motion of smoke particles in air with a microscope.

After the observation, she claims that as smoke is a gas, the smoke particles, according to the kinetic theory of matter, will n[illegible]ly with high speeds, thus resulting in the

Brownian motion of the smoke particles.

For Examiner's Use

(a) State whether Joanne's claim about the Brownian motion of the smoke particles is **correct** or **incorrect**. Explain.

.....

.....

.....

.....

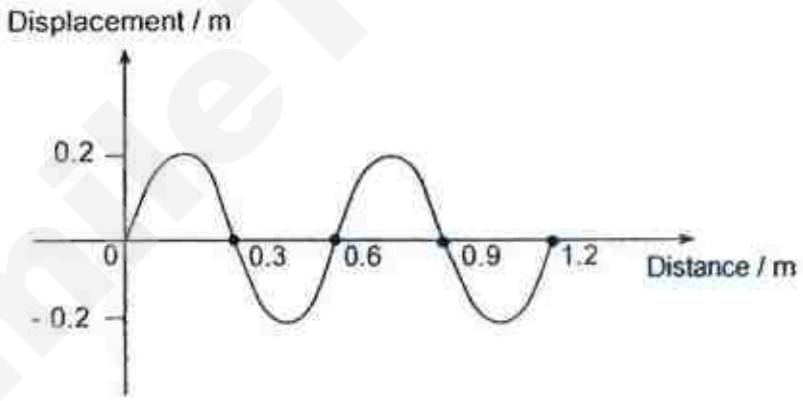
..... [3]

(b) Describe how the movement of the smoke particles would change if the temperature of the air increases.

.....

..... [2]

7 The figure below shows the displacement – distance graph of a transverse wave that travels along a rope at a particular instant of time.



The end of the rope moves through three complete oscillations every second.

(a) What is meant by a *transverse wave*?

.....

..... [1]

(b) State the frequency of the wave.

..... [1]

(c) Calculate the speed of the wave.

For Examiner's Use

Speed of the wave = ... [2]

(d) State whether sound wave is an example of a transverse wave or not.

..... [1]

8 An electron travels horizontally towards a vertical uniform electric field formed by a pair of parallel metal plates as shown in **Fig. 8**.

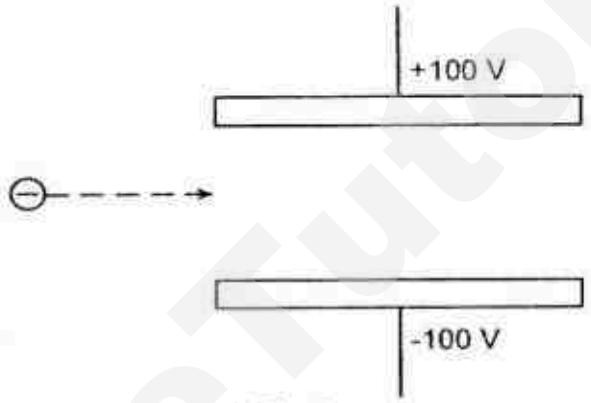


Fig. 8

(a) Define *electric field*.

.....

..... [1]

(b) On **Fig. 8**,

(i) draw the electric field pattern between the plates, [2]

(ii) complete the path of travel of the electron through the plates. [1]

9 **Fig. 9** shows a direct current passing through an electromagnet.

Soft iron core

For Examiner's Use

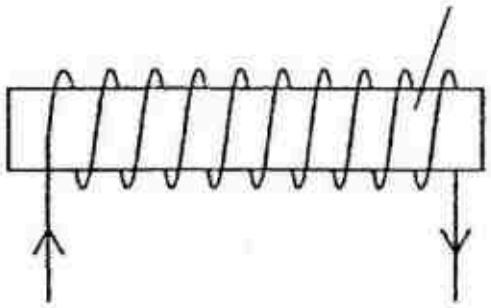


Fig. 9

(a) On **Fig. 9**,

(i) label N at the north pole of the electromagnet, [1]

(ii) draw the magnetic field pattern around the electromagnet. [2]

(b) What is the function of the soft iron core?

.....

..... [1]

(c) Describe **two** ways to increase the magnetic field strength of the electromagnet.

1. .....

.....

2. .....

..... [2]

(d) State the effect on the magnetic field strength if the soft iron core is replaced by a copper core of the same dimensions.

..... [1]

Section B

Answer **all** questions from this section.

Answer only one of the two alternative questions in **Question 12**.

