SA2 Coral Secondary School ____ 2
SA2 East Spring Secondary School ____ 34
SA2 Fuhua Secondary School ____ 68
SA2 Gan Eng Seng School ____ 96
SA2 Geylang Methodist School ____ 136
SA2 Innocents' High School ____ 184
SA2 Kuo Chuan Presbyterian Secondary ____ 218
SA2 Pasir Ris Crest School ____ 258
SA2 Peirce Secondary School ____ 305
SA2 St. Joseph's Institution ____ 355
SA2 St. Patrick's School ____ 392
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SA2 Yuying Secondary School ____ 464

Name:	Class: Sec _____	Index No.: _____

3E

CORAL SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2016

PHYSICS

5059/01

SECONDARY 3 EXPRESS

Additional Material: OTAS

Paper 1

14 Oct 2016

Duration: 45 mins

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 all the work you hand in.

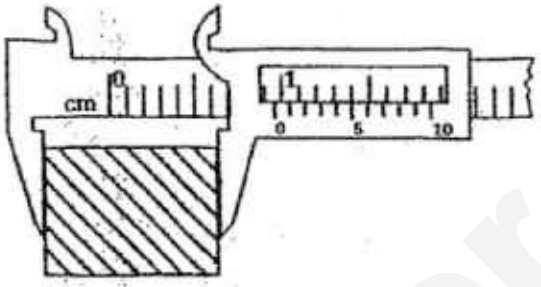
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS sheet.

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

This question paper consists of **10** printed pages, including this page.

[Turn over

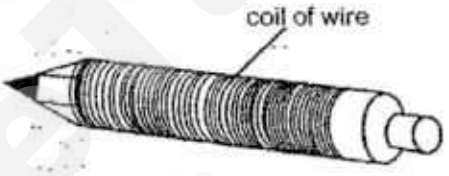
1 A pair of vernier calipers is used to measure the thickness of a piece of wood as shown in the figure below. When the jaws are closed, the reading of the vernier calipers is 0.1 mm.



What is the thickness of the wood?

A 0.84 cm B 0.94 cm C 0.95 cm D 0.96 cm

2 A piece of wire is wound tightly round a pen as shown in the diagram below. The turns are next to one another but not overlapping. When there are 500 turns of the wire, the length of the pen covered by the wire is found to be 3.8 cm.



What is the average diameter of the wire?

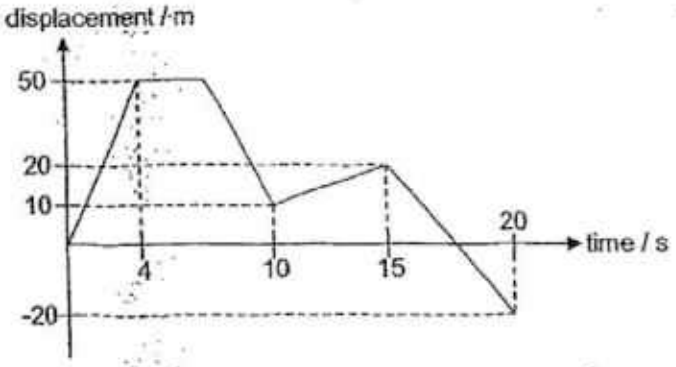
A 0.0076 mm B 0.0038 mm C 0.076 mm D 0.038 mm

3 A truck travelling at 20 m/s undergoes uniform deceleration of 3 m/s^2 for 4 s.

What is the final velocity of the truck?

A 0 m/s B 8 m/s C 20 m/s D 32 m/s

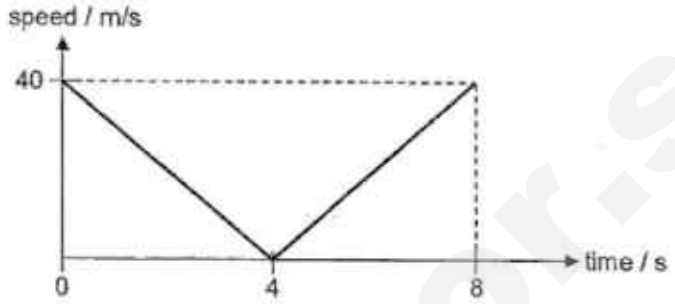
4 The displacement-time graph of an object for its 20 s journey is shown below.



What is the total distance travelled by the object in the 20 s journey?

A 20 m B 70 m C 100 m D 140 m

5 The diagram below represents the speed-time graph of a rock that is thrown vertically upwards with an initial speed of 40 m/s.



What is the maximum height reached by the rock?

A 40 m B 80 m C 160 m D 320 m

6 A boy pushes a wooden block across a table at a constant velocity.

Which statement is correct?

A The reaction force is the force that the block pushes back on the boy.

B The reaction force is the friction that opposes the motion of the block.

C The frictional force is greater than the pushing force.

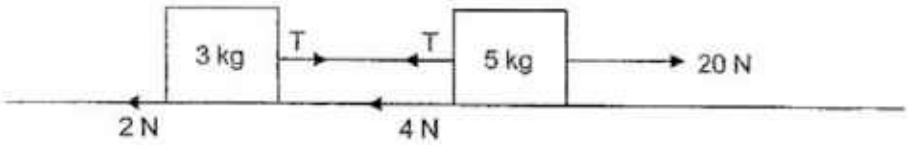
D The frictional force is smaller than the pushing force.

7 The mass of a model rocket is 120 kg. The rocket engine is able to provide an upward thrust of 1500 N.

What is the acceleration of the rocket?

A 2.0 m/s^2 B 2.5 m/s^2 C 10.0 m/s^2 D 12.5 m/s^2

8 The diagram below shows two blocks being pulled by a 20 N force. The two blocks of mass 3 kg and 5 kg are held together by a light, inextensible string. The friction on the 3 kg and 5 kg blocks are 2 N and 4 N respectively.



What is the magnitude of the tension T?

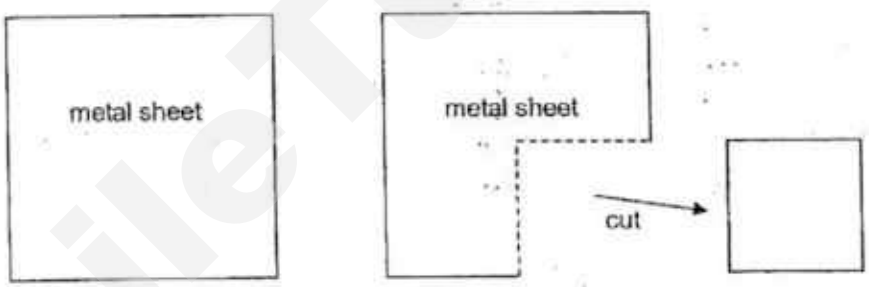
A 5.25 N B 7.25 N C 14.00 N D 20.00 N

9 In 1969, humans created history when Neil Armstrong became the first human to walk on the Moon.

Which option about his mass and the gravitational pull he experienced on the moon is correct?

	mass	gravitational pull
A	same as on earth	less than on earth
B	less than on earth	less than on earth
C	same as on earth	zero
D	less than on earth	zero

10 A uniform flat rectangular piece of metal sheet has a density of 7.00 g/cm^3. One quarter of the metal sheet is cut out as shown in the diagram below.



What is the density of the one quarter metal sheet?

A 1.75 g/cm^3 B 3.50 g/cm^3 C 7.00 g/cm^3 D 28.00 g/cm^3

11 When solid P of mass 12 g is immersed in a measuring cylinder filled with water, it displaces the same volume of water as solid Q of mass 8 g.

What can be deduced about the densities of solids P and Q?

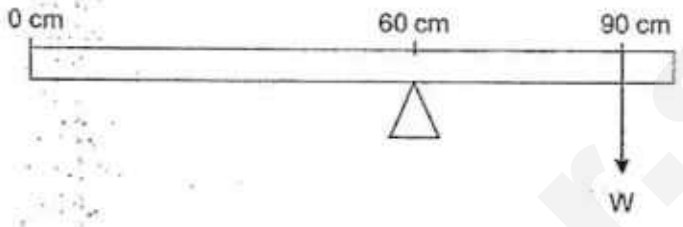
A P and Q have the same density.

B Density of P is 4 times the density of Q.

C Density of P is 2 times the density of Q.

D Density of P is 1.5 times the density of Q.

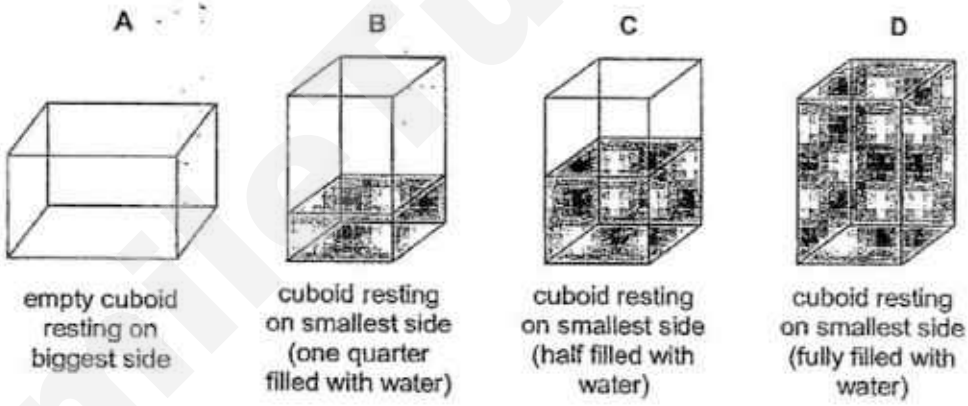
12 A uniform metre rule of weight 1.04 N balances at the 60 cm mark when a weight W is placed at the 90 cm mark.



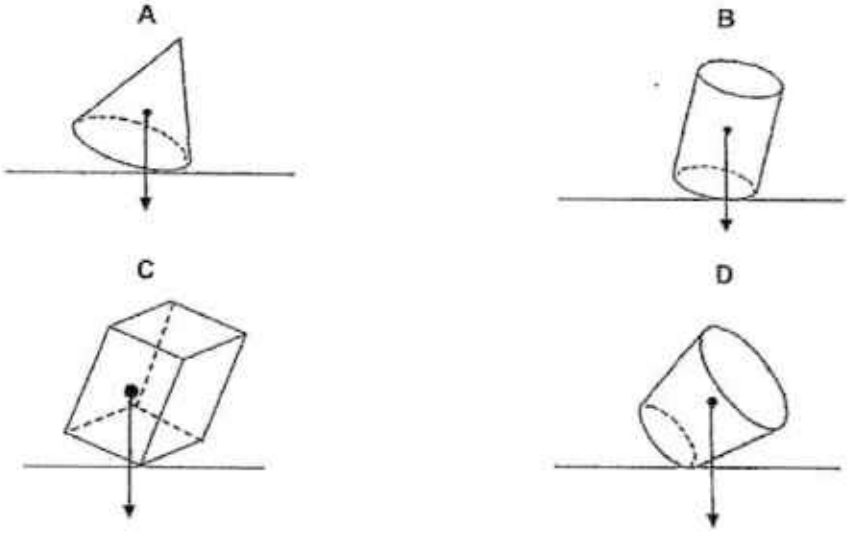
What is the value of W?

A 0.347 N **B** 0.578 N **C** 0.693 N **D** 1.04 N

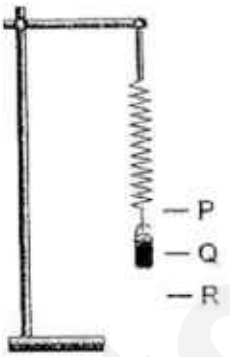
13 Which of the following boxes topples most easily when disturbed?



14 Which of the following boxes will topple at the position shown?



15 A mass suspended from a spring is at rest at point Q. The mass is pulled down to point R and released. The mass moves vertically upwards and reaches a maximum height at P.



Which statement represents the total energy conversion that takes place from R to P?

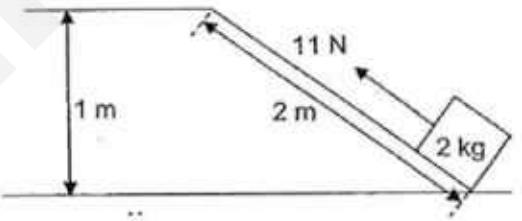
A elastic potential energy → kinetic energy

B elastic potential energy → kinetic energy + elastic potential energy

C elastic potential energy → gravitational potential energy + elastic potential energy

D elastic potential energy → gravitational potential energy + kinetic energy

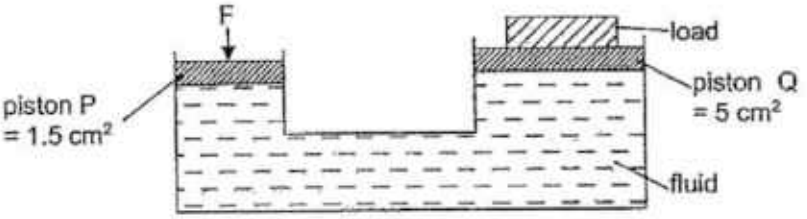
16 A force of 11 N pulls a 2 kg block up a rough slope at a constant velocity.



What is the work done against friction?

A 1 J B 2 J C 20 J D 22 J

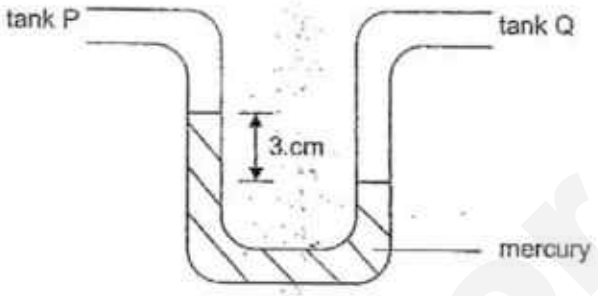
17 A force F is applied on piston P such that the piston moves down 2 cm. This causes piston Q to move up.



What is the distance moved by piston Q?

A 0.6 cm B 1.0 cm C 2.0 cm D 6.7 cm

18 A U-tube containing mercury is connected to two gas tanks as shown. The pressure of the gas in tank P is 80 cm Hg.



What is the pressure of the gas in tank Q?

A 77 cm Hg B 80 cm Hg C 83 cm Hg D 86 cm Hg

19 The mercury level in a mercury-in-glass thermometer rises as the temperature rises.

Which of the following remains constant?

A density of mercury

B internal energy of mercury

C mass of mercury

D volume of mercury

20 A mercury-in-glass thermometer and a platinum resistance thermometer are calibrated linearly from measurements at the ice and steam points. The two thermometers should necessarily agree

A at every temperature within the operating temperature range of the thermometer.

B only at the calibration points.

C at the temperature of zero Kelvin.

D at the temperature mid-way between the calibration points.

21 When fine pollen grains suspended in water are viewed under a microscope, they are seen to be making small, erratic movements.

Why is this so?

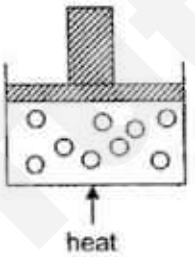
A There are convection currents in the water.

B They are being hit by randomly moving water molecules.

C They are moving and colliding with one another.

D They are living organisms so they move around.

22 The diagram shows gas molecules being heated in an air-tight cylinder that is enclosed by a fixed piston, such that the volume remains constant.



Which of the following statement(s) explain(s) why the pressure increases?

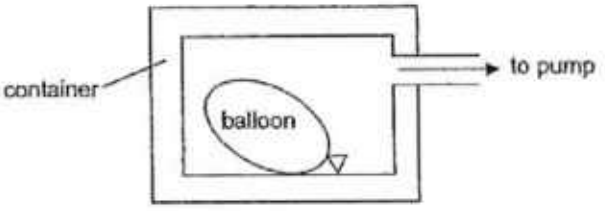
1 The speed of molecules increases.

2 The force of each collision between the molecule and the wall increases.

3 The rate of collision increases.

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

23 A balloon of volume 2 cm^3 is placed in an air-tight container and the pressure inside and outside the balloon are initially the same at 760 mm Hg. A pump removes some air such that the pressure outside the balloon is now 500 mm Hg, causing the balloon to expand.



What is the final volume of the balloon?

A 3.00 cm^3 B 3.04 cm^3 C 4.00 cm^3 D 4.04 cm^3

24 Which of the following statements about a vacuum flask are true?

1 The plastic stopper reduces heat loss by convection and evaporation.

2 The vacuum in the flask reduces heat loss by radiation.

3 The silver surface reduces heat loss by conduction.

4 The vacuum reduces heat loss by conduction and convection.

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

25 A match which is placed 3 cm directly above a flame is ignited. However, a similar match placed 3 cm beside the same flame is not ignited.

This is because most of the heat energy is transferred by

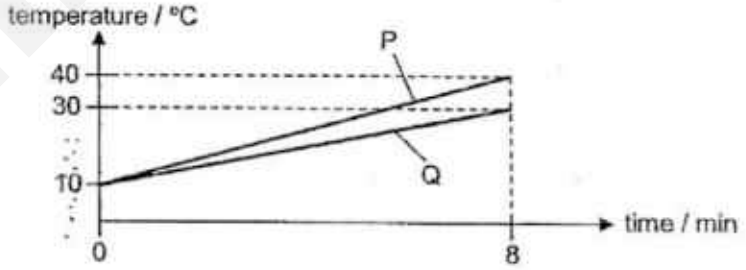
A radiation.

B conduction.

C convection.

D evaporation.

26 2 kg of sample P and 1 kg of sample Q are heated over the same heater for 8 minutes. The graph shows the temperature changes for samples P and Q.



Which statement is correct?

A Specific heat capacity of P is equal to specific heat capacity of Q.

B Specific heat capacity of P is 3 times the specific heat capacity of Q.

C Specific heat capacity of Q is 3 times the specific heat capacity of P.

D Heat capacity of Q is equal to heat capacity of P.

27 A heater of power 200 W is immersed in a filter funnel of crushed melting ice. Before the heater is switched on, 10 g of water is collected from the melting ice in 1 minute. When the heater is switched on, the mass of water collected from the melting ice in 1 minute is 50 g.

What is the specific latent heat of fusion of ice?

A 4 J/g **B** 5 J/g **C** 240 J/g **D** 300 J/g

28 Which of the following is a difference between boiling and evaporation?

A Intermolecular force weakens during boiling but not during evaporation.

B Boiling does not increase kinetic energy of molecules but evaporation does.

C Boiling involves all the molecules in the liquid but evaporation does not.

D Boiling increases the internal energy while evaporation does not.

29 Which of the following are properties of electromagnetic waves?

1 All electromagnetic waves can travel through vacuum.

2 All electromagnetic waves are invisible.

3 All electromagnetic waves carry no charges.

4 All electromagnetic waves can be reflected.

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

30 Below are four statements about the uses of electromagnetic waves.

1 Gamma rays are used in medical treatment.

2 Infra-red waves are used in sunbeds.

3 Microwaves are used in satellite TV.

4 X-rays are used in intruder alarms.

How many of these statements is/are correct?

A 1 **B** 2 **C** 3 **D** 4

~ END OF PAPER ~

Name:	Class: Sec _____	Index No.: _____

3E

CORAL SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2016

PHYSICS
5059/02

Paper 2
4 Oct 2016

SECONDARY 3 EXPRESS

Duration: 1 hour 30 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

Section A

Answer **all** questions in the spaces provided.

Section B

Answer **all** questions.

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.
Unless otherwise stated, use $g = 10\ m/s^2$ for all your calculations.

For Examiner's Use		
Section	**Question(s)**	**Marks**
A	1 – 8	
B	9	
	10	
	Total Marks	

This question paper consists of **15** printed pages, including this page.

[Turn over

SECTION A

Answer **all** questions in this section. [50 marks]

1 Fig. 1.1 shows the velocity-time graph of an object as it travels from point A to point B in 22 seconds.

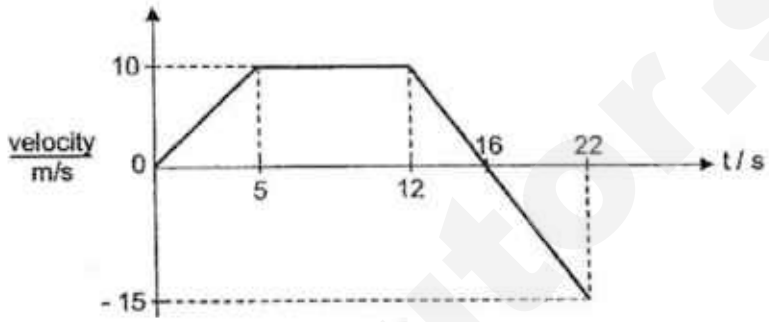


Fig. 1.1

(a) Calculate the acceleration of the object during the period of

(i) t = 0 s to t = 5 s,

acceleration = ... [1]

(ii) t = 12 s to t = 22 s.

acceleration = ... [2]

(b) Describe the motion of the object throughout the whole journey.

.....

.....

.....

..... [2]

(c) Determine the displacement of point B from A.

displacement = ... [2]

(d) State the time during the journey when the object is furthest away from A.

time = ... [1]

2 Fig. 2.1 shows the air resistance experienced by a rock as it is released from rest from a certain height above the ground. After 10 s, the rock reaches terminal velocity.

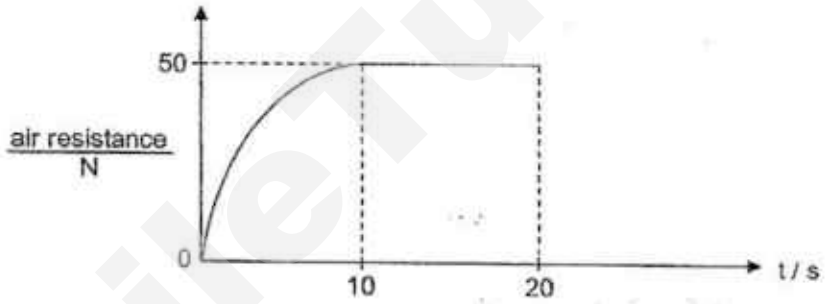


Fig. 2.1

(a) State the initial acceleration of the rock.

acceleration = ... [1]

(b) Explain why the air resistance increases in the first 10 s.

.....

..... [1]

(c) Use Newton's Laws of motion to explain why the rock accelerates first then reaches terminal velocity.

.....

.....

.....

..... [2]

(d) Hence, state the weight of the rock.

weight = ... [1]

(e) The weight of the rock is one of the two forces that forms an action-reaction pair of forces.

Describe the other force of the action-reaction pair.

.....

..... [1]

3 An object of weight W is suspended by two ropes from a beam, as shown in Fig 3.1.

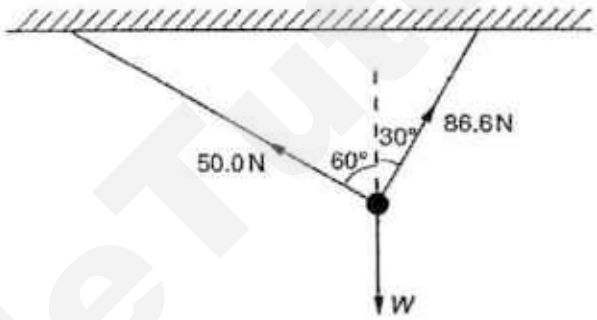


Fig. 3.1

(a) In the space below, draw a scale diagram to find the resultant force due to the tension in the ropes.

State the scale used.

resultant force = ... [3]

(b) Hence, state the weight W of the object.

W = ... [1]

4 Fig. 4.1 shows a submarine resting near the bottom of the sea. To float up to the surface, the seawater that fills the two ballast tanks are removed and replaced with air. Fig. 4.2 shows the total mass, volume of the submarine and the density of seawater.

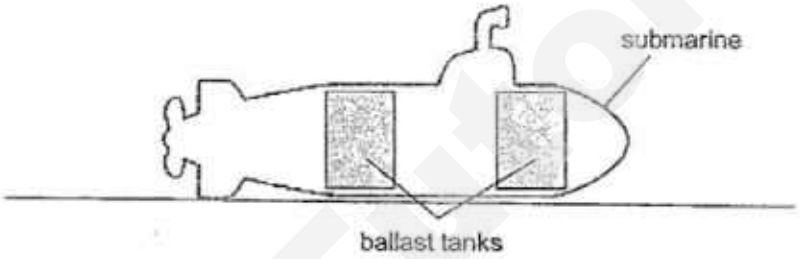


Fig. 4.1

total mass of submarine (with ballast tank filled with seawater)	120 000 kg
total volume of submarine	100 m^3
density of seawater	1 020 kg/m^3

Fig. 4.2

(a) Calculate the density of the submarine when the ballast tank is still filled with seawater.

density = ... [1]

(b) Explain why by replacing seawater in the ballast tanks with air, the submarine can float up to the surface.

.....

.....

.....

..... [2]

(c) Hence, determine the minimum volume of seawater that has to be removed from the ballast tanks for the submarine to float up.

minimum volume = ... [3]

5 Figure 5.1 shows a simplified diagram of a paper hole-puncher. A force of 5 N is applied on the arm of the hole-puncher which causes the knife to come down and punch a hole in a piece of paper inserted under the hole-puncher.

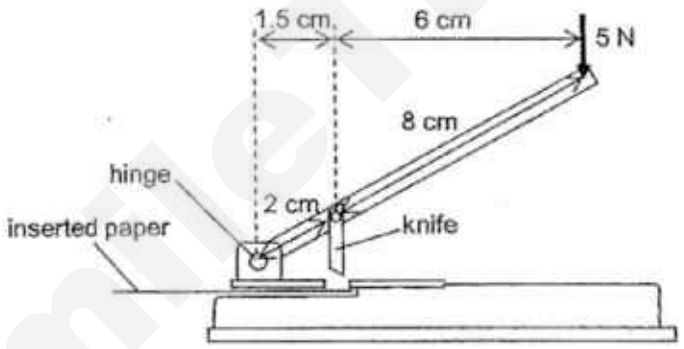


Fig. 5.1

(a) State what is meant by moment of a force.

.....

..... [1]

(b) Determine the force exerted by the knife on the paper.

force = ... [2]

(c) The same force of 5 N is exerted in a new direction as shown in Fig. 5.2.

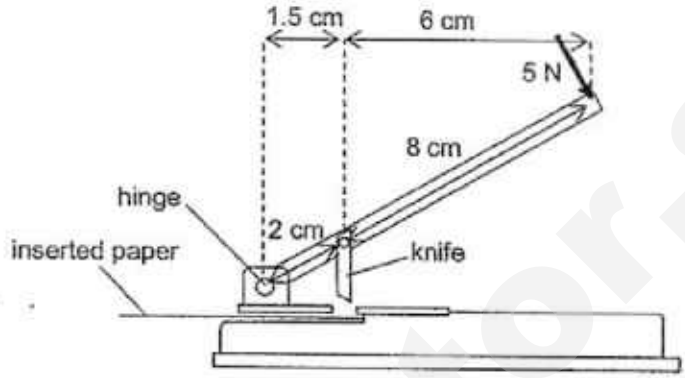


Fig. 5.2

(i) Explain whether the hole-puncher will exert a greater or smaller force on the paper through the knife.

.....

.....

..... [1]

(ii) Suggest two changes to the design of the hole-puncher such that the same 5 N force can also create a greater force on the paper.

.....

.....

.....

..... [2]

6 Fig. 6.1 shows an electric toy car of mass 500 g that is powered by batteries. From point A, the car accelerates uniformly from rest and reaches point B 5 s later with a velocity of 2 m/s. From point B, the battery power is cut and the car slows down under a constant frictional force to rest at C, 3 m from B.

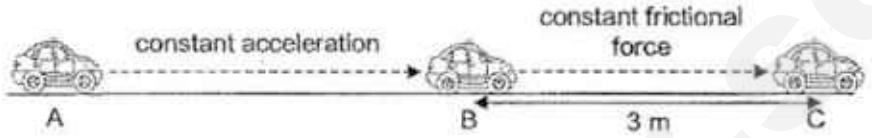


Fig. 6.1

(a) It is assumed that there are no resistive forces acting on the car or energy loss between A to B.

(i) State the energy conversion that occurs as the battery powers the toy car from point A to B.

.....

..... [1]

(ii) Hence, calculate the average power delivered by the battery from point A to B.

average power = ... [2]

(iii) The same experiment in Fig. 6.1 is repeated 20 times before the battery is exhausted of its stored energy.

Determine the amount of energy stored in the battery in the beginning.

energy stored = ... [1]

(b) Determine the constant frictional force required to bring the toy car to a stop from B to C.

frictional force = ... [2]

7 Due to the recent heat wave, Ah Sheng bought a portable air-conditioner to cool his room. Fig. 7.1 shows some key features of his room and the location of his portable air-conditioner.

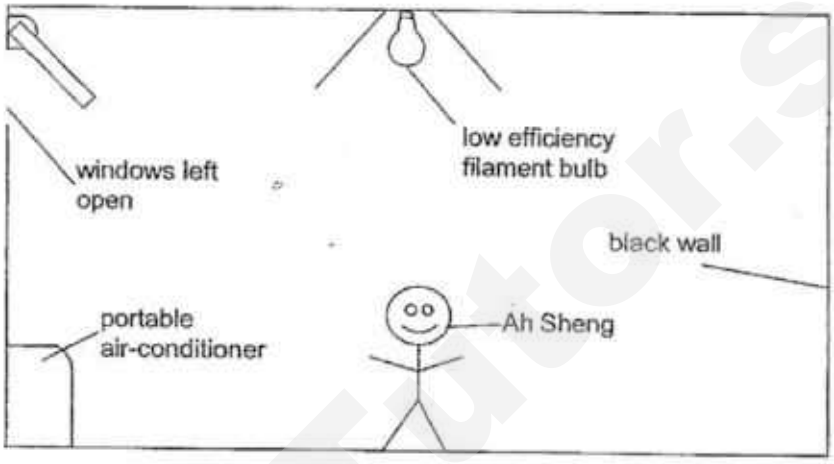


Fig. 7.1

When the portable air-conditioner is used, Ah Sheng is not able to effectively cool his room.

(a) Explain briefly how each of the following features listed affect the effectiveness of cooling the room.

(i) portable air-conditioner,

.....

.....

..... [2]

(ii) black wall,

.....

..... [1]

(iii) low efficiency light bulb,

.....

..... [1]

(iv) windows left open.

.....

..... [1]

(b) Ah Sheng believes that the main reason why his room is not effectively cooled is because there are not enough furniture in the room. He suggests adding more furniture as this will reduce the remaining volume of the room to be cooled.

State, with a reason, if adding more furniture will improve the efficiency.

.....

.....

.....

..... [2]

8 Fig. 8.1 shows the relationship between the power delivered and the wavelength of the sun's radiation. The shaded portion represents the region of visible light. The range of wavelength for visible light is between 400 nm to 700 nm.

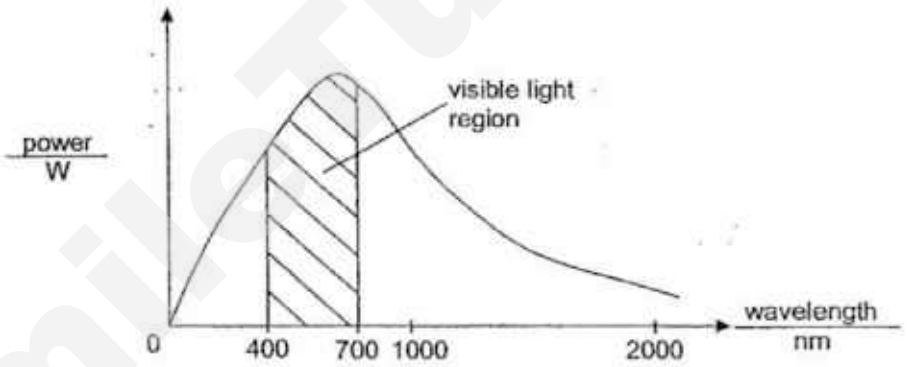


Fig. 8.1

(a) Explain, using the graph in Fig. 8.1, why the sun's radiation is not efficient in delivering visible light energy to the Earth.

.....

.....

..... [1]

(b) The sun is able to warm the Earth due to a particular type of electromagnetic radiation.

(i) State the name of this radiation.

..... [1]

(ii) Using Fig. 8.1, estimate the wavelength of this radiation.

..... [1]

(iii) State another use of this radiation.

..... [1]

(c) A thermocouple is used to measure the temperature on Earth due to the sun's radiation. When the thermocouple's cold and hot junctions are placed in ice point and steam point of pure water, the e.m.f. produced is 12 mV. The hot junction is now placed under the sun's radiation at noon time and the e.m.f. produced is 5.2 mV.

(i) Determine the temperature of the hot junction due to the sun's radiation.

temperature = ... [2]

(ii) It is known that the temperature of Earth's surface depends on the time of the day. The temperature at noon is said to be warmer than that in early evening, just before sunset.

Suggest a reason for this.

.....

..... [1]

SECTION B

Answer **all** the questions in this section. [20 marks]

9 Fig. 9.1 and Fig. 9.2 show an experiment to measure the specific heat capacity of a piece of metal.

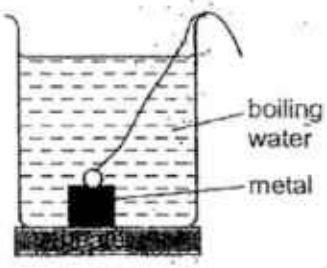


Fig. 9.1

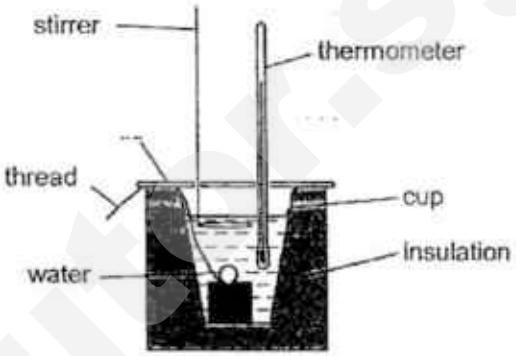


Fig. 9.2

The piece of metal is heated in boiling water until it has reached the temperature of the water. It is then transferred rapidly to some water in a well-insulated cup. A very sensitive thermometer is used to measure the initial and final temperatures of the water in the cup. The specific heat capacity of water is 4200 J / kg°C.

The readings from the experiment are as follows:

mass of metal = 50 g
mass of water in cup = 200 g
initial temperature of water in cup = 21.1 °C
final temperature of water in cup = 22.9 °C

(a) State what is meant by the specific heat capacity of water is 4200 J / kg°C?

.....

..... [1]

(b) Explain the purpose of having a layer of insulation around the cup in Fig. 9.2.

.....

..... [1]

(c) The metal and the water in the cup reached thermal equilibrium at the final temperature of the water.

(i) State what is meant by thermal equilibrium.

.....

..... [1]

(ii) Calculate the temperature rise of the water in the cup and the temperature fall of the piece of metal.

temperature rise of water = ...

temperature fall of metal = ... [2]

(iii) Calculate the thermal energy gained by the water in the cup.

thermal energy gained = ... [2]

(iv) Calculate the specific heat capacity of the metal.

specific heat capacity = ... [2]

(d) The cup has to be made of a material that has very low specific heat capacity so that the accuracy in the calculation of the specific heat capacity is not greatly affected.

Explain why.

.....

..... [1]

10 Fig. 10.1 shows a barometer which is used to measure the atmospheric pressure. Fig. 10.2 shows the same barometer with a layer of liquid X added to the surface of the mercury in the trough.

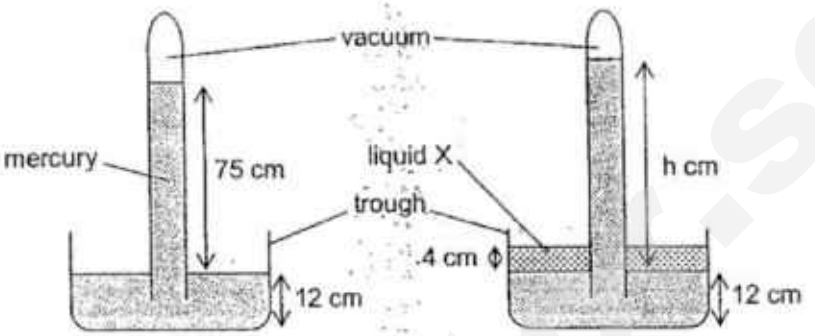


Fig. 10.1 **Fig. 10.2**

The density of mercury is 13600 kg/m³ and that of liquid X is 5200 kg/m³. The base area of the trough is 16 cm².

(a) State the value of the atmospheric pressure in cmHg.

atmospheric pressure = ... [1]

(b) Calculate the pressure in Pa at the bottom of the trough in Fig. 10.1.

pressure = ... [2]

(c) Hence, calculate the force exerted at the bottom of the trough in Fig. 10.1.

force exerted = ... [1]

(d) When liquid X is added in Fig. 10.2, the mercury level in the barometer rises.

(i) Explain why the mercury level rises.

.....

..... [1]

(ii) Hence, calculate the new height h.

h = ... [2]

(e) The barometer in Fig. 10.1 undergoes one of the following modifications.

State the effect on the mercury level in Fig. 10.1 for each modification.

(i) using a barometer tube of larger cross-sectional area,

..... [1]

(ii) replacing the mercury with a liquid of lower density,

..... [1]

(iii) adding more mercury into the trough such that the height of mercury in the trough becomes 14 cm.

..... [1]

~ END OF PAPER ~

CSS EOY Examination 2016
Secondary 3 Express
Physics (5059)

Marking Scheme:

Paper 1

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

Paper 2

Section A

1	(a) i	acceleration = (10 – 0)/5 = 2 m/s^2	 A1
	ii	acceleration = (0 – 10) / (16 – 12) = -10 / 4 = - 2.5 m/s^2	C1 A1
	(b)	t = 0 to 5s, the object undergoes constant acceleration. t = 5 to 12s, the object travels at constant velocity. t = 12 – 22s, the object experiences negative acceleration. B1 (at least 1 correct only) B2 (all correct).	 B2
	(c)	Displacement = ½ (16 + 7)(10) – ½ (6)(15) = 70 m	C1 A1
	(d)	16 s	A1
2	(a)	10 m/s^2	A1
	(b)	The speed is increasing.	B1

	(c)	When the rock is released, the resultant force on the rock decreases as the air-resistance increases and act against the weight of the rock. Based on Newton's 2nd law the acceleration decreases. When it reaches terminal velocity, the air-resistance equals the weight and the object travels at constant velocity based on Newton's 1st law as there is no resultant force.	B1 B1
	(d)	50 N	A1
	(e)	The gravitational force the rock exerts on the Earth.	B1
3	(a)	Appropriate scale Correct scale drawing Resultant force = 98 – 102 N	B1 B1 B1
	(b)	value equal to resultant force in (a)	B1
4	(a)	density = 120000 / 100 = 1200 kg/m^3	 A1
	(b)	As the seawater is removed from the tanks, the mass of the submarine reduces. This will cause the average/effective density to reduce below the seawater's density, causing it to float.	B1 B1
	(c)	new density of submarine to float = 1020 kg/m^3 m/v = 1020 new mass m = 1020 x 100 = 102 000 kg amount of seawater removed = 120 000 – 102 000 = 18 000 kg volume of seawater removed = 18000 / 1020 = 17.6 m^3	 A1 A1 A1
5	(a)	Product of the force and the perpendicular distance of the line of action of the force to the pivot.	B1
	(b)	F x 1.5 = 5 x 7.5 F = 25 N (no marks if 2 cm and 10 cm are used instead)	C1 A1
	(c) i	The force on the knife will be greater. Because the perpendicular distance of the 5 N force applied is longer.	 B1

	ii	reduce the perpendicular distance of knife from pivot increase the length of the arm and exert the 5 N force at the end.	B1 B1
6	(a)i	Chemical potential energy -> kinetic energy	B1
	ii	Power delivered = change in KE / time = (1/2 x 0.5 x 2^2) / 5 = 0.2 W	 C1 A1
	iii	Energy per experiment = 0.2 x 5 = 1 J Total energy = 1 x 20 = 20 J	 B1
	(b)	F x d = KE F x 3 = ½ x 0.5 x 2^2 F = 0.333 N	 C1 A1
7	(a) i	The cold air produced by the portable air conditioner is denser and sinks. The air-conditioner is positioned too low so it does not produce convection currents are formed.	B1 B1
	ii	Black colour is a good emitter of radiation and radiates more heat into the room as the wall is warmer.	B1
	iii	The low efficiency filament bulb gives out a lot of heat energy by radiation, warming up the room.	B1
	iv	The open windows allow warm air to enter the room, making the room warm.	B1
	(b)	It will not improve the effectiveness. Because the furniture will increase the heat capacity as it has more matter.	B1 B1
8	(a)	Most of the radiation delivered by the sun is outside the visible light region on the graph. So efficiency is low.	B1
	(b) i	Infrared	B1
	ii	700nm – 1000 nm accepted (e.c.f. allow from i)	B1
	iii	Burglar alarm / remote control device or any relevant answer (e.c.f. allow from i)	B1
	(c)i	12 = k(100 – 0) k = 0.12 5.2 = k(θ- 0) 5.2 = 0.12(θ- 0)	 C1

		$\theta = 43.3$ °C	A1
	ii	The sunlight shines perpendicular to the surface at noon time but side way to the surface in the evening so more radiation will strike the surface during noon time to make the surface warmer.	B1

Section B

9	(a)	It meant that when 1 kg of water absorbs 4200 J of thermal energy, it will rise in temperature by 1 °C/K.	B1
	(b)	It reduce heat loss to the surrounding so as to improve the accuracy of the experiment.	B1
	(c) i	It meant that there is no net heat transfer between the metal and the water.	B1
	ii	Temperature rise of water = 22.9 – 21.1 = 1.8 °C Temperature fall of metal = 100 – 22.9 = 77.1 °C	B1 B1
	iii	Energy gain = $mc\Delta\theta$ = 0.2 x 4200 x 1.8 = 1512 J	 C1 A1
	iv	$mc\Delta\theta$ = 1512 0.05 x c x 77.1 = 1512 c = 392 J / kgK	 C1 A1
	(d)	With low specific heat capacity, the heat energy absorbed by the cup during the experiment will be insignificant so that very little heat is lost to heat up the cup.	B1
10	(a)	75 cmHg	B1
	(b)	Pressure = hpg = (0.75 + 0.12) x 13600 x 10 = 118320 Pa	 C1 A1
	(c)	F = P x A = 118320 x 16 / 10000 (e.c.f. allowed) = 189 N	 A1
	(d)i	The liquid increase the pressure exerted on the surface of mercury in the trough, this pushes the mercury level in the tube up.	B1
	ii	hpg = 0.75 x 13600 x 10 + 0.04 x 5200 x 10 h x 13600 x 10 = 104080 h = 76.5 cm	C1 A1

	(e)i	No change in level	B1
	ii	Liquid level increases	B1
	iii	height of mercury level increase by 2 cm, or height difference with surfaces remains unchanged.	B1

EAST SPRING SECONDARY SCHOOL

Towards Excellence and Success

Name: _____ ( )

Class: 3-1

Second Semester Examination 2016
Secondary Three Express

PHYSICS

Tuesday 11 October 2016

2 hours 15 minutes
0935 - 1150

Additional materials:
OTAS

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces provided above, and on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
You may assume $g = 10$ m/s^2 whenever necessary, unless otherwise stated.
Calculators are allowed.