10 **Source A**

For Examiner's Use

One end of a spring is fixed to a support. A mass is attached to the other end of the spring. The arrangement is shown in **Fig. 10.1**.

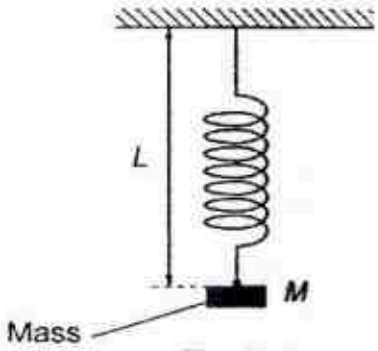


Fig. 10.1

The arrangement is used to determine the length L of the spring when mass M is attached to the spring. The procedure is repeated for different values of M. The variation of mass M with length L is shown in **Fig. 10.2**.

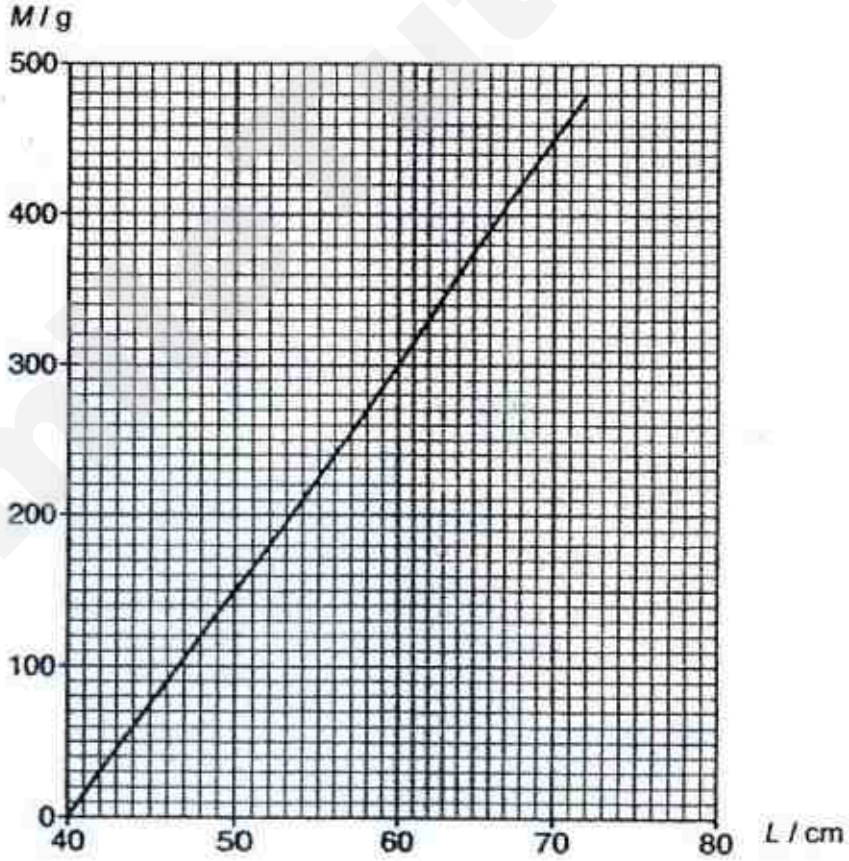


Fig. 10.2

Source adapted from: 2015 GCE A Level: H2 Physics Paper 2

Source B

Hooke's law is a principle of physics that states that the force F needed to extend or compress a spring by some distance X is proportional to that distance.

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That is:

$$F = kX$$

where k is the spring constant.

Source adapted from: https://en.wikipedia.org/wiki/Hooke%27s_law

Source C

Elastic potential energy is the potential energy stored as a result of deformation of an elastic object, such as the stretching of a spring. It is equal to the work done to stretch the spring, which depends upon the spring constant k as well as the distance stretched.

The work done W to stretch the spring a distance X is given as:

$$W = \frac{1}{2}kX^2$$

where k is the spring constant.

Source adapted from: http://hyperphysics.phy-astr.gsu.edu/hbase/pespr.html

(a) By considering the equation shown in **Source** B, show that the spring constant k of the spring shown in **Fig. 10.1** is $k = \frac{Mg}{10(L-40)}$ where g is the acceleration due to free fall. Show your working clearly. [2]

(b) Calculate the value of k for the spring shown in **Fig. 10.1**. The SI unit of k must be shown clearly.

k = ... [2]

(c) Calculate the elastic potential energy stored in the spring shown in **Fig. 10.1** when it is extended to 70 cm.