Section A [25 marks]
Answer **all** questions in soft pencil on the OTAS.

Section B [45 marks]
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section C [30 marks]
Answer **any three** questions.
Write your answers in the spaces provided on the question paper.

At the end of the examination, hand in the OTAS separately.

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

Section	Marks
A	/ 25
B	/ 45
C	/ 30
Total	/ 100

This question booklet consists of 27 printed pages including the cover page.

Section A [25 Marks]

Answer **ALL** questions in soft pencil on the OTAS.

A1 Fig. A1.1 below shows the reading of the zero error of the micrometer screw gauge. Fig. A1.2 shows the reading of the same instrument when it is used to measure the width of an object.

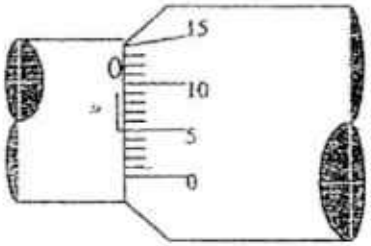


Fig. A1.1

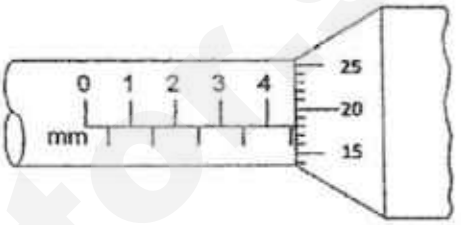
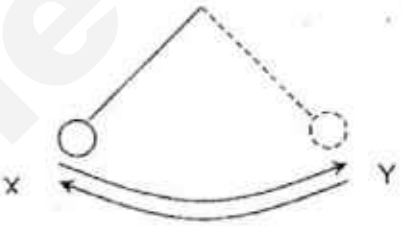


Fig. A1.2

What is the width of the object?

A 4.63 mm **B** 4.73 mm **C** 4.83 mm **D** 4.85 mm

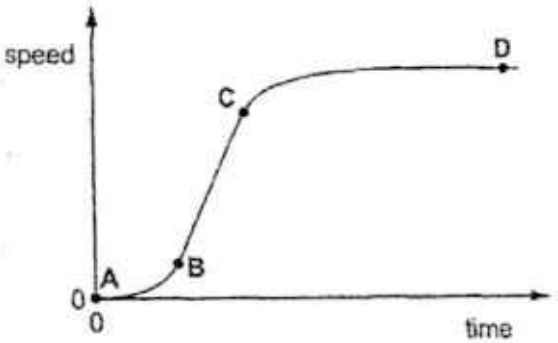
A2 It takes 20 s for a pendulum to swing from X to Y and back again 20 times.



What is the period of the pendulum if the mass is doubled?

A 0.5 S **B** 1 s **C** 2 s **D** 20 s

A3 The graph shows the speed of a weather balloon as it rises through the atmosphere.

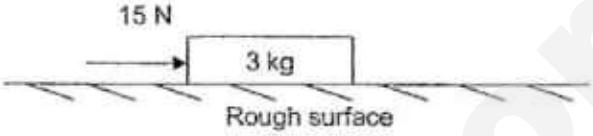


At which point (**A**, **B**, **C** or **D**) in the rise of the balloon does the acceleration start to decrease?

A4 A hammer hits a nail on a piece of wood with a speed of 6 m/s. If it drives the nail 0.1 m into the wood, what is the average deceleration of the hammer?

A 18 m/s² **B** 60 m/s² **C** 120 m/s² **D** 180 m/s²

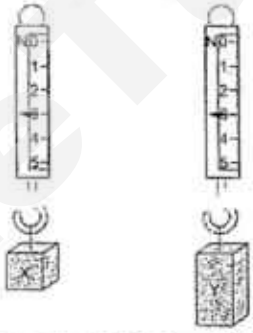
A5 When pushed with a force of 15 N, a 3 kg box accelerates at 2 m/s² across a rough surface.



What force would be needed for the box to move at a constant speed instead?

A 5 N **B** 6 N **C** 9 N **D** 15 N

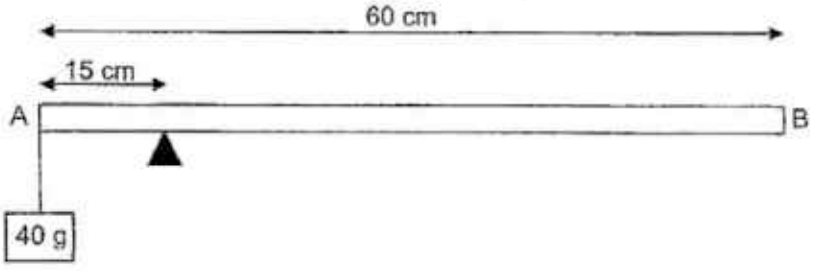
A6 Two blocks of metal X and Y hang from spring balances as shown in the diagram.



Which of the following statements (**A**, **B**, **C** or **D**) is true?

A They have the same mass and the same volume but different weights.
B They have the same mass and the same weight but different volumes.
C They have the same mass, the same volume and the same weight.
D They have the same weight and the same volume but different masses.

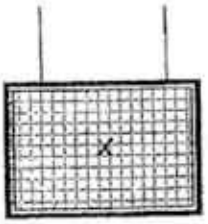
A7 A uniform plank AB of length 60 cm is balanced horizontally across a pivot placed 15 cm from A as shown below. A mass of 40 g is hung from the end A.



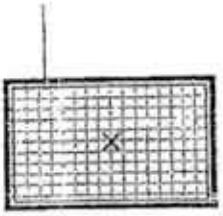
What is the weight of the ruler?

A 0.13 N **B** 0.40 N **C** 13 N **D** 40 N

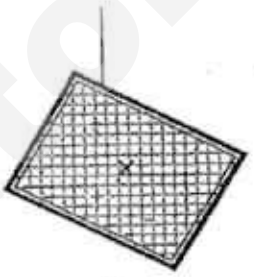
A8 A picture frame, with centre of gravity at X, hangs from two strings as shown in the figure below.



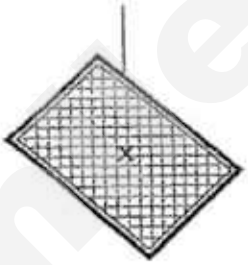
Which one of the following figures shows how the picture frame hangs when one of the strings breaks?



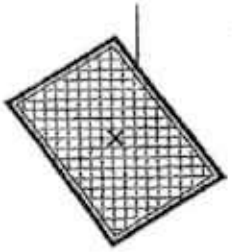
A



B

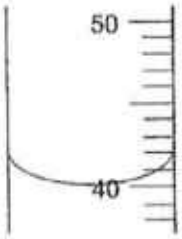


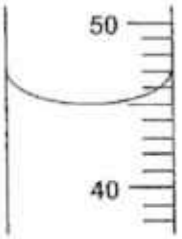
C



D

A9 The figures below show the difference in water level (cm^3) before and after a stone is submerged in a measuring cylinder.

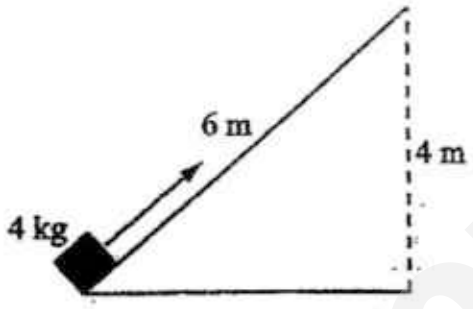




If the mass of the stone is 0.020 kg, what is the density of the stone?

A 0.004 g/cm^3 **B** 0.1 g/cm^3 **C** 0.25 g/cm^3 **D** 4 g/cm^3

A10 The diagram shows a box of mass 4 kg being pulled up a rough ramp from rest.



Given that the speed of the box is 2 m/s at the top of the ramp and the friction along the ramp is 5 N, how much work is done to move the box up the ramp?

A 30 J **B** 160 J **C** 190 J **D** 198 J

A11 A bodybuilder uses a chest expander with five springs. It takes a force of 200 N to extend one spring by 15 cm.

What is the average power needed to extend the chest expander by 15 cm in 10 seconds?

A 3 W **B** 15 W **C** 30 W **D** 150 W

A12 Molten iron is poured into a mould and allowed to cool. During the process when iron is changing from liquid to solid, the iron particles

A move slower.
B decrease in size.
C move closer to one another.
D move slower and closer to one another.

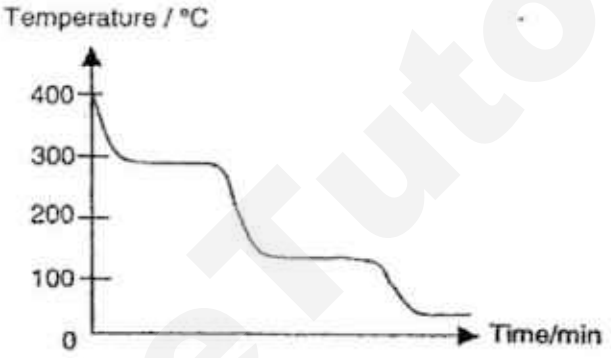
A13 Gas inside a sealed container of fixed volume is heated. Which of the following **does not** increase?

A The average distance between the gas molecules.
B The average kinetic energy of the gas molecules.
C The number of collisions per second by the gas molecules on the walls of the container.
D The force due to the collisions between the gas molecules and the walls of the container.

A14 A wooden chair feels warmer than a metal chair even when they are at the same temperature. Which of the following statements best explains this?

A Wood is a better absorber of radiant heat.
B Metal is a better emitter of radiant heat.
C Wood is a better conductor of heat.
D Metal is a better conductor of heat.

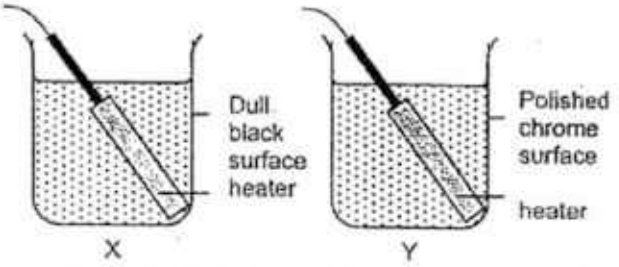
A15 A gaseous substance is cooled at a constant rate and its temperature is recorded every minute, as shown in the graph below.



At which of the following temperatures is the substance a liquid?

A 0 °C **B** 100 °C **C** 200 °C **D** 350 °C

A16 In the diagram below, two copper cans X and Y with outer surface of different texture are filled with the same amount of water at room temperature.



If both the cans are heated with heaters of the same power, which of the following statements is correct?

A Water in X boils faster because a dull black surface is a better insulator.
B Water in X boils faster because a dull black surface is a better radiator.
C Water in Y boils faster because a polished chrome surface is a poorer radiator.
D Water in Y boils faster because a polished chrome surface is a poorer conductor.

A17 A heater supplies 6800 J of thermal energy is to heat 30 g of ice at 0°C. The specific latent heat of fusion of ice is 340 J/g. How much ice remains after heating?

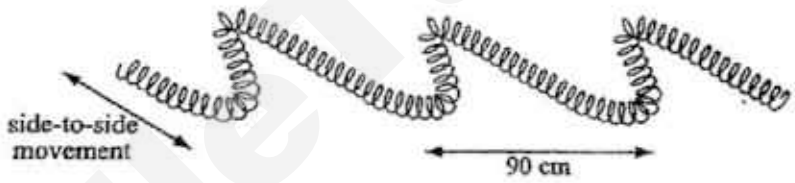
A 0 g **B** 10 g **C** 20 g **D** 30 g

A18 The lengths of mercury thread in the uniform tube above the bulb of a mercury thermometer are 20 mm in melting ice and 170 mm in steam directly above boiling water.

What is the temperature indicated by the thermometer when the length of mercury thread is 10 mm?

A – 6.7 °C **B** – 5.9 °C **C** 5.9 °C **D** 6.7 °C

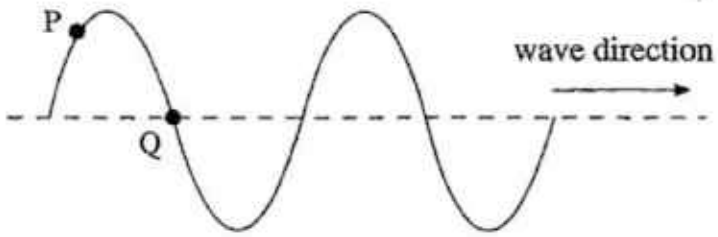
A19 A wave is made by shaking a coil of spring from side to side. The distance between two successive troughs is 90 cm, and 3 waves are produced in 1 second.



How long does the wave take to travel 4.5 m along the spring?

A 1.67 s **B** 13.5 s **C** 15 s **D** 60 s

A20 The diagram shows a wave on a string with two points P and Q marked. The wave is moving in the direction shown.



What will happen next?

A P will move up.
B P will move to the right.
C Q will move up.
D Q will not move.

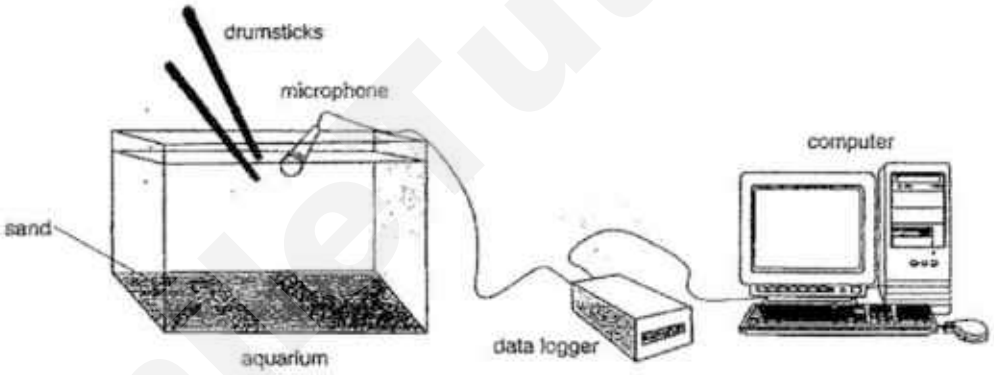
A21 Below are four statements on the uses of electromagnetic radiation.

X-rays are used in intruder alarms.
Microwaves are used in satellite TV.
Infra-red waves are used in sunbeds.
Gamma rays are used in ear thermometers.

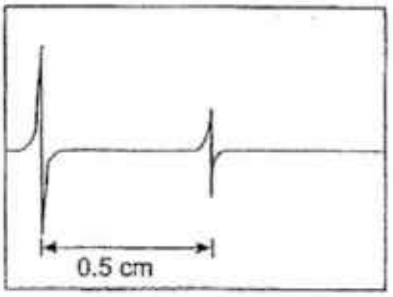
How many of these statements are correct?

A 0 **B** 1 **C** 2 **D** 3

A22 An experiment is carried out to measure the speed of sound in water as shown below. An aquarium with sand at the bottom is filled with water, and a microphone, wrapped in plastic, is placed near the water surface.



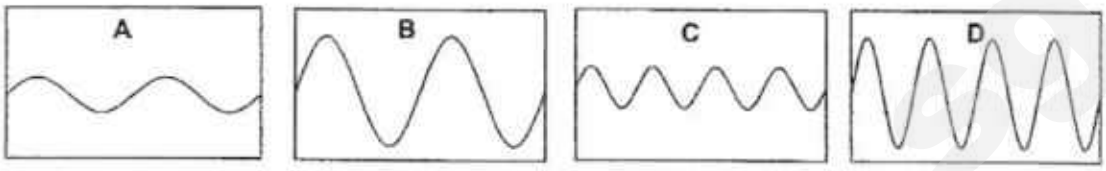
Two drumsticks, with their heads immersed in the water, are hit against each other to make one sharp sound pulse, and the sounds are detected by the datalogger and displayed on the screen as shown below.



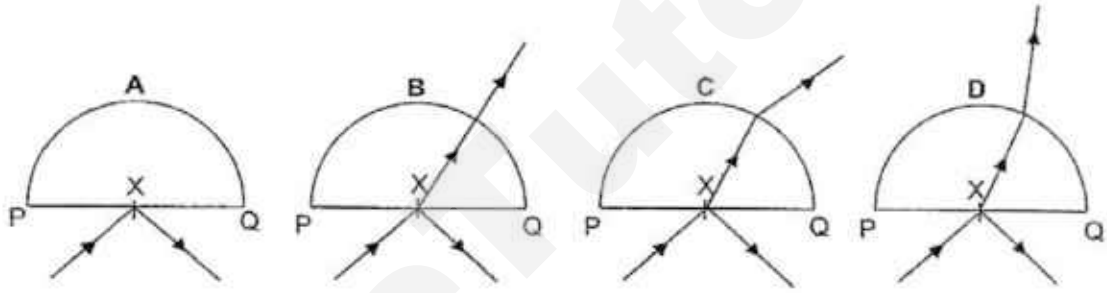
Given that 1 cm on the screen represents 1 ms of time, and the depth of water is 28 cm, find the speed of sound in water.

A 560 m/s **B** 1120 m/s **C** 1790 m/s **D** 3570 m/s

A23 Which of the following sound waves (**A, B, C** or **D**) is the softest with the highest pitch?

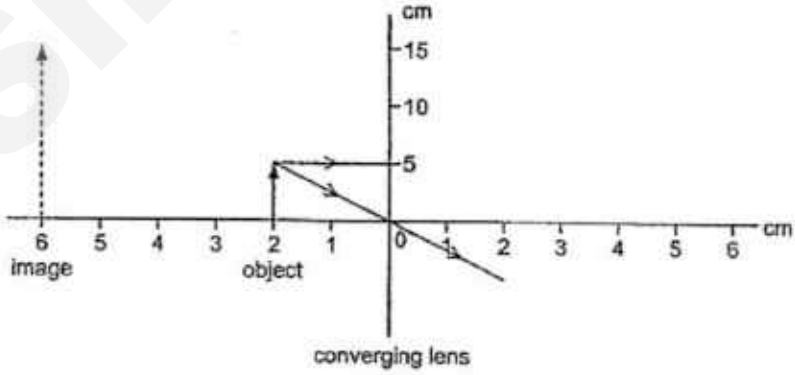


A24 X is the midpoint of the straight edge PQ. Which of the following best illustrates the path of light as it is shone onto a semi-circular glass block?



A25 An object 5.0 cm high is placed 2.0 cm from a converging (convex) lens which is being used as a magnifying glass.

The image produced is 6.0 cm from the lens and is 15 cm high.



What is the focal length of the lens?

A 2.0 cm **B** 3.0 cm **C** 4.0 cm **D** 6.0 cm

- End of Section A -

Section B [45 marks]

Answer **ALL** questions in the spaces provided.

B1 An object of mass 20 kg is initially at rest on a rough horizontal surface. A horizontal force F is then applied to it. Fig. B1.1 shows a graph of the variation of F applied with time. The object moves with an acceleration of 0.4 ms^{-2} in the first 12 s.

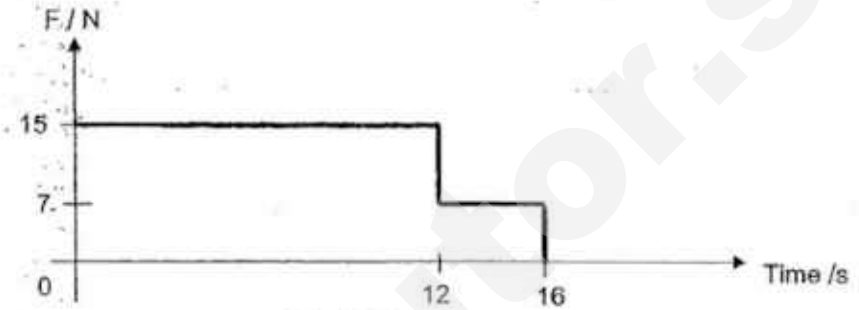


Fig. B1.1

(a) Calculate

(i) the speed of the object when the time t = 12 s.

speed = ...[2]

(ii) the distance travelled by the object in the first 12 s.

distance = ...[1]

(iii) Calculate the frictional force between the surfaces. Assume that air resistance is negligible.

frictional force = ...[2]

(b) In the presence of air resistance, the acceleration would change and not remain constant at 0.4 ms^{-2} in the first 12 s.

Explain, in terms of the forces acting on the object, why the acceleration would change.

.....

.....

.....

.....

..... [2]

B2 Fig. B2.1 shows a uniform beam of mass 100 kg being supported by two rollers. A student of mass 50 kg is standing in a position such that his centre of gravity (C.G) is 0.5 m away from point T.

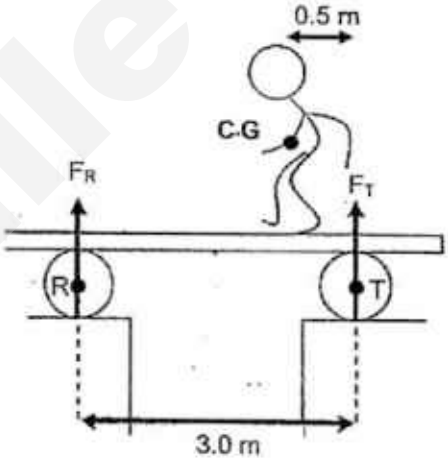


Fig. B2.1

(a) Describe one difference between *mass* and *weight*.

.....

..... [1]

(b) Calculate the weight of the beam. The gravitational field strength is 10 N/kg.

Weight = ... [1]

(c) On Fig. B2.1, draw the weight acting on the beam. [1]

(d) By taking moments about R, calculate the reaction force F_T.

F_T = ... [2]

(e) Hence, or otherwise, calculate the reaction force F_R.

F_R = ... [1]

(f) State how the reaction forces F_T and F_R will change as the student walks towards point R.

.....

..... [1]

B3 The G-Max Reverse Bungy at Clarke Quay uses a giant catapult to launch people seated inside a metal-framed capsule vertically upwards using elastic cords.

When the capsule is about to be launched, each cord applies a force of 1600 N and the cords are at 95° to each other as shown in Fig. B3.1.

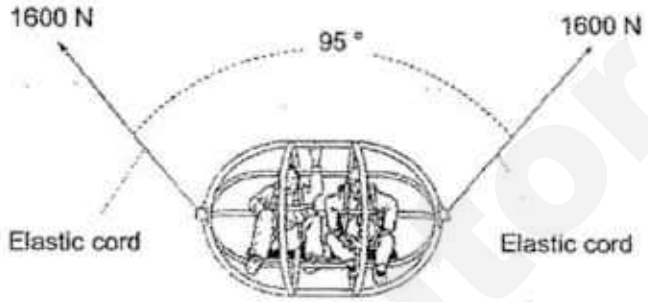


Fig. B3.1

(i) By drawing a scaled diagram, find the resultant of these two forces, indicating clearly its magnitude and its direction.

Magnitude = ...

Direction: .....

[3]

(ii) Calculate the minimum force required to hold the capsule in place prior to the launch, given that the weight of the capsule with its occupants is 1500 N.

Force: ..... [1]

B4 Fig. B4.1 shows a roller coaster of mass 400 kg being released from rest at **A**. It is assumed that the friction between the track and the roller coaster is negligible.

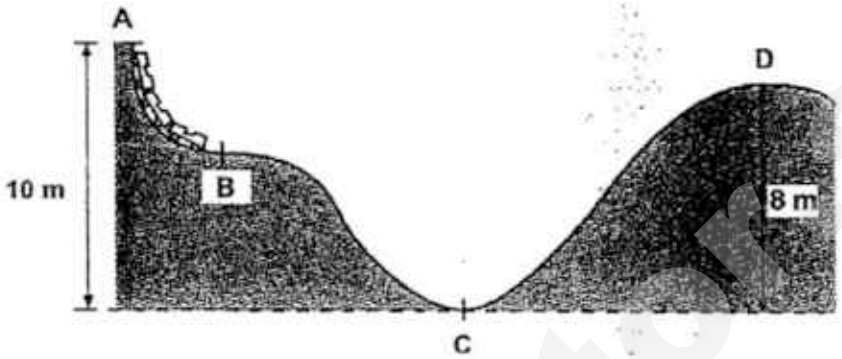


Fig. B4.1

(a) Describe how the energy of the roller coaster would change as it moves from A to B.

.....

.....

.....

..... [2]

(b) Calculate the gravitational potential energy of the roller coaster at point A.

Gravitational Potential Energy = ... [1]

(c) Calculate the speed of the roller coaster by the time it reaches point D.

Speed = ... [2]

B5 Fig. B5.1 below shows a ray of red and violet light passing into the surface of water.

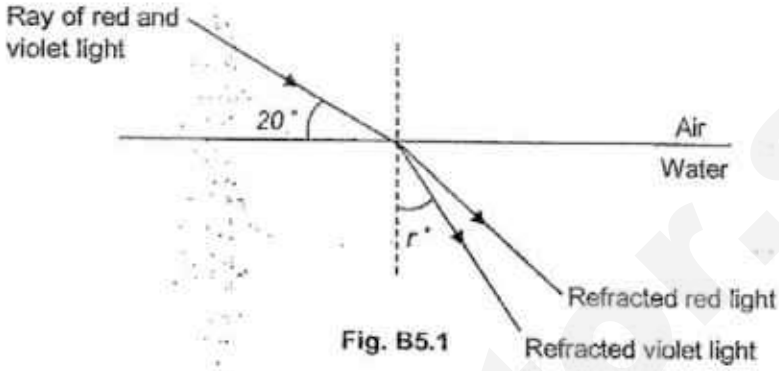


Fig. B5.1

(a) Explain what is meant by the term *refractive index*.

.....

.....

..... [1]

(b) The refractive index of water for red and violet light are 1.33 and 1.35 respectively.

Calculate the angle of refraction of the refracted violet ray.

Angle of refraction = ... [2]

(c) Describe how the speed, wavelength and frequency of the red light will change as it travels from air to water.

Speed: ..... Wavelength: .....

Frequency: ..... [1]

(d) Explain how Fig. B5.1 shows that the speed of the red light is higher than the speed of the violet light.

.....

..... [1]

B6 An object is placed in front of a thin converging lens and a real image is formed on the opposite side of the lens. The object distance is varied and the image distance is measured. A graph of the image distance against object distance is shown in Fig. B6.1.

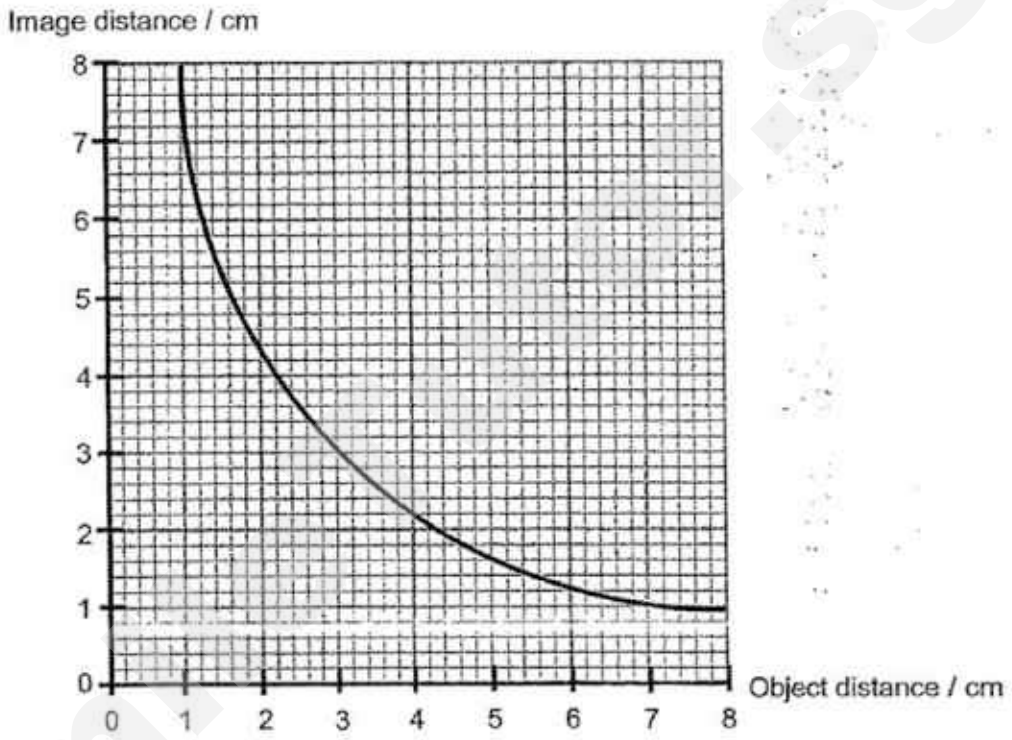


Fig. B6.1

Fig. B6.2 is an incomplete full-scale ray diagram. Using data from Fig. B6.1, complete Fig.B6.2 for the object when it is placed at a certain distance in front of the thin converging lens. Show clearly the image position and state the focal length of the lens.

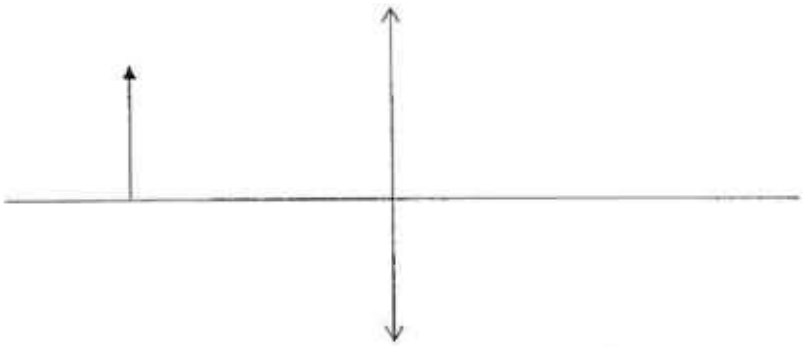


Fig. B6.2

Focal length = ... [4]

B7 Fig. B7.1 shows the positions of particles of a medium at a particular instant when a longitudinal sound wave, travelling from left to right, passes through the medium. Before the wave arrived, the particles were all spaced equally apart at their original undisturbed positions which are shown by the vertical lines.

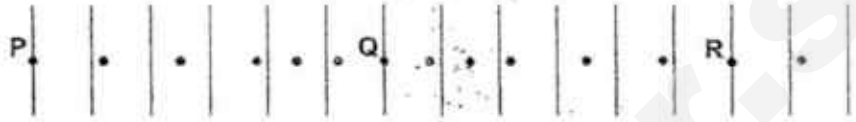


Fig. B7.1

(a) Explain what is meant by *longitudinal wave*.

.....

.....

..... [1]

(b) Given that the distance between P and Q is 10 cm and the frequency of the sound is 20 Hz.

(i) Calculate the speed of the wave

Speed = ... [2]

(ii) Calculate the time taken for the compression at Q to move to the position at R.

Time = ... [2]

(c) Describe how the movement of the particle at point P will change when

(i) A louder sound passes through it.

.....

..... [1]

35

(ii) A higher pitch sound passes through it.

.....

..... [1]

B8 Fig. B8.1 shows the cooling fins that are found behind a refrigerator. The black metal cooling fins help to transfer heat away from the hot fluid which flows through the metal pipe. As a result, a cooler fluid flows out of the metal pipe.

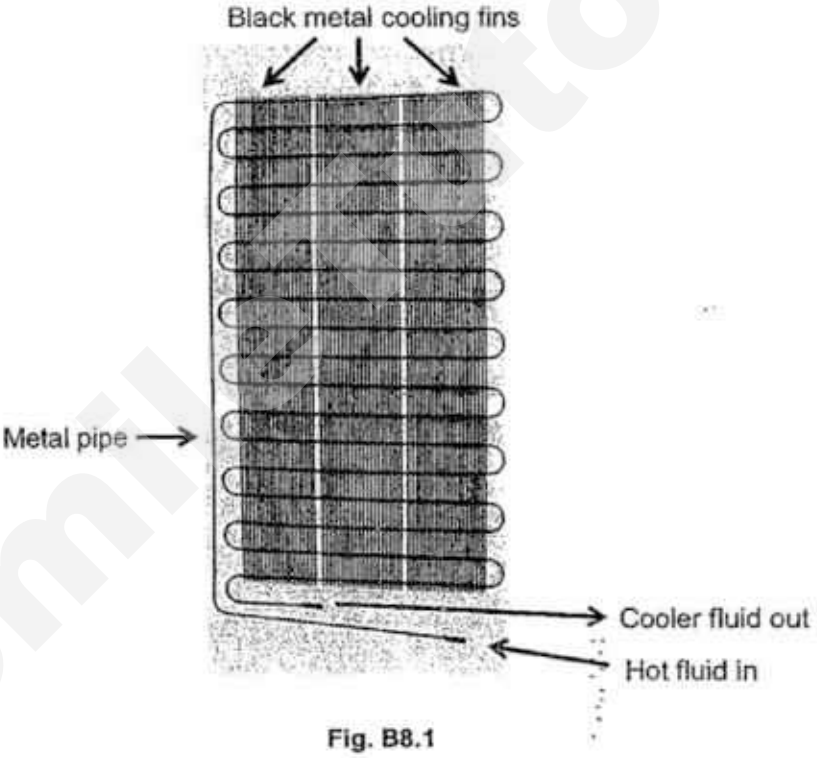


Fig. B8.1

(a) Describe how heat is transferred from the hot fluid to the cooling fins and then to the surrounding air. In your answer, state clearly the heat transfer processes involved.

.....

.....

.....

.....

..... [2]

(b) Explain how the features of the cooling fins allow heat to be transferred easily away from the hot fluid flowing in the metal pipe.

.....

.....

.....

.....

.....

..... [3]

(c) The refrigerator is able to transfer 36 MJ of heat energy in 4 hours. Calculate the power of the refrigerator.

power = ... [1]

- End of Section B -

Section C [30 marks]
Answer any **three** questions in the spaces provided.

C1 A student carries out an experiment to study the flow of heat. The student heats a 600 g metal block M in boiling water at 100 °C for 10 minutes until the block has the same temperature as the boiling water as shown in Fig. C1.1.

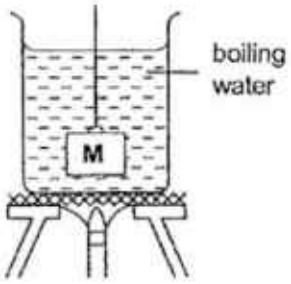


Fig. C1.1

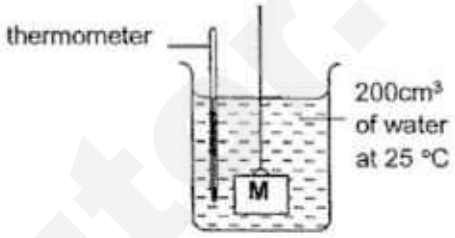


Fig. C1.2

The student then transfers the metal block into a beaker containing 200 cm³ of water at 25 °C as shown in Fig. C1.2.

The temperature of water in the beaker is recorded at 30-second intervals. The student then plots a graph of the temperature of the water against time as shown in Fig. C1.3.

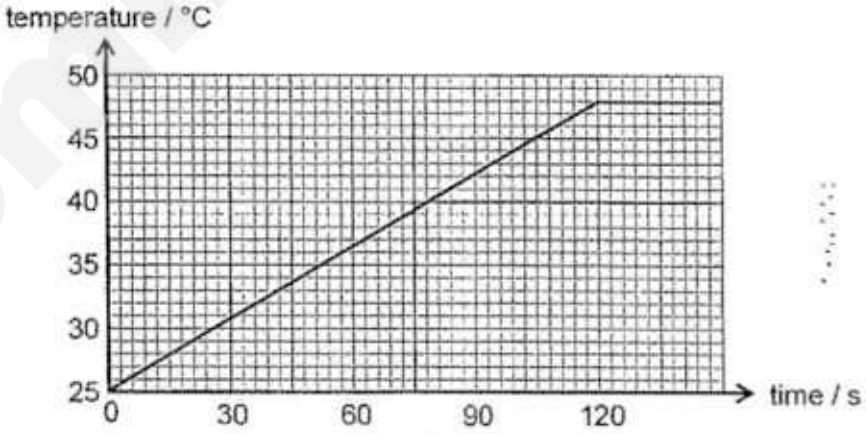


Fig. C1.3

(a) Explain why the temperature of the water remains constant at 50 °C after 120 seconds.

.....

..... [1]

(b) Explain what is meant by the *specific heat capacity of water is 4200 J/(kg°C)*.

.....

..... [1]

(c) The density of water is 1 g/cm³. Calculate the heat gained by the water in the first 120 seconds.

Heat gained = ... [3]

(d) Calculate the specific heat capacity of the metal block M.

Specific heat capacity = ... [2]

(e) During 0 s to 120 s, some water may have evaporated from the beaker.

(i) Explain, using the concept of particles, how evaporation takes place.

.....

.....

.....

.....

..... [2]

(ii) Explain how evaporation can cause the value calculated in **(c)** to be inaccurate.

.....

..... [1]

C2 Fig. C2.1 shows a periscope which may be used to see what is behind a vehicle when towing a caravan. Two mirrors should be used, but only one mirror has been shown in Fig. C2.1.

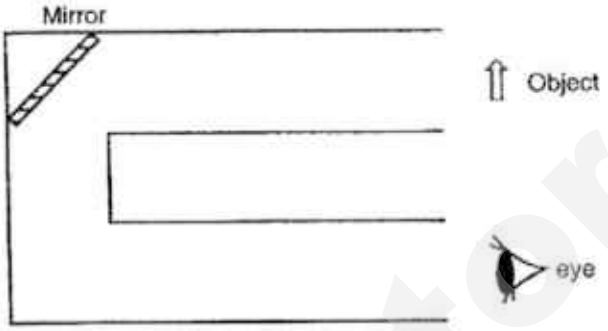


Fig. C2.1

(a) On Fig. C2.1, draw the second mirror in the correct position. [1]

(b) Draw accurately a ray of light from the

(i) top of the object to the eye. [1]

(ii) bottom of the object to the eye. [1]

(c) From your answers in part **(b)**, deduce whether the image is *upright* or *inverted*.

..... [1]

(d) Triangular glass prisms are usually used in place of the mirrors in the periscope by causing the light to undergo total internal reflection as shown in Fig. C2.2.

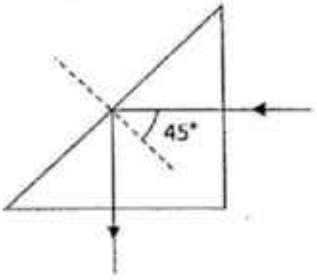


Fig. C2.2

(i) Explain why the light does not bend when it enters the glass prism from air.

..... [1]

(ii) Explain what is meant by the term *critical angle* of the glass prism.

.....

..... [1]

(iii) Given that the speed of light in air and glass is 2.99×10^8 m/s and 1.98×10^8 m/s respectively.

Calculate the critical angle of the glass prism.

Critical angle = ... [2]

(e) Glass mirrors usually have a layer of glass to protect the reflecting silvered surfaces from scratches as shown in Fig. C2.3.

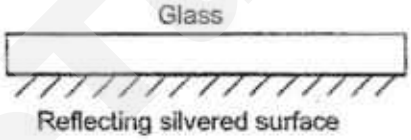


Fig. C2.3

Explain how the layer of glass would affect the image seen in the periscope.

.....

.....

.....

.....

.....

..... [2]

C3 **(a)** Brownian motion provides evidence that the molecules in a gas are moving.

(i) Draw a labelled diagram of an experiment that demonstrates Brownian motion.

[2]

(ii) Describe what is seen in the experiment.

..... [1]

(iii) State two reasons why the motion in **(aii)** is observed.

.....

.....

.....

.....

.....

..... [2]

(b) A filament lamp emits electromagnetic (E.M) waves with a range of wavelengths. Fig. C3.1 shows the energy emitted per second at each wavelength.

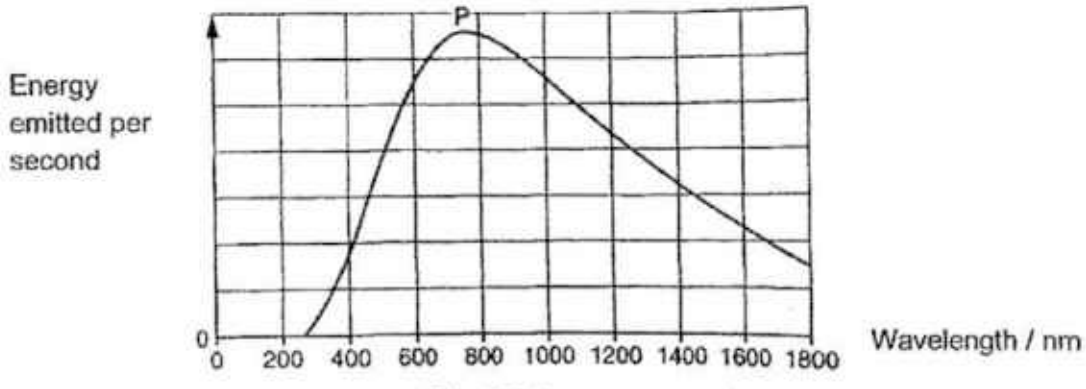


Fig. C3.1

The wavelength of visible light is between 400 nm and 700 nm.

(i) Suggest **two** other E.M waves that are emitted by the filament lamp other than light.

..... [2]

(ii) Given that the total amount of light energy emitted by the lamp was 1.8 MJ per second and the amount of electrical energy used by the lamp was 3 MJ per second.

Calculate the efficiency of the lamp.

efficiency = ... [1]

(iii) The glass casing of the filament lamp can be sprayed with a coating that will absorb E.M waves of a certain frequency.

By assuming a suitable value for the speed of the E.M waves, calculate the minimum frequency of E.M wave that should be absorbed so that the lamp is more efficient.

The glass should absorb EM waves with frequencies higher than ..... [2]

C4 A pedulum consisting of a metal sphere attached to a thin thread is shown in Fig. C4.1. When the thread is vertical, the metal sphere is at A. The metal sphere is moved to B by a horizontal force of 2.5 N.

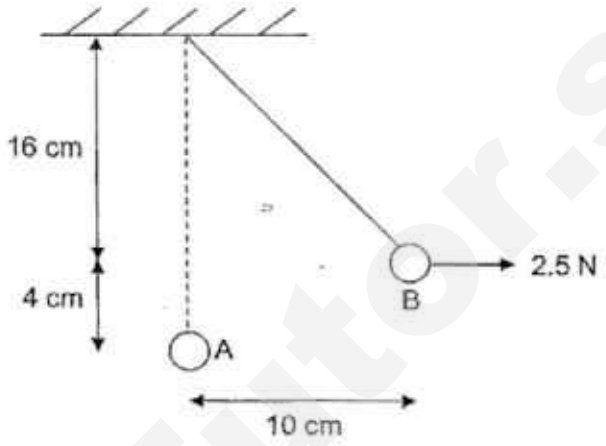


Fig. C4.1

(a) Draw a fully-labelled free-body diagram to showing all the forces acting on the metal sphere when it is at B. Name the forces clearly.