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Elastic potential energy = ... [2]

(d) A mass of 300 g is attached to the spring shown in **Fig. 10.1**, and held at rest with length *l* of 40 cm. The mass is then released and the spring extends.

(i) State the energy changes in the mass-spring system as the mass falls towards its lowest position from its point of release. Numerical values are not required.

.....

.....

.....

.....

..... [2]

(ii) Use your answer in **(c)** to calculate the speed of the mass when the spring has extended by 30 cm from its point of release.

Speed of the mass = ... [3]

11 A battery of e.m.f. *E* and internal resistance *r* is connected to a variable resistor as shown in **Fig. 11.1**.

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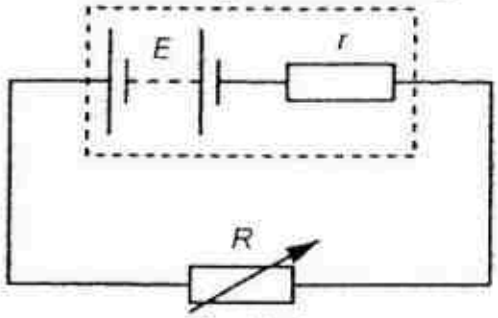

Fig. 11.1

The total power produced in the battery is P_T. The power dissipated in the variable resistor is P_R.

The variations of P_T and of P_R with resistance R of the variable resistor are shown in **Fig. 11.2**.

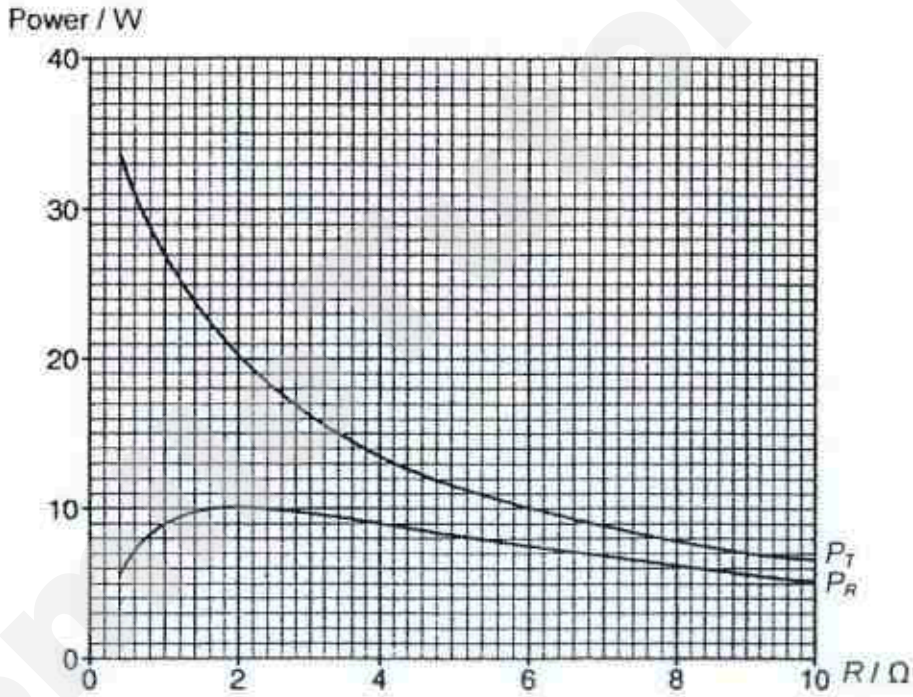

Fig. 11.2

(a) For resistance $R = 4.0\ \Omega$, use **Fig. 11.2**

(i) to show that the current in the circuit is 1.5 A. [2]

(ii) to determine the work done per unit charge across R.

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Work done per unit charge = ... [2]

(iii) to determine the e.m.f. E of the battery.

E = ... [2]

(b) Suggest what is represented by the quantity $(P_T - P_R)$.

.....

..... [1]

(c) Use the values of P_T and P_R at R = 4.0 Ω and the information in **(a)(i)** to determine the internal resistance r of the battery.

r = ... [2]

12 EITHER

A spring hangs vertically from a fixed point. A copper plate is attached to the free end of the spring, as shown in **Fig. 12.1**.