[1]

(b) The metal sphere is now released so that the pendulum is free to swing.

Explain why the metal sphere begins to move when released and why it continues to move past point A.

.....

.....

.....

.....

..... [2]

(c) The mass of the metal sphere is 400 g.

(i) Calculate the work done to raise the sphere.

Work done = ...[2]

(ii) Calculate the moment produced at point B due to its weight.

Moment = ...[2]

(d) Explain why the metal sphere eventually comes to a rest at point A after a while.

.....

..... [1]

(e) A student determines the time for one complete swing of the pendulum. She uses two methods.

In the first method, she measures the time for one complete swing.

In the second method, she measures the time for 20 complete swings and divides the total time by 20.

Explain why the second method gives a more accurate result than the first method.

.....

.....

.....

.....

..... [2]

30

- End of Section C -

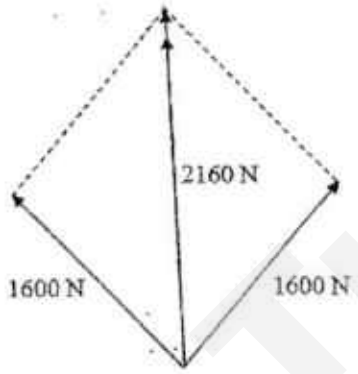
Answers

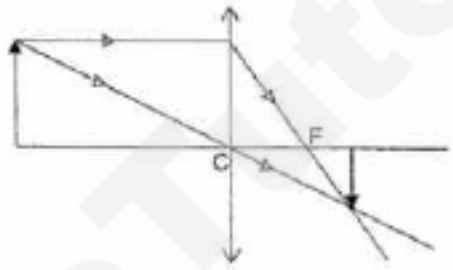
Qn	1	2	3	4	5	6	7	8	9	10
Ans	A	B	C	D	C	B	B	C	D	D

Qn	11	12	13	14	15	16	17	18	19	20
Ans	B	C	A	D	C	C	B	A	A	C

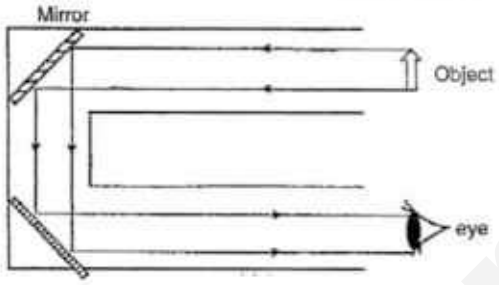
Qn	21	22	23	24	25
Ans	B	B	C	B	B

Qn	Answer	Mark
B1a(i)	a = (v-u) / t 0.4 = (v – 0) / 12 v = 4.8 m/s	 1 1
B1a(ii)	Distance = area under graph = ½ x 4.8 x 12 = 28.8 m	 1
B1a(iii)	F_r = m x a = 20 x 0.4 = 8 N F_r = F – friction 8 = 15 – friction Friction = 7 N	 1 1
B1b	As the object moves faster, the amount of air **resistance acting on it increases**. This will cause the **resultant force on the object to decrease**. Since F = m x a, the acceleration will decrease as well.	1 1
B2a	Mass is the **amount of substance inside a body** whereas weight is the **amount of gravitational force** acting on a body.	1
B2b	W = m x g = 100 x 10 = 1000 N	1
B2c	Weight is drawn in the middle and pointing downwards.	1
B2d	Sum of CW moments = Sum of ACW moment 1000 x 1.5 + 500 x 2.5= F_T x 3 F_T = 917 N	 1 1

B2e	Total upward force = Total downward force $F_T + F_R = W$ $917 + F_R = 1000 + 500$ $F_R = 583$ N	1
B2f	F_T will decrease whereas F_R will increase.	1
B3a	 Parallogram [1m] Magnitude = 2160 N (Accept 1944 N to 2376 N) [1m] Direction = 48° from 1600 N (Accept 46° to 50°) [1m]	3
B3b	Minimum Force = 2160 – 1500 = 660 N	1
B4a	At point A, the roller coaster would have **only gravitational potential energy**. As the roller coaster move from A to B would **lose gravitational potential energy** and **gain kinetic energy**. At **point B**, the roller coaster would have **both gravitational potential energy and kinetic energy**.	 1 1
B4b	GPE = m x g x h = 400 x 10 x 10 = 40,000 J	1
B4c	$E_A = E_D$ $GPE_A = GPE_D + KE_D$ $40{,}000 = 400 \times 10 \times 8 + \frac{1}{2} \times 400 \times v^2$ v = 6.32 m/s	 1 1
B5a	It is the ratio of the sine of the angle of incidence to the sine of the angle of refraction. **OR** It is the ratio of the speed of light in vacuum to the speed of light in the optical medium	1

B5b	n = sin i / sin r 1.35 = sin 70 / sin r r = 44.1°	 1 1
B5c	Speed decreases. Wavelength decreases. Frequency remain the same.	1
B5d	The red light does not bend as much towards the normal than the violet light.	1
B6	 1 ray drawn passing through C [1m] Image distance = 2.2 cm [1m] 1 ray drawn passing through lens and then F [1m] Focal length = 1.4 cm [1m]	4
B7a	A longitudinal wave is a wave which **travels in a direction** that is **parallel** to the **direction of vibration of particles.**	1
B7bi	v = f x λ = 20 x 20 = 400 cm/s	 1 1
B7bii	T = 1 / f = 1 / 20 = 0.05 s. Time taken for compression to move = 0.05 / 2 = 0.025 s.	 1 1
B7ci	Particle P will away from its rest position with a **larger displacement.**	1
B7cii	Particle P will **oscillate more times in one second.**	1

B8a	Heat is transferred from the hot fluid to the metal pipe and then to the cooling fin by **conduction**. Heat is transferred from the cooling fin to the surrounding air by **radiation**.	2
B8b	The fins are painted black as **black is a good emitter of heat.** This **increases the heat lost** to the surroudings by **radiation**. The fins are made of metal as **metal is a good conductor of heat.** This **increases the heat lost** to the surroudings by **conduction**. There are **many fins placed behind** to **increase the surface area.** This **increases the heat lost** to the surroudings by **radiation**.	3
B8c	P = E / t = 36 * 10^6 / (4*3600) = 2500 W	1
C1a	The water and the metal block has **reached thermal equilibrium.** OR There is no net transfer of heat between the water and metal block.	1
C1b	It means 4200 J of heat energy is needed to raise the temperature of 1 kg of water by 1°C.	1
C1c	m = D x V = 1 x 200 = 200 g Q = mcΔθ = 0.2 x 4200 x (48-25) = 19,320 J	 1 1 1
C1d	Heat loss by metal block = Heat gained by water mcΔθ = 19320 0.6 x c x (100-48) = 19320 c = 619 J/kg°C	 1 1
C1ei	The **particles at the water surface** which has **enough energy** to **overcome the downward attractive forces from the other particles** are able escape into the surroundings, leaving behind less energetic particles in the water.	1 1
C1eii	The **mass of the water would decrease due to evaporation,** hence the heat gained by the water will be lesser.	1

C2a C2b		3
C2c	Inverted	1
C2d(i)	The light is travelling along the normal	1
C2d(ii)	It is the angle of incidence in the optically denser medium such that the angle of refraction in the optically less dense medium is 90°	1
C2d(iii)	n = speed of light in air / speed of light in glass = $2.99 \times 10^8 / 1.98 \times 10^8$ = 1.51 c = $\sin^{-1}(1/n)$ = $\sin^{-1}(1/1.51)$ = 41.5°	1 1
C2e	As the light enters the glass mirror, **some light would be weakly reflected at the glass surface** and most of the light would refract through the glass, reflect at the reflecting surface and then refract out of the glass. The **weak reflected ray would cause the eye to see a faint image** which would interfere with the actual image.	1 1
C3ai	Apparatus drawn : light source, microscope, glass box, smoke	2
C3aii	The smoke moves in a constant and random motion.	1
C3aiii	The smoke particle is being **bombarded unevenly by the air particles at different speeds.** This is because the **air particles are in a constant and random motion.**	1 1
C3bi	Ultra violet and infra red	1
C3bii	Efficiency = $(1.8 \times 10^6 / 3 \times 10^6) \times 100$ = 60 %	1

33

C3biii	$f = v / \lambda$ $= 3 \times 10^8 / 700 \times 10^{-9}$ $= 4.29 \times 10^{14}$ Hz $f = v / \lambda$ $= 3 \times 10^8 / 400 \times 10^{-9}$ $= 7.5 \times 10^{14}$ Hz The glass should absorb frequency **higher than 7.5×10^{14} Hz.**	 1 1
C4a	Pulling force (acting to the right) Tension force (acting along string, away from sphere) Gravitational force (acting downwards)	1
C4b	The sphere begins to move due to the **resultant force** from the tension and gravitational force. The sphere continues to move past point A as it has **kinetic energy**.	1 1
C4ci	WD = increase GPE $= m \times g \times h$ $= 0.4 \times 10 \times 0.04$ $= 0.16$ J	 1 1
C4cii	Moment = F x d $= 0.4 \times 10 \times 0.1$ $= 0.4$ Nm	 1 1
C4d	**All** the kinetic energy of the sphere has been converted to heat and sound energy as it swings.	1
C4e	The second method reduces the **human reaction error** as the error is **shared out among the 20 oscillations**.	2

Candidate Name: _____ Class | Index No.

FUHUA SECONDARY SCHOOL

Secondary Three Express

End of Year Examination 2016

3E

PHYSICS 5059

6 October 2016
1045 - 1300
2 hour 15 minutes
Additional Materials: OMR, Graph Paper, Writing paper & Electronic calculator

READ THESE INSTRUCTIONS FIRST

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

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A (30 marks)

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

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

Section B (40 marks)

Answer **all** questions and write your answers in the spaces provided.

Section C (30 marks)

Answer **all** the questions and write your answers on the writing papers and graph paper provided. Start each question on a fresh page of paper.

At the end of the examination, fasten your Section C securely together.

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

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

PARENT'S SIGNATURE	FOR EXAMINER'S USE			
	Section A	Section B	Section C	Total
	/30	/40	/30	/100

Setter: Mr Raymond Loh *Vetter: Ms Chen Liyun*

This question paper consists of 21 printed pages including this page.

34

Section A: Multiple Choice Questions [30 marks]

Answer **all** questions and shade your answers on the OMR sheet provided.

1 Which of the following sets consists of only vector?

(i) Gravitational field strength
(ii) Gravitational acceleration
(iii) Density
(iv) Temperature

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

2 A man on top of a building throws a ball vertically upwards. After the ball has reached its maximum height, it starts to fall to the ground floor of the building. The following graph describes the motion of the ball.

Which of the following correctly represents the y-axis of the graph?

A displacement
B speed
C velocity
D acceleration

3 Fig. 3.1 shows a velocity-time graph of an object in motion.

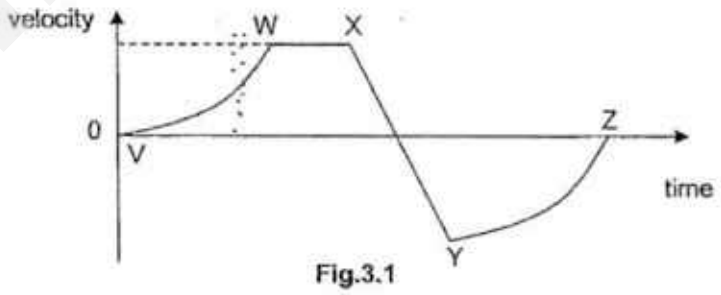


Fig.3.1

Which of the following statements are **not** correct?

(i) The direction the object is moving during XY is the same as during YZ.
(ii) The object is not moving during WX.
(iii) Both stages VW and YZ involve increasing rate of change of velocity.

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

4 Fig. 4.1 shows two cars P and Q started from the same point on a level road at different speeds.

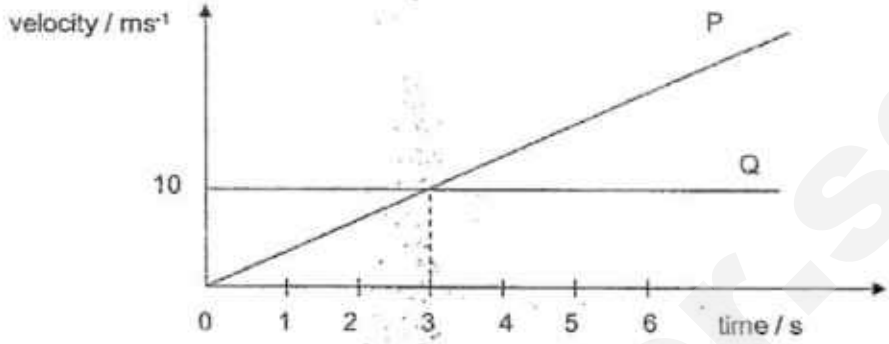


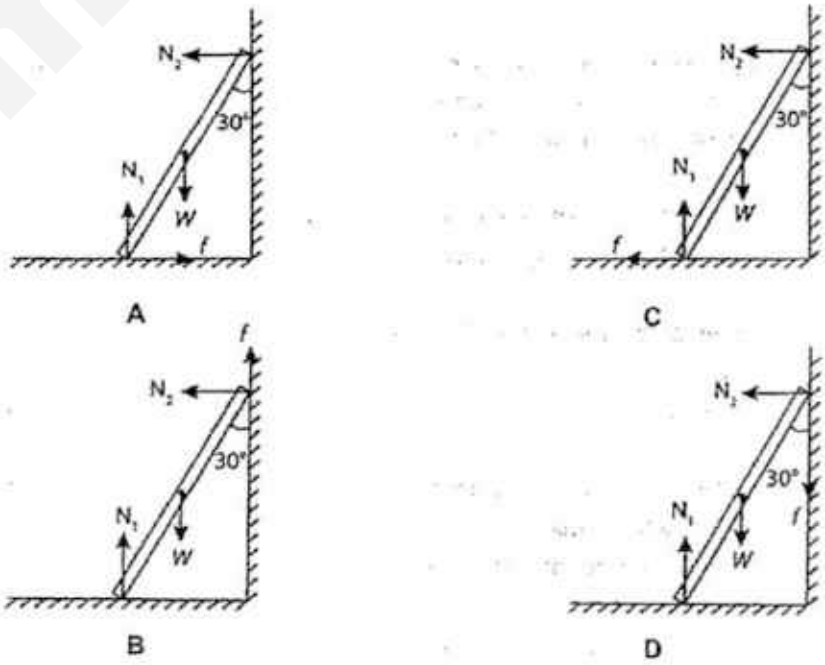
Fig. 4.1

Which of the following statements are correct?

(i) Both cars meet at 6.0 s.
(ii) Car Q is ahead of car P at 3.0 s.
(iii) Acceleration for car Q is zero while that for car P is 3.3 m/s².

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

5 A stationary uniform ladder of weight (W) is leaning against a smooth vertical wall on a rough ground. The ladder makes an angle of 30° with the vertical wall. Frictional force (f) and contact forces (N_1 and N_2) by the rough ground and the smooth wall acting on the ladder are given. Which diagram correctly shows the forces acting on the ladder?



6 Fig. 6.1 shows a car accelerating along a road. The wheel shown is connected to the engine. In which direction is the force of friction exerted by the road on the car tyre?

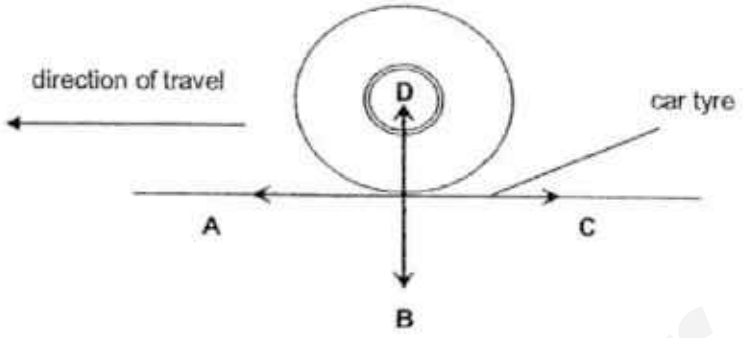


Fig. 6.1

7 A 20000 kg airplane travels at a constant speed of 175 ms^{-1}, at a constant height of 20 km above sea level. Its engines provide a constant forward pushing force of 500 kN.

Find the resultant force acting on the airplane.

A	539 kN	C	200 kN
B	500 kN	D	0 N

8 The table below shows the result of an experiment in which a piece of rubber with a density of 1.38 g/cm^3 is cut into half of its original size and is placed in four different liquids.

Liquid	Density of liquid / g cm^{-3}	Observation
Mercury	13.6	W
Water	1.00	X
Benzene	0.880	Y
Paraffin	0.700	Z

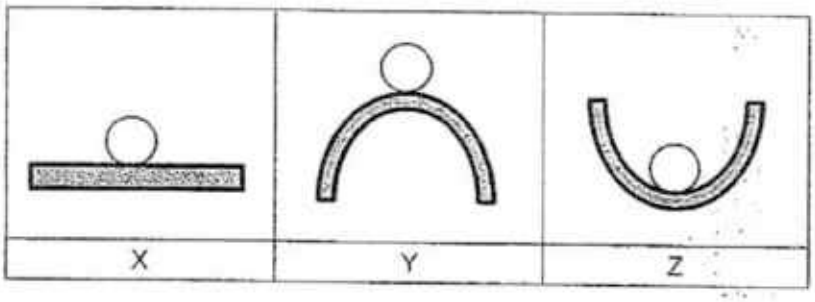
Which set shows how the small piece of rubber will behave in the different liquids?

	W	X	Y	Z
A	floats	sinks	sinks	sinks
B	floats	floats	sinks	sinks
C	sinks	floats	floats	floats
D	sinks	sinks	floats	floats

9 Which of the following objects has the **least** inertia?

A A ball of mass 500 g travelling at 10.0 m/s
B A stationary trolley weighing 20 N.
C An athlete weighing 700 N running the 100 m race in 11 s
D A car of mass 800 kg moving at a constant speed of 80 km/h.

10 Which of the following sets shows the correct equilibrium position the sphere is in?



	X	Y	Z
A	stable	neutral	unstable
B	neutral	unstable	stable
C	stable	unstable	neutral
D	neutral	stable	unstable

11 A diver at position **P** has his centre of gravity (c.g.) as shown in Fig. 11.1. He raises his arms in position **Q** and bends his body in position R as shown.

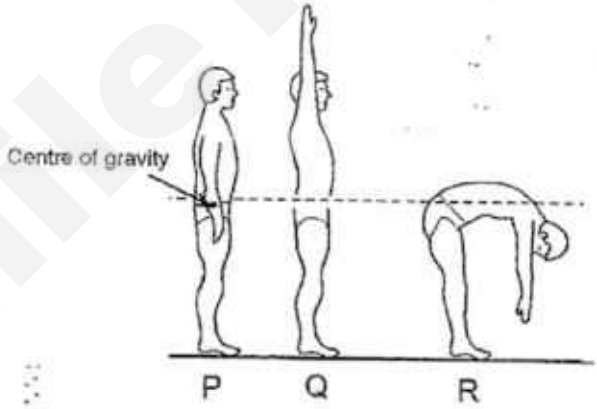


Fig. 11.1

Which of the statements are true?

(i) When he raises his arms at position Q, his c.g. is shifted upwards.
(ii) At position R, he becomes less stable.
(iii) The position of his c.g. remains unchanged throughout P, Q and R.

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 5.0 kg cylindrical roller being pushed onto a step. Given that the radius of the roller is 5.0 cm and the step is 2.0 cm high, calculate the minimum force, **F**, needed to push the roller over the step. (g = 10 N/kg)

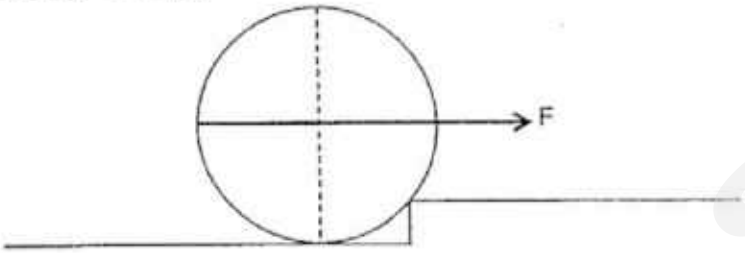


Fig. 12.1

A 62.5 N **B** 66.7 N **C** 75.0 N **D** 83.3 N

13 A toy bird balances on a finger as shown.

What is the purpose of the paper clips?

A Raise the centre of gravity of the toy for greater stability.
B Lower the centre of gravity of the toy for greater stability.
C Increase the mass of the toy for greater inertia.
D Raise the surface area of the toy for greater stability.

14 Fig. 14.1 shows a uniform cube of mass m on a rough surface.

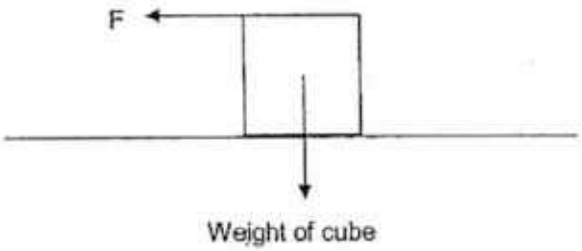


Fig. 14.1

If the minimum horizontal force F needed to just tilt the cube about its edge is 100 N, determine the mass m of the cube.

A 5.0 kg **B** 20 kg **C** 50 kg **D** 200 kg

15 Three forces of magnitude 10 N, 10 N and 20 N are applied on a wheel as shown in Fig. 15.1.

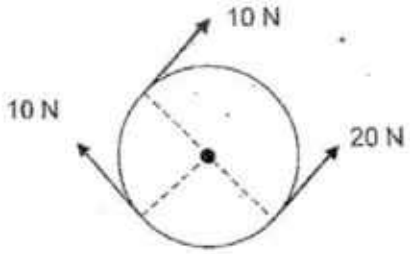


Fig. 15.1

Which of the statements regarding resultant force and resultant moment are correct?

	Net Force	Net Moment
A	Non-zero	Non-zero
B	Zero	Zero
C	Zero	Non-zero
D	Non-zero	Zero

16 The volume of a constant mass of gas in a cylinder is reduced at a constant temperature as shown in Fig. 16.1.

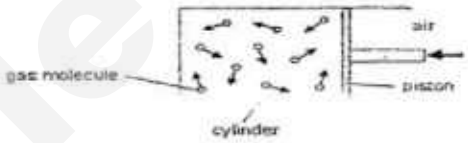


Fig. 16.1

Which of the statements are correct?

(i) The gas molecules will collide against the inner wall more frequently.
(ii) The average distance between the gas molecules will become shorter.
(iii) The gas molecules will move around more haphazardly at a higher average speed.

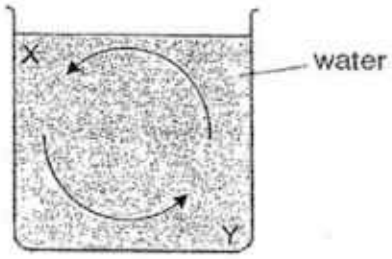
A (i) and (ii) only
B (ii) and (iii) only
C (i) and (iii) only
D (i), (ii) and (iii)

17 Brownian motion can be observed in illuminated smoke particles contained in a sealed transparent cell using a low power microscope.
Which of the following statements are **not** correct?

(i) The speed of the observed motion is unaffected by temperature.
(ii) The random motion of the smoke particles is due to their own collisions.
(iii) Air molecules are too tiny to be observed through the microscope.

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

18 A beaker contains water at room temperature.



How can the convection current be set up in the water as shown above?

A Place an ice cube at X
B Put ice near Y outside beaker
C Heat water at X with a heating coil
D Blow through a straw position at Y

19 In which of the following is an application of thermal conduction?

A greenhouses
B electric kettles
C household hot water system
D soldering iron rods

20 The whiteboard in a classroom normally feels cooler than the top of a table because the whiteboard is a better _____ than the top of the table.

A thermal conductor
B radiator of radiant heat
C reflector of radiant heat
D absorber of radiant heat

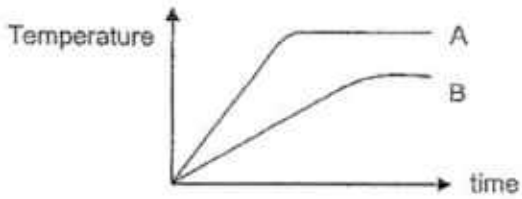
21 A resistance thermometer indicates 0.50 Ω at the ice point and 2.5 Ω at 650 °C.
What will be the resistance when the resistance thermometer is measuring the steam point?

A 0.31 Ω
B 0.81 Ω
C 0.38 Ω
D 0.88 Ω

22 The energy required to change liquid water into water vapour at the same temperature is called the latent heat of vaporization. What does this energy do?

A It increases the average separation of the water molecules.
B It increases the average speed of the water molecules.
C It increases the temperature of the air near the water.
D It splits the water molecules into their separate atoms.

23 Two different liquids of equal masses are heated using the same heater. The graph shows how the temperature of each liquid changes with time.



Which of the following statements are true?

(i) Liquid A has a higher boiling point than liquid B.
(ii) Liquid B has a higher specific heat capacity than liquid A.
(iii) Liquid A boils earlier than liquid B.

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

24 A glass containing 50 g of water is left on a table in a room. After some time, only 10 g of the water remained.

Specific heat capacity of water = 4 200 J kg^{-1} $°C^{-1}$
Specific latent heat of vaporization = 2.3×10^6 J kg^{-1}

Determine the energy lost by the water in the glass due to evaporation.

A 92000 J
B 23000 J
C 16800 J
D 42000 J

25 Fig. 25.1 shows the graph of a wave motion.

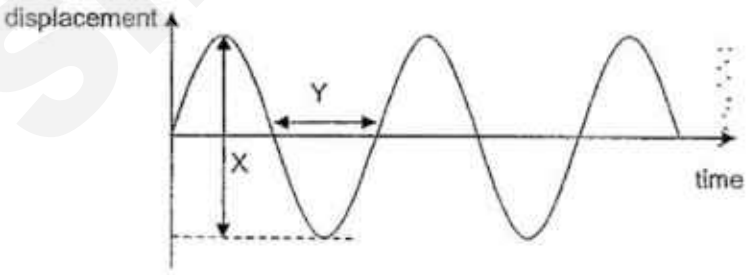


Fig. 25.1

Which of the following sets is correct?

	Amplitude	Frequency
A	X	Y
B	X	$(2Y)^{-1}$
C	X/2	Y
D	X/2	$(2Y)^{-1}$

26 Fig. 26.1 shows a thin converging lens is used to produce a focused image of a candle on a screen.

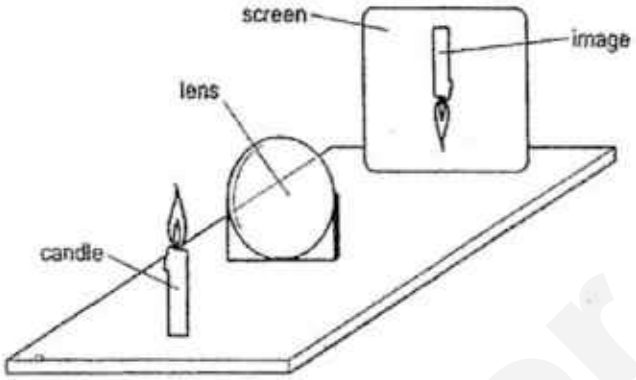


Fig. 26.1

If the lower half of the lens is covered with a piece of black tape, what will happen to the image?

A	It disappears.	**C**	It appears partially blocked.
B	It becomes dimmer.	**D**	It becomes vertically upright.

27 Fig. 27.1 shows the paths of two rays of light from an object. The object is 10 cm in front of a lens in the position shown.

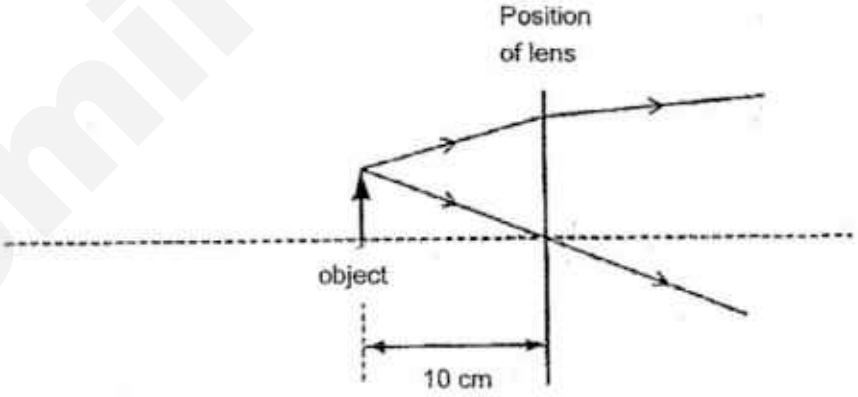


Fig. 27.1

Which of the following sets is correct?

	Type of lens	Focal length
A	Converging	less than 10 cm
B	Converging	more than 10 cm
C	Diverging	less than 10 cm
D	Diverging	more than 10 cm

28 A ray of light is incident upon a plane mirror at angle θ. The mirror is then rotated through 20 ° with the direction of the ray of light remains unchanged.

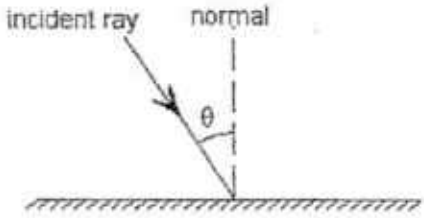


Fig. 28.1

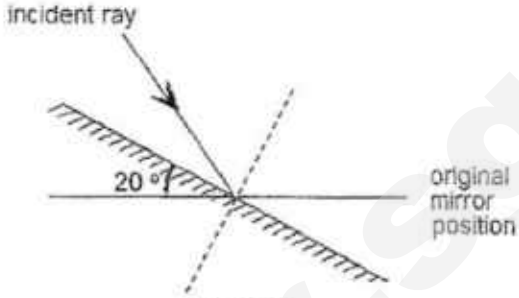


Fig. 28.2

If the angle of reflection in Fig. 28.2 is 30 °, determine the incident angle θ in Fig. 28.1.

A 10 ° B 20 ° C 30 ° D 45 °

29 Fig. 29.1 shows components in the electromagnetic spectrum.

P	X-rays	Q	visible light	infrared	*R*	radio waves

Fig. 29.1

	P	Q	R
A	ultraviolet	gamma rays	microwaves
B	ultraviolet	microwaves	gamma rays
C	microwaves	gamma rays	ultraviolet
D	gamma rays	ultraviolet	microwaves

30 A man standing at X sends out a loud sound from a transmitter. A sound sensor is placed at Y to collect the data of the sound received. When the sound wave travels from air to water, which of the following sets of data is correct?

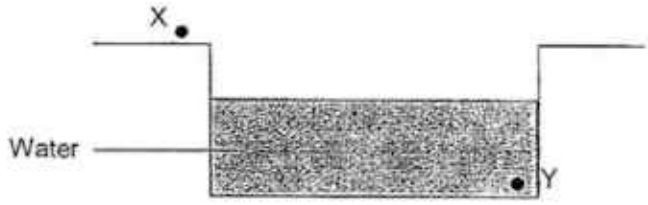


Fig. 30.1

	Pitch	Speed	Loudness
A	Higher	Unchanged	Softer
B	Lower	Unchanged	Louder
C	Unchanged	Faster	Softer
D	Unchanged	Slower	Louder

Section B: Structured Questions [40 marks]

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

31 A parachutist falls vertically after leaping off a plane. After falling for some time, he opens his parachute. Fig. 31.1 shows the velocity-time graph of the parachutist from the time he leapt off the plane to the time he landed safely on the ground.

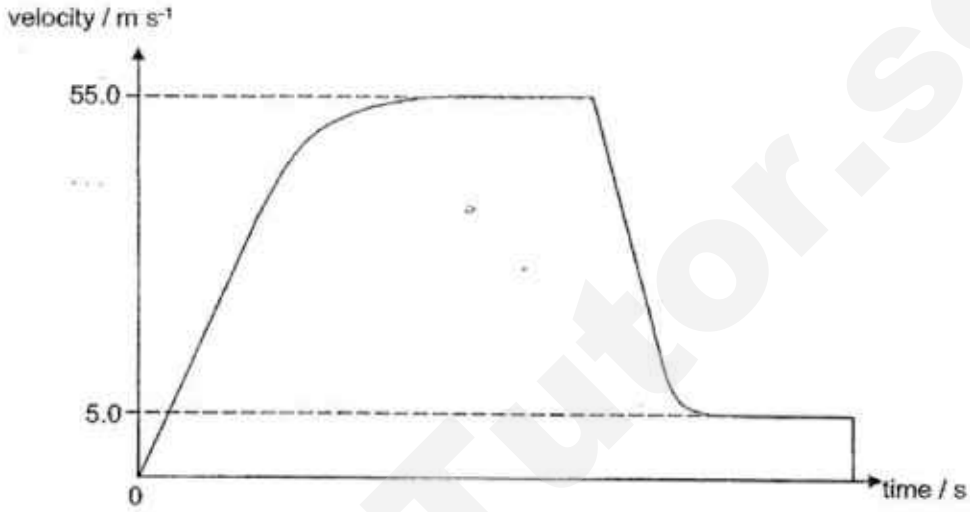


Fig. 31.1

(a) Identify the point at which the parachute is fully opened and that the parachutist starts to experience a net force of 0 N. Label this point as **P**. [1]

(b) Determine the duration from the time he reaches terminal velocity (with his parachute fully opened) to the time he lands on the ground if the distance covered during this period is 50 m.

duration = _____ [2]

(c) The same parachutist makes another jump. Suggest how he can achieve a bigger terminal velocity with his parachute open. Explain your answer.

_____

_____

_____

_____ [2]

32 Fig. 32.1 shows a 500 g clock hanging at the mid-point of a horizontal wire stretched between two nails. The magnitude of the force exerted by each nail on the wire is T.

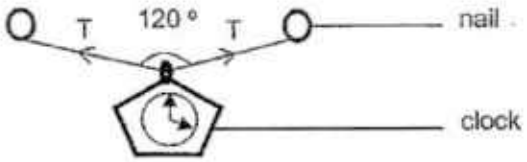


Fig. 32.1

(a) **"According to Newton's third law, the action-reaction pair for the weight of the clock is the resultant force of the tensions in the wire."**
Comment if the above statement is true. Explain your answer.

_____

_____

_____ [2]

(b) Calculate the force exerted by the weight of the clock on the wire.

weight W = _____ [1]

(c) By means of a scale diagram, determine the magnitude of the force T in the wire if the clock is at equilibrium and the angle made by the bent wire is 120 °. (Note that the diagram in Fig. 32.1 is not drawn to scale)

tension T = _____ [2]

33

(a) State what is meant by *inertia*.

_____

_____ [1]

(b) A hole is be drilled through a cube as shown in Fig. 33.1.

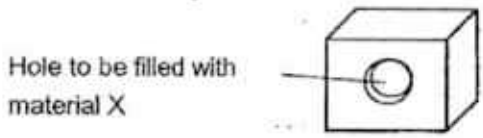


Fig. 33.1

Length of each side	5.0 cm
Radius of the hole	1.0 cm
Density of cube	8950 kg/m³
Density of material X	7900 kg/m³

Calculate the density of the composite cube. (Leave your answer in S.I. unit.)

density = _____ [4]

34 Fig. 34.1 shows a windsurfer in equilibrium with a wind force acting on the sail of his board. The weight of the windsurfer is 800 N.

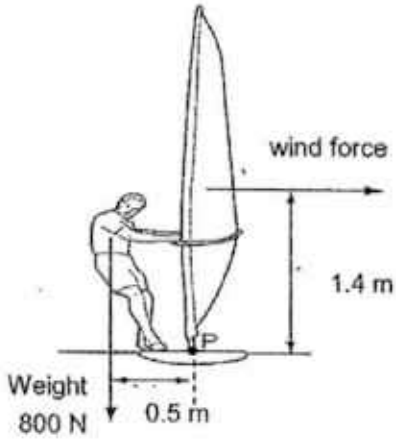


Fig. 34.1

(a) State the *principle of moments* that applies to a body in *equilibrium*.

_____

_____

_____ [1]

(b) Calculate the force of the wind acting on the sail.

force = _____ [2]

(c) If the force exerted by the wind on the sail is increased, suggest how the windsurfer is able to maintain his equilibrium. Explain your answer.

_____

_____

_____

_____ [2]

35 A partially inflated balloon is placed under a bell jar as shown in Fig. 35.1.

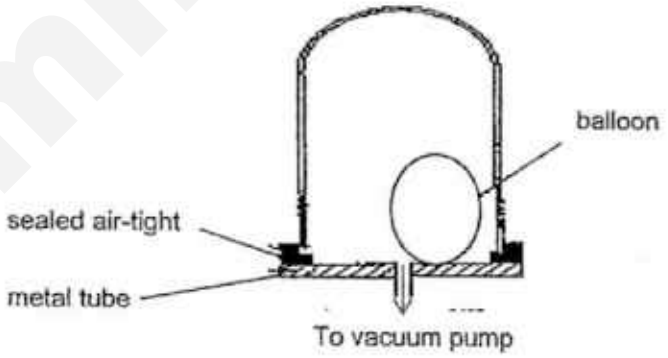


Fig. 35.1

(a) Explain in terms of molecular motion how the trapped air in the balloon creates a pressure on the balloon.

_____

_____

_____ [2]

(b) A vacuum pump is turned on (air is being taken out from the bell jar) for several minutes. Suggest and explain what will happen to the balloon.

_____

_____

_____

_____ [3]

36 A plastic cup of negligible mass contains 250 g of liquid at room temperature of 20 °C. An immersion heater is used to raise the temperature of the liquid by supplying 8.5 kJ of thermal energy.

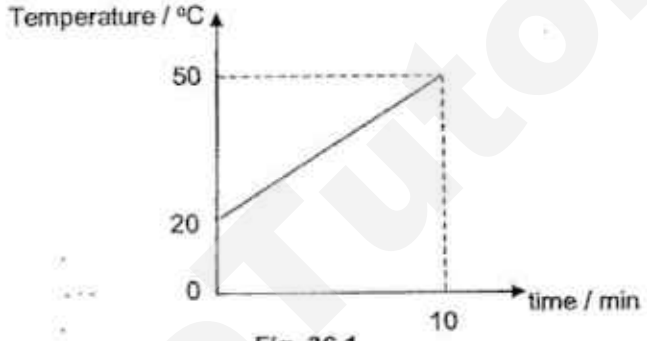


Fig. 36.1

The temperature of the liquid is found to rise in a linear fashion and reaches 50 °C in 10 minutes time as shown in Fig. 36.1. Assuming that there is no energy loss to the surrounding.

(a) Calculate the specific heat capacity of the liquid.

Specific heat capacity= _____ [2]

(b) In reality, there is energy loss to the surrounding. In Fig. 36.1, sketch how the temperature of the liquid will vary with time. [1]

(c) Suggest a way in which the energy from the heater may be wasted and explain how this factor would affect the measurement of the specific heat capacity of the liquid.

_____

_____

_____ [3]

37 Fig. 37.1 shows an art piece displayed in a room.

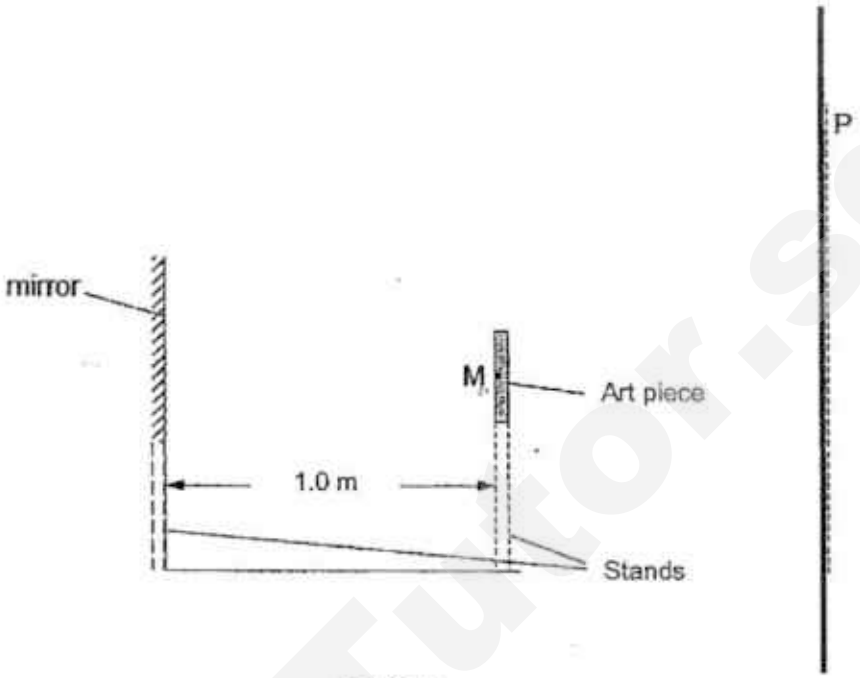


Fig. 37.1

(a) The art piece is supported by a transparent stand. A mirror is placed 1.0 m behind the art piece to ensure that the back of the art piece can be seen by anyone looking from the line P. M is a point on the back of the art piece.

(i) On Fig. 37.1, locate the image of point M behind the mirror and label it as X. [1]

(ii) Draw two rays of light from point M reflecting from the mirror to show the two furthest points at which the visitors at the line P can see the image. Indicate these two points with the letters A and B. [2]

(b) Fig. 37.2 shows two rays going into an air bubble in water. Complete the ray diagram if the refractive index is 1.33. Note that the figure below is drawn to scale. [2]

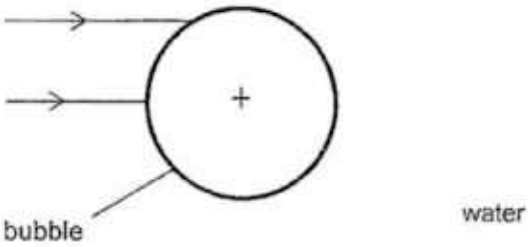


Fig. 37.2

38 An ultrasound device is placed near one wall and it emits an ultrasound wave that reflects back from the opposite wall. The time between sending out the ultrasound wave and receiving the reflection is 30 ms. The speed of ultrasound in air is 340 m/s.

(a) Calculate the distance between the device and the opposite wall.

Distance = _____ [2]

(b) Explain why ultrasound is used in pre-natal scanning instead of using X-rays.

_____

_____

_____

_____ [2]

Section C: Free Response Questions [30 marks]

Answer ALL the questions in this section.