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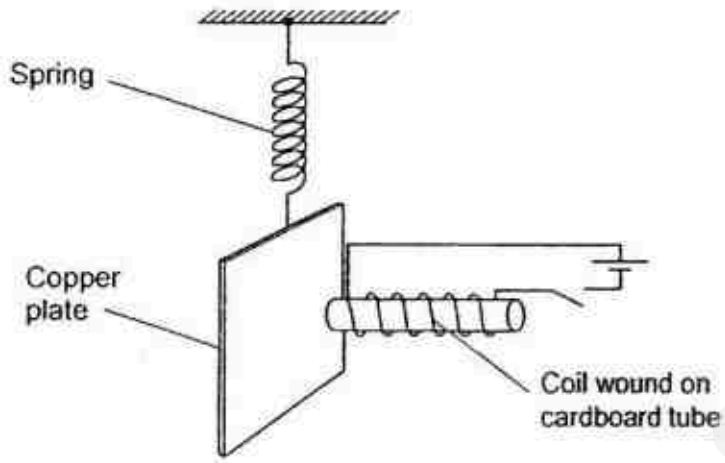

Fig. 12.1

One end of a coil of wire, wound on a cardboard tube, is placed near to the copper plate.

The copper plate is displaced vertically and then released. The variation with time t of the vertical displacement y of the plate is shown in **Fig. 12.2**.

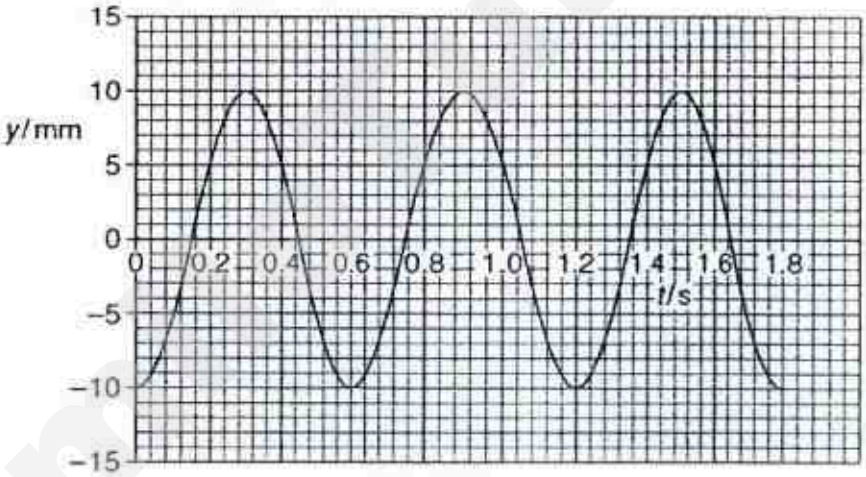

Fig. 12.2

(a) Calculate the frequency of the oscillation.

Frequency of oscillation = ... [2]

(b) Write down the amplitude of the oscillation.

..... [1]

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(c) At time t = 1.8 s, the current in the coil in **Fig. 12.1** is switched on. The variation with time t of the subsequent oscillations of the plate is shown in **Fig. 12.3**.

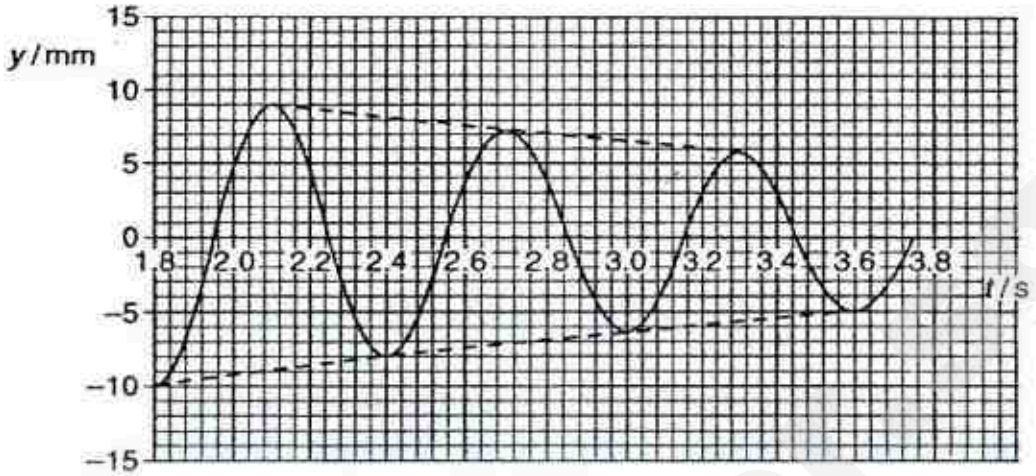

Fig. 12.3

(i) Explain why the amplitude of the oscillations is lower after the coil is switched on.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(ii) It is observed that the amplitude of the oscillations decreases with a decreasing rate. Explain.

.....

.....

.....

..... [2]

12 OR

Fig. 12.4 is drawn to scale. The focal length of the converging lens is 4.0 cm.

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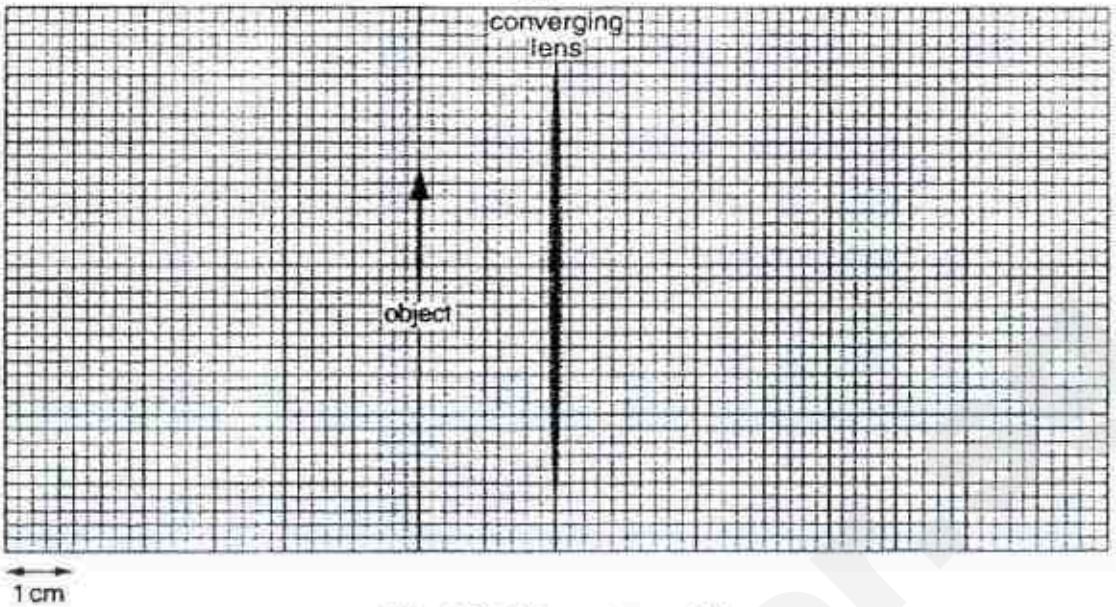

Fig. 12.4 (Drawn to scale)

(a) On **Fig. 12.4** draw two rays from the top of the object to locate the top of the image. Draw the image of the object. [3]

(b) Describe the characteristics of the image.

..... [2]

(c) The object is moved closer to the lens. State two changes that this causes to the image.

1. .....

.....

2. .....

..... [2]

(d) Given that the refractive index of the glass that is used to make the converging lens is 1.5, calculate the speed of light as it travels in the lens.

Speed of light in glass = ... [2]

(e) The colour of the image formed is the same as the object. What is the physical difference between blue light and red light?

.....

..... [1]

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End of paper

4E Prelim 2017 Physics P2

Paper 1 (40 marks)