Write your answers on the **writing paper** and **graph paper** provided.

39 A heat sink is a device used to remove thermal energy from a machine. Fig. 39.1 shows a heat sink with the computer chip placed under it. The heat sink and the computer chip are in contact with each other.

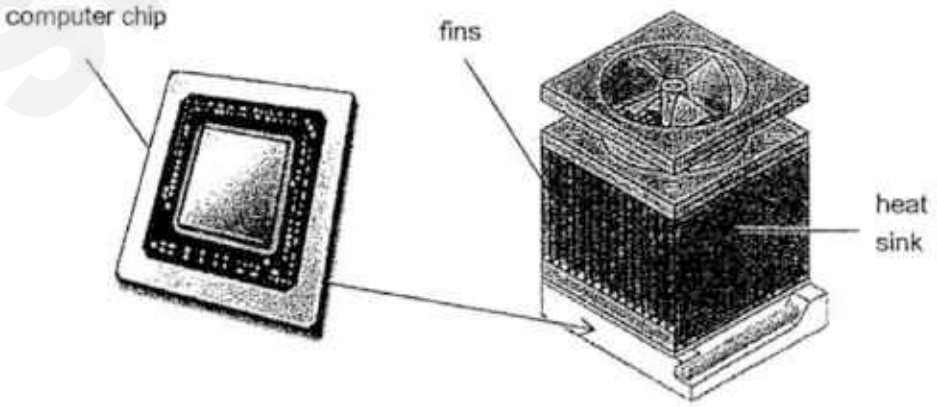


Fig. 39.1

The heat sink is made of aluminium and the top of the computer chip is made of plastic. Fig. 39.2 shows the heat sink designed with many fins and air spaces between the fins.

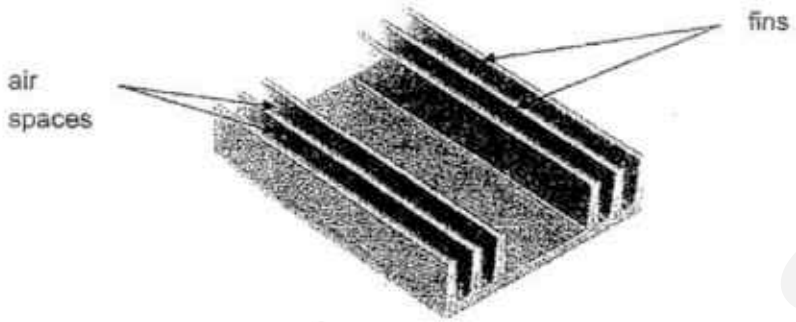


Fig. 39.2

Fig. 39.3 shows a graph that illustrates how the temperature difference between the heat sink and the surrounding air varies with the amount of heat energy released by the heat sink per second.

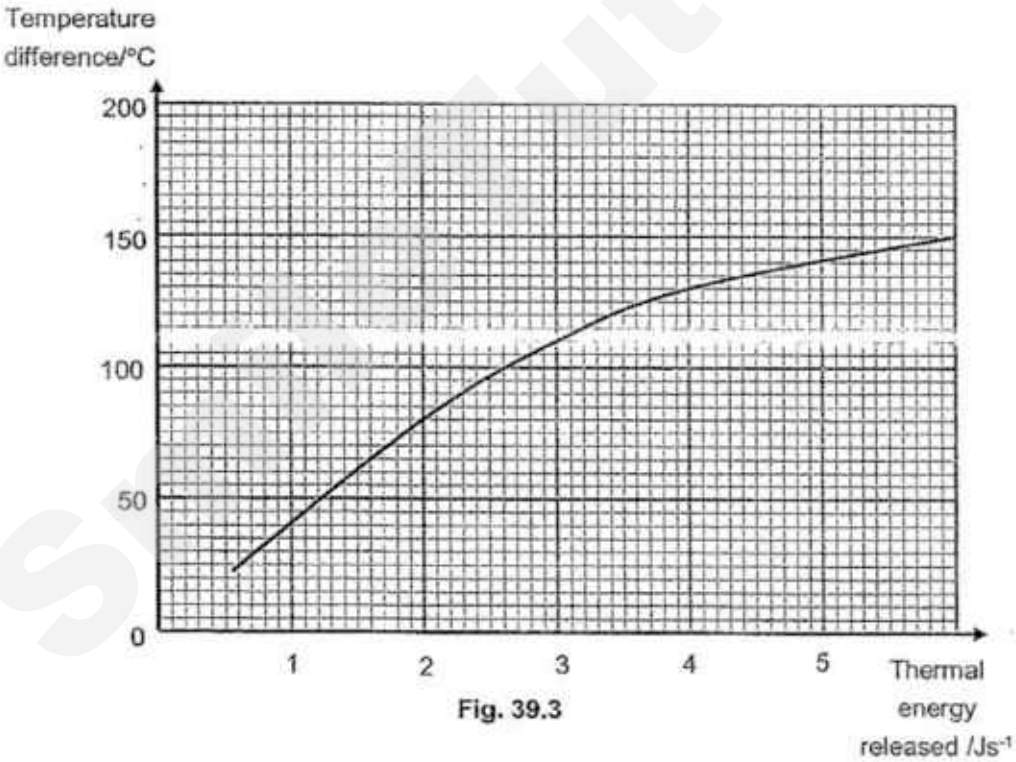


Fig. 39.3

(a) State the three processes involved in transferring thermal energy away from the chip. [3]

(b) Explain how each feature of the heat sink can help in promoting each process mentioned in **(a)**. [3]

(c) State the conclusion you can make from Fig. 39.3 and suggest a reason for this conclusion. [2]

(d) The room temperature is at 20 °C. If the heat sink is at 100 °C, determine the amount of thermal energy released in half an hour. [2]

40 Fig. 40.1 shows a side view of a water wave produced in a ripple tank. The wave generator moves up and down 10 times in 20 s. The horizontal distance between adjacent crests is 4.0 cm and the vertical distance between the crest and trough is 2.0 cm. Water waves are classified as transverse waves.

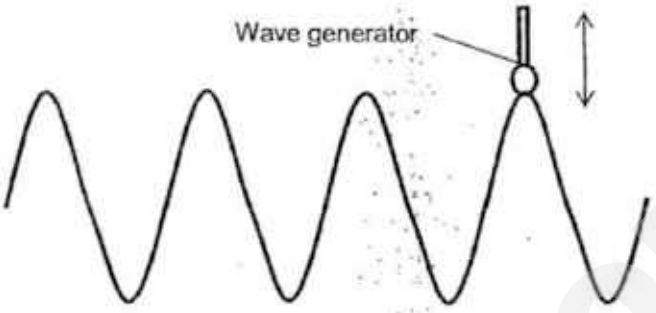


Fig. 40.1

(a) Define the term *transverse wave*. [1]

(b) Determine the frequency and period of the wave. [2]

(c) Hence, or otherwise, calculate the speed of the wave. [2]

(d) The depth of the water in the ripple tank is increased and the speed is doubled. Determine the new wavelength of the wave. [2]

(e) Assuming no energy lost, sketch a graph of displacement /cm against distance /cm for the new water wave on your graph paper with all values clearly labelled. [2]

(f) On the same graph, sketch a new wave to show how the wave will appear 0.50 s later. Label this graph as X. [1]

41 A converging lens is used to produce an image of an illuminated object on a screen. For each object position, the measurement of distance between the object and lens (object distance) and the measurement of distance between image and lens (image distance) were recorded. Fig.41.1 shows a graph of image distance against object distance.

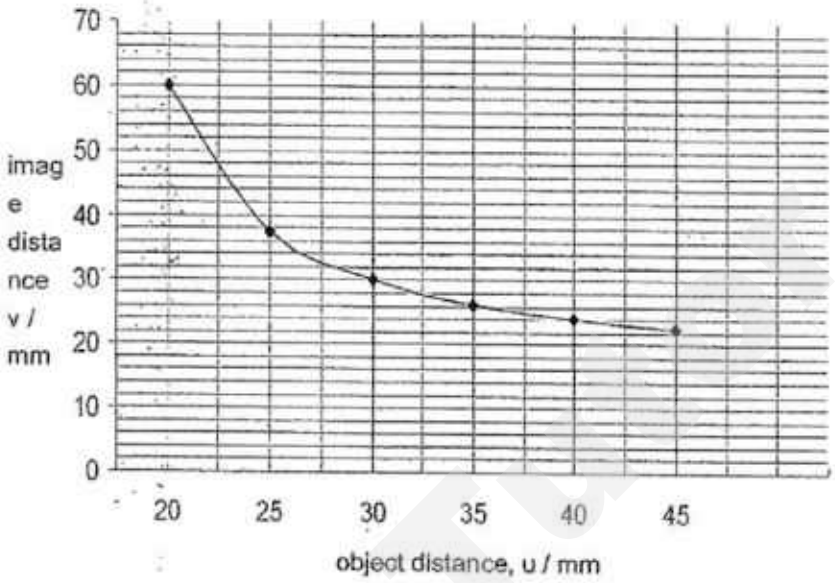


Fig. 41.1

(a) From the graph, determine the focal length of the lens. Explain how you obtained your answer. [2]

(b) Calculate the magnification m when the object distance is 40 mm. (Given: m = v/u) [2]

(c) Describe the nature of the image formed in **41(b)**. Hence, name the instrument that would produce this kind of image. [2]

(d) An object with a 4.0 cm height is now placed 1.0 cm in front of the same converging lens. Draw a scaled ray diagram on the graph paper provided and determine the height of the new image. Label your diagram clearly. [3]

(e) Describe, as accurately as possible, the nature of the new image formed. [1]

End of Paper

Candidate Name: _____ Class | Index No.

FUHUA SECONDARY SCHOOL

Secondary Three Express

End of Year Examination 2016

3E

PHYSICS (SOLUTIONS) 5059

6 October 2016
1045 - 1300
2 hour 15 minutes
Additional Materials: OMR, Graph Paper, Writing paper & Electronic calculator

READ THESE INSTRUCTIONS FIRST

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

Write in dark blue or black pen.

You may use a HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A (30 marks)

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

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

Section B (40 marks)

Answer all questions and write your answers in the spaces provided.

Section C (30 marks)

Answer all the questions and write your answers on the writing papers and graph paper provided. Start each question on a fresh page of paper.

At the end of the examination, fasten your Section C securely together.

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

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

PARENT'S SIGNATURE	FOR EXAMINER'S USE			
	Section A	Section B	Section C	Total
	/30	/40	/30	/100

Setter: Mr Raymond Loh *Vetter: Ms Chen Liyun*

This question paper consists of 21 printed pages including this page.

45

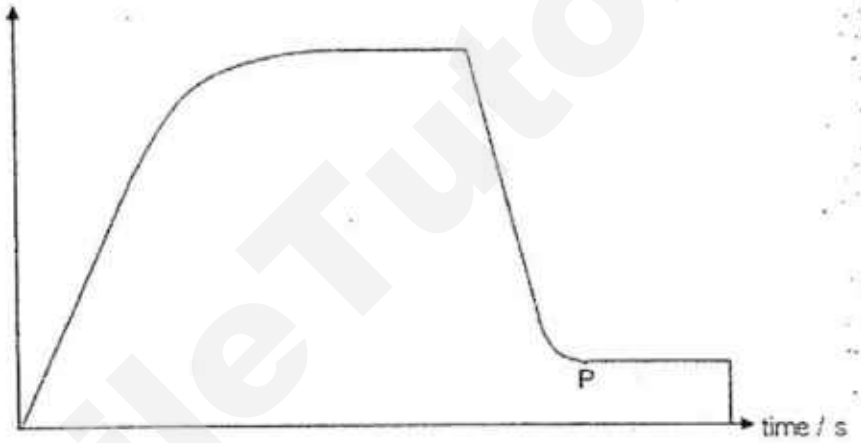
Marking Scheme

1	2	3	4	5	6	7	8	9	10
A	C	A	D	A	A	D	A	A	B

11	12	13	14	15	16	17	18	19	20
A	B	B	B	D	A	A	A	D	A

21	22	23	24	25	26	27	28	29	30
B	A	D	A	D	B	B	A	D	C

31a velocity / m s^{-1} [2]



[1]

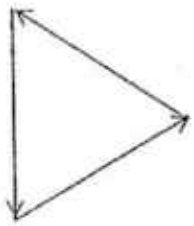
b Duration = 50 / 5.0
= 10 s

c He can <u>use a smaller surface parachute</u>. With a smaller surface parachute, he will experience a smaller upward drag (air resistance). According to Newton's 2nd Law, he will experience a <u>smaller net upward force</u> compared to the first jump. As the upward drag balances with his weight, his <u>deceleration decreases to zero</u> at a bigger terminal velocity. (Alt Answer = Carry something heavy with him) [1] [1]

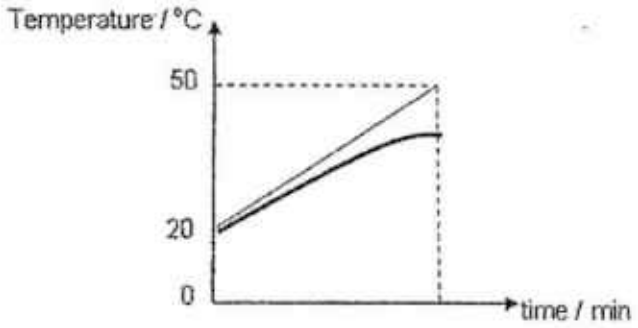
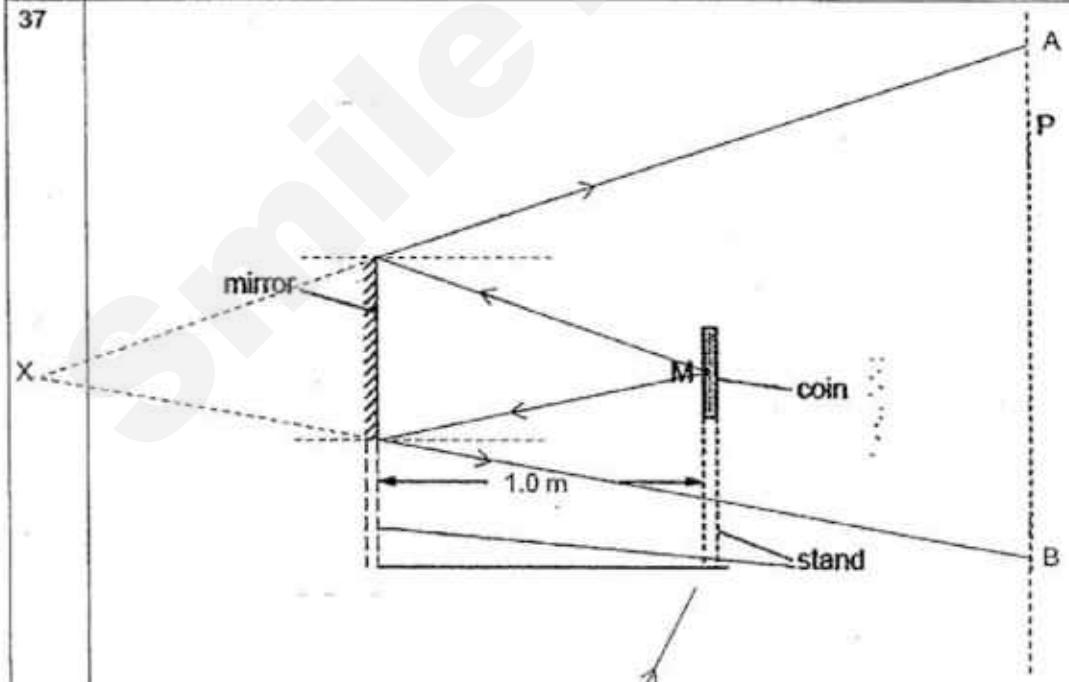
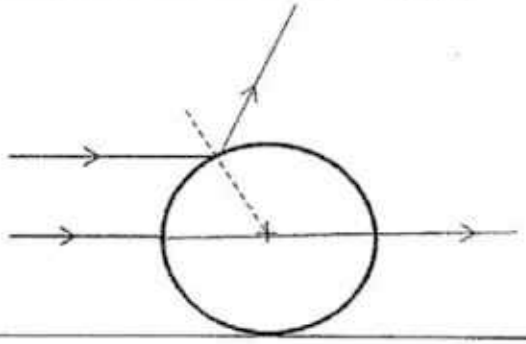
32a The statement is **false**. <u>According to Newton's 3rd law, for action-reaction pair, the forces must be of the same nature and from different bodies</u>. Since both the weight of the clock and the resultant force of the tensions are acting on <u>the same body</u> (clock) and they are <u>different in nature</u>, they cannot be action-reaction pair. [1] [1]

b W = mg
= 0.50 x 10
= 5.0 N [1]

c T = 5.0 N
[1] diagram & appropriate scale [1]
[1] T= 5.0 N [1]

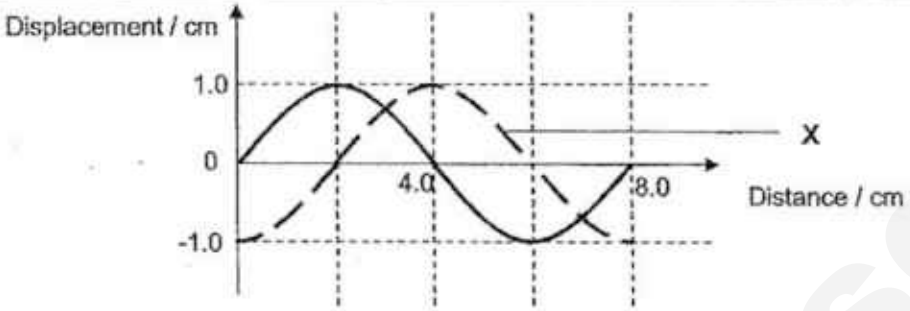
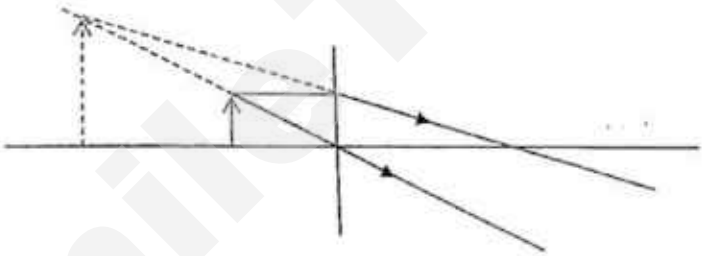


33a	The inertia of an object refers to the reluctance of the object to change its state of rest or motion, due to its mass.	[1]
b	Volume of cube = 5.0 x 5.0 x 5.0 = 125 cm^3 Volume of hole drilled = πr^2 x 5.0 = $\pi(1.0)^2$ x 5.0 = 15.7 cm^3	[1]
	Mass of cube after drilling = 8.950 x (125 – 15.7) = 978 g Mass of X in hole = 7.9 x 15.7 = 124 g	[1]
	Density of composite = Total Mass / Total Volume = (978 + 124) / 125 = 8.82 g/cm^3 or 8.8 g/cm^3 = 8820 kg/m^3 or 8800 kg/m^3	[1] [1]
34a	Principle of moments states that when a body is in equilibrium, the sum of clockwise moments about the pivot is equal to the sum of anticlockwise moments about the same pivot.	[1]
b	By Principle of Moments, Taking moments about pivot P, Total ACW moments = Total CW moments (800 N)(0.5 m) = (F_{wind})(1.4 m) F_{wind} = 286 N	[1] [1]
c	The man can lean further away from the sail where the line of action of his weight is further away from pivot P. When he leans further away, he creates a larger anticlockwise moment to balance / counteract the bigger clockwise moment created by the wind.	[1] [1]
35a	Air molecules moving randomly collide with the inner wall of the balloon. This exerts a force which in turn creates a pressure within the balloon since pressure is defined as the ratio of force exerted to the area it is being exerted on.	[1] [1]
b	The balloon becomes bigger (or expands). When the air is removed from the jar by the vacuum pump, the pressure in the jar becomes smaller than the pressure in the balloon. This pressure difference will cause a net force to be exerted out from the balloon to cause its expansion until the pressure in the balloon becomes the same as the pressure in the jar.	[1] [1] [1]
36a	8 500 = 0.25 x c x (50-20) c = 1100 J kg^{-1} °C^{-1} or 1130 J kg^{-1} °C^{-1} or c = 1.1 J g^{-1} °C or 1.13 J g^{-1} °C^{-1}	[1] [1]

b		[1]
c	Thermal energy is lost to the surrounding. or Thermal energy is absorbed by the plastic cup. (Any other reasonable answers)	[1]
	The specific heat capacity of the liquid will be larger than expected.	[1]
	Specific heat capacity = Energy supplied / (mass x change in temperature). If same amount of energy is supplied by the heater and that energy is lost from the water to surrounding, the change in temperature of the water will be then be minimal for the same duration. This will result in a larger specific heat capacity obtained.	[1]
37		[1] [1] [1]
		[1] [1]

38a	Let distance between the device and the opposite wall be d. Speed of sound = Total distance / Total Time 340 $= \frac{2d}{0.030}$ 2d = 10.2 d = 5.1 m (2 s.f.)	 [1] [1]
b	X-rays are ionizing and causes mutation of cells which will cause harm to the foetus. Hence, ultrasound is used instead of X-rays in the scanning of foetus.	[1] [1]

39a	Conduction, convection, radiation	[3]
b	Aluminium is a good thermal conductor. It helps in conducting thermal energy away quickly via both molecular vibration and free electron diffusion. The fins have big area exposed to the air. Hence, it helps in radiant heat emission at a higher rate. The air circulating near the fins gains thermal energy and convection occurs. The air expands and becomes less dense. The hot air rises while the denser cool air sinks to cool the fins further. (Accept: **Convection current** formed will help in cooling the fins)	[1] [1] [1]
c	The conclusion is that the higher the temperature difference between the heat sink and the surrounding air, the higher the rate of energy released. The higher the temperature difference between the heat sink and the surrounding air, the higher the rate of emission of radiant heat (infrared radiation).	[1] [1]
d	From graph, when temperature difference = 100 – 20 = 80 °C, P = 2.0 J/s E = Pt E = 2.0 x 30 x 60 E = 3600 J	 [1] [1]
40a	**Transverse waves** are waves that travel **perpendicular** to the direction of the medium's particle vibration.	[1]
b	f = 10 / 20 = 0.50 Hz T = 20/10 = 2.0 s	[1] [1]
c	v = fλ = 0.50 x 4.0 (allow for e.c.f.) = 2.0 cm/s	 [1] [1]
d	4.0 = 0.50 x λ (allow for e.c.f.) λ = 8.0 cm	[1] [1]

e		[1] [1]
f		[1]
41a	Focal length is 15 mm. At 2F, object distance of 30 mm is equal to the image distance of 30 mm. Hence focal length = 30/2 = 15 mm.	[1] [1]
b	When object distance is 40 mm, image distance is 24 mm as shown in the graph. Hence m = 24/40 = 0.60 (no unit and 2s.f.)	[1] [1]
c	Image formed is diminished, real and inverted. Camera	[1] [1]
d	 Two real rays from object Arrowheads Dotted lines and image (Height = 12.0 cm) The image is virtual, upright and magnified.	[1] [1] [1] [1]

E

GAN ENG SENG SCHOOL
End-of-Year Examination 2016

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS (Sec 3 Express) 5059/01

Paper 1 Multiple Choice

10 October 2016
1 hour

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the OTAS.

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

Read the instructions on the OTAS 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.

Total Marks

/ 40

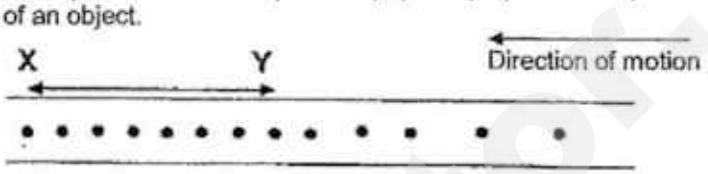
This paper consists of 15 pages including the cover page.

48

1 Which of the following represents the longest length?

A 1.2×10^{-4} Mm
B 1.2×10^{3} km
C 1.2×10^{5} cm
D 1.2×10^{7} μm

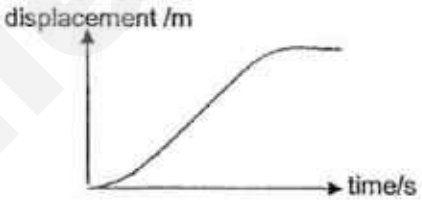
2 A ticker-timer, which puts 40 dots on a piece of paper tape per second, is used to investigate the movement of an object.



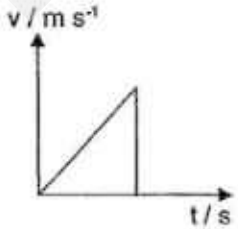
What is the length of time that corresponds to the distance between X and Y on the tape and the motion of the object?

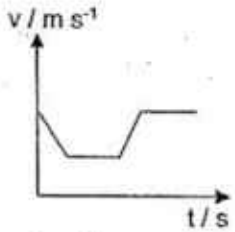
	Time	Motion
A	0.175 s	Increasing speed
B	0.175 s	Decreasing speed
C	0.200 s	Increasing speed
D	0.200 s	Decreasing speed

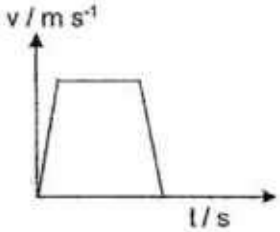
3 The graph below shows the displacement-time graph of a runner from a fixed point, along a straight track.

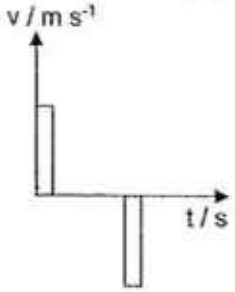


Which graph below represents the velocity of the same runner over the same period of time?

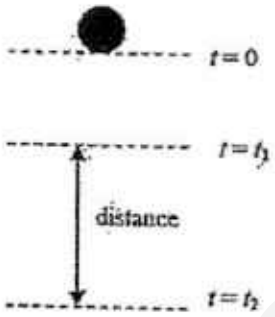
A


B


C


D


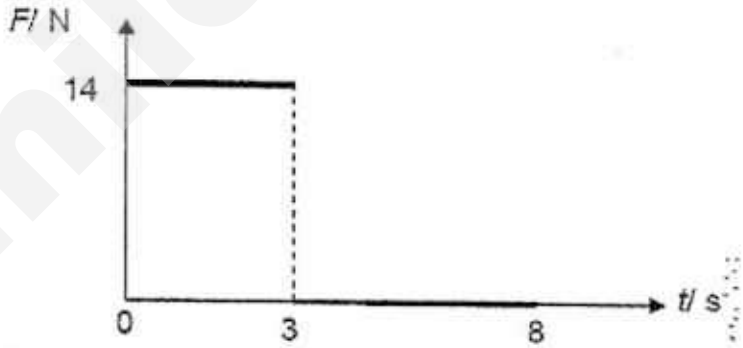
4 A ball is dropped vertically from rest at time $t = 0$ and accelerates downward with an acceleration g.



What distance does it travel between $t = t_1$ and $t = t_2$?

A $\frac{1}{2} g t_2^2$
B $\frac{1}{2} g(t_1 + t_2)$
C $\frac{1}{2} g(t_2 - t_1)^2$
D $\frac{1}{2} g(t_2^2 - t_1^2)$

5 An object of mass 4 kg starts from rest and moves along a straight line on a rough horizontal surface. A force F acts on the object in its direction of motion. A graph of F against t is shown below. Assume constant friction of 2 N.

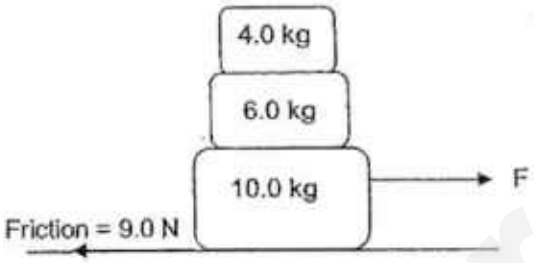


What is the velocity of the object at $t = 8$ s?

A 5.0 m/s
B 6.5 m/s
C 9.5 m/s
D 13.0 m/s

49

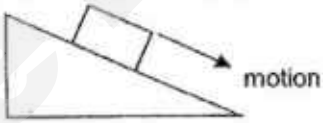
6 A replica of a wedding cake consists of three tiers stacked on top of one another. A student baker pulls the cake with a force F as shown. The bottom layer accelerates at 1.0 m/s^2.



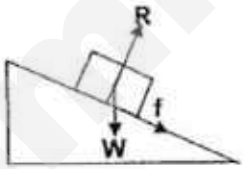
If the surfaces between each object are frictionless and the frictional force between the 10 kg layer and the floor is 9.0 N, which of the following statements is correct?

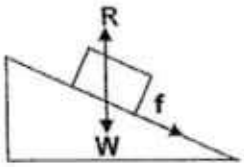
A The 4.0 kg and 6.0 kg layer also accelerate at 1.0 m/s^2
B The acceleration of the 6.0 kg layer will be larger than the 10 kg object as it has a smaller inertia.
C The force, F acting on the 10 kg layer is 19 N.
D The contact force between the 6.0 kg and 4.0 kg layer is 4.0 N

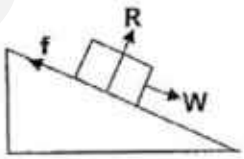
7 A block is allowed to slide down a rough inclined plane as shown in the diagram below. The forces acting on the block include normal reaction force R, its weight W and friction f.

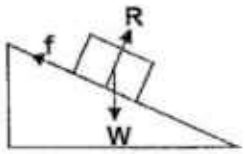


Which of the following diagrams shows all the forces acting on the block?

A


B


C


D


8 While on a mission on the moon, Low Jun hangs a 200 kg object freely and pushes it from the side. As compared to on earth, he feels that the object ..... .

A is easier to be pushed on the moon
B is more difficult to be pushed on the moon
C requires no effort to be pushed on the moon
D requires the same effort to be pushed as on the moon

9 The density of a liquid is 1.2×10^3 kg/m^3. If 1 cm^3 of the liquid changes to 600 cm^3 of vapour, the density of the vapour in kg/m^3 is..... .

A $\frac{1.2}{600}$

B $\frac{1.2 \times 10^3}{600}$

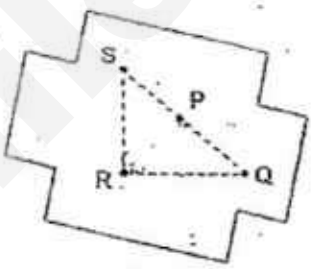
C 1.2×10^3

D $\frac{1.2 \times 10^3}{10^6} \times 600$

10 Which of the following objects has the greatest inertia?

A A 1 kg object moving at 30 m/s.
B A 5 kg object at rest.
C A 10 kg object moving at 2 m/s.
D A 15 kg object at rest.

11 A flat lamina has four points P, Q, R and S marked on it. When the lamina is freely suspended from P, Q is observed to be directly above P and S is directly below P. When it is freely suspended from R, S is observed to be directly below R. The weight of the lamina is 1.5 N.



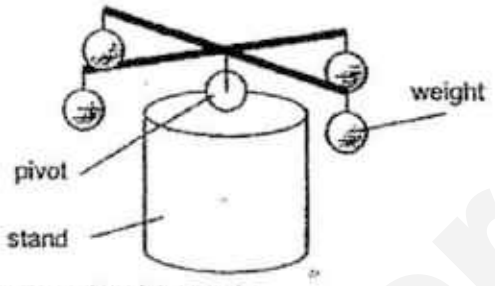
PQ = PS
QS = 0.500 m
RQ = 0.400 m

Fig. 11

With the lamina now suspended from P and displaced as shown in Fig. 11, what moment will cause the lamina to swing?

A 0.300 Nm anticlockwise
B 0.300 Nm clockwise
C 0.375 Nm anticlockwise
D 0.375 Nm clockwise

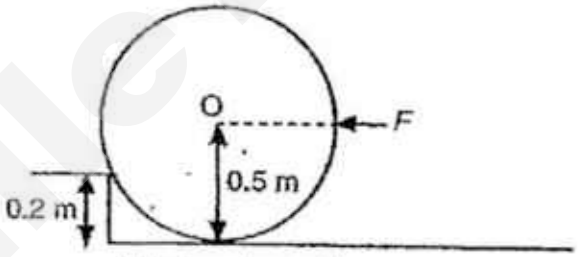
12 The diagram shows a balancing toy pivoted on a stand. If the toy is tilted slightly, it does not topple but returns to its original position.



This is because the centre of gravity of the toy is ..... .

A inside the weights
B exactly at the pivot
C directly below the pivot
D within the stand under the pivot

13 A uniform circular barrel of weight 1500 N and radius 0.5 m rests against a step of height 0.2 m as shown.



(Not drawn to scale)

What is the smallest horizontal force *F* though the centre O needed to push the barrel over the step?

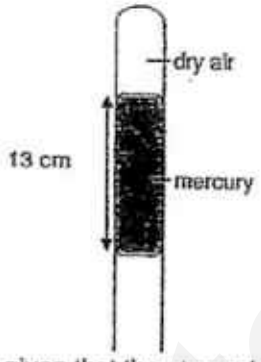
A 1125 N
B 1200 N
C 1875 N
D 2000 N

14 A manometer is used to measure the pressure of a gas. Which of the following factors would affect the reading?

I. The density of the liquid in the manometer
II. Cross-sectional area of the tube
III. Amount of liquid used.

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

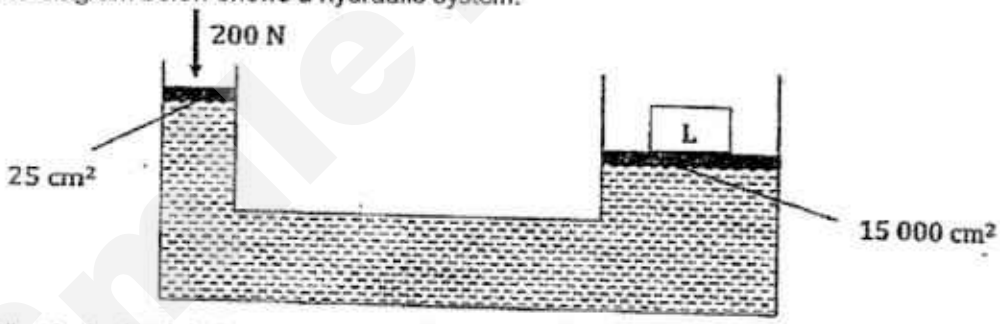
15 The diagram shows a column of dry air enclosed in a narrow capillary tube by a thread of mercury 13 cm in length.



What is the pressure of the dry air, given that the atmospheric pressure is 76 cm Hg?

A 13 cm Hg
B 63 cm Hg
C 76 cm Hg
D 89 cm Hg

16 The diagram below shows a hydraulic system.



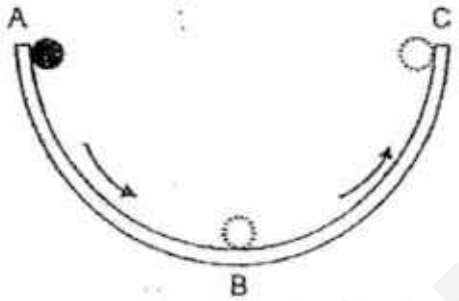
What is the load, L that can be raised by a force of 200 N applied on the piston of cross-sectional area 25 cm².

A 2.0×10^2 N
B 1.9×10^2 N
C 1.2×10^5 N
D 3.0×10^5 N

17 When the pendulum bob of a simple pendulum is swinging, the work done by the tension in the string on the bob is ..... .

A zero
B the gain in kinetic energy of the bob
C directly proportional to the length of the string
D depends on the swinging amplitude of the pendulum.

18 A ball of mass m is held at rest at one side of a frictionless curved track of height h.



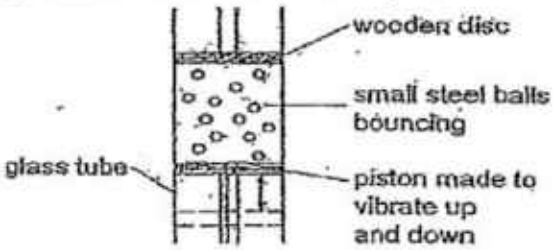
The ball is released and it rolls down the track from A to B and up to the other side of the track from B to C. Which of the expressions below represent the speed of the ball at the lowest point of the track?

A $(2gh)^2$
B $\sqrt{2gh}$
C $\sqrt{gh}$
D $\sqrt{mgh}$

19 A block of mass 3 kg is initially at rest on a frictionless, horizontal surface. The block is moved 8.0 m in 2.0 s by the application of a horizontal force 12 N. What is the average power developed while moving the block?

A 24 W
B 32 W
C 48 W
D 96 W

20 The following model is used to illustrate the behaviour of gas molecules. When the piston vibrates more rapidly, the wooden disc is forced further up the tube.



To cause the disc to return to its original position, weights are placed on the disc. This is similar to the situation when a gas is .....

A cooled then heated
B cooled then compressed
C heated then compressed
D heated then cooled

21 Marcus observes the Brownian motion of air mixed with smoke particles in a glass cell with a microscope and he sees moving points of light. These points of light come from ..... .

A air particles only moving randomly
B both smoke and air particles moving randomly
C smoke particles only moving randomly
D air movement in the glass cell.

22 A gas can be easily compressed because ..... .

A average molecular speeds are low
B intermolecular forces are very weak
C the molecules are elastic
D the molecules are very small

23 Which of the following temperatures is equivalent to 501 °C?

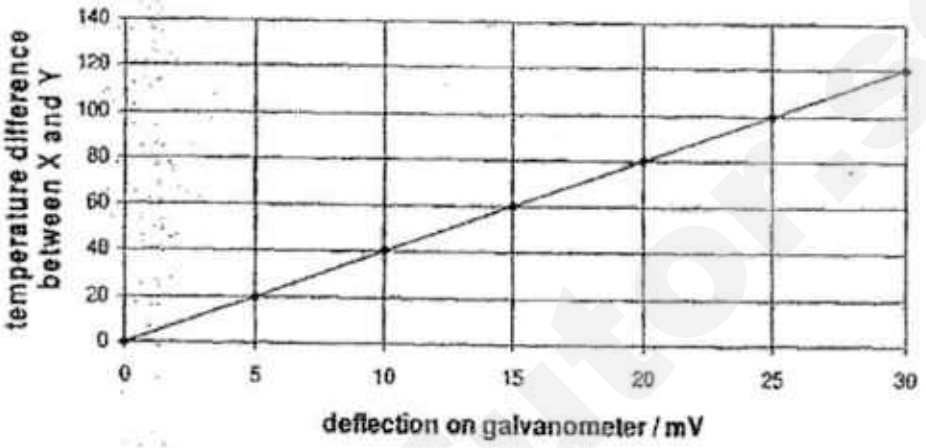
A - 228 K
B 228 K
C 774 K
D 775 K

24 The length of the alcohol thread in a thermometer is 3 cm at ice point and 5 cm at a temperature of 10 °C. What is the length of the alcohol thread when the thermometer is placed in pure boiling water?

A 23 cm
B 35 cm
C 46 cm
D 50 cm

52

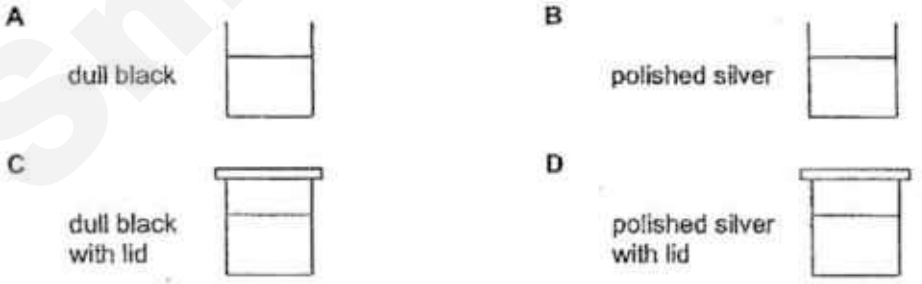
25 A thermocouple is constructed by putting two soldered ends (junctions) of two different metals into different temperatures. The galvanometer shows a deflection that depends on the temperature difference between the junctions X and Y.



If X is placed in a substance of 20 °C and Y is placed in another substance of higher temperature, a deflection of 20 mV is seen, what is the temperature of Y?

A 20 °C
B 80 °C
C 100 °C
D 120 °C

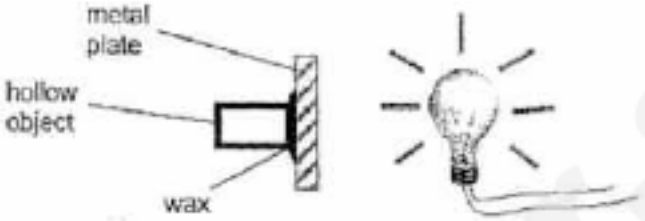
26 The diagram shows four similar cans. Each can contains the same volume of water initially at 80 °C. After five minutes, which can will contain the warmest water?



27 Which of the following would not produce convection currents in a container filled with water at 30 °C?

A Dropping a piece of hot metal into the water
B Floating a piece of ice on water
C Lighting a candle beneath the container
D Placing a 100 W lit bulb above the water surface

28 A hollow object is stuck horizontally to a metal plate with wax. A 100 W filament light bulb is switched on and placed close to the metal plate. After a while, the wax melted and the object fell off.



Which of the following are correct heat transfer processes that took place?

A Convection and radiation
B Conduction and radiation
C Conduction and convection
D Conduction, convection and radiation

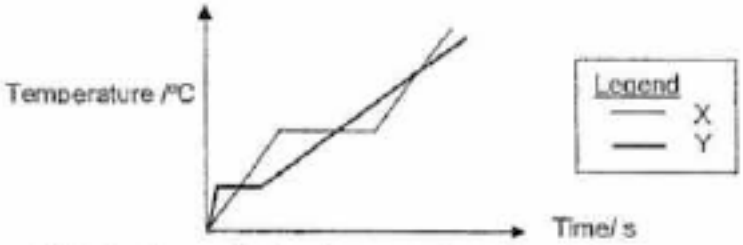
29 A lead bullet of mass 1 g at 30 °C is fired horizontally at a speed of 300 m/s into a large block of ice of temperature 0 °C, in which it is embedded. The bullet is then left to cool to 0 °C. How much ice is melted? [Specific heat capacity of lead = 128 J kg^{-1} $°C^{-1}$, specific latent heat of fusion of ice = 336 000 J kg^{-1}]

A 0.121 g
B 0.158 g
C 0.145 g
D 0.189 g

30 Pure water has a boiling point at 100 °C at 1 atmospheric pressure. Which of the following best explains the energy of water molecules at boiling point?

A The water molecules are gaining kinetic energy
B The water molecules are gaining potential energy
C The water molecules are gaining kinetic and potential energy
D The water molecules do not gain energy.

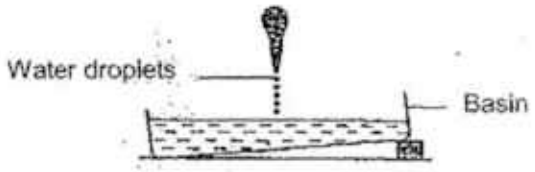
31 Equal masses of two solids X and Y are heated successively in a well-lagged calorimeter. Heat energy is supplied to each of them at the same rate. A temperature-time graph for the process is shown below.



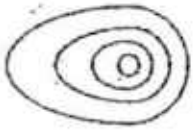
Which statement below is correct about X and Y?

A Solids X and Y have the same specific latent heat of fusion.
B Solid Y has a higher melting point than solid X.
C Solids X and Y melt at the same temperature.
D Solid X has a lower specific heat capacity than solid Y.

32 A tilted basin contains water. Water is dripped at a constant rate into the basin as shown in the diagram below.

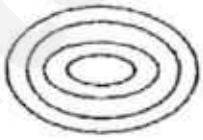


Which of the following patterns of the wavefronts will be observed in the basin?

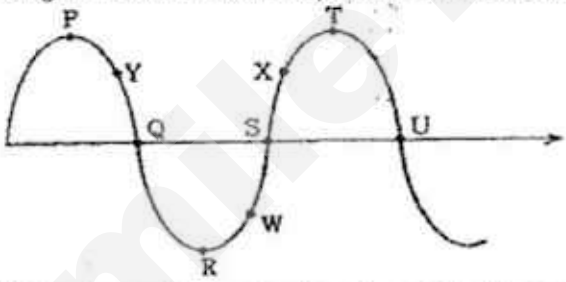
A


B


C


D


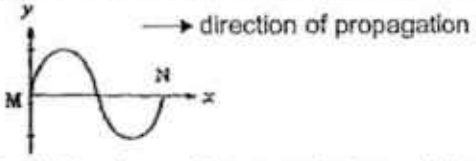
33 The figure below shows a snapshot of a transverse wave.



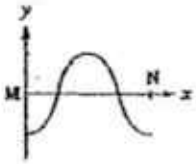
Which pair of points are in phase (moving in the same direction and having the same displacement from the rest position)?

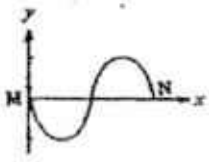
A P and R
B Q and U
C Y and W
D S and T

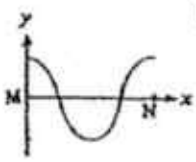
34 A wave is travelling along the positive x-axis. The diagram below shows part of the displacement-time graph at a certain instant.

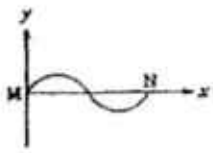


What is the shape of the wave between MN after one quarter of the period?

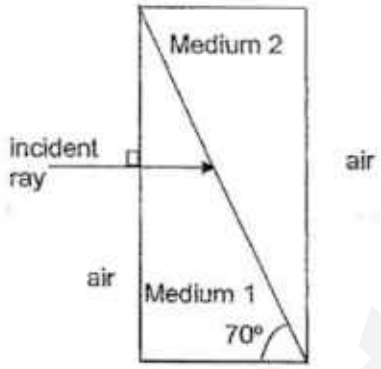
A


B


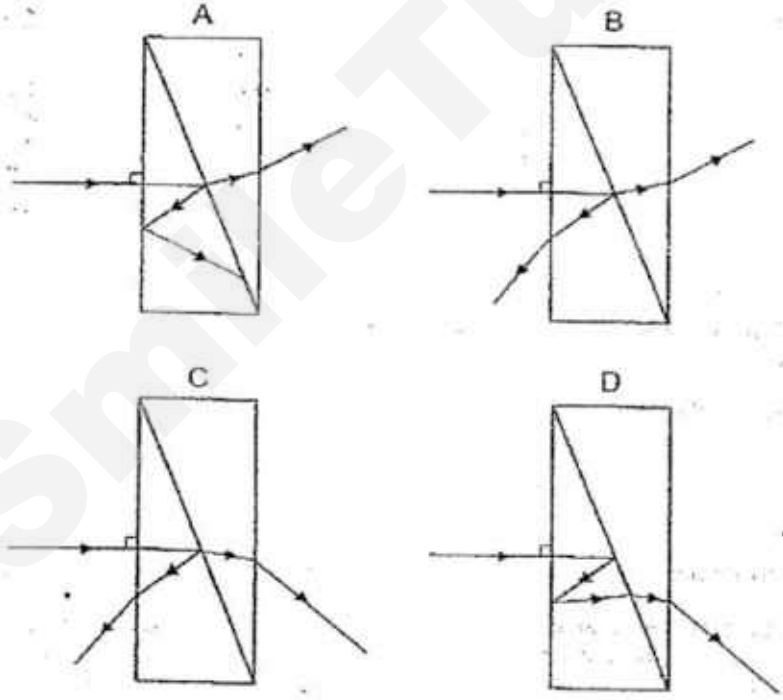
C


D


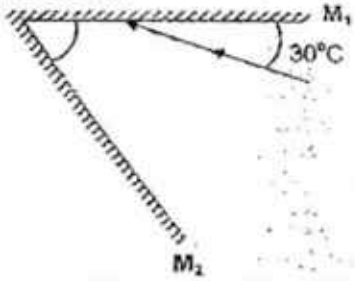
35 Two prisms made from different glass are placed in perfect constant to form a rectangular block surrounded by air as shown. Medium 1 has a refractive index of 1.74 while medium 2 has a higher refractive index than medium 1.



Which diagram below represents the path of the ray after it enters medium 1?



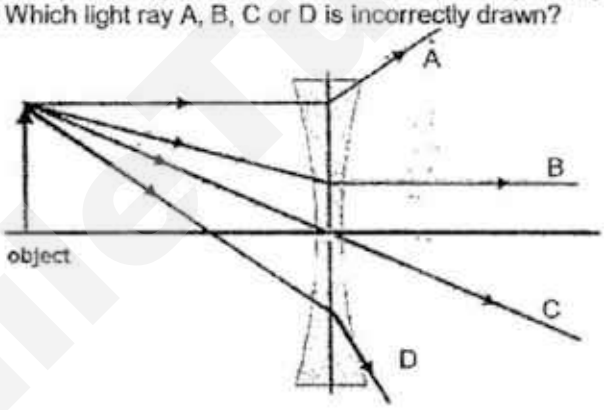
36 Two plane mirrors M_1 and M_2 make an angle of 60° with each other. A beam of light from a ray box is incident on mirror M_1 as shown.



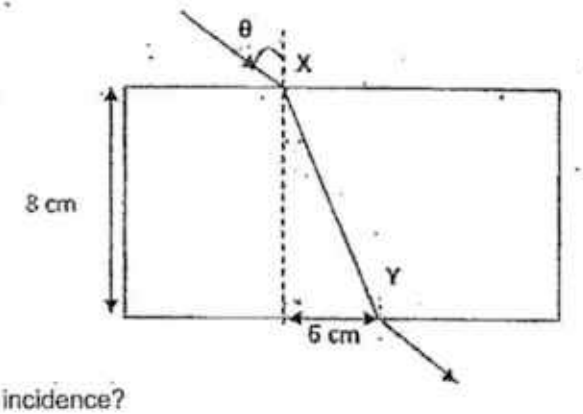
What would be the angle of reflection of the ray at mirror M_2?

A 0°
B 30°
C 60°
D 90°

37 In the diagram below, only three light rays from the object passing through the diverging lens are correctly drawn. Which light ray A, B, C or D is incorrectly drawn?



38 The diagram shows a light ray entering a glass block of refractive index 1.50 at X and emerging at Y.



What is the angle of incidence?

A 44.3°
B 64.2°
C 26.2°
D 71.3°

39 Waves P and W are components of the electromagnetic spectrum. P has a longer wavelength than Q. Which of the following statements is true about P and Q?

A Q has a lower frequency than P
B P can travel faster than Q in vacuum
C P is radiowave and Q is infrared
D Q is ultraviolet ray and P is X-ray

40 An X-ray scanner at an airport emits X-rays that have a frequency of 3×10^{17} Hz. What is the wavelength of these X-rays?

A 10 μm
B 1 μm
C 1 nm
D 10 nm

END OF PAPER

GAN ENG SENG SCHOOL
End-of-Year Examination 2016

CANDIDATE NAME

CLASS

INDEX NUMBER

PHYSICS (Sec 3 Express)
Paper 2 Theory

5059/02
12 October 2016
1 hour 45 minutes

Candidates answer on the Question Paper.
Calculators are allowed in the examination.

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer all questions.

Section B
Answer all questions. Question 14 has a choice of parts to answer.

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 [ ] at the end of each question or part question.

For Examiner's Use	
Section A	50
Section B	30
Total	80

56

This paper consists of **17** pages including the cover page.

For Examiner's Use

Section A [50 marks]

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

1 Ari determines the thickness of a coin by taking a few readings at different positions of the coin with a micrometer screw gauge and finding the average. Fig. 1.1 shows one of those readings. Fig 1.2 shows the same micrometer screw gauge when it is fully closed.

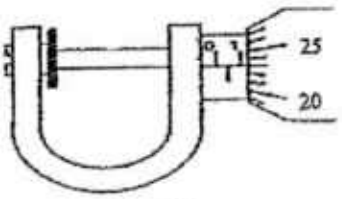


Fig. 1.1

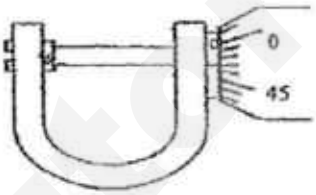


Fig. 1.2

(a) Determine the zero error on the micrometer screw gauge and thereafter, the actual thickness of the coin.

Zero error = ...[1]
Actual thickness = ...[1]

(b) Ari uses the thimble instead of the ratchet to turn the screw gauge during the experiment. What effect would this have on the accuracy of the thickness obtained?

.....

.....[1]

2 During a monsoon storm, a rock falls off a cliff from rest into soft mud beneath it. The rock, of weight 5 N, takes 2 s to fall before it embeds itself 20 cm into the mud. Assume air resistance is negligible.

(a) Calculate the height of the cliff.

Height = ...[2]

For Examiner's Use

2 (b) Calculate the time taken of the rock between hitting the mud and coming to rest inside it.

Time taken = ...[2]

(c) Calculate the average acceleration of the rock in the soft mud.

Average acceleration = ...[2]

3 Two beginner figure skaters, Alice and Bob stand at rest on a smooth ice rink where there is negligible friction. They hold on to each other for support when a force of 200 N is exerted on them by a third person. The figure skaters move with an acceleration of 1.6 m/s^2. The mass of Alice is 50 kg.

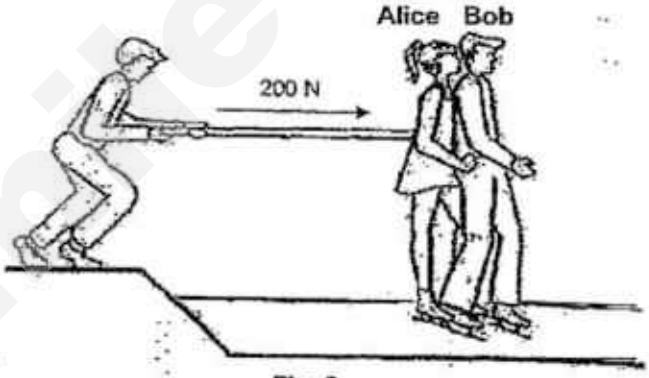


Fig. 3

(a) Calculate Bob's mass.

Mass = ...[3]

(b) Calculate the force of Alice on Bob.

Force of Alice on Bob = ...[1]

For Examiner's Use

4 Fig 4 shows James swimming at 2 m/s relative to the water in a river. He sets out 50 ° to the bank of the river and is carried downstream as he swims since the river flows at 1.5 m/s.

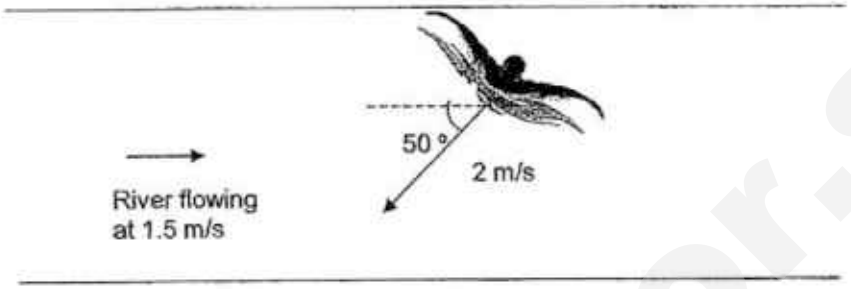


Fig. 4

Using the graphical method of a vector diagram, find the magnitude and direction of his resultant velocity.

Magnitude = ...
Direction = ...[4]

For Examiner's Use

5 An alloy is made of 65 % iron and 35 % copper by volume. It is used as a spare part in the International Space Station (ISS). The density of copper and iron is 8.90 g/cm^3 and 6.98 g/cm^3 respectively.

(a) Determine the density of 100 cm^3 of the alloy.

Density = ...[2]

(b) State and explain what change would occur in the value of (a) if the spare part was reduced to half its size and brought from Earth to the ISS. Assume temperature remains constant.

.....

.....

.....[2]

6 Fig. 6 shows a paper weight that has been displaced and is stationary in its new displaced position. The centre of gravity of the paper weight is clearly shown.

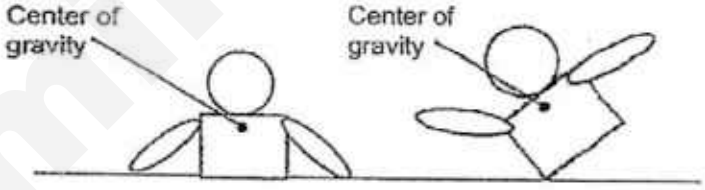


Fig. 6

(a) State and explain the type of equilibrium the paper weight is in after it is displaced.

.....

.....

.....[2]

(b) If this paper weight is freely suspended, explain the position of its centre of gravity.

.....

.....

.....[2]

For Examiner's Use

7 Fig 7 shows a diver snorkelling in the sea. In an attempt to do deep sea snorkelling, he has extended the length of his snorkel tube. The density of water is 1024 kg/m^3 and the atmospheric pressure at sea level is 1.0×10^5 Pa.

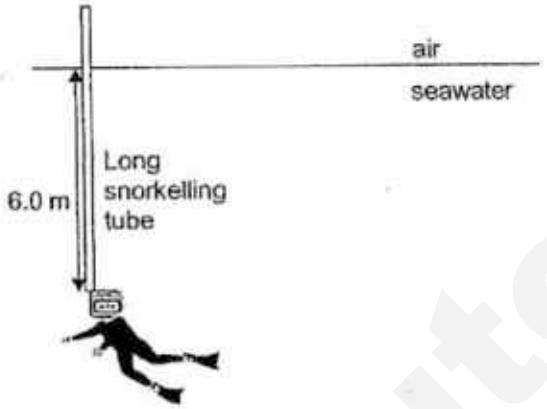


Fig. 7

(a) Calculate the pressure acting on the diver when he is 6.0 m under water.

Pressure = ...[2]

(b) The human lungs can withstand a pressure difference of up to one-twentieth of atmospheric pressure. Calculate how far the diver can swim below the surface of the sea by breathing through the snorkel tube.

Distance under the sea = ...[2]

(c) Explain what will happen to the diver when he breathes through the snorkel tube when he is 6.0 m below the surface of the sea.

.....

.....[1]

For Examiner's Use

8 Nicky investigates the principle of conservation of energy by using the pendulum experiment. He releases the pendulum from a certain height h, as shown in Fig. 8.1, and measures the speed of the pendulum bob during the oscillation.

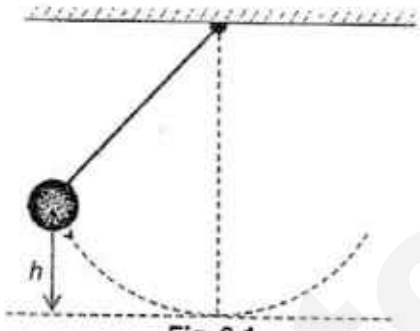


Fig. 8.1

Fig. 8.2 shows how the speed of pendulum bob varies with time in the first 2.0 s.

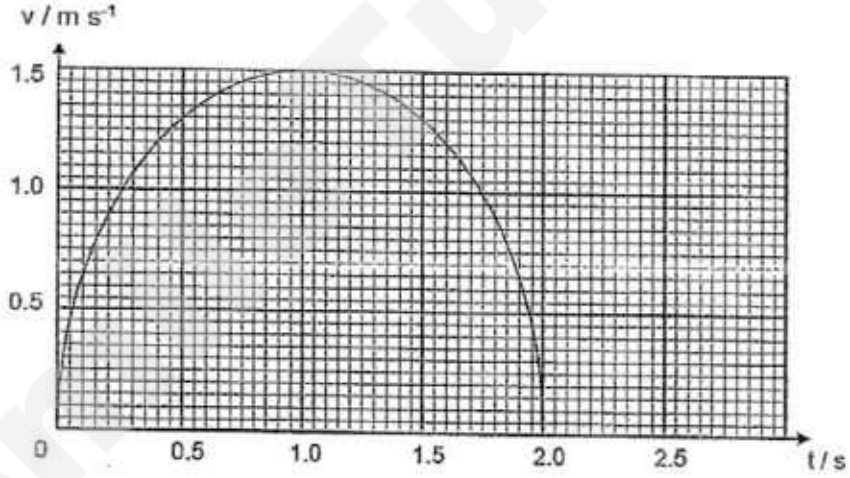


Fig. 8.2

(a) State the principle of conservation of energy.

.....

.....[1]

(b) Determine the period of oscillation of this pendulum.

Period of oscillation = ...[1]

For Examiner's Use

8 (c) Calculate the height, h, from which the pendulum is released.

h = ...[2]

9 Fig. 9 shows Luqman attempting underwater photography in a swimming pool. When he takes a photo with flash, there is a circle of light formed on the water's surface as shown in the diagram. Assume that the camera flash is a point source of light represented by point **P** and that the camera is at a depth of 0.525 m. Take the refractive index of water to be 1.33.

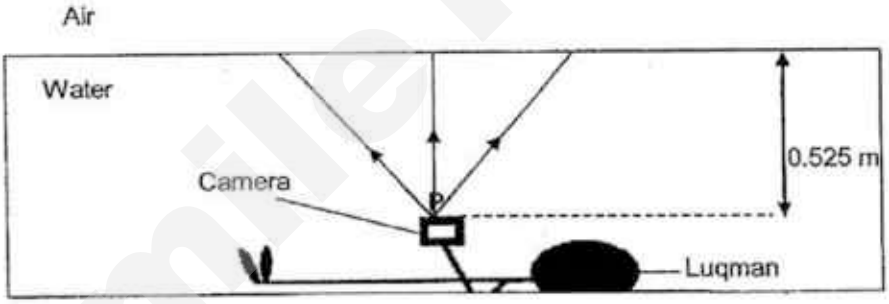


Fig. 9

(a) On Fig. 9, two of the light rays are incident on the water at the critical angle. Continue the rays of light and label the critical angles **C** on Fig. 9. [2]

(b) Calculate the radius of the circle of light formed on the water surface.

Radius = ...[2]

For Examiner's Use

9 (c) In order to continue his pool photography more comfortably, Luqman wants to increase the temperature of the pool water. Explain where he should put the heater.

.....

.....

.....

.....[2]

10 A small, very brightly illuminated display is located at the back of a projector. The projector lens produces an inverted and magnified image of the display on a white classroom wall. Fig. 10 is a scale diagram showing the position and size of both the display and the image on the wall.

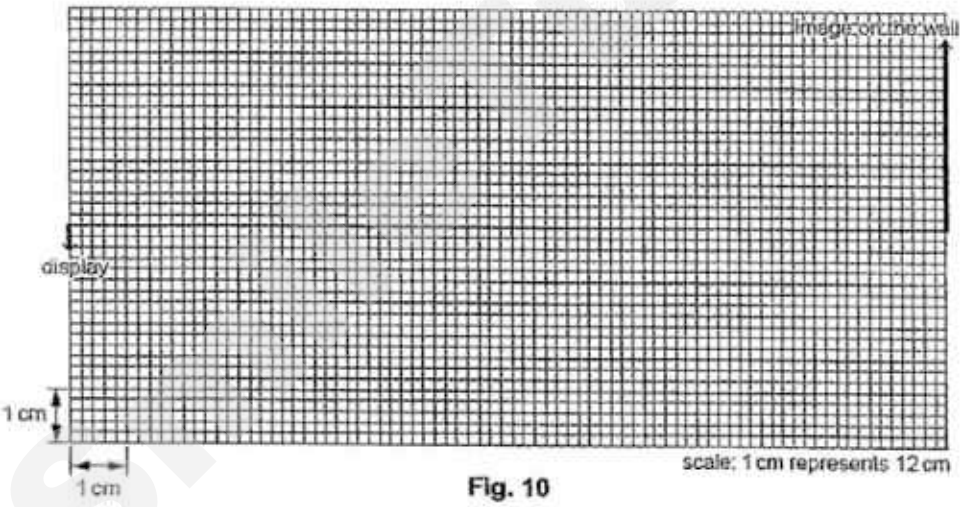


Fig. 10

On Fig. 10, determine the focal length of the lens.

Focal length = ...[4]

60

For Examiner's Use

11 **(a)** Fig. 11 shows some oil in a ripple tank that has shallow and deep sections. A machine in the shallow section generates 1800 waves per minute. The waves in the shallow section move towards the deep section in the direction shown.

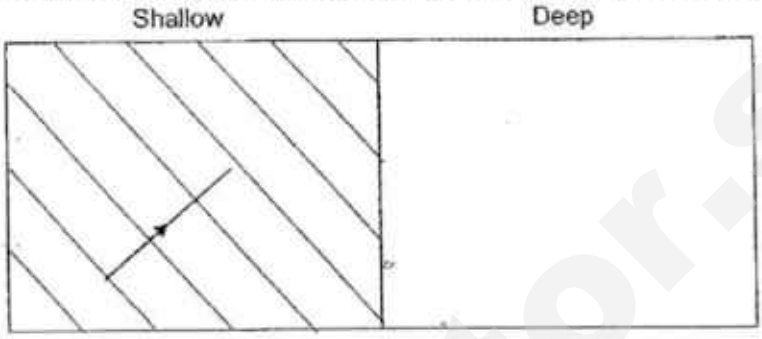


Fig. 11

There is a distance of 0.70 m between the wave crests in the shallow section.

(i) Calculate the velocity of the waves in the shallow section.

Velocity = ...[2]

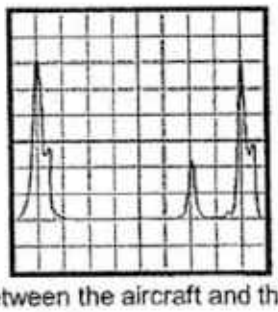
(ii) State what happens to the wavelength of the wave in the deep section.

.....

.....[1]

(iii) On Fig. 11, draw the wavefronts and indicate the direction of the wave in the deep section. [1]

(b) A radar station detects an aircraft flying near it using electromagnetic waves. The radar station sends a pulse of the electromagnetic wave every 40 μs. The pulses are reflected from the aircraft back to the station. These signals are displayed on the screen of a Cathode Ray Oscilloscope.



Estimate the distance between the aircraft and the station.

Distance = ...[2]

For Examiner's Use

Section B [30 marks]

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

Answer only one of the two alternative questions in **Question 14.**

12 Each year, American families celebrate Thanksgiving Day with a traditional feast that includes a roasted turkey. A turkey is well cooked when it reaches an internal temperature of 85 °C. A pop-up turkey timer thermometer is used to indicate that the turkey in an oven is cooked. The turkey timer is inserted into the thickest part of the turkey breast, avoiding bone and fat. When the required temperature has been reached, the turkey timer pops up. Fig.12 shows a pop-up turkey timer thermometer before cooking and after it has popped up.

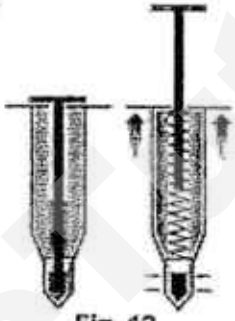


Fig. 12

The turkey timer is made of a stick with a spring in a case held into place by a soft metal in the tip of the casing. The metal is solid at room temperature and melts at 85 °C. When the metal melts, it frees the end of the stick that had been trapped in the metal. The elastic potential energy from the spring turns into kinetic energy which pushes the stick up. Assume room temperature as 25 °C.

(a) State and explain the process in which the heat is transferred from the turkey to the turkey timer.

.....

.....

.....

.....[2]

(b) The turkey cooks for 4 hours in a 4.4 kW oven. Given that the specific heat capacity of the metal is 0.13 kJ/kg/°C and its mass is 150 g, calculate the specific latent heat of fusion of the metal in the turkey timer.

Latent heat of fusion = ...[3]

For Examiner's Use

12 (c) On the axes below, sketch the heating curve of the metal in the turkey timer from the time the oven is started to the time the metal melts. Label the axes accordingly.

[2]

(d) Explain why there is no change in kinetic energy of the metal particles when it changes from solid to liquid at 85 °C.

.....

.....

.....

.....[2]

(e) A turkey timer is reusable for up to 200 times. Suggest a method to return the stick to its original position after it has been used.

.....

.....[1]

For Examiner's Use

13 A small boat is powered by an outboard motor of variable power output P. Fig. 13.1 shows the variation with speed P when the boat carries different loads.

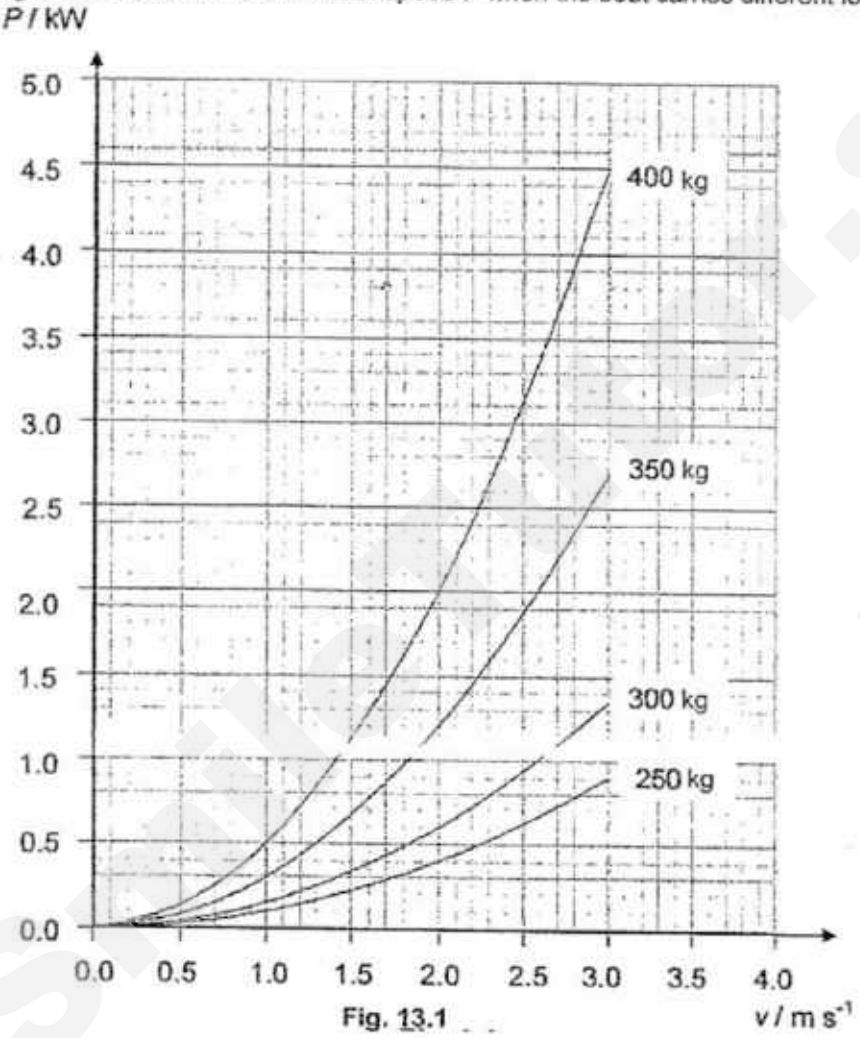


Fig. 13.1

The masses shown are the total mass of the boat plus passengers.

(a) For the boat having a steady speed of 2.00 m/s and a total mass of 250 kg, determine the power of the engine and the resistive force acting on the boat.

Power of the engine = ...[1]

Resistive Force on the boat = ...[2]

6²

For Examiner's Use

13 (b) The boat of mass 350 kg moves with a speed of 2.50 m/s.

(i) Estimate the total energy that the motor provides for the boat to travel for 30 minutes.

Total energy = ...[2]

(ii) The amount of energy given off when 1.00 kg of fuel is mixed with oxygen in the air is 45.0 MJ. The efficiency of the motor in converting the energy released with the combination of oxygen and the fuel is 40.0 %. Determine the total amount of fuel that would be expended.

Total fuel expended = ...[2]

(c) Fig. 13.2 shows how the speeds of 2 boats of equal mass vary with respect to time. Boat A starts from rest while boat B travels at constant speed.

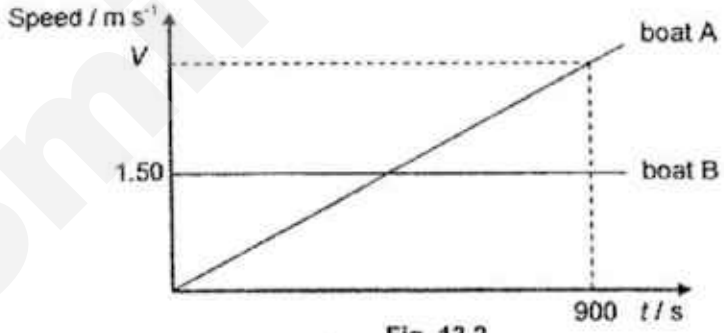


Fig. 13.2

(i) Both Boat A and B travel the same distance at t = 900 s. Calculate the velocity, V at t = 900 s.

Velocity, V = ...[1]

(ii) Which boat requires more petrol? Why?

.....

.....

.....[2]

For Examiner's Use

EITHER

14 (a) Fig 14.1 shows a pump.

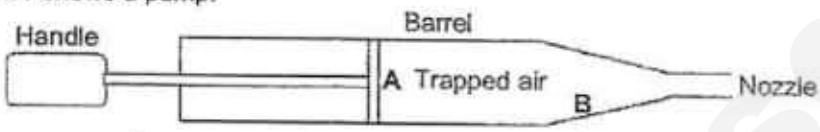


Fig. 14.1

When the nozzle is blocked and the handle is slowly pushed in so that the temperature of the air in the barrel remains constant, the pressure of the air rises.

(i) Explain, in terms of the molecular motion, whether trapped air creates a smaller, larger or same pressure on face A compared to face B of the pump.

.....

.....

.....

.....[2]

(ii) Explain why the pressure increases when the handle is slowly pushed in. State one assumption in your explanation.

.....

.....

.....

.....[2]

63

For Examiner's Use

14 (a) (iii) The cross-sectional area of the barrel is 1000 mm². The pump handle is pushed in until the trapped air is at a pressure that corresponds to the U - shaped tube containing water as shown in Fig.14.2.

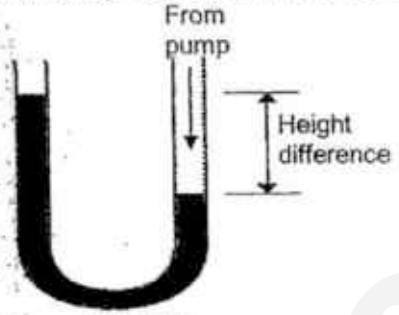


Fig. 14.2

The difference in water levels is 20.0 cm. Assume atmospheric pressure is 10 m water. Calculate the force applied to the handle.

Force = ...[3]

(b) The difference in water levels was measured at different temperatures and the readings are tabulated.

Temperature θ/°C	30	40	50	60
Difference in water levels/ cm	20.0	25.0	35.0	50.0

(i) Using kinetic theory of matter, explain why the difference in water levels increases when temperature increases.

.....

.....[1]

(ii) If the apparatus is used to construct a thermometer where the difference in water level is related to the temperature of the environment, suggest two limitations of this thermometer.

.....

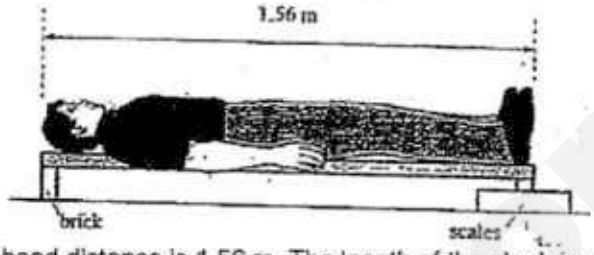
.....

.....[2]

For Examiner's Use

OR

14 Bryant conducts an experiment to find the centre of gravity of a person. He lies flat on a uniform plank of mass 15 kg. The plank, with Bryant on it, is placed on a brick and some bathroom scales as shown in the diagram below.



Bryant's toe-to-head distance is 1.56 m. The length of the plank is also 1.56 m. Bryant's mass is 62 kg.

(a) Identify and label all the forces acting on the system. [3]

(b) The reading on the bathroom scales is 30 kg. Use this information to determine how far Bryant's centre of gravity is from his toes.

Distance of centre of gravity from toes = ...[3]

(c) Bryant then gets up to sit in an upright position on the plank with his feet still aligned to the scales. Explain how the reading on the scale would change.

.....

.....

.....[2]

(d) If the brick is replaced by another bathroom scale, find the reading on the scale.

Reading on the scale = ...[2]

END OF PAPER

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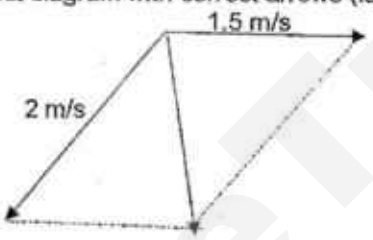
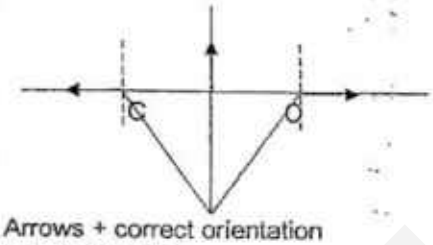
2016 Sec 3Ex Pure Phy 5059 EOY Marking Scheme

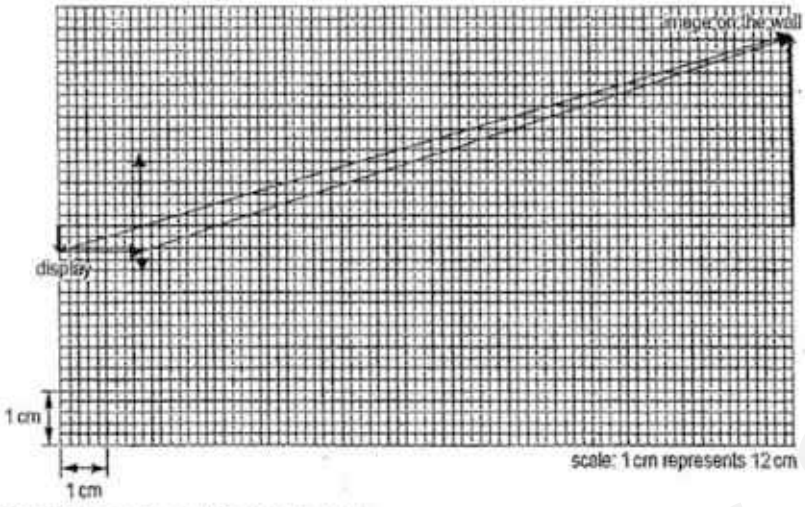
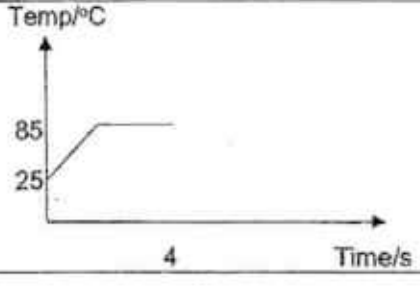
No	Answer	Notes
1	B	
2	A	
3	C	
4	D	
5	B	
6	C	
7	D	
8	D	
9	B	
10	D	
11	A	
12	D	
13	D	
14	A	
15	B	
16	C	
17	A	
18	B	
19	C	
20	C	
21	C	
22	B	
23	C	
24	A	
25	C	
26	D	
27	D	
28	B	
29	C	
30	B	
31	D	
32	A	
33	B	
34	A	
35	A	
36	A	
37	B	
38	B	
39	C	
40	C	

Paper 2

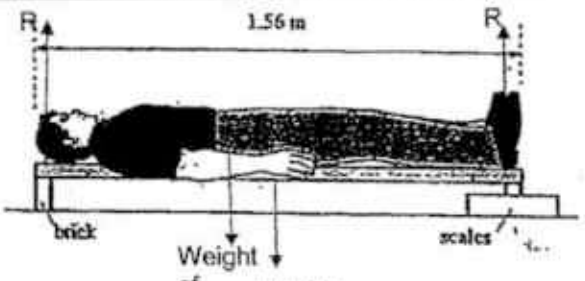
No	Answer	Marks
1a	Zero error = - 0.03 mm Actual thickness = 1.23 – (-0.03) = 1.26 mm	1 1
1b	Inaccurate as inconsistent force used to tighten the micrometer screw gauge / Smaller reading obtained due to over-tightening	1

2a	Height = ½ x 2 x (final velocity) h = ½ x 2 x v a = (v-u)/t 10 = (v)/2 v = 20 m/s h = ½ x 2 x 20 = 20 m	1 1
2b	S = 0.5 vt 0.20 = 0.5 (20) t t = 0.020 s	1 1
2c	a = (v-u)/t = -20/0.020 = -1000 m/s²	1 1
3a	F = ma m = 200 /1.6 = 125 kg Mass of B = 125 – 50 = 75 kg	 1 1 1
3b	F = 75 x 1.6 = 120 N	 1
4	Scale 1 cm : 0.5 m/s (or any appropriate scale) Correct diagram with correct arrows (labelled angles etc)  Magnitude = 1.56 m/s (1.46 – 1.66 m/s) Direction : 81° w. r to 1.5 m/s (+/- 2 degrees)	1 1 1 1
5a	65 cm³ of Iron : m_{iron} = 6.98 x 65 = 453.7 g 35 cm³ of Copper : m_{copper} = 8.90 x 35 = 311.5 g Density = (453.7 + 311.5) / 100 = 7.65 g/cm³ or 7650 kg/m³	1 1
5b	There would be no change in the density Density of a material is fixed	1 1
6a	Unstable equilibrium. The centre of gravity has been raised, but the line of action of the weight lies directly on the pivot, hence there is no net moment.	1 1
6b	When the centre of gravity is not directly under the point of suspension, its weight will produce a moment about the point of suspension, causing the object to oscillate. The object comes to rest when the centre of gravity of the object is directly below the point of suspension. The line of action of the weight passes through the pivot and hence there is no net moment.	1 1

7a	Pressure = Patm + Pwater = $1.0 \times 10^5 + 6(1024)(10)$ = 1.61×10^5 Pa	1 1
7b	Pressure difference = $1/20 \times (1.0 \times 10^5)$ = 5000 Pa P = hpg 5000 = h x 1024 x 10 h = 0.488 m	 1 1
7c	The diver will have difficulty breathing as the pressure difference between his lungs and the external environment is much greater.	1
8a	Energy cannot be created or destroyed, but can be changed from one form to another.	1
8b	Period = 2 x 2 = 4 s	1
8c	GPE lost = KE gained $Mgh = ½ mv^2$ $h = ½ (1.5)^2 / 10$ = 0.113 m	 1 1
9a	 Arrows + correct orientation Label of angles.	 1 1
9b	Critical angle = sin-1 (1/n) = sin-1 (1/1.33) = 48.75 ° Radius of circle of light = 0.525 tan 48.75 = 0.598 m (accept 0.599 m)	 1 1
9c	Heater should be at the bottom of the pool. The hot water will expand, and since less dense, will rise. The denser cool water will sink to take its place and the cycle will repeat, creating a convection current.	1 1

10	 Straight ray from object to image Vertical line labelled L where first ray intersects principal axis Second ray drawn from arrowhead of object to lens (parallel to principal axis) and straight to arrowhead of image. Focal length = 1.8 x 12 = 21.6 cm (19 – 23 cm)	1 1 1 1
11ai	Velocity = frequency x wavelength = 1800/60 x 0.70 = 21.0 m/s	1 1
11aii	Wavelength increases in the deep section.	1
11aiii	Wavelengths wider with correct direction indicated by arrow Refracted wavefronts drawn from incident at the boundary, perpendicular to direction of refracted wave motion.	1 1
11b	Each division = 40μs/8 = 5 μs Speed = 2d/t $3 \times 10^8 = 2d/(6 \times 5\ \mu s)$ d = 4500 m	 1 1
12a	Conduction Since the timer and the turkey are in contact, thermal energy is transferred to the case of the timer and the soft metal therein. The free electrons and metal atoms have an increased vibrational kinetic energy and collide with adjacent atoms.	1 1
12b	Energy from oven = Energy to raise metal temperature + Energy to melt metal 4.4 kW x 4(60x60) = 0.15 x 0.13k x (85 – 25) + (0.15 x l_f) l_f = 422 000 kJ kg^{-1}	1 1 1
12c		

	Correct shape Axes labelled and values of temperature correct	1 1
12d	The energy absorbed during the melting process is used to overcome the forces of attraction between the molecules /increase the potential energy and no energy goes to increase the kinetic energy of the particles.	1 1
12e	Melt the metal by placing it in a beaker of hot water. Hold stick down and let the metal solidify.	1
13a	P = 0.40 kW P = Fv $0.4 \times 10^3 = F \times 2$ F = 200 N	1 1 1
13bi	Energy = PT $= (1.9 \times 10^3) \times (30 \times 60)$ = 3.42 MJ	1 1
13bii	Efficiency = output / input x 100 $40/100 = 3.42 \times 10^6$ / input energy Input energy = 8.55 MJ Total amount of fuel = 8.55 / 45 = 0.190 kg	1 1
13ci	Since distance travelled by boat A and B are equal, area under both graphs are equal. $900 \times 1.5 = ½ \times 900 \times v$ v = 3 m/s	1
13cii	Boat A, the energy output from the engine is used to overcome friction as well as increase the kinetic energy of the boat.	1 1
E14 ai	Same Number of collisions that molecules make on the wall per unit time / frequency of collisions with wall are same on face A and B	1 1
E14 aii	Assumption is that temperature is constant. At constant mass, when volume of the gas decreases, rate of collision increases and pressure increases.	1 1
E14 aiii	Pg = hpg + Patm = 20 cm water + 10 m water = 10.2 m water F = PA $= (10.2 \times 1000 \times 10) \times (0.001)$ = 102 N	1 1 1
E14 bi	As the temperature increases, the kinetic energy of the molecules increase and the collisions per unit volume increases. Hence, water level increases.	1
E14 bii	The difference in water level is not linearly related to the temperature rise Water has a high heat capacity meaning that large amounts of thermal energy is needed for a rise in temperature Or Water has a low boiling point which makes the thermometer unsuitable for the measurement of high temperatures.	1 1

O14 a	 Reaction forces Weight of plank Weight of Bryant	 1 1 1
O14 b	Taking moments about the brick, 150 x 0.78 + 620 x d = 300 x 1.56 d = 0.57 m cg is 0.99 m from toes	 1 1 1
O14c	As he gets up, his centre of gravity is shifted to the right closer to the scale, so the reading increases.	1 1
O14 d	Total up forces = total down forces R + 300 = 620 + 150 R = 470 N Reading on the scale = 47 kg	 1 1

Geylang Methodist School (Secondary)
End-Of-Year Examination 2016

PHYSICS **5059/01**

Paper 1 **Sec 3 Express**

Additional materials : OAS **45 minutes**

Setter : Mr Sng Peng Hock **12 Oct 2016**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Answer all questions. Shade your answers on the OAS provided.