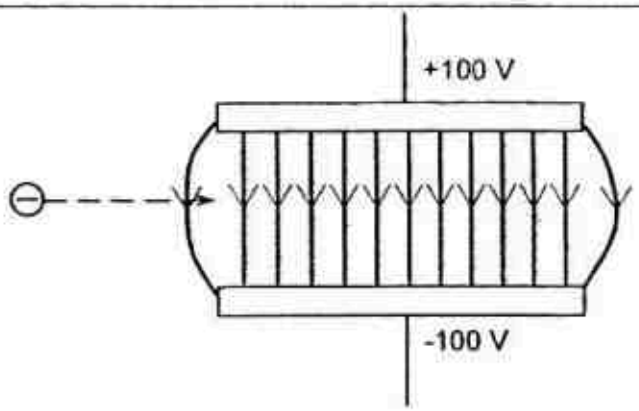
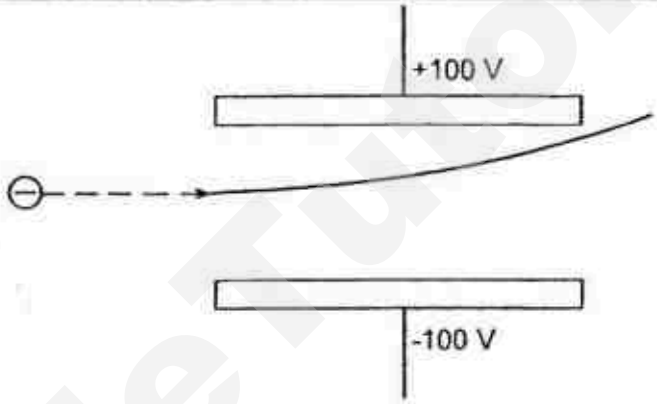
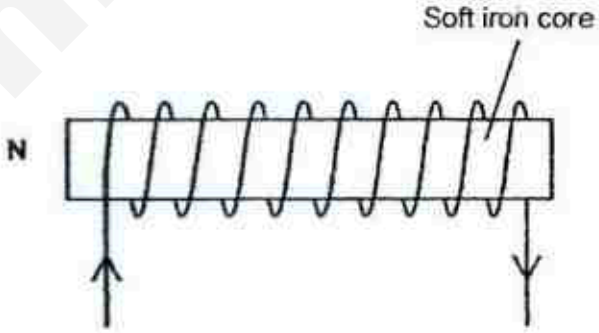
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40

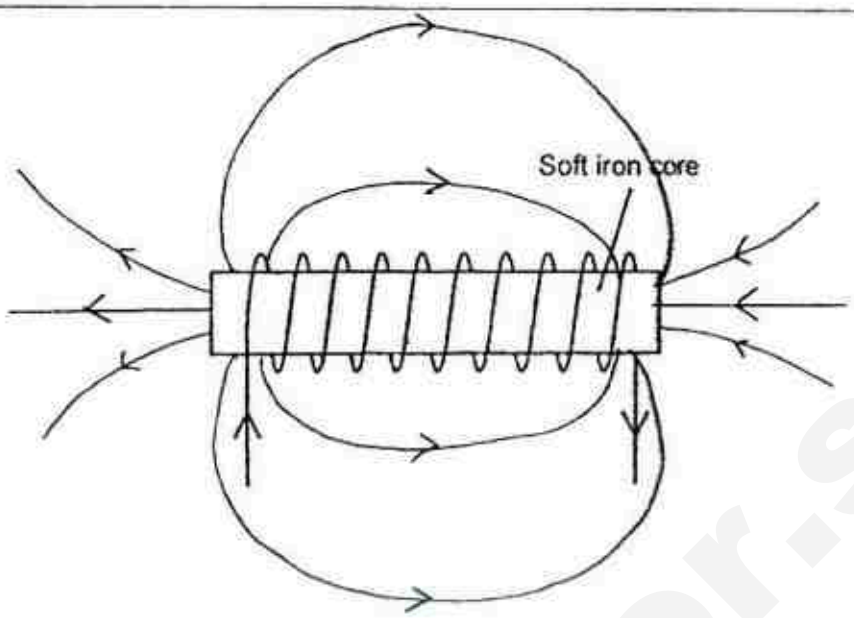
Paper 2 Section A (50 marks)

1a	LHS = m s^{-1} RHS = (m s^{-2}) × s = m s^{-1} **(valid)**	Working [1] Ans [1]
1b	LHS = s RHS = $\sqrt{m/(m \times s^{-2})} = \sqrt{s^2} = s$ **(valid)**	Working [1] Ans [1]
1c	LHS = N = kg m s^{-2} RHS = kg × m s^{-1} × m = kg m^2 s^{-1} **(invalid)**	Working [1] Ans [1]
	Total	[6]
2a	4	[1]
2b	10 m	[1]
2c	3.5 s	[1]
2d	3	[1]
2e	Velocity = $\frac{-1.0-4.0}{8.0-5.0} = \frac{-5.0}{3.0} \approx -1.7$ m s^{-1} (2 or 3 s.f)	Working [1] Ans [1]
	Total	[6]

3a	200 N (2 or 3 s.f)	[1]
3bi	Taking upwards as positive, $F_R = F + W$ $F = F_R - W = (20.0 \times 0.50) - (-200) = 10.0 + 200 = 210$ N (2 or 3 s.f)	Working [1] Ans [1]
3bii	The bunch of bananas will **accelerate upwards [1]** with an acceleration of **0.50 m s^{-2} [1]**.	[2]
	Total	[5]
4a	If the ramp is tilted any further, the **vertical line through centre of gravity of the lorry will lie outside its base [1]**. The **weight of the lorry will cause a clockwise moment about the side of the lorry closer to the wall [1]**, causing the lorry to fall over.	[2]
4b	The lower the centre of gravity, the larger the angle of tilt. *OR* The higher the centre of gravity, the smaller the angle of tilt.	[1]
4c	$p = \frac{F}{A} = \frac{50000}{6 \times 0.058} \approx 140000$ Pa (2 or 3 s.f)	Working [1] Ans [1]
	Total	[5]
5a	Temperature is the measure of the hotness and coldness of a body. *OR* Temperature is a measure of the average kinetic energy of the particles in the body.	[1]
5b	**1.** The darker the colour of the body, the higher the rate of thermal radiation. **2.** The duller the surface of the body, the higher the rate of thermal radiation. **3.** The larger the surface area of the object, the higher the rate of thermal radiation. **4.** The higher the surface temperature of the surface of the object relative to the surrounding, the higher the rate of thermal radiation. **Any 2, **[1]** each*	[2]

5c	Rate of heat loss by chamber and a monkey = $\frac{m_{water} c_{water} \Delta\theta}{t}$ $= \frac{3.0 \times 4200 \times (32 - 25)}{3600}$ = 24.5 W **[1]** Rate of heat loss by chamber and 2 monkeys = $\frac{m_{water} c_{water} \Delta\theta}{t}$ $= \frac{7.0 \times 4200 \times (32 - 25)}{3600}$ = 57.17 W **[1]** Rate of loss of thermal energy of the 2nd monkey = 57.17 − 24.5 = 33 W **[2]** (2 or 3 s.f)	Working [3] Ans [1]
	Total	[7]
6a	**Incorrect [1].** **Smoke is not a gaseous matter but a clutter of small solid particles [1].** The Brownian motion of the smoke particles are **caused by the uneven bombardment of the invisible air particles [1].**	[3]
6b	The smoke particles will move **faster [1] and more haphazardly [1].**	[2]
	Total	[5]
7a	Transverse wave is a wave motion such that **the vibration of the source is perpendicular to the direction of the propagation of the wave.**	[1]
7b	3 Hz	[1]
7c	$v = f\lambda = 3 \times 0.6 = 1.8\ \mathrm{m\ s^{-1}}$ (2 or 3 s.f)	Working [1] Ans [1]
7d	Sound wave is **not** an example of a transverse wave.	[1]
	Total	[5]
8a	Electric field is a region where an electric charge experiences an electric force.	[1]

8bi	 ***[1]*** *for correct shape* ***[1]*** *for correct direction*	[2]
8bii		[1]
	Total	[4]
9ai		[1]

9aii	 ***[1]*** *for correct shape* ***[1]*** *for correct direction*	[2]
9b	It is used to concentrate the magnetic field lines, thereby increasing the magnetic field strength of the electromagnet.	[1]
9c	**1.** Increase the current flowing through the coil. **[1]** **2.** Increase the number of turns per unit length of the coil. **[1]**	[2]
9d	The magnetic field strength of the electromagnet will **decrease**.	[1]
	Total	[7]

Paper 2 Section B (30 marks)

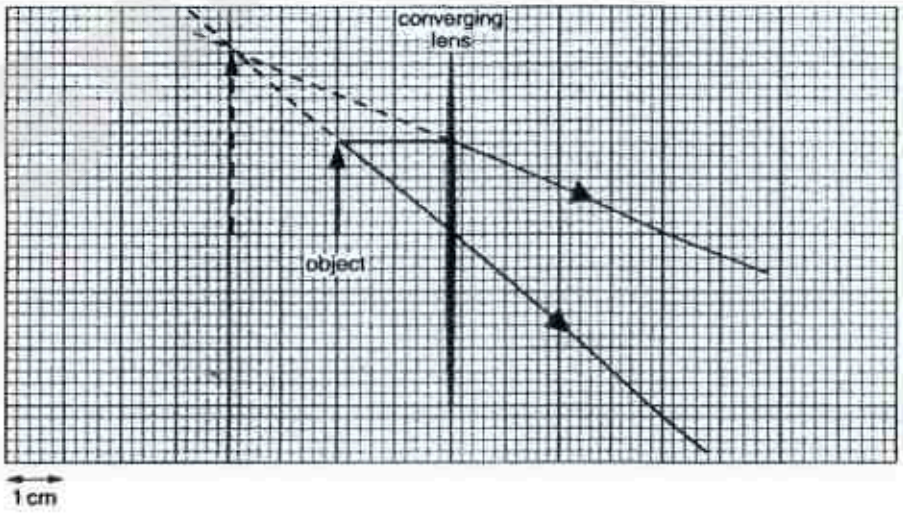
10a	$F = kX \rightarrow w = k\frac{(l-40)}{100}$ **[1]** $mg = k\frac{(l-40)}{100}$ **[1]** $\frac{Mg}{1000} = k\frac{(l-40)}{100} \rightarrow k = \frac{Mg}{10(l-40)}$ (shown)	[2]
10b	$k = \frac{Mg}{10(l-40)} = \frac{300 \times 10}{10(60-40)} = 15\ \text{N m}^{-1}$ (2 or 3 s.f)	Working **[1]** Ans **[1]**