At the end of the examination, submit OAS and the question paper separately.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark.

Any rough work should be done in this booklet.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

This document consists of **11** printed pages and **1** blank page.

[Turn over

68

1 What is the correct unit for the quantity shown?

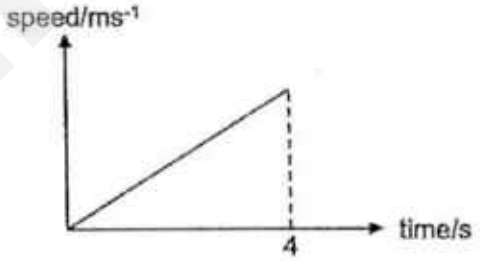
	quantity	unit
A	electromotive force (e.m.f.)	N
B	latent heat	J
C	pressure	kg/m^2
D	weight	kg

2 A simple pendulum takes 34.0 s to complete 20 oscillations.

What would be the period of the pendulum if the mass of the pendulum bob was doubled and the experiment repeated?

A 0.85 s B 1.7 s C 3.4 s D 6.8 s

3 The diagram below shows the speed time graph of a stone released from a certain height and hit the ground in 4 seconds.



At what height was the stone released? (Ignore air resistance)

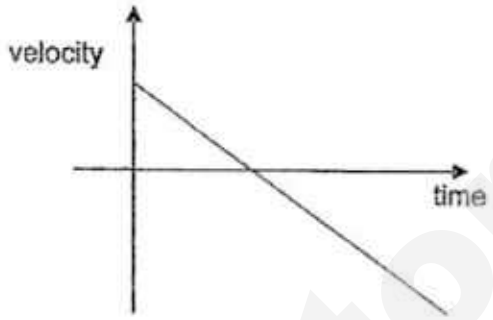
A 20 m B 40 m C 80 m D 160 m

4 A box of mass 2 kg is pushed with a force of 10 N on a rough surface. It accelerates from rest to a speed to 10 m/s after 5 seconds.

What is the frictional force acting on the box?

A 0 N B 4 N C 6 N D 10 N

5 The graph shows how the velocity of a ball varies with time.



Which of the following situations is best illustrated by the graph?

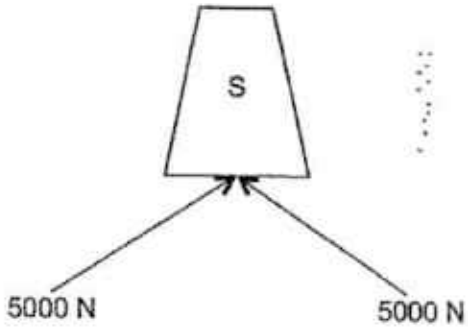
A The ball is released from a height.

B The ball is thrown upwards.

C The ball is thrown down from a height.

D The ball rolls down a slope.

6 Two tug boats were pushing a sand barge, S, with 5000 N forces each. The forces are acting at an angle of 120° from one another as shown below.

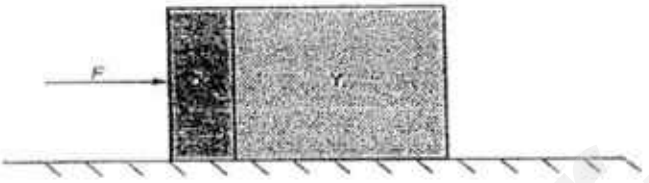


What is the value of the resultant force acting on the sand barge?

A 4000 N B 5000 N C 5500 N D 6000 N

69

7 Two blocks X and Y, of masses m and $4m$ respectively, are accelerated along a smooth horizontal surface by a force F applied to block X as shown.



What is the magnitude of the force exerted by block Y on block X during this acceleration?

A F/5 B 2F/5 C 3F/5 D 4F/5

8 When a solid X of mass 12 g is immersed in a displacement can filled with water, it displaces the same volume of water as a solid Y of mass 8 g.

What can be deduced about the densities of solids X and Y?

A Both X and Y have the same density

B The density of X is greater than Y by 4 g/cm^3.

C The density of X is one and half times the density of Y.

D The density of Y is one and half times the density of X.

9 An object weighs 16 N on the moon where the acceleration of free fall is 1.6 m/s^2.

How much will it weigh on Earth where the acceleration of free fall is 10 m/s^2?

A 16 N B 25.6 N C 100 N D 160 N

10 The position of the centre of gravity of an object _____

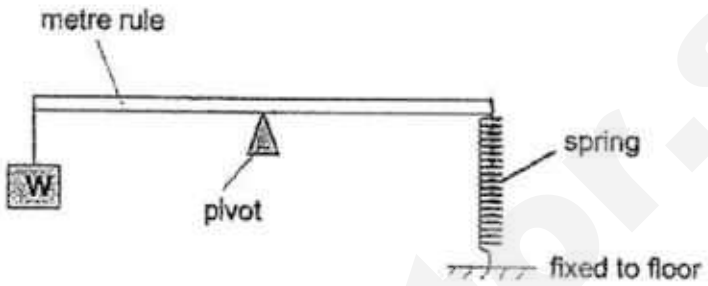
A always lies within the body object.

B depends on the weight of the object.

C depends on the distribution of mass.

D depends the gravitational field strength around the object.

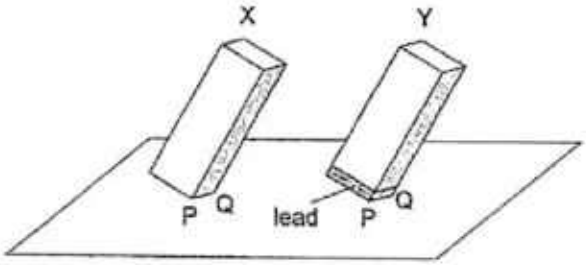
11 A **stretched** spring is attached to one end of a metre rule as shown. A weight W is hung at the other end. The metre rule is pivoted at the centre and remains horizontal.



The weight W is moved towards the pivot.
How does the force in the spring change?

	force in spring	direction of spring force acting on metre rule
A	increases	down
B	decreases	down
C	increases	up
D	decreases	up

12 The figure below shows two identical rectangular wooden blocks X and Y.
Block Y has a layer of lead attached to its base.
The blocks were tilted about edges PQ as shown in the figure.



Which of the following statements is true?

A X and Y will topple together at the same angle.

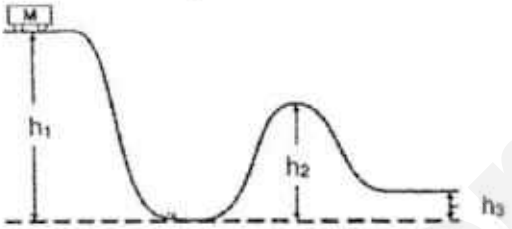
B X will topple over at a smaller angle of tilt compared to Y.

C Y will topple over at a smaller angle of tilt compared to X.

D Both will not topple over.

70

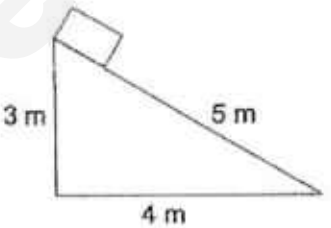
13 A cart of mass M on a frictionless track is at rest at the top of a hill of height h_1, as shown in the diagram. It starts moving down the first slope towards the second hill of height h_2.



What is the kinetic energy of the cart when it reaches the top of the next hill with a height of h_2?

A $Mg(h_2 - h_3)$ B Mgh_2 C $Mg(h_1 - h_2)$ D $Mg(h_1 - h_3)$

14 A box of mass 2 kg slides down a slope from rest as shown below.



Given that friction along the slope is 3.2 N, what is the speed of the box at the foot of the ramp?

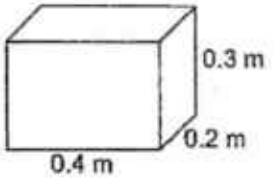
A 6.63 m/s B 7.10 m/s C 7.75 m/s D 8.72 m/s

15 An electric motor lifts a load of 1000 N through a vertical height of 2.0 m in 10 s. The input power to the motor is 500 J/s.

What is the efficiency of the crane?

A 10 % B 40 % C 50 % D 60 %

16 A block of dimension 0.2 m by 0.3 m by 0.4 m rests on the floor as shown in the diagram below. The block has density of 6000 kg/m^3.



What is the pressure exerted by the block on the floor?

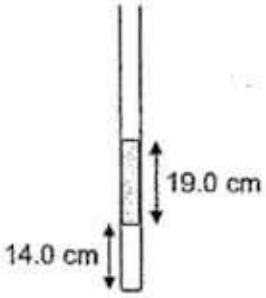
A 1800 Pa B 18000 Pa C 100000 Pa D 1000000 Pa

17 The RSS Archer submarine is cruising at a depth of 65 m. The density of seawater is 1020 kg/m^3 and atmospheric pressure is 1 x 10^5 Pa.

What is the pressure acting on the submarine at this depth?

A 66300 Pa B 166300 Pa C 663000 Pa D 763000 Pa

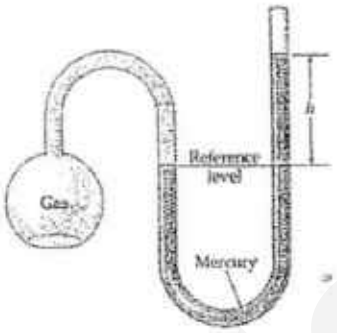
18 In the figure below, a column of air 14.0 cm long is trapped in a capillary tube by a thread of mercury 19.0 cm long. The atmospheric pressure is equivalent to 76.0 cm Hg.



What is the pressure of the air in the tube?

A 14.0 cm Hg B 57.0 cm Hg C 62.0 cm Hg D 95.0 cm Hg

19 The diagram below shows a constant volume gas thermometer.



What is the thermometric property used in this thermometer?

A volume of gas

B volume of mercury

C height of mercury

D pressure of gas

20 A gas is heated in a rigid sealed vessel.

What happens to the internal energy and density of the gas?

	internal energy	density
A	remains constant	remains constant
B	remains constant	decreases
C	increases	remains constant
D	increases	increases

21 Air is enclosed in a cylinder and the piston is pushed down slowly at constant temperature until the volume is halved.

Which of the following is true?

A The average kinetic energy of the molecules is doubled.

B The average number of molecules per unit volume is halved.

C The number of collisions per unit area is doubled.

D The total force exerted by the molecules on the piston is unchanged.

22 Which statement describes the motion and the arrangement of the molecules in a solid?

A Molecules vibrate about fixed positions within an orderly arrangement.

B Molecules vibrate about fixed positions within a random arrangement.

C Molecules move randomly within an ordered arrangement.

D Molecules move randomly within a random arrangement.

23 A match would ignite if it was held 10 cm above a bunsen flame but would not ignite if held 10 cm to one side of the flame. This is because there is more heat energy transferred by _____.

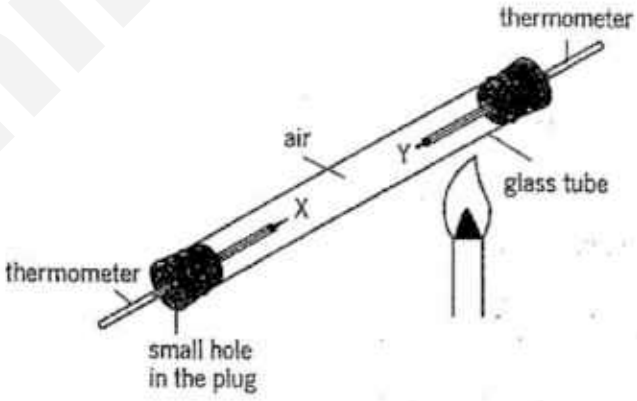
A conduction

B convection

C diffusion

D radiation

24 The diagram below shows a glass tube with two thermometers inserted at X and Y. The air in the glass tube has an initial temperature of 25 °C. The glass tube is then heated for one minute.



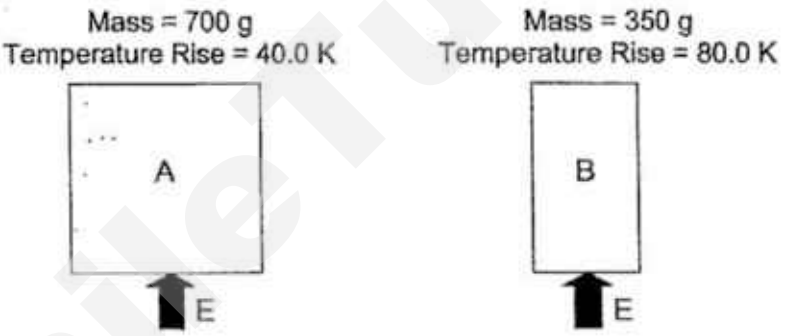
Which of the following shows the most likely temperatures recorded by thermometers X and Y?

	temperature at X / °C	temperature at Y / °C
A	25	25
B	25	45
C	45	35
D	45	45

25 In which of the following is most of the heat transferred by conduction?

A keeping warm beside a fire place
B boiling of water in a kettle
C frying of an egg on a metal pan
D heating of food in a microwave oven

26 Two blocks of copper, A and B, each receives the same amount of energy E. The mass of A is twice the mass of B. The temperature rise of A is half the temperature rise of B.



Which statement about A and B is incorrect?

A The specific heat capacity of A is the same as the specific heat capacity of B.
B The heat capacity of A is the same as the heat capacity of B.
C Both A and B have the same specific latent heat of fusion.
D The heat capacity of A is twice the heat capacity of B.

27 An ice cube at a temperature of 0 °C is put into a drink at a temperature of 10 °C. After a short time during cooling, some of the ice has melted and the drink has cooled to a temperature 8 °C.

What is the temperature of the remaining ice?

A 0 °C B 2 °C C 4 °C D 8 °C

28 A small amount of alcohol and water are at the same temperature. Which of the following statement best explains why the alcohol feels cooler when placed on the hand as compared to water?

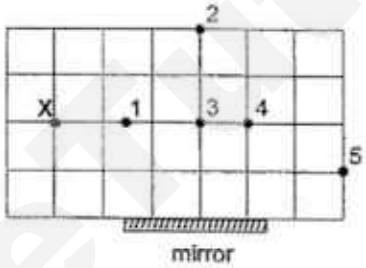
A Alcohol has a lower boiling point than water.

B Alcohol is a better conductor of heat compared to water.

C Alcohol has a higher specific latent heat of vaporisation than water.

D Alcohol evaporates more readily than water.

29 A student stands at point X as shown in the diagram below.



Which of the pins, 1, 2, 3, 4 or 5, will he be able to see in the mirror?

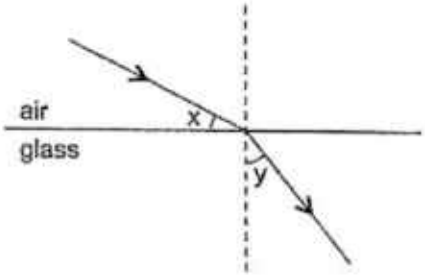
A pins 1, 2 and 3

B pins 2, 3 and 4

C pins 3, 4 and 5

D pins 2, 3, 4 and 5

30 A ray of light passes through from air to glass as shown in the following diagram below (which is not to scale).



Given that x = 20° and y = 40°, what is the refractive index of the glass?

A 0.53 B 1.46 C 1.53 D 1.87

End of paper

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Geylang Methodist School (Secondary)
End-Of-Year Examination 2016

Candidate Name

Class

Index Number

PHYSICS **5059/02**

Paper 2 Physics **Sec 3 Express**

Additional materials : Nil **1 hour 30 minutes**

Setter : Mr Sng Peng Hock **12 Oct 2016**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section B
Answer **all** questions. Write your answers on the writing papers provided.

At the end of the examination, fasten the writing papers securely with the question paper.

Candidates are reminded that all quantitative answers should include appropriate units. You are advised to show all your working in a clear, orderly manner.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
Total	/ 70

This document consists of **11** printed pages and **1** blank page.

[Turn over

74

SECTION A

Answer **ALL** questions in this section in the spaces provided.

1 A 5 kg parcel is dropped off vertically from a helicopter 600 m above the ground at time t = 0 s. After some time of falling through the air, its parachute is deployed by remote control. The speed-time graph for the first 25 seconds of its journey through the air is shown in Fig. 1.1 below.

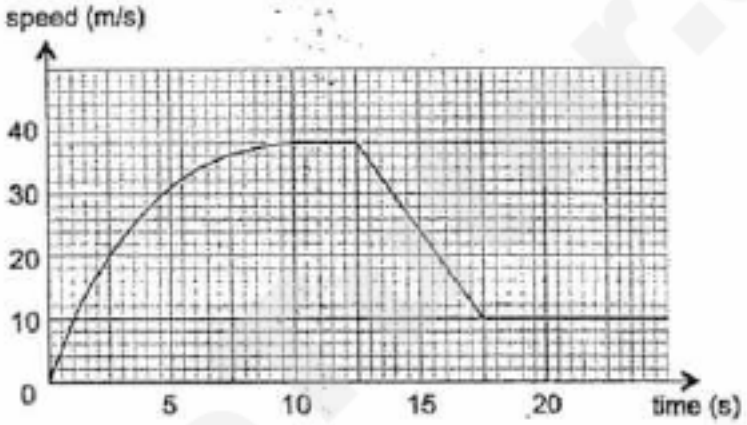


Fig. 1.1

(a) Is the object free-falling at any point during the first 25 seconds?

Explain your answer clearly with reference to Fig. 1.1 above.

_____

_____

_____

_____ [3]

(b) State the time at which the object first achieves terminal velocity.

_____ [1]

(c) Explain, in terms of forces, how the object achieves the first terminal velocity.

_____

_____

_____

_____ [3]

(d) Explain, in terms of forces, why the object experiences deceleration at time 12.5 s.

_____

_____

_____

_____ [3]

2 Fig. 2.1 shows a cube with sides 8 cm, made of substance X. Substance X has a density of 12.5 g/cm^3.

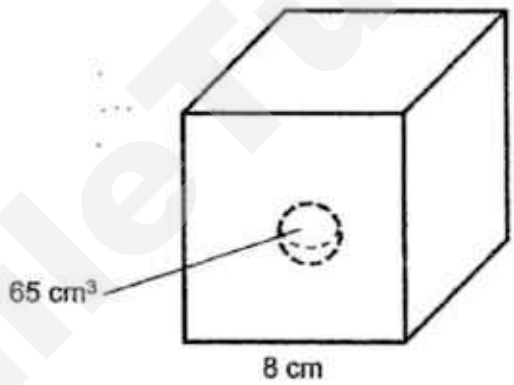


Fig. 2.1

The cube has a hollow spherical centre with a volume of 65 cm^3.

(a) Find the mass of the cube with the hollow spherical centre.

mass = _____ [2]

75

(b) The hollow spherical centre is then filled with substance Y, which has a density 5 g/cm^3.

Calculate the average density of the block with the substance Y filled in the centre.

density = _____ [3]

3 Fig. 3.1 shows a student, of weight *W* N, standing 0.30 m from end A of a uniform plank AB.

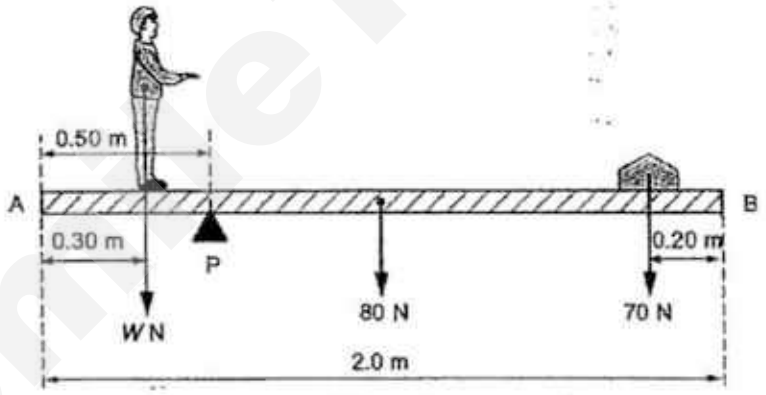


Fig. 3.1

The plank has a weight of 80 N and length 2.0 m. A pivot P supports the plank and is 0.50 m from end A. A weight of 70 N is moved to balance the weight of the student. The plank is in equilibrium when the 70 N weight is 0.20 m from end B.

Calculate the weight of the student.

weight = _____ [3]

4 Fig. 4.1 shows a conveyor belt moving boxes, each of weight 80 N. A motor is used to keep the conveyor belt moving continuously.

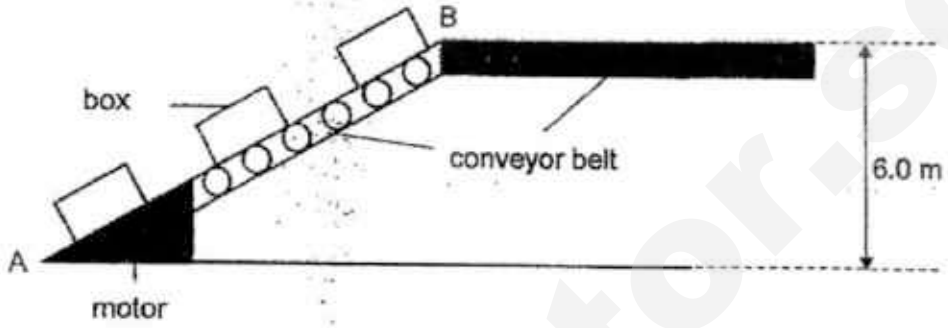


Fig. 4.1

(a) Calculate the increase in gravitational potential energy of a box when it moves from position A to position B.

gain in GPE = _____ [2]

(b) The conveyor belt is able to move 4 boxes from position A to B in 1.0 minute. Determine the power output of the motor.

power = _____ [2]

5 The stem of a thermometer is graduated in centimetres. It registers 1 cm when the bulb is -10 °C and 25 cm when the bulb is in steam at atmospheric pressure.

What is the temperature in °C when the thermometer registers 18 cm?

76 temperature = _____ [2]

6 Fig. 6.1 below shows the arrangement of particles of a particular substance as it is cooled.

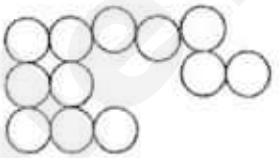
Time elapsed / min	Arrangement of particles	Temperature / °C	State(s) of substance
0		50	All liquid
5		10	
10		10	
15		10	All solid

Fig 6.1

(a) Complete the table. [3]

(b) Name the process which is occurring from t = 5 min to t = 15 min.

_____ [1]

(c) Explain how you arrived at your answer in part (b). Which component of internal energy has been changing?

_____

_____

_____ [2]

7 Fig. 7.1 shows a method of heating a room using solar energy instead of conventional sources of energy during cold weather in temperate countries. A brick wall with a blackened surface is placed behind a double-glazed window facing the Sun. During the day, the wall stores energy received from the Sun as thermal energy. At night, the heat from the blackened surface is transferred to the air next to it.

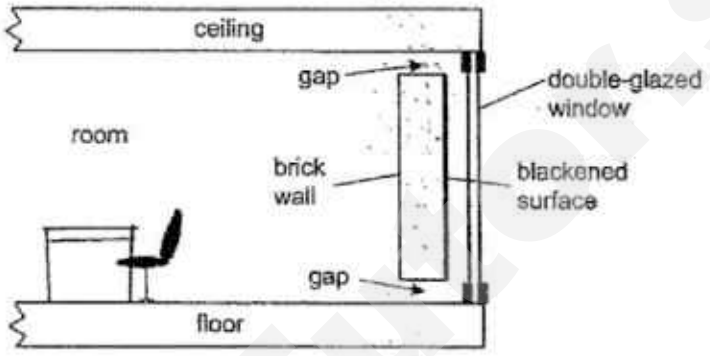


Fig 7.1

(a) Explain how the blackened surface helps to heat up the room during the night.

_____

_____

_____ [2]

(b) Describe how the heated air next to the wall is transferred throughout the room during the night.

_____

_____

_____ [2]

(c) The double-glazed window consists of two sheets of glass which traps a layer of air between them.

Explain how the double-glazed window helps to reduce heat loss in the room during the night.

_____

_____

_____ [2]

8 The diagram below shows a large rectangular tank containing a transparent liquid. A plane mirror is placed along the bottom of the tank. A ray of light is incident on the surface of the liquid at an angle of 35° as shown below.

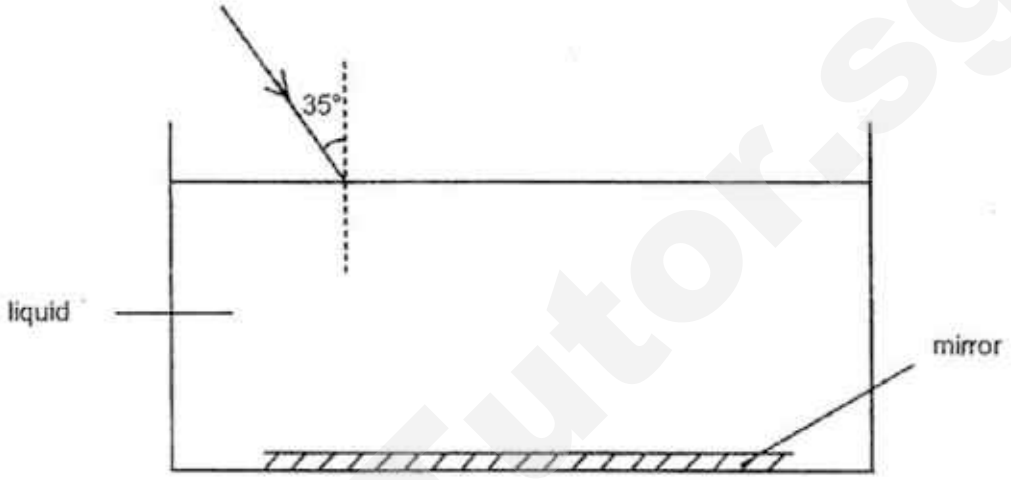


Fig 8.1

(a) If the refractive index of the liquid is 1.47, calculate the angle of refraction as the light ray enters the transparent liquid.

angle of reflection = _____ [2]

(b) Complete the diagram above to show the path of the ray of light until it emerges from the surface. Indicate all the angles with their respective normals. (You need not measure the angles to scale). [2]

End of Section A

SECTION B

Answer **all** the questions in this section
Write your answers on the writing papers provided.

9 Fig. 9.1 shows a helicopter with a mass of 1000 kg. The rotation of the blades can produce a maximum upward force of 18 kN.

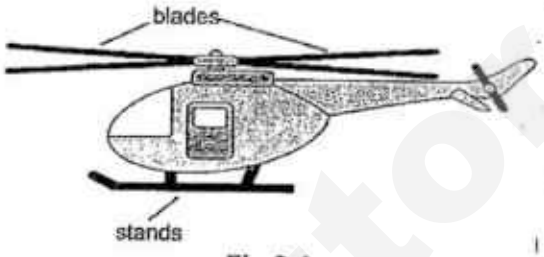


Fig 9.1

(a) The helicopter is stationary with its stands resting on the ground. The weight of the helicopter is one of the two forces that form an action-reaction pair of forces.

Describe the other force of this action-reaction pair. [2]

(b) Explain using Newton's third Law, how the helicopter produces an upward force. [2]

(c) The pilot flying the helicopter has a mass of 80 kg.

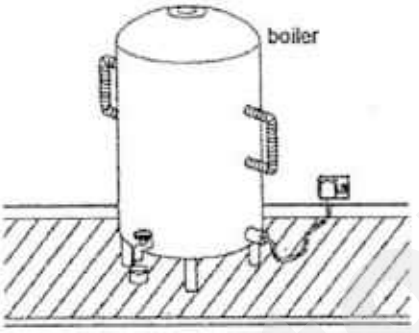
(i) What is the minimum upward force the helicopter must produce in order to lift off? [1]

(ii) What is the highest possible upward acceleration using the maximum upward force? [2]

(d) After applying the maximum upward force for 10 s, the helicopter is in the air. The pilot then decides to hover the helicopter at a fixed height.

Using Newton's first Law, explain how this can be achieved. [3]

10 Fig.10.1 below shows an electric boiler in a kitchen.



The boiler contains 35 kg of water at 28 °C.
The specific heat capacity of water is 4200 J/(kg °C).
The specific latent heat of vaporization of water is 2.26 MJ/kg.

(a) Calculate the thermal energy needed to raise the temperature of the water from 28 °C to its boiling point. [2]

(b) The water in the boiler is heated by a 7200 W immersion heater.

Calculate the minimum time required for the heater to bring the water to its boiling point. [2]

(c) Suggest one reason why the actual time is greater than the minimum time calculated in **(b)**. [1]

(d) Due to a fault in the thermostat setting, the heater is not deactivated when the water reaches its boiling point and steam is produced.

Calculate the mass of the water left in the boiler 5 minutes after steam is first produced. [4]

(e) Suggest a mechanical safety feature that would prevent any danger created by the fault in **(d)**. [1]

11 A light ray is incident upon a triangular glass block with a speed of 3×10^8 m/s as shown in the Fig 11.1 below (not to scale). It was found that the speed of light in the glass block is two-third that of the speed of light in air.

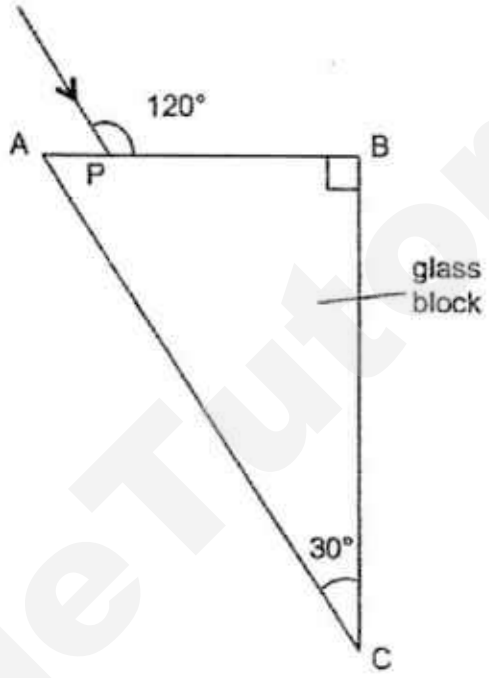


Fig 11.1

(a) Explain what will happen to the light ray as it enters the glass block. [2]

(b) Determine the refractive index, n, of the glass block. Hence, find the angle of refraction of the light ray after passing through point P. [4]

(c) Calculate the critical angle of the glass block. [1]

(d) Complete the path of the light ray from point P in Fig 11.1 and show what happens on the side AC. Indicate all angles and normal clearly. [3]

END OF PAPER

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Geylang Methodist School (Secondary)
End-Of-Year Examination 2016

PHYSICS **5059/01**

Paper 1 **Sec 3 Express**

Additional materials : OAS **45 minutes**

Setter : Mr Sng Peng Hock **12 Oct 2016**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Answer **all** questions. Shade your answers on the OAS provided.

At the end of the examination, submit OAS and the question paper separately.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark.

Any rough work should be done in this booklet.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

This document consists of **11** printed pages and **1** blank page.

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80

1 What is the correct unit for the quantity shown?

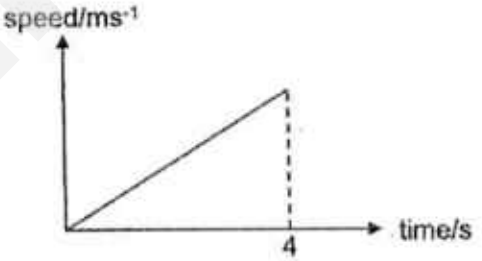
	quantity	unit
A	electromotive force (e.m.f.)	N
B	latent heat	J
C	pressure	kg/m^2
D	weight	kg

2 A simple pendulum takes 34.0 s to complete 20 oscillations.

What would be the period of the pendulum if the mass of the pendulum bob was doubled and the experiment repeated?

A 0.85 s B 1.7 s C 3.4 s D 6.8 s

3 The diagram below shows the speed time graph of a stone released from a certain height and hit the ground in 4 seconds.



At what height was the stone released? (Ignore air resistance)

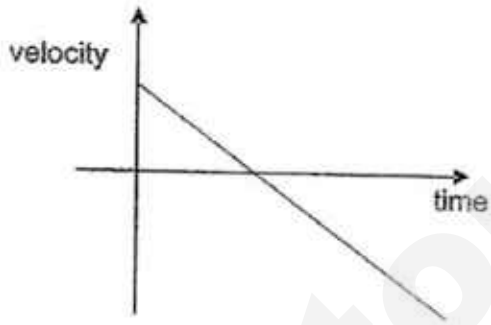
A 20 m B 40 m C 80 m D 160 m

4 A box of mass 2 kg is pushed with a force of 10 N on a rough surface. It accelerates from rest to a speed to 10 m/s after 5 seconds.

What is the frictional force acting on the box?

A 0 N B 4 N C 6 N D 10 N

5 The graph shows how the velocity of a ball varies with time.



Which of the following situations is best illustrated by the graph?

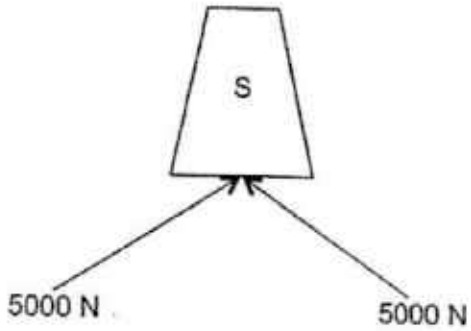
A The ball is released from a height.

B The ball is thrown upwards.

C The ball is thrown down from a height.

D The ball rolls down a slope.

6 Two tug boats were pushing a sand barge, S, with 5000 N forces each. The forces are acting at an angle of 120° from one another as shown below.

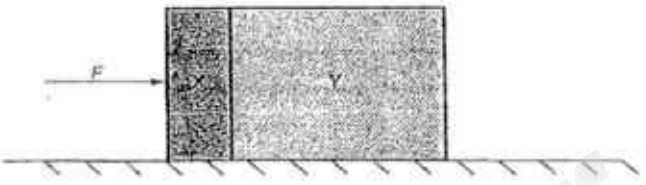


What is the value of the resultant force acting on the sand barge?

A 4000 N B 5000 N C 5500 N D 6000 N

81

7 Two blocks X and Y, of masses m and $4m$ respectively, are accelerated along a smooth horizontal surface by a force F applied to block X as shown.



What is the magnitude of the force exerted by block Y on block X during this acceleration?

A F/5 B 2F/5 C 3F/5 D 4F/5

8 When a solid X of mass 12 g is immersed in a displacement can filled with water, it displaces the same volume of water as a solid Y of mass 8 g.

What can be deduced about the densities of solids X and Y?

A Both X and Y have the same density

B The density of X is greater than Y by 4 g/cm^3.

C The density of X is one and half times the density of Y.

D The density of Y is one and half times the density of X.

9 An object weighs 16 N on the moon where the acceleration of free fall is 1.6 m/s^2.

How much will it weigh on Earth where the acceleration of free fall is 10 m/s^2?

A 16 N B 25.6 N C 100 N D 160 N

10 The position of the centre of gravity of an object _____

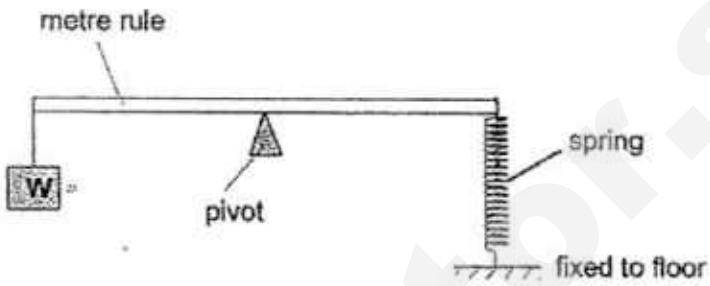
A always lies within the body object.

B depends on the weight of the object.

C depends on the distribution of mass.

D depends the gravitational field strength around the object.

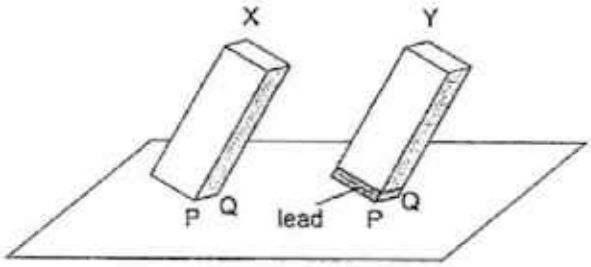
11 A **stretched** spring is attached to one end of a metre rule as shown. A weight W is hung at the other end. The metre rule is pivoted at the centre and remains horizontal.



The weight W is moved towards the pivot.
How does the force in the spring change?

	force in spring	direction of spring force acting on metre rule
A	increases	down
B	decreases	down
C	increases	up
D	decreases	up

12 The figure below shows two identical rectangular wooden blocks X and Y.
Block Y has a layer of lead attached to its base.
The blocks were tilted about edges PQ as shown in the figure.



Which of the following statements is true?

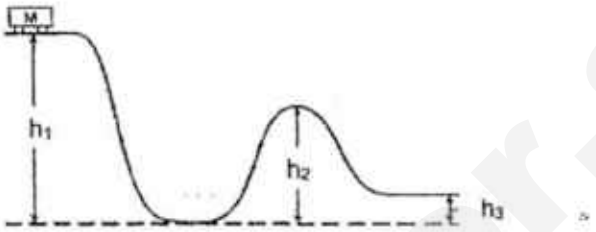
A X and Y will topple together at the same angle.

B X will topple over at a smaller angle of tilt compared to Y.

C Y will topple over at a smaller angle of tilt compared to X.

D Both will not topple over.

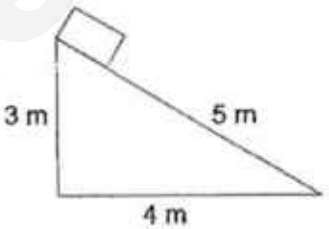
13 A cart of mass M on a frictionless track is at rest at the top of a hill of height h_1, as shown in the diagram. It starts moving down the first slope towards the second hill of height h_2.



What is the kinetic energy of the cart when it reaches the top of the next hill with a height of h_2?

A $Mg(h_2 - h_3)$ B Mgh_2 C $Mg(h_1 - h_2)$ D $Mg(h_1 - h_3)$

14 A box of mass 2 kg slides down a slope from rest as shown below.



Given that friction along the slope is 3.2 N, what is the speed of the box at the foot of the ramp?

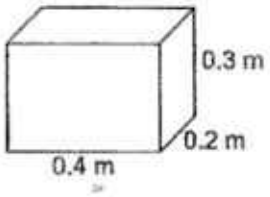
A 6.63 m/s B 7.10 m/s C 7.75 m/s D 8.72 m/s

15 An electric motor lifts a load of 1000 N through a vertical height of 2.0 m in 10 s. The input power to the motor is 500 J/s.

What is the efficiency of the crane?

A 10 % B 40 % C 50 % D 60 %

16 A block of dimension 0.2 m by 0.3 m by 0.4 m rests on the floor as shown in the diagram below. The block has density of 6000 kg/m^3.



What is the pressure exerted by the block on the floor?

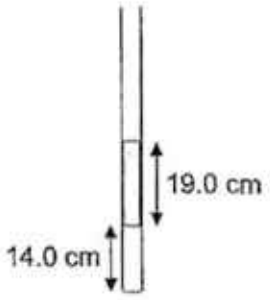
A 1800 Pa **B** 18000 Pa C 100000 Pa D 1000000 Pa

17 The RSS Archer submarine is cruising at a depth of 65 m. The density of seawater is 1020 kg/m^3 and atmospheric pressure is 1 x 10^5 Pa.

What is the pressure acting on the submarine at this depth?

A 66300 Pa B 166300 Pa C 663000 Pa **D** 763000 Pa

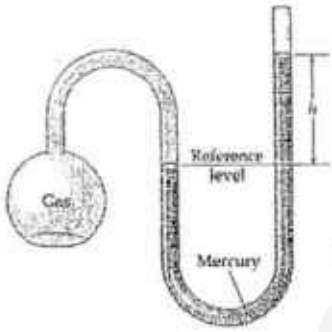
18 In the figure below, a column of air 14.0 cm long is trapped in a capillary tube by a thread of mercury 19.0 cm long. The atmospheric pressure is equivalent to 76.0 cm Hg.



What is the pressure of the air in the tube?

A 14.0 cm Hg B 57.0 cm Hg C 62.0 cm Hg **D** 95.0 cm Hg

19 The diagram below shows a constant volume gas thermometer.



What is the thermometric property used in this thermometer?

A volume of gas

B volume of mercury

C height of mercury

D pressure of gas

20 A gas is heated in a rigid sealed vessel.

What happens to the internal energy and density of the gas?

	internal energy	density
A	remains constant	remains constant
B	remains constant	decreases
C	increases	remains constant
D	increases	increases

21 Air is enclosed in a cylinder and the piston is pushed down slowly at constant temperature until the volume is halved.

Which of the following is true?

A The average kinetic energy of the molecules is doubled.

B The average number of molecules per unit volume is halved.

C The number of collisions per unit area is doubled.

D The total force exerted by the molecules on the piston is unchanged.

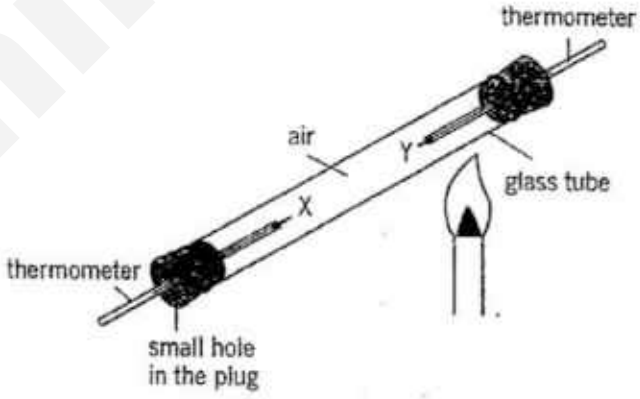
22 Which statement describes the motion and the arrangement of the molecules in a solid?

A Molecules vibrate about fixed positions within an orderly arrangement.
B Molecules vibrate about fixed positions within a random arrangement.
C Molecules move randomly within an ordered arrangement.
D Molecules move randomly within a random arrangement.

23 A match would ignite if it was held 10 cm above a bunsen flame but would not ignite if held 10 cm to one side of the flame. This is because there is more heat energy transferred by _____.

A conduction
B convection
C diffusion
D radiation

24 The diagram below shows a glass tube with two thermometers inserted at X and Y. The air in the glass tube has an initial temperature of 25 °C. The glass tube is then heated for one minute.



Which of the following shows the most likely temperatures recorded by thermometers X and Y?

	temperature at X / °C	temperature at Y / °C
A	25	25
B	25	45
C	45	35
D	45	45

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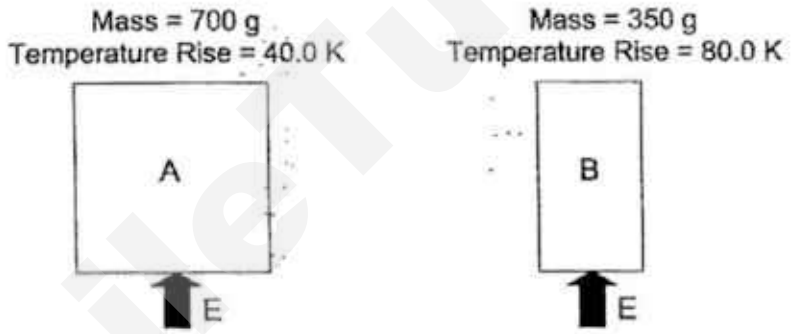
25 In which of the following is most of the heat transferred by conduction?

A keeping warm beside a fire place
B boiling of water in a kettle
C frying of an egg on a metal pan
D heating of food in a microwave oven

26 Two blocks of copper, A and B, each receives the same amount of energy E. The mass of A is twice the mass of B. The temperature rise of A is half the temperature rise of B.



Which statement about A and B is incorrect?

A The specific heat capacity of A is the same as the specific heat capacity of B.
B The heat capacity of A is the same as the heat capacity of B.
C Both A and B have the same specific latent heat of fusion.
D The heat capacity of A is twice the heat capacity of B.

27 An ice cube at a temperature of 0 °C is put into a drink at a temperature of 10 °C. After a short time during cooling, some of the ice has melted and the drink has cooled to a temperature 8 °C.

What is the temperature of the remaining ice?

A 0 °C B 2 °C C 4 °C D 8 °C

28 A small amount of alcohol and water are at the same temperature. Which of the following statement best explains why the alcohol feels cooler when placed on the hand as compared to water?

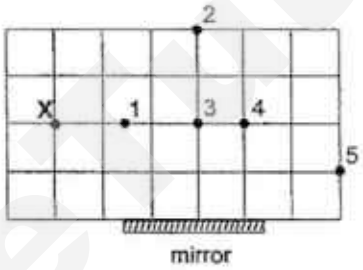
A Alcohol has a lower boiling point than water.

B Alcohol is a better conductor of heat compared to water.

C Alcohol has a higher specific latent heat of vaporisation than water.

D Alcohol evaporates more readily than water.

29 A student stands at point X as shown in the diagram below.



Which of the pins, 1, 2, 3, 4 or 5, will he be able to see in the mirror?

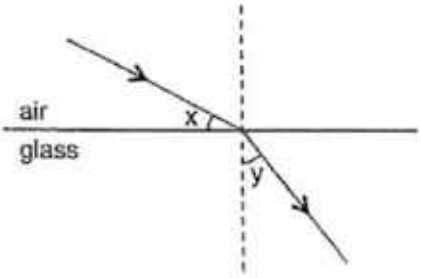
A pins 1, 2 and 3

B pins 2, 3 and 4

C pins 3, 4 and 5

D pins 2, 3, 4 and 5

30 A ray of light passes through from air to glass as shown in the following diagram below (which is not to scale).



Given that x = 20° and y = 40°, what is the refractive index of the glass?

A 0.53 B 1.46 C 1.53 D 1.87

End of paper

85

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Geylang Methodist School (Secondary)
End-Of-Year Examination 2016

Candidate Name	Solutions		
Class		Index Number	

PHYSICS **5059/02**

Paper 2 Physics **Sec 3 Express**

Additional materials : Nil **1 hour 30 minutes**

Setter : Mr Sng Peng Hock **12 Oct 2016**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section B
Answer **all** questions. Write your answers on the writing papers provided.

At the end of the examination, fasten the writing papers securely with the question paper.

Candidates are reminded that all quantitative answers should include appropriate units. You are advised to show all your working in a clear, orderly manner.

Gravitational field strength is assumed to be 10 N/kg and acceleration due to gravity, *g*, is assumed to be 10 m/s^2, unless otherwise specified.

For Examiner's Use	
Section A	/ 40
Section B	/ 30
Total	/ 70

This document consists of **11** printed pages and **1** blank page.

[Turn over

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SECTION A

Answer **ALL** questions in this section in the spaces provided.

1 A 5 kg parcel is dropped off vertically from a helicopter 600 m above the ground at time t = 0 s. After some time falling through the air, its parachute is deployed by remote control. The speed-time graph for the first 25 seconds of its journey through the air is shown in Fig. 1.1 below.

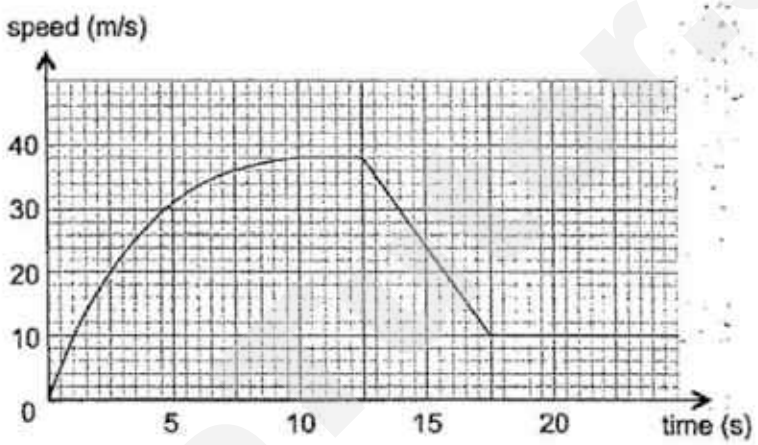

Fig. 1.1

(a) Is the object free-falling at any point during the first 25 seconds?

Explain your answer clearly with reference to Fig. 1.1 above.

No. Free falling means the only force acting on the object is its own weight. [1] The graph will show a positive constant acceleration. [1] The graph does not show any positive constant acceleration throughout the 25 s. [1]

(b) State the time at which the object first achieves terminal velocity.

At 10 s. [1]

(c) Explain, in terms of forces, how the object achieves the first terminal velocity.

As the object starts falling, it accelerates due to the gravitational force. [1] As its speed increases, air resistance acting on it in the opposite direction starts to increase. [1] When the air resistance equals the its weight in magnitude, there is zero resultant force and it falls with constant velocity. [1]

(d) Explain, in terms of forces, why the object experiences deceleration at time 12.5 s.

At 12.5 s, the parachute is deployed. [1] The increase in surface area causes the air resistance to increase and exceeds the object's weight. [1] This gives a resultant force in the upward direction, causing the object to decelerate. [1]

2 Fig. 2.1 shows a cube with sides 8 cm, made of substance X. Substance X has a density of 12.5 g/cm^3.

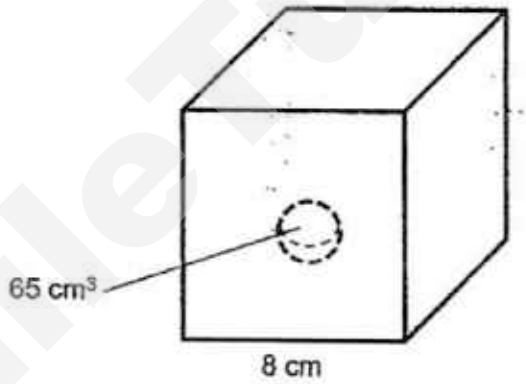

Fig. 2.1

The cube has a hollow spherical centre with a volume of 65 cm^3.

(a) Find the mass of the cube with the hollow spherical centre.

vol = 8 x 8 x 8 – 65 cm^3 = 447 cm^3 [1]

mass = 447 x 12.5 g = 5587.5 g [1]

mass = _____

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(b) The hollow spherical centre is then filled with substance Y, which has a density 5 g/cm^3.

Calculate the average density of the block with the substance Y filled in the centre.

mass of substance Y = 65 x 5 g = 325 g [1]
total mass = 5587.5 + 325 g = 5912.5 g [1]
average density = 5912.5 / 512 g/cm^3 = 11.5 g/cm^3 [1]

density = _____

3 Fig. 3.1 shows a student, of weight *W* N, standing 0.30 m from end A of a uniform plank AB.

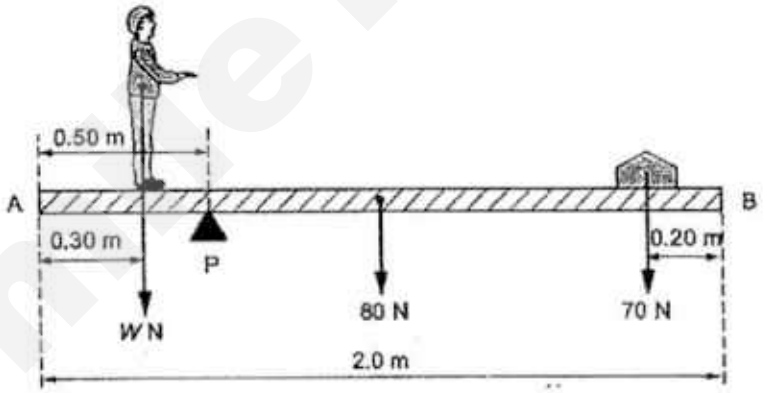


Fig. 3.1

The plank has a weight of 80 N and length 2.0 m. A pivot P supports the plank and is 0.50 m from end A. A weight of 70 N is moved to balance the weight of the student. The plank is in equilibrium when the 70 N weight is 0.20 m from end B.

Calculate the weight of the student.
Since the plank is in equilibrium, sum of clockwise moments is equal to sum of anti-clockwise moments about pivot P. [1]

80 x 0.5 + 70 x 1.3 = W x 0.2 [1]

W = 665 N [1]

weight = _____

4 Fig. 4.1 shows a conveyor belt moving boxes, each of weight 80 N. A motor is used to keep the conveyor belt moving continuously.

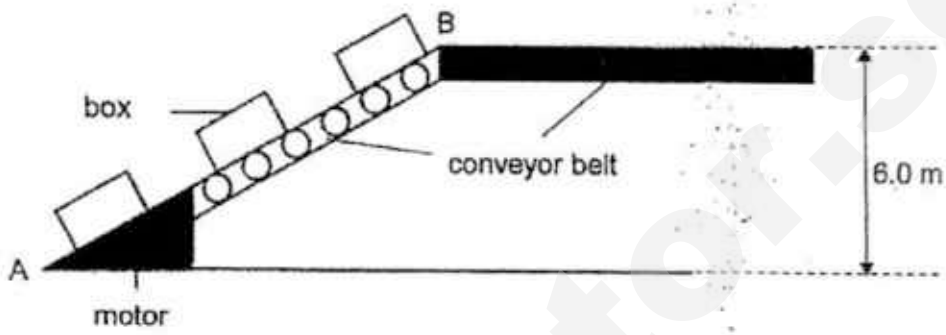


Fig. 4.1

(a) Calculate the increase in gravitational potential energy of a box when it moves from position A to position B.

gain in GPE = 80 x 6 J [1]
= 480 J [1]

gain in GPE = _____

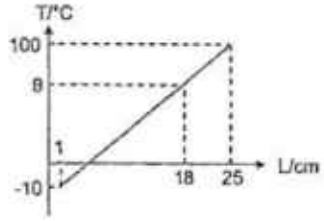
(b) The conveyor belt is able to move 4 boxes from position A to B in 1.0 minute. Determine the power output of the motor.

power = work done / time
= (480 x 4) / (1 x 60) W [1]
= 32 W [1]

power = _____

5 The stem of a thermometer is graduated in centimetres. It registers 1 cm when the bulb is -10 °C and 25 cm when the bulb is in steam at atmospheric pressure.

What is the temperature in °C when the thermometer registers 18 cm?



[100 – (-10)] / (25 – 1) = (100 - θ) / (25 – 18) [1]

θ = 67.9 °C [1]

temperature = _____

6 Fig. 6.1 below shows the arrangement of particles of a particular substance as it is cooled.

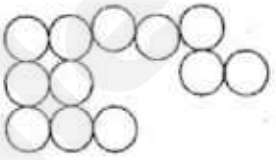
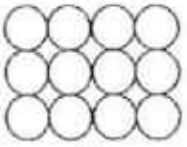
time elapsed / min	arrangement of particles	temperature / °C	state(s) of substance
0		50	All liquid
5		10	All Liquid [1]
10		10	Liquid & Solid [1]
15	 [1]	10	All solid

Fig 6.1

(a) Complete the table. [3]

(b) Name the process which is occurring from t = 5 min to t = 15 min.

Solidification [1]

(c) Explain how you arrived at your answer in part (b).

Which component of internal energy has been changing?

The arrangement of the particles is changing from random to orderly. [1]

Internal potential energy is decreasing. [1]

7 Fig. 7.1 shows a method of heating a room using solar energy instead of conventional sources of energy during cold weather in temperate countries. A brick wall with a blackened surface is placed behind a double-glazed window facing the Sun. During the day, the wall stores energy received from the Sun as thermal energy. At night, the heat from the blackened surface is transferred to the air next to it.

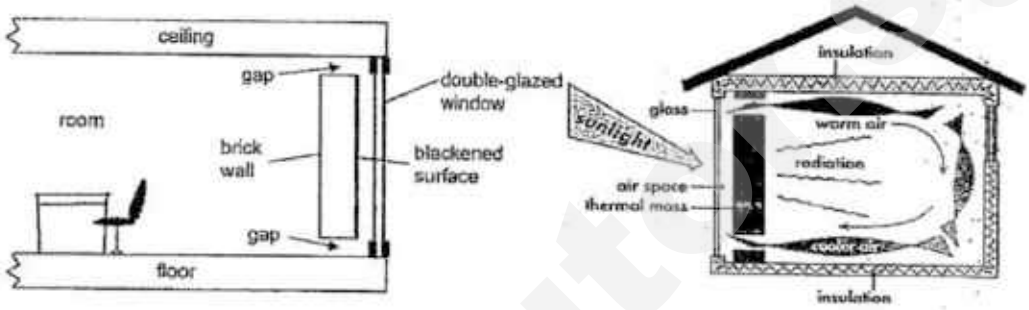


Fig 7.1

(a) Explain how the blackened surface helps to heat up the room during the night.

Black surfaces are good emitter of radiant heat. [1]

At night it will radiate heat to the room more efficiently. [1]

(b) Describe how the heated air next to the wall is transferred throughout the room during the night.

The heated air being less dense will rise and move through the top gap into the room. [1] Cooler air in the room being denser will sink and move through the bottom gap into area next to wall. [1] This sets up a convection current.

(c) The double-glazed window consists of two sheets of glass which traps a layer of air between them.

Explain how the double-glazed window helps to reduce heat loss in the room during the night.

Air between the two sheets of glass is a poor conductor of heat. [1]

This help to reduce heat loss from the room to surrounding by conduction. [1]

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8 The diagram below shows a large rectangular tank containing a transparent liquid. A plane mirror is placed along the bottom of the tank. A ray of light is incident on the surface of the liquid at an angle of 35° as shown below.

[1] correct angles, [1] correct arrows

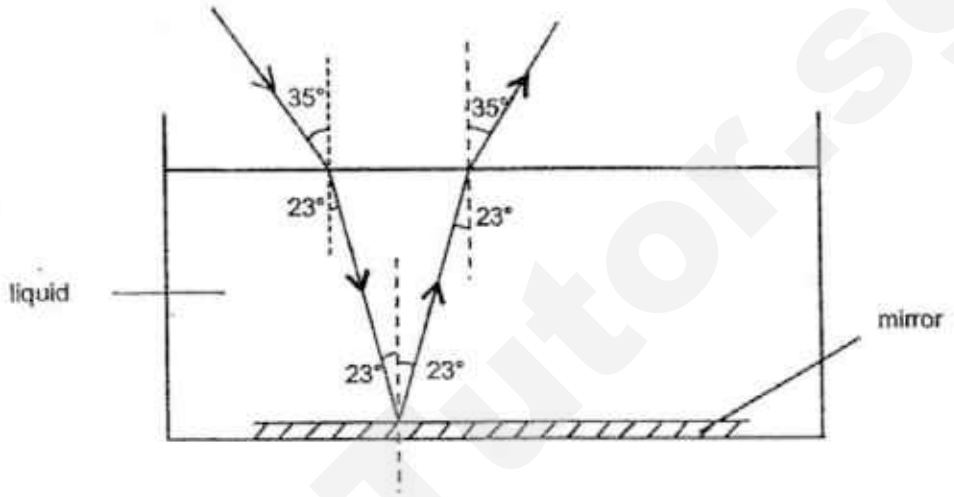


Fig 8.1

(a) If the refractive index of the liquid is 1.47, calculate the angle of refraction as the light ray enters the transparent liquid.

sini / sinr = 1.47 [1]

r = $\sin^{-1}$ (sini / 1.47) = 23.0° [1]

angle of reflection = _____

(b) Complete the diagram above to show the path of the ray of light until it emerges from the surface. Indicate all the angles with their respective normals. (You need not measure the angles to scale). [2]

End of Section A

SECTION B

Answer **all** the questions in this section

Write your answers on the writing papers provided.

9 Fig. 9.1 shows a helicopter with a mass of 1000 kg. The rotation of the blades can produce a maximum upward force of 18 kN.

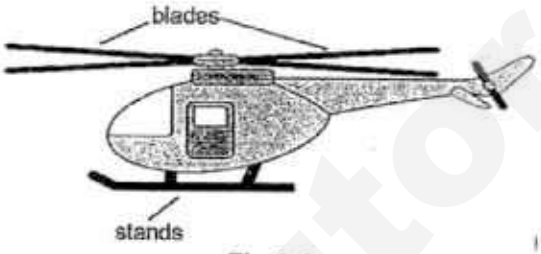


Fig 9.1

(a) The helicopter is stationary with its stands resting on the ground. The weight of the helicopter is one of the two forces that form an action-reaction pair of forces.

Describe the other force of this action-reaction pair.

The other force is the attractive force[1] the helicopter exerts on the Earth. [1]

(b) Explain using Newton's third Law, how the helicopter produces an upward force.

The blades pushes air down, and based on Newton's third Law, the air will exert an equal force on the blades upwards. [1] This force gives the helicopter an upward force since the blades are attached to the helicopter. [1]

(c) The pilot flying the helicopter has a mass of 80 kg.

(i) What is the minimum upward force the helicopter must produce in order to lift off?

force = 1080 X 10 = 10800 N [1]

(ii) What is the highest possible upward acceleration using the maximum upward force?

F_{net} = 18000 – 10800 = 7200 N [1]

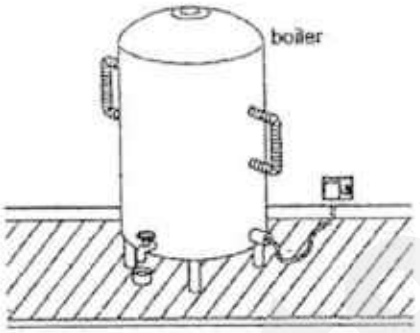
a = 7200 / 1080 = 6.67 m/s^2 [1]

(d) After applying the maximum upward force for 10 s, the helicopter is in the air. The pilot then decides to hover the helicopter at a fixed height.

Using Newton's first Law, explain how this can be achieved.

Based on Newton's first Law, there should be no resultant vertical force acting on the helicopter in order for it to stay at a fixed height. [1] The pilot need to reduce the upward force [1] until the upward force balances the weight / is 10800N. [1]

10 Fig.10.1 below shows an electric boiler in a kitchen.



The boiler contains 35 kg of water at 28 °C.
The specific heat capacity of water is 4200 J/(kg °C).
The specific latent heat of vaporization of water is 2.26 MJ/kg.

(a) Calculate the thermal energy needed to raise the temperature of the water from 28 °C to its boiling point.
$Q = mc\Delta\theta = 35 \times 4200 \times (100 - 28)$ [1]
$= 10584000$ J [1]

(b) The water in the boiler is heated by a 7200 W immersion heater.

Calculate the minimum time required for the heater to bring the water to its boiling point.
time = 1058400 / 7200 [1]
= 1470 s = 24.5 min [1]

(c) Suggest one reason why the actual time is greater than the minimum time calculated in **(b)**.
Heat is lost to the surrounding. [1]

(d) Due to a fault in the thermostat setting, the heater is not deactivated when the water reaches its boiling point and steam is produced.
Calculate the mass of the water left in the boiler 5 minutes after steam is first produced.

$Q = 5 \times 60 \times 7200 = 2160000$ J [1]
$m = Q / l_v = 2160000 / 2.26 \times 10^6$ [1]
$= 0.956$ kg [1]
mass of water left = 35 – 0.956 = 34.0 kg (3sf) [1]

(e) Suggest a mechanical safety feature that would prevent any danger created by the fault in **(d)**.

A release valve is needed to prevent pressure build up in the boiler when steam is produced. [1]

11 A light ray is incident upon a triangular glass block with a speed of 3×10^8 m/s as shown in the Fig 11.1 below (not to scale). It was found that the speed of light in the glass block is two-third that of the speed of light in air.

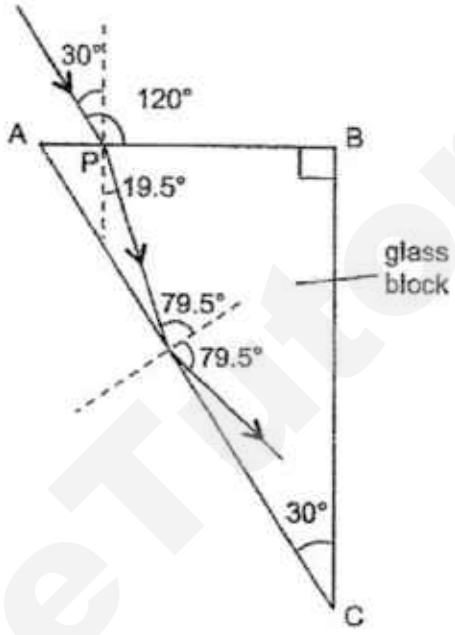


Fig 11.1

[1] each arrow [1] for correct angles

(a) Explain what will happen to the light ray as it enters the glass block.
Refraction will take place and the light ray will bend towards the normal. [1]
This happens because the speed of light in the glass block is lower than that in air. [1]

(b) Determine the refractive index, n, of the glass block. Hence, find the angle of refraction of the light ray after passing through point P.
speed of light in the glass block is 2/3 of c,
using $n = c / v$ [1]
$n = 1.5$ [1]
$n = \sin i / \sin r$
$1.5 = \sin 30 / \sin r$ [1]
$r = \sin^{-1} (\sin 30 / 1.5) = 19.5°$ [1]

(c) Calculate the critical angle of the glass block.
$n = 1 / (\sin c)$
$c = \sin^{-1} (1/1.5) = 41.8°$ [1]

(d) Complete the path of the light ray from point P in Fig 11.1 and show what happens on the side AC. Indicate all angles and normal clearly. [3]

END OF PAPER

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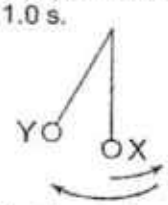
Section A Multiple Choice Questions (35 marks)
Answer **all** the questions in this section on the Multiple Choice Answer Sheet provided.

1. A pendulum started swinging from position X at time $t = 0$ s.
The period of the pendulum is 1.0 s.



A stopwatch is used to record the time t when it starts swinging from position X to position Y. Which of the following is most likely to be the time t?

A 0.5 s B 0.75 s C 1.5 s D 3.0 s

2. Which pair of units both measure the same quantity?

A N and kg.m/s^2
B g/cm^3 and Pa
C m/s and N.m
D W and J

3. Vernier calipers are used to measure the diameter of a ball-bearing.

Diagram 1 shows the calipers when the jaws are closed.
Diagram 2 shows the calipers when the ball-bearing is between the jaws.

diagram 1

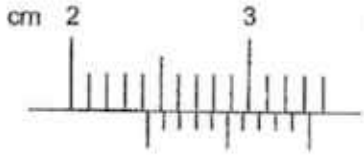
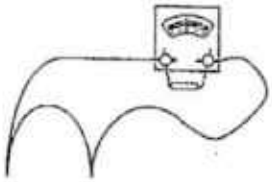


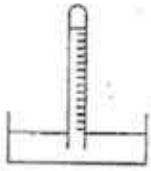
diagram 2

What is the diameter of the ball-bearing?

A 2.31 cm
B 2.41 cm
C 2.43 cm
D 2.45 cm

4. How many of the following instrument(s) measure vector quantities?

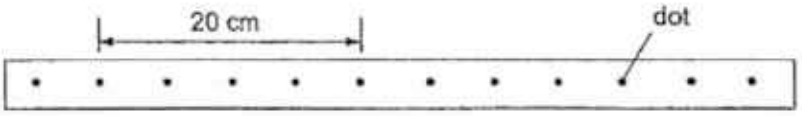




A 1 B 2 C 3 D 4

2 92

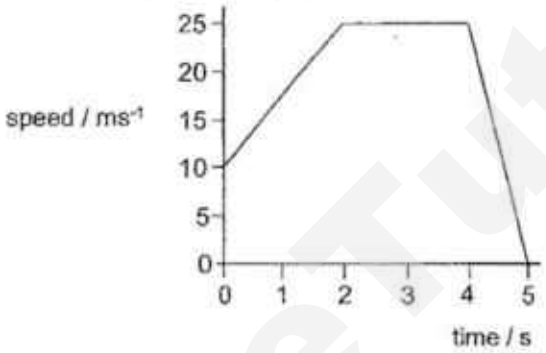
5. A strip of paper tape is pulled at constant speed under a vibrating arm. The arm vibrates regularly, making 50 dots per second.



What is the speed of the tape?

A 0.4 cm/s B 100 cm/s C 200 cm/s D 250 cm/s

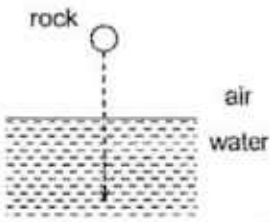
6. The diagram below is a speed-time graph of a car.



What is the acceleration of the car?

A 0 ms^{-2} B 5 ms^{-2} C 7.5 ms^{-2} D 12.5 ms^{-2}

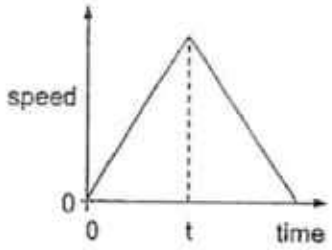
7. A rock is released from air and falls through water.



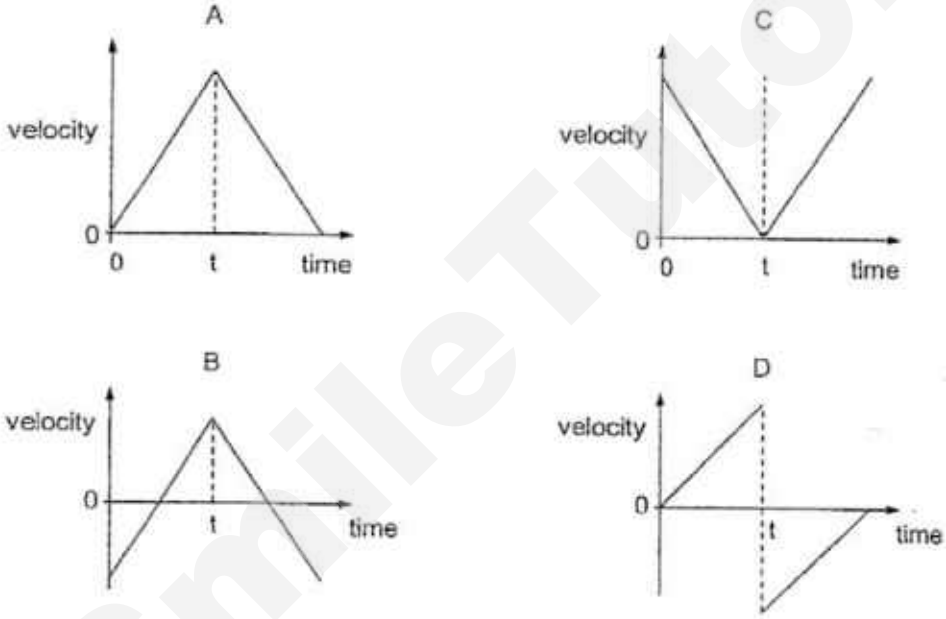
Which row shows the change in acceleration and velocity of the rock immediately after it enters the water?

	acceleration	velocity
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

8. A ball is released at a height and hits the ground at time *t*. The ball then bounces up. The diagram below is a speed-time graph of the ball.

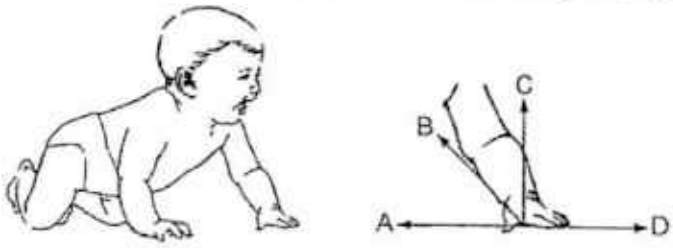


Which of the following is the correct velocity-time graph of the ball?



9. A baby uses his hands to crawl forward.

Which arrow indicates the direction of the force of friction acting on one of his hand?



10. At lift off, the mass of a small water rocket is 2.5 kg. The rocket experiences an upward thrust of 45 N. The gravitational field strength *g* is 10 N/kg.

Which is the initial acceleration of the rocket?

A 0.055 ms^{-2} B 8 ms^{-2} C 10 ms^{-2} D 18 ms^{-2}

11. A parachutist jumps off a plane and falls towards the ground.

At this moment, which statement about the forces acting on him is correct?

A There are no forces acting on the parachutist.
B The upward force on the parachutist is equal to the weight of the parachutist.
C The upward force on the parachutist is lesser than the weight of the parachutist.
D The upward force on the parachutist is more than the weight of the parachutist.

12. When an aeroplane lands, it requires to travel some distance before coming to a stop.

Which property of the aeroplane causes this requirement?

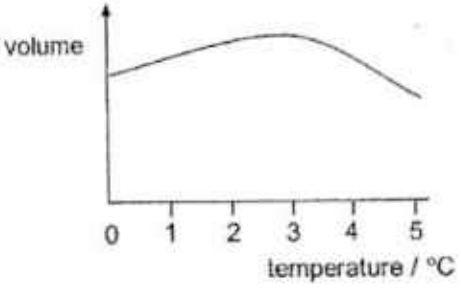
A density
B mass
C pressure
D weight

13. A doughnut and bun, of the same thickness and diameter are made from the same dough.

Compared to the bun, the doughnut has

A the same density but lesser volume and mass.
B the same mass but lesser density and volume.
C the same volume but lesser density and mass.
D lesser mass, volume and density.

14. The graph shows the variation of volume with temperature for a fixed mass of solid.



From the graph, it can be seen that the density of the solid reaches

A a minimum value at 3 °C.
B a minimum value at 5 °C.
C a maximum value at 0 °C.
D a maximum value at 3 °C.

15. A deep ocean vessel of weight 7.00×10^4 N at the surface of the ocean descends to the bottom of the ocean. The gravitational field strength changes from 9.81 N/kg at the surface to 9.85 N/kg at the bottom.

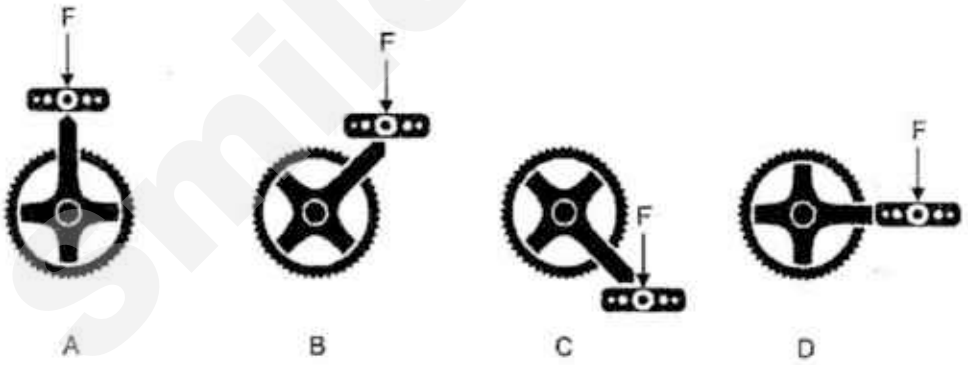
Which are the mass and the weight of the vessel at the bottom of the ocean?

	mass at the bottom / kg	weight at the bottom / N
A	7.11×10^3	7.00×10^4
B	7.11×10^3	7.03×10^4
C	7.14×10^3	7.00×10^4
D	7.14×10^3	7.03×10^4

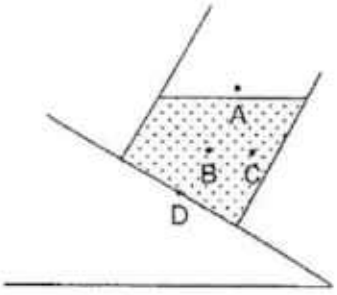
16. Which statement about gravitational fields is **not** true?

A Gravitational fields cause forces on objects because they have mass.
B Only planets and stars have gravitational fields.
C The gravitational field of the Earth acts inwards towards the centre of the Earth.
D The gravitational field strength on the Earth is more than on Moon because the Earth has a larger mass than the Moon.

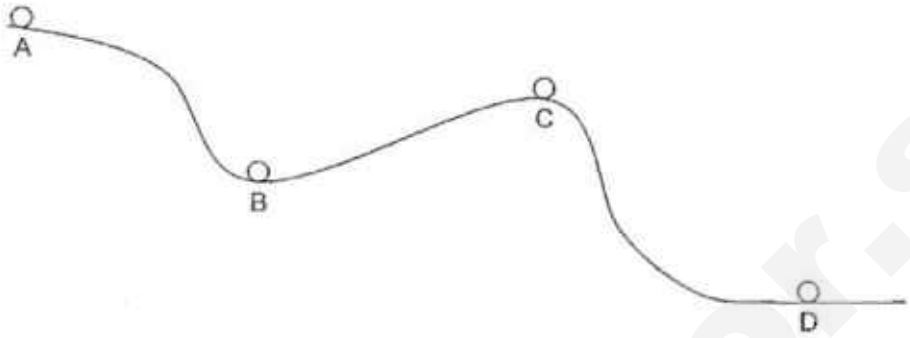
17. The same amount of force is exerted on a bicycle pedal at four different positions. At which position is the force exerting the most turning effect on the pedal?



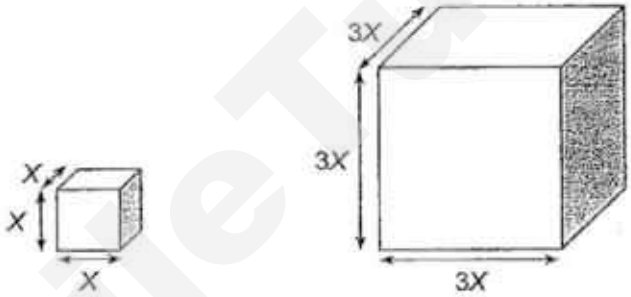
18. A container filled with water is resting on an inclined plane. Where is most likely to be the centre of gravity of the container?



19. Four balls are placed along a track.
Which ball is at stable equilibrium?



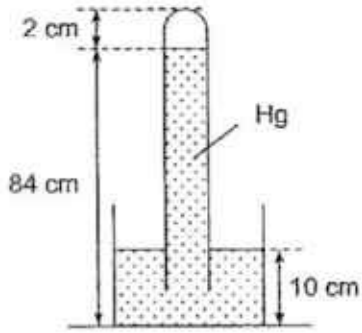
20. A cube of sides X cm each exerts a pressure P on a surface due to its weight.
A larger cube, made of same material, has sides $3X$ cm.



What is the pressure exerted on the surface by larger cube?

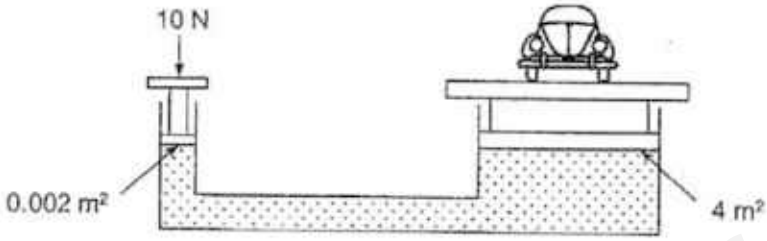
A $\frac{1}{3}P$ B P C $3P$ D $27P$

21. What is the atmospheric pressure measured by the barometer?



A 74 cm Hg B 76 cm Hg C 84 cm Hg D 86 cm Hg

22. A hydraulic press is used to support the weight of a car by applying a 10 N on a 0.002 m^2 piston.



What is the weight of the car?

A 200 N B 2000 N C 20,000 N D 200,000 N

23. A bulb is being powered by a battery.
What is the energy conversion in the bulb?

A chemical potential energy to light and thermal energy
B chemical potential energy to electrical energy
C electrical energy to light and thermal energy
D electrical energy to chemical potential and light energy

24. Which of the following does **not** use kinetic energy to generate electricity?

A hydroelectric dam
B solar panel
C tidal wave turbine
D wind turbine

25. Which of the following is an example where no net work is done?

A A car moving at constant speed in a straight line.
B A man doing push-ups.
C A crane lifting a load.
D A bird lifting off from a tree branch.

26. In a Brownian motion experiment, specks of light are observed and seen to move around randomly.
Which of the following best explains the observation?

A The specks of light are dust particles which are moving randomly on their own.
B The specks of light are air particles which are moving randomly.
C The specks of light are dust particles which absorb the light to move around.
D The specks of light are dust particles which are collided by unseen air particles continuously.

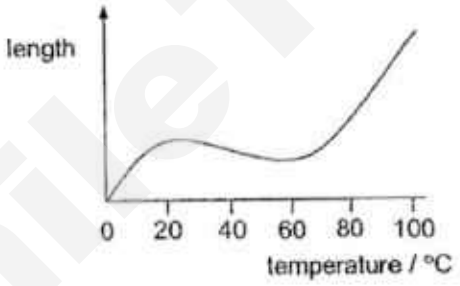
27. Which of the following is **not** suitable as a thermometric property?

A volume of a liquid of fixed density
B pressure of a gas of fixed volume
C resistance of a metal
D e.m.f. across two electrical junctions formed by two different metals

28. A thermometer is used to measure the temperature of a beaker of water which is heated from 30 °C to 100 °C.
What is the final temperature and temperature change in Kelvins?

	final temperature / K	temperature change / K
A	100	70
B	273	343
C	373	70
D	373	343

29. The diagram below shows how the length of an unknown liquid changes with temperature.



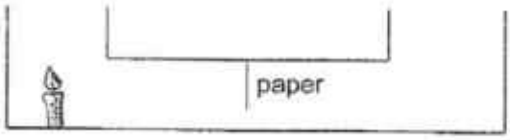
Which temperature range will the length of the liquid be suitable as a thermometric property?

A 0 °C to 40 °C
B 0 °C to 100 °C
C 40 °C to 80 °C
D 80 °C to 100 °C

30. An astronaut suit is white on the outside. This helps the astronaut to maintain his body temperature when the astronaut is exposed directly to the sun.
Which of the following best explains how the suit works?

A White is a poor absorber so the astronaut gains heat slowly.
B White is a poor radiator so the astronaut loses heat slowly.
C White is a good absorber so the astronaut gains heat slowly.
D White is a good radiator so the astronaut loses heat slowly.

31. A chamber with two open ends contains a lit candle and a thin piece of paper suspended in the middle.



After some time, the air in the chamber moves and the paper starts to sway.
Which of the following explains how the paper would sway?

A The paper will sway away from the candle as it heats up.
B The paper will sway away from the candle as air near the candle sinks.
C The paper will sway towards the candle as air near the candle rises.
D The paper will sway to and fro as it continuously heats and cools down.

32. Four bars, all of different masses, are each placed with one end in boiling water.
The times taken for the temperature of the other end to increase by 5 °C are measured.

Which bar has the highest heat capacity?

	mass / kg	time / s
A	2	40
B	4	30
C	5	20
D	10	10

33. Which of the following decreases when a liquid is being cooled above melting point?

A the average kinetic energy of the molecules
B the molecular size
C the molecular mass
D the total number of molecules

34. Which statement describes the boiling of water?

A It occurs at a fixed temperature and only on the surface.
B It occurs at a fixed temperature and throughout the liquid.
C It occurs at any temperature and only on the surface.
D It occurs at any temperature and throughout the liquid.

35. The energy released when steam changes into water at the same temperature is called latent heat of condensation.
What happens when this energy is released?

A Separate water atoms combine into molecules.
B The speed of the water molecules decreases.
C The temperature of the water molecules decreases.
D The water molecules become closer to one another.

Section B (35 marks)
Answer **all** the questions in this section in the spaces provided.

1 A motorised gear is used to run a conveyor belt as shown in Fig. 1.1.

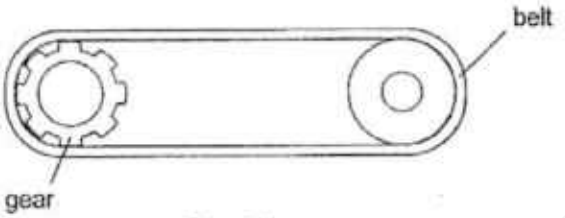


Fig. 1.1

Whenever the gear rotates 360°, it makes a click sound and the gear completes one revolution.

(a) An accurate value for the average time for one complete revolution is obtained.

Describe what measurements are taken and how they are used to find the average time for one complete revolution.

_____

_____

_____

_____

_____ [3]

(b) A student calculates the average power of the gear.

(i) Apart from the measurement in **(a)** and distance travelled for one revolution, state the other measurement that is needed.

_____ [1]

(ii) State, **in words**, the equation needed to calculate the average power of the gear.