10c	Elastic potential energy = $\frac{1}{2}kX^2 = \frac{1}{2} \times 15 \times (\frac{70-40}{100})^2 = 0.675$ J (2 or 3 s.f)	Working [1] Ans [1]
10di	The **gravitational potential energy of the mass** at its point of release will be converted to the **kinetic energy of the mass** itself and the **elastic potential energy stored in the spring. [1]** As the mass reaches its lowest position, **all of its gravitational potential energy** will be converted to the **elastic potential energy stored in the spring. [1]**	[2]
10dii	Change in GPE = $mgh = \frac{300}{1000} \times 10 \times \frac{30}{100} = 0.90$ J **[1]** KE = GPE – EPE $\frac{1}{2}mv^2 = 0.90 - 0.675$ $v = \sqrt{\frac{2 \times 0.225}{300/1000}} = 1.2$ m s^{-1} (2 or 3 s.f) **[2]**	Working [2] Ans [1]
	Total	[11]
11ai	When $R = 4.0\ \Omega$, $P_R = 9.0$ W **[1]** $P_R = I^2R \rightarrow I = \sqrt{\frac{P_R}{R}} = \sqrt{\frac{9.0}{4.0}} = 1.5$ A (Shown) **[1]**	[2]
11aii	$V = IR = 1.5 \times 4.0 = 6.0$ V (2 or 3 s.f)	Working [1] Ans [1]
11aiii	When $R = 4.0\ \Omega$, $P_T = 13.5$ W $P_T = EI \rightarrow E = \frac{P_T}{I} = \frac{13.5}{1.5} = 9.0$ V (2 or 3 s.f)	Working [1] Ans [1]
11b	The power dissipated in the internal resistance of the battery.	[1]
11c	$P_T - P_R = I^2r \rightarrow r = \frac{P_T - P_R}{I^2} = \frac{13.5 - 9.0}{1.5^2} = 2.0\ \Omega$ (2 or 3 s.f)	Working [1] Ans [1]
	Total	[9]

EITHER

12a	$f = \frac{3}{1.8} \approx 1.7$ Hz (2 or 3 s.f)	Working [1] Ans [1]
12b	10 mm	[1]
12ci	A **magnetic field is created around the coil** as the coil is switched on. **[1]** As the **copper plate, an electrical conductor, oscillates, it cuts the magnetic field of the coil. [1]** According **to Faraday's law of electromagnetic induction, an induced e.m.f will be created across the copper plate, thus creating induced eddy in the copper plate. [1]** According to **Lenz's law, the induced eddy current will created a magnetic field to oppose the change producing itself.[1]** **This will create a resistive force that will dampen the oscillation of the copper plate**, thereby reducing the amplitude of oscillations. **[1]**	[5]
12cii	As the amplitude decreases, **the copper plate will cut the magnetic field of the coil at a lower rate. [1]** This will result in **a lower resistive force created to dampen the oscillation. [1]**	[2]
	Total	[10]

OR

12b	 ***for each correct ray drawn (dotted or solid where necessary with correct arrow), [1] for correct image drawn.***	[3]

12b	Upright, virtual, enlarged ***[1]*** *if only 2 is correct* ***[0]*** *if less than 2 is correct*	[2]
12c	**1.** The size of the image will reduce. **[1]** **2.** The image will be closer to the lens. **[1]**	[2]
12d	$n = \frac{c}{v} \rightarrow v = \frac{c}{n} = \frac{3.0 \times 10^8}{1.5} = 2.0 \times 10^8 \text{ m s}^{-1}$ (2 or 3 s.f)	Working [1] Ans [1]
12e	They have different frequencies. *OR* They have different wavelengths.	[1]
	Total	[10]