_____

_____

_____ [2]

(c) The gear rotates at a fixed rate which is very fast. Thus it is not accurate to measure the distance travelled by the belt directly. Suggest a more accurate method to determine the distance travelled.

_____

_____ [1]

2 In space, a rock moves in a straight line at constant speed. However, the motion of the rock changes as it approaches Earth as shown in Fig. 2.1.

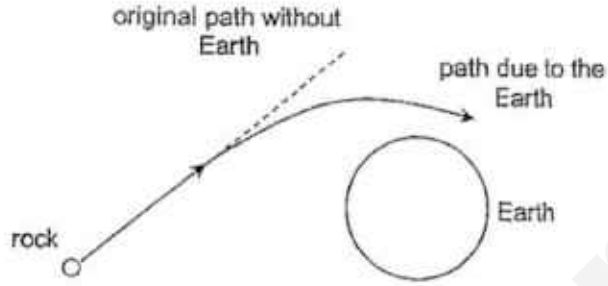


Fig. 2.1 (not to scale)

(a) The gravitational field strength of Earth causes the motion of the rock to change.

(i) State what is meant by the ***gravitational field strength*** of Earth.

_____

_____ [1]

(ii) Describe, in terms of forces, how the gravitational field strength of Earth cause the motion of the rock to change.

_____

_____ [1]

(iii) As the rock approaches Earth, it enters the atmosphere. The rock experiences the effects of air resistance and no longer gains speed.

State the energy change that occurs and explain, using ideas about conservation of energy, why the rock no longer gains speed as it falls through the atmosphere.

_____

_____

_____ [2]

(b) The rock eventually landed on Earth and found to be spherical in shape. Its mass and diameter are measured to be 0.5 kg and 4.95 cm respectively.

(i) Calculate the density of the rock. Give your answer in g/cm^3.
(Volume of a sphere = 4/3 πr^3)

density = _____ g/cm^3 [2]

(ii) The mass of pure iron of the same volume as the rock is 0.495 kg.
State and explain whether the rock is made of pure iron.

_____

_____

_____ [1]

3 A 50 N cat sits in the middle of a 2 m plank supported by two pivots A and B as shown in Fig. 3.1. The plank is of negligible weight.

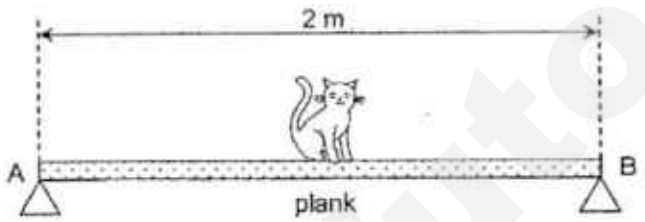


Fig. 3.1 (not to scale)

(a) (i) Determine the moment acting on the bridge by the weight of the cat about the pivot A. Also, indicate the direction of this moment.

moment = _____ N.m [2]

direction of moment = _____ [1]

(ii) There is an upward force acting on the bridge by pivot B.
Determine this force and state any law or principle you used.

upward force = _____ N [2]

(b) The cat then walks along the plank towards pivot B.
Explain the change, if any, to the force calculated in (a)(ii).

_____

_____

_____ [2]

4 A car has four tyres which support the weight of the body. One tyre of the car is as shown in Fig. 4.1.

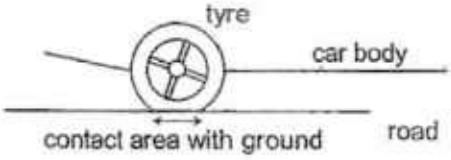


Fig. 4.1

Fig. 4.2 shows the contact area of one tyre with the ground at different air pressure inside the tyre.

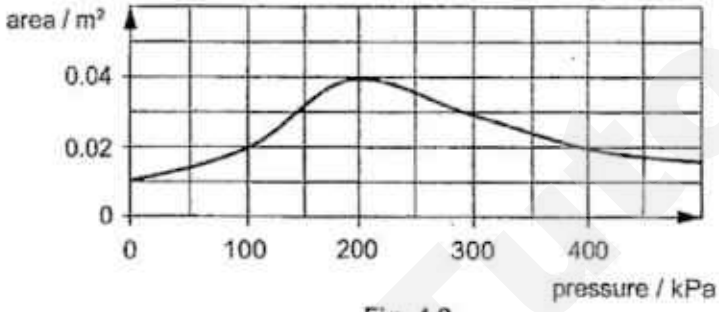


Fig. 4.2

(a) (i) On a particular day, all four tyres of the car are each inflated with an air pressure of 200 kPa. Determine the weight of the car.

weight = _____ N [2]

(ii) The contact area of the tyres has found to decrease after the car travelled a long distance. Suggest a possible reason for this.

_____

_____

_____ [1]

(b) A manometer filled with mercury is used to measure the pressure of one tyre when the contact area of that tyre is 0.02 m² as shown in Fig. 4.3.

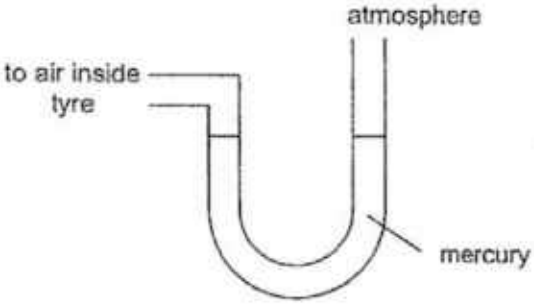


Fig. 4.3

Some air is released from the tyre.
The air pressure inside the tyre now becomes 98,640 Pa.

(i) Using Fig. 4.2 and 4.3, state the atmospheric pressure.

atmospheric pressure = _____ Pa [1]

(ii) Determine the height difference in the mercury levels in both arms.
The density of mercury is 13,600 kg/m^3.

height difference = _____ cm [2]

(iii) On Fig. 4.4 below, draw (to scale) the mercury levels in both arms.

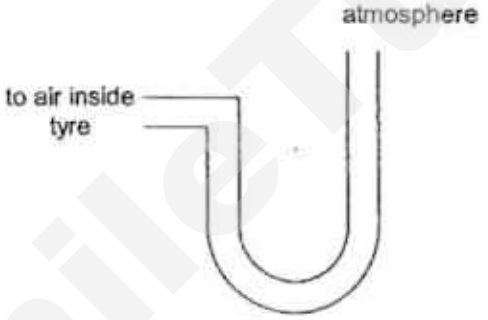


Fig. 4.4 [1]

5 A game at a fun fair requires the participant to use a hammer to exert a force on a lever to elevate a mass vertically, in order to hit the bell as shown below in Fig. 5.1a. The mass is 10.0 kg and the bell is 4.0 m above the mass.

Fig. 5.1b shows the enlarged view of the lever.

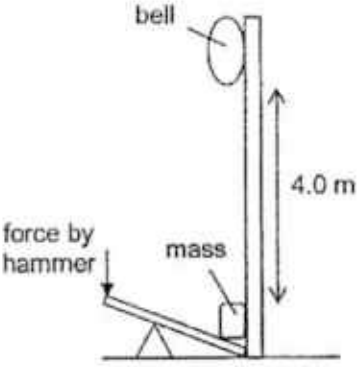


Fig. 5.1a (not to scale)

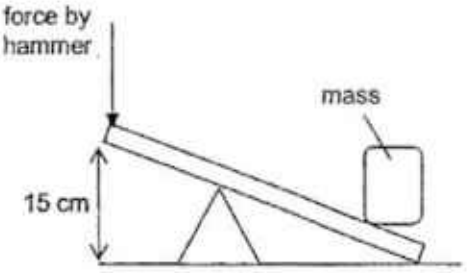


Fig. 5.1b (not to scale)

A man uses the hammer to exert a force of 3000 N on the edge of the lever and the mass start to rise vertically.

(a) (i) Determine the work done by the man on the lever.

work done = _____ J [1]

(ii) State the amount of energy gained by the mass when the hammer just struck the lever.

energy gained = _____ J [1]

(b) (i) The mass rises and hits the bell.
Determine the amount of kinetic energy that the mass has just before hitting the bell. State any principle used in your calculation.

kinetic energy = _____ J [3]

(ii) After hitting the bell, the mass is instantaneously at rest. It then falls back to the lever.
Determine the falling speed of the mass just before reaching the lever.

speed = _____ ms^{-1} [2]

Section C (30 marks)
Answer **all** the questions in this section in the spaces provided.
Answer only one of the two alternative questions in **Question 8**.

6 Two identical chambers are filled with unknown gases X and Y as shown in Fig. 6.1a and Fig. 6.1b. The chambers are supporting identical weights through movable pistons.

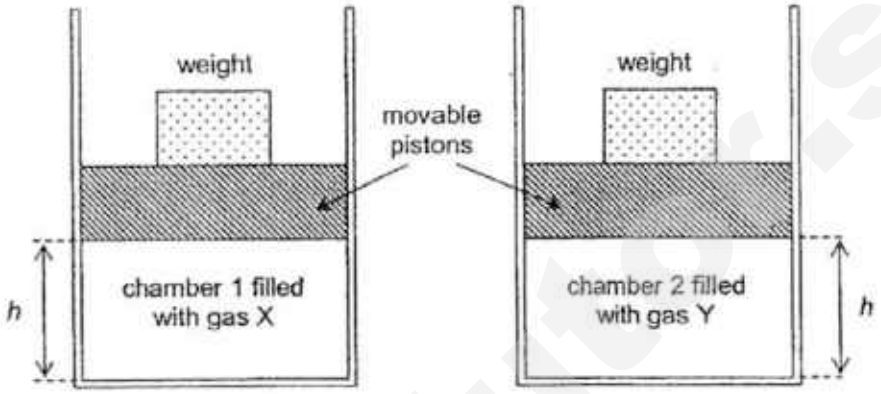


Fig. 6.1a (not to scale) **Fig. 6.1b** (not to scale)

Gas X has a higher relative molecular mass than gas Y.

(a) The temperatures of the chambers are slowly increased.
The height of the piston of each chamber *h* is measured at various temperatures.
Fig. 6.2 shows the readings obtained.

temperature / °C	h / cm	
	chamber 1	chamber 2
0	0.5	0.5
100	1.0	1.5
200	1.5	2.5
300	2.0	3.5
400	2.7	4.7
500	3.6	6.0
600	4.3	6.0
700	4.3	6.0

Fig. 6.2

(i) Using data from Fig. 6.2, describe the relationship between the temperature and the height of the piston of chamber 1.

1. for 0 °C to 300 °C, _____

_____

2. for 400 °C to 700 °C. _____

_____ [2]

(ii) The data in Fig 6.2 provides some evidence of a relationship between the relative molecular mass of the gas and the maximum pressure exerted by the gas. State this possible relationship.

_____

_____ [1]

(iii) At the same temperature (except for 0°C), in terms of kinetic model of matter, explain why the pressure exerted by each gas is different.

_____

_____

_____ [2]

(b) The experiment is repeated with smaller chambers filled with the same amount of gases. Fig. 6.3 shows the new readings obtained at low temperatures.

temperature / °C	*h* / cm	
	chamber 1	chamber 2
0	0.7	0.6
100	1.3	1.8

Fig. 6.3

(i) Explain why the values of *h* at the same temperature are higher in Fig 6.3 than in Fig 6.2.

_____

_____

_____

_____ [2]

(ii) Suggest one other difference that is seen when the readings at values of temperature greater than 100°C are compared to those in Fig. 6.2.

_____

_____ [1]

(c) Explain how the extremely small particles of the gases in the chambers are able to support the weights.

_____

_____

_____ [2]

7 For an event during the National Day Parade, a helicopter flies past near the stadium with a flag attached via a cable as shown in Fig. 7.1. The helicopter and the flag move in a straight line at a constant altitude with a constant speed of 240 km/h.

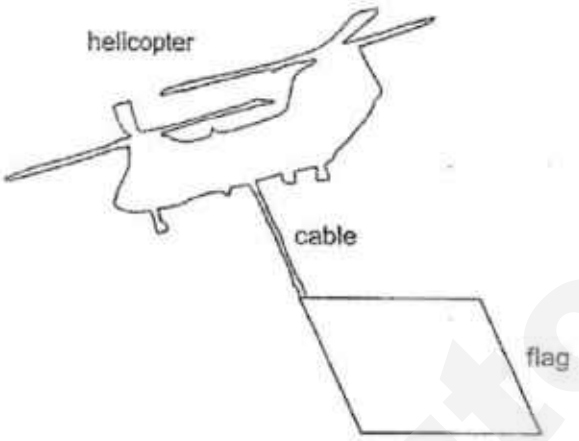


Fig. 7.1

(a) One force, the tension on the flag by the cable, is shown on Fig. 7.2.
The tension is 40,000 N and is 115° from the horizontal.
(The diagram is **not** drawn to scale.)

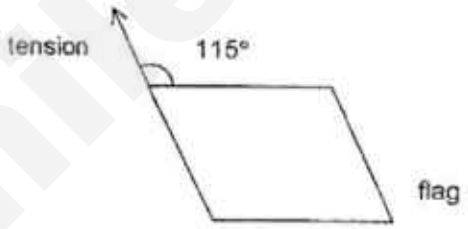


Fig. 7.2

(i) On Fig. 7.2, draw and label two other forces acting on the flag. [2]

(ii) By considering the forces on the flag, explain why the speed of the flag remains constant.

_____

_____

_____

_____ [2]

(iii) In the space below, by means of a scale diagram, determine the magnitude of the two other forces you have drawn in (i).

The magnitudes of the forces are _____ N and _____ N. [4]

(b) Describe the force that is the part of the action-reaction pair with the tension on the flag by the cable, and state the body on which it acts.

_____

_____ [2]

8 Either

A metallic metre rule is held firmly at the 0 cm mark by a metal clamp while the 95 cm mark is being heated constantly as shown in Fig. 8.1. The temperature of the rule is measured at various positions along the rule.

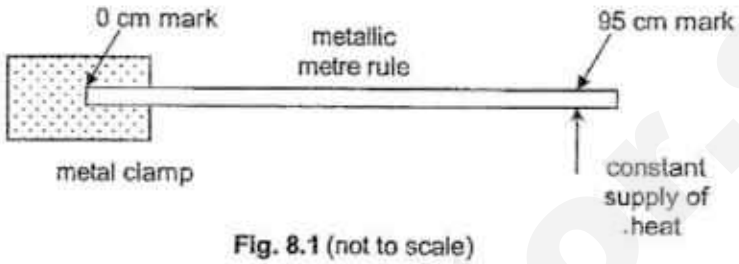


Fig. 8.1 (not to scale)

Fig. 8.2 shows the temperature-position graph of the metre rule with four main points plotted.

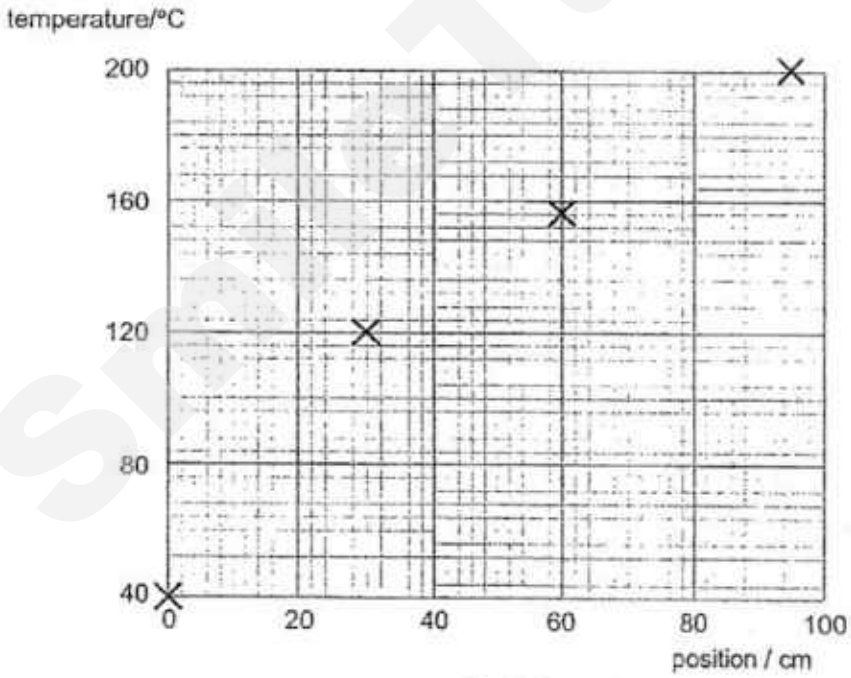


Fig. 8.2

(a) (i) On Fig. 8.2, draw a line to complete the temperature-position graph for position = 0 cm to position = 95 cm. The line passes through all four points. [2]

(ii) State the mode(s) that thermal energy is lost to the surroundings at the 50 cm mark.

_____ [1]

_____

(iii) The rate of heat lost at 0 cm is much greater than that at 50 cm mark. Suggest a possible reason.

_____

_____

_____ [2]

(b) The metre rule is then removed and immersed completely into a pail of water to cool down.

A student then collects the following data to estimate the final temperature of the water as shown in Fig. 8.3.

time taken for temperature of metre rule to become constant	2 minutes
rate of heat lost by metre rule	3500 J/s
heat capacity of the metre rule	900 J/°C

initial temperature of water	30 °C
specific heat capacity of water	4200 J/(kg °C)
mass of water in pail	25 kg

Fig. 8.3

(i) Determine the final temperature of the water.

final temperature = _____ °C [3]

(ii) Explain if the actual final temperature of the water will be higher or lower than the value calculated in (b)(i).

_____

_____

_____ [2]

8 OR

A car slows down as it approaches a traffic light as shown in Fig. 8.4.
The values of the time t when the car passes points A, B, C and D are marked on Fig. 8.4.

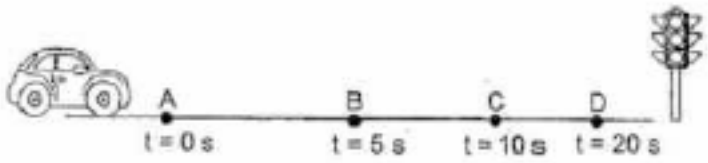


Fig. 8.4 (not to scale)

Fig. 8.5 shows the velocity-time graph of the motion with four main points plotted.

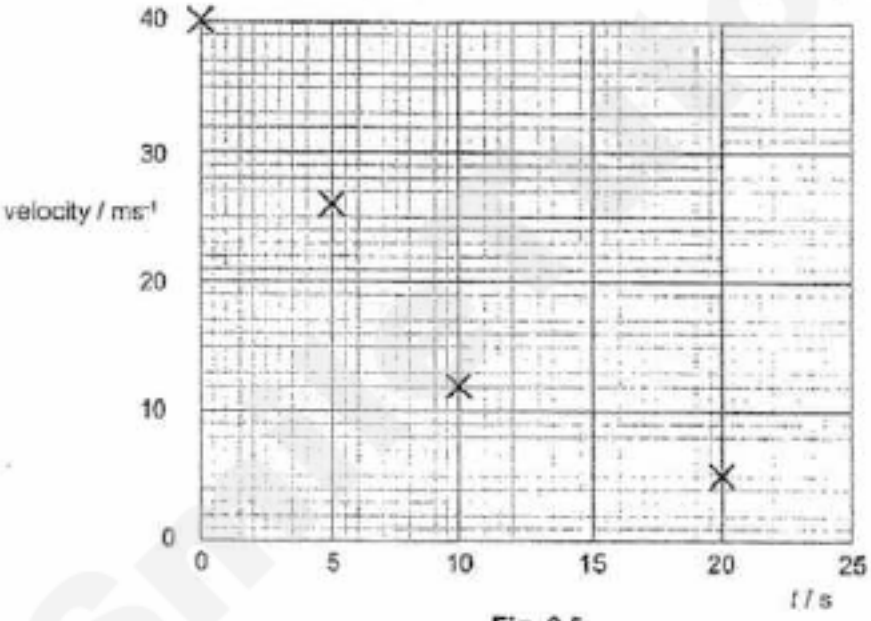


Fig. 8.5

Between A and C there is uniform deceleration. After D, the velocity of the car is constant.

(a) On Fig. 8.5, draw a line to complete the velocity-time graph from $t = 0$ s to $t = 25$ s. [1]

(b) Calculate the average distance between

(i) points A and B,

average distance = _____ m [2]

(ii) points B and C.

average distance = _____ m [1]

(c) The distance between A and D is 350 m. The displacement of the car is zero at point A.

(i) On Fig. 8.6, draw a displacement-time graph for the motion. [1]

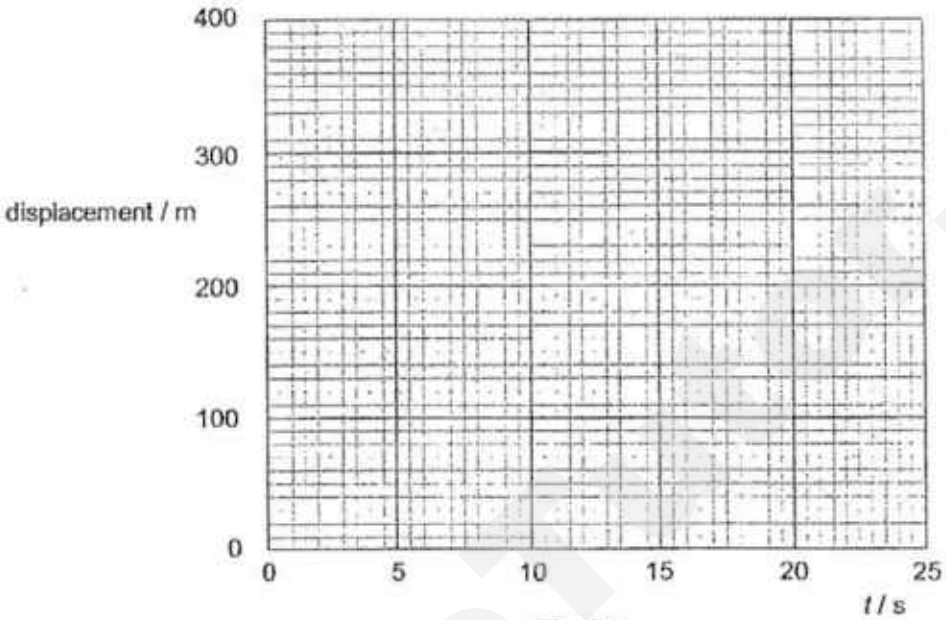


Fig. 8.6

(ii) Explain how your displacement-time graph shows that there is deceleration before D.

_____

_____

_____ [2]

(d) The distance between A and the traffic light is 400 m.

(i) Determine the time t where the car will reach the traffic light.

time t = _____ s [2]

(ii) Hence, or otherwise, determine the average speed of the car from A to the traffic light.

average speed = _____ m/s [1]

End of Paper

Marking Scheme for EOY 2016 Sec 3E Physics

Section A (30 **marks)**

Paper 1	Solution	Answer
1.	1 complete oscillation would be from X to Y and back to X. The number of oscillation in the question is ¾.	B
2.	F = m a [N] = [kg][ms^{-2}]	A
3.	Zero error = – 0.02 cm Measurement = 2.43 cm Diameter = 2.43 – (– 0.02) = 2.45 cm	D
4.	Only the spring balance/force meter measures a vector (force). Stopwatch (time) Thermocouple (temperature) Barometer (pressure)	A
5.	time taken for 1 spacing = 1/50 time taken for 4 spacings = 4/50 speed = dist/time = 20/(4/50) = 250 cm/s	D
6.	Acceleration = +ve grad. of s-t graph = (25 – 10) / (2 – 0) = 7.5 ms^{-2}	C
7.	In water, the resistive force is higher thus the acceleration will decrease. However it is still an acceleration, not deceleration. Thus the velocity will still increase but lesser.	B
8.	After time t, the ball is moving in the opposite direction with maximum speed decreasing to zero.	D
9.	For baby to crawl forward, his hands must be pulling (backwards) the ground. Thus the friction will be in the opposite direction.	D
10.	net F = m a upward F – W = m a 45 – 2.5(10) = 2.5 x a a = 8 ms^{-2} (most student will forget about the weight -> 18 ms^{-2})	B
11.	The parachutist has just started falling so he could not have reached terminal velocity.	C
12.	Inertia (dependent on mass) is the property that causes an object to be reluctant to change its state of motion.	B
13.	Both objects are made of same material so the densities would be the same.	A
14.	Density is inversely proportional to volume, more volume, less dense. At 3 °C, the volume is at maximum thus the density is at minimum.	A
15.	Mass = W / g = 7.00 x 10^4 / 9.81 = 7.14 x 10^3 kg (remains constant) At the bottom, W = m g = 7.14 x 10^3 x 9.85 = 7.03 x 10^4 N	D
16.	Any object with mass will have a gravitational field.	B
17.	For the most turning effect with the same applied force, the perpendicular distance from the pivot must be the longest.	D
18.	Since the container is not toppling, the weight has to be causing an anti-clockwise moment. The C.G. should be around the centre of the water since it has more mass than the container.	B
19.	For stable equilibrium, the ball would return to its original position when slightly displaced.	B
20.	Big cube can be made up of 27 small cubes P = F / A = 27 / (3 x 3) = 3 *P* OR, there are 3 small cubes stacked up for every X^2 of the big cube.	C

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21.	Patm = level of Hg above the level of Hg in the basin = 84 – 10 = 74 cm Hg	A
22.	$P_1/A_1 = P_2/A_2$ 10/0.002 = W/4 W = 20,000 N	C
23.	Main function of bulb is to convert electrical energy to thermal energy and light energy.	C
24.	All turbines (including hydroelectric dam) uses kinetic energy as input.	B
25.	Work is done only if there is a change in state of motion (or acceleration)	A
26.	Recall, KMT.	D
27.	The liquid should have fixed mass, not density as both volume and mass will need to change with temperature so that the density will remain constant.	A
28.	Final temperature = 100 + 273 = 373 K Change in temperature = 373 – 303 = 70 K	C
29.	The change in length has to be linear (straight line) in order for the change in length to be appropriate as a thermometric property.	D
30.	Heat transfer is from Sun to astronaut. Thus the white serves to prevent this heat transfer from Sun to astronaut.	A
31.	Air near the lit candle becomes heated, less dense and rise. So cool air from the right opening will flow in and cause the air in the chamber to move from right to left.	C
32.	$Q = C\Delta\theta$ $Pt = C\Delta\theta$ $C = Pt/\Delta\theta$ The one that takes the longest will have the highest heat capacity regardless of the mass. OR the one that is the most difficult to heat up.	A
33.	No change in state, thus only speed and spacing (only very slightly) will change.	A
34.	Recall.	B
35.	State change, only spacing will change.	D

Section B (35 marks)

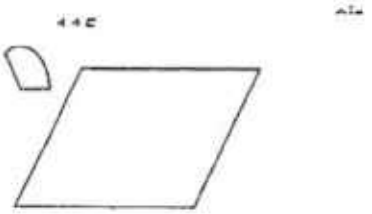
No.	Solution	Marks
1	a) Using stopwatch,	A1 – instrument
	time for at least 10 complete revolutions (by start timing when the 1st click is heard and stop timing when the 11st click is heard.)	A1 – at least 10 oscillations for accurate value
	Take the average of the timing (by dividing 10) to find the average time for one complete revolution.	A1 – processing of data
	(b)(i) Force of gear (by motor)	A1

	(ii) Average power is calculated by dividing the product of force and distance travelled by the average time. c) Determine the circumference of the gear from measuring the diameter of the gear. It will be the distance travelled by the belt for one complete revolution. (Accept any other logical suggestion.)	A1 – product of F and D A1 – division by t A1
2	a)(i) It is a region where a unit mass will experience a (gravitational) force.	A1
	(ii) The gravitational field causes the rock to experience a net force. (since the net force on the rock was initially zero) (Accept rock experiences weight due to effect of gravitational field which changes the initial net force)	A1
	(iii) As the rock falls, it loses gravitational potential energy which converts to thermal energy instead of kinetic energy. Since the kinetic energy remains unchanged, the speed remains unchanged.	A1 A1
	b)(i) Volume of a sphere = $4/3\ \pi r^3$ = 63.5 (63.51) cm^3	A1
	density = mass / volume = 0.5 x 1000 / 63.5 = 7.87 (7.874) g/cm^3	A1
	(ii) The rock is mostly likely made of pure iron within limits of experimental (measurement) error. 0.495 ≈ 0.5 kg (1 s.f.) (Accept any other logical explanation)	A1
3	a)(i) $M = F \times \perp d$ = 50 x (2 / 2) = 50 N.m	A½ A½ A1
	Direction is clockwise.	A1
	(ii) By principle of moment, sum of anti-clockwise moment = sum of clockwise moment $F_B \times 2 = 50$ N.m $F_B = 25$ N	A1 A1
	OR since the cat is at the middle, $F_A = F_B$ Then by Netwon's 1st Law, since the plank is not moving, net force on plank = 0 $F_A + F_B - W_{cat} = 0$ $F_B = 25$ N	
	b) When the cat moves towards B, the clockwise moment (about A) increases. This causes the anti-clockwise (about A) to increase in order to balance the clockwise moment. Thus F_B will increase.	A1 A½

		A½
4	a) (i) When P = 200 kPa, $A_{1\,cm} = 0.04\ m^2$ For one tyre, $P = W / A$ $200{,}000 = W / 0.04$ $W = 200{,}000 \times 0.04$ $= 8{,}000\ N$ Weight of car = 4 x 8,000 = 32,000 N (ii) After travelling some distance, the <u>air will have been heated and exerts a larger pressure</u>. (expansion of air will be much more than the tyre) <u>Using Fig. 4.2</u>, with higher pressure, the contact area becomes lesser. b)(i) Based on Fig. 4.2, P_{air} = 100 kPa Using Fig. 4.3, $P_{atm} = P_{air}$ = <u>100 kPa</u> (ii) Since the air in tyre is exerting less pressure than P_{atm}, the mercury level will be higher in the left arm. $P_{air} + P_{Hg} = P_{atm}$ $98{,}640 + (h)(13{,}600)(10) = 100{,}000$ $h = 0.01\ m$ $= 1\ cm$ c)	A½ A½ A½ A½ A½ B1 A½ A½ A½ A½ A½ – 1 cm height difference A½ – higher in the left arm
5	a)(i) W.D. = F x //d = 3000 x (15/100) = 450 J (ii) 450 J b)(i) By principle of conservation/conversion of energy, KE + GPE at the bottom = KE + GPE at the top 450 J + 0 J = KE + mgh 450 = KE + (10)(10)(4)	A½ A½ B1 A1 A1

	KE = 50 J	A1
	(ii) KE + GPE at the top = KE + GPE at the bottom $0 + 400 = KE + 0$ $\frac{1}{2} mv^2 = 400$ $v^2 = 80$ $v = 8.94\ (8.944)\ ms^{-1}$	 A1 A½ A½ (3 s.f.)

Section C (20 **marks)**

No.	Solution	Marks
6	a)(i) 1. The height increases uniformly with temperature. 2. The height increases at non-uniformly and reaches a maximum value from 600 °C onwards. (ii) The lesser the relative molecular mass of the gas, the higher the maximum pressure exerted. (Having a maximum pressure at lower temperature does not answer the question of the relationship between mass and pressure.) (iii) With the same amount of kinetic energy (at the same temperature), having higher mass means the gas X particles (in chamber 1) will move at lower speed. This causes the amount of impact/force exerted by particles (in chamber 1) per unit area to be less. Or less frequent. b)(i) Given lesser space (volume) the frequency of collision on the walls of chamber by particles increases. This causes the am ount of average impact/force per unit area(on the walls) to increase. (ii) Amount of maximum height (pressure) will be higher. OR the maximum height (pressure) will be attained at lower temperatures. (b) There are many particles. Thus the high frequency of the collisions adds up/attribute to a sizable amount of force.	 A1 A½ A½ A1 A1 A1 A1 A1 A1 A1 A1
7	a)(i) 	A½ – weight from approximate position of C.G. A½ – label A½ - air resistance

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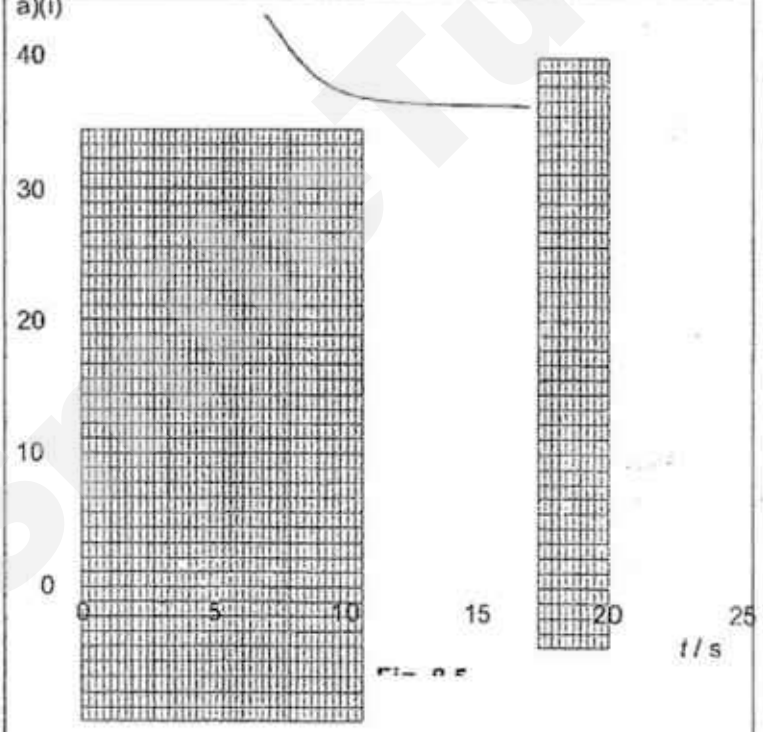
		touching any part of the flag, preferably C.G. A½ – label
	(ii) All three forces balanced out. The net force acting on the flag is zero. Thus the acceleration on the flag is zero. (iii) suitable scale (at least 1cm : 10,000 N) Either OR Weight = 36,000 N (35,000 to 37,000) Air resistance = 17,000 N (16,000 to 18,000) (b) Tension on cable by flag is of same amount but of opposite direction.	A1 A1 A½ A1 - label all 3 forces (A½ if 2 out of 3) A½ – right angle triangle/rectangle A1 – direction of all 3 forces (A½ if 2 out of 3) A½ A½ A1 A1
8E	a)(i) temperature/ °C 2 1 1 8 4 0 2 4 6 8 1 position /	A1 – curve between 0 cm to about 10 cm A1 – straight line between about 20 cm to 100 cm

Fig. 8.2

	(ii) Conduction and radiation (to surroundings/air)	A½, A½
	iii) The rule is in contact with the metal clamp at 0 cm mark. Since metal is a good conductor thus it helps to increase the rate of heat loss.	A1 A½ A½
	b)(i) By principle of conservation of energy, heat lost by rule = heat gained by water $P\,t = mc\Delta\theta$ $3500 \times (2 \times 60) = 25 \times 4200 \times (\theta - 30)$ $\theta = 34\ °C$	A1 A1 A1
	(ii) The final temperature will be lower as there is also heat lost to the surroundings.	A1 A1
8OR	a)(i)  	A½ - straight line from 0 to 10 s A½ - curve from 10 to 20 s and straight line from 20 to 25 s. (more guided so less credit compared to 8E)
	b)(i) average distance = area under v-t graph $= ½ (40 + 26)(5 - 0)$ $= 165$ m	A1 A1

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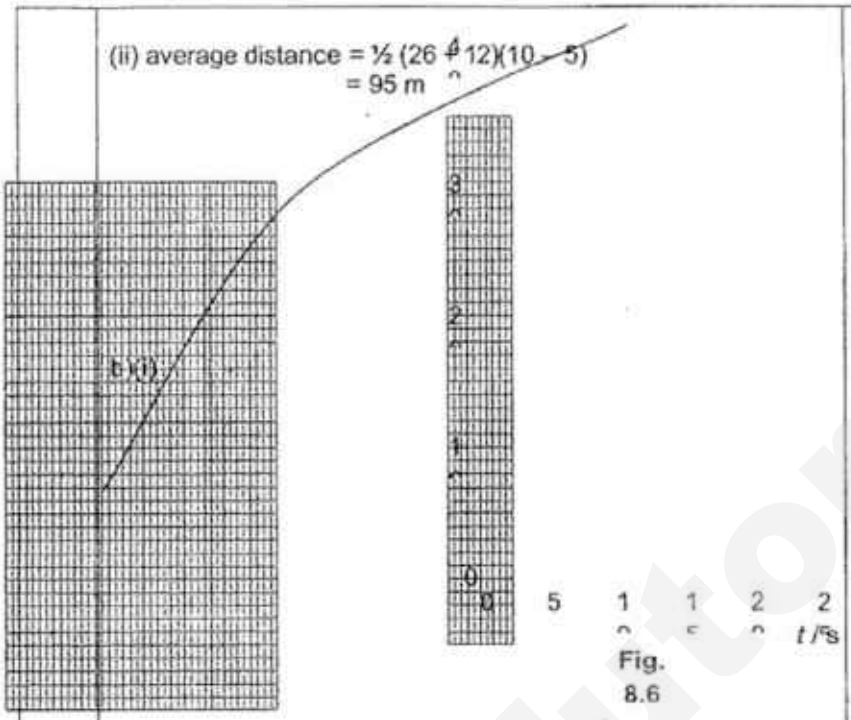
	(ii) average distance = ½ (26 + 12)(10 – 5) = 95 m  Fig. 8.6	A1 Allow e.c.f. for t = 5 and 10 s. A½ – all points correctly potted including 0 s and 20 s. (Allow e.c.f. for t = 5 and 10 s) A½ – curve around 5 s and straight line around 20 s
	(ii) The line/graph is a curve with <u>decreasing gradient</u>. Since the gradient of <u>d-t graph represents the velocity</u>, the velocity decreases.	A1 A1 (max A1 if only mention change but not decrease)
	d)(i) From Fig. 8.5, velocity at d (t = 20 s) = 5 ms^{-1} From Fig. 8.6, displacement at D = 350 m Displacement/distance between D and traffic light = 400 – 350 = 50 m Since velocity after D is constant, displacement/distance = velocity x time 50 = 5 x time time = 10 seconds	 A½ A1

	$t = 20 + 10 = 30$ s Students can use gradient from Fig. 8.6 at t = 20 s to find the uniform speed. (but it should be 5 ms^{-1} since it is already given in Fig. 8.5.) (No credit if student extend line outside graph area in Fig. 8.6 to find directly) (ii) average speed = total distance / total time = 400 / 30 = 13.3 ms^{-1}	A½ (max A1 if grad. is far off from 5 ms^{-1}) A1 Allow e.c.f. from (i)

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2016 END OF YEAR EXAMINATION
Secondary 3 Express

NAME

CLASS

REG. NO

Physics (SPA)

10 October 2016

2 Hours

Additional Materials: Multiple Choice Answer Sheet

Setter: Mr Yap Shinn

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer all questions.
Write in soft pencil.
Do not use staples, paper clips, highlighters and glue or correction fluid.
Write your class, name and index number on the Multiple Choice Answer Sheet in the spaces provided.

There are **thirty** questions in Section A. 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 Multiple Choice Answer Sheet.

Section B
Answer all questions.
Write your class, name and index number on the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagram, graphs or rough working.
Write your answers in the spaces provided in the Question Paper.

Section C
Answer all questions. Question **10** has a choice of parts to answer.
Write your answers in the spaces provided in the Question Paper.

For sections **A, B** and **C**, please assume acceleration of free fall as 10 ms^{-2}

The number of marks is given in brackets [ ] at the end of each question or part question.
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.
You are allowed to use calculators.

.....
Parent's signature/
Date

FOR EXAMINER"S USE	
Section A	/ 30
Section B	/ 40
Section C	/ 30
Total	

This document consists of **31** printed pages including the cover page.

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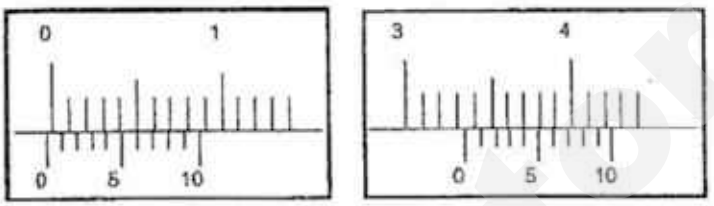
[Turn over

Section A (30 marks)

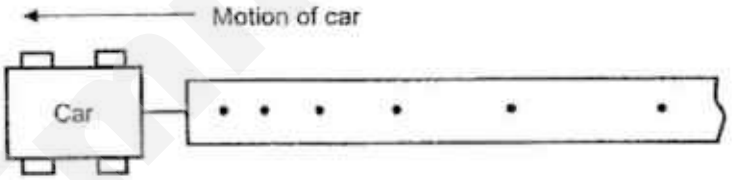
1 The diagram on the left shows the reading on the vernier caliper when the jaws are closed. The diagram on the right shows the reading on the vernier caliper when a piece of nail was placed between the jaws.



What is the length of the nail?

A 3.28 cm
B 3.30 cm
C 3.38 cm
D 3.40 cm

2 A ticker tape timer is used to investigate the speed of a toy car. The ticker tape obtained is shown below.

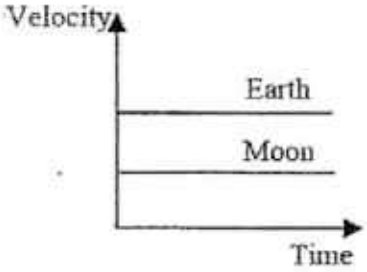


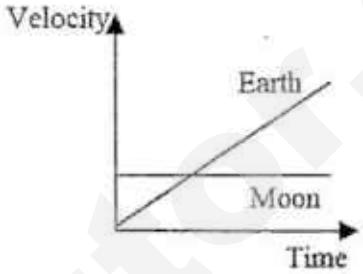
The speed of the remote control car is _____.

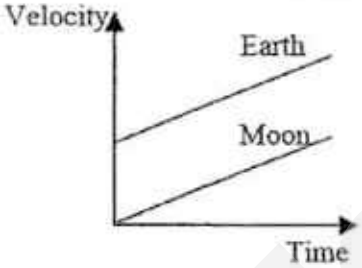
A increasing with increasing acceleration
B increasing with decreasing acceleration
C decreasing with increasing deceleration
D decreasing with decreasing deceleration

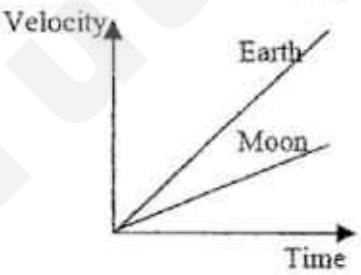
3 When a rock is dropped on Earth, it accelerates at about 10 ms^{-2}. However, when a rock is dropped on the moon, it only accelerates at 1/6 of the acceleration on Earth.

Which diagram shows the velocity-time graph when rocks of the same mass are dropped on Earth and on the moon?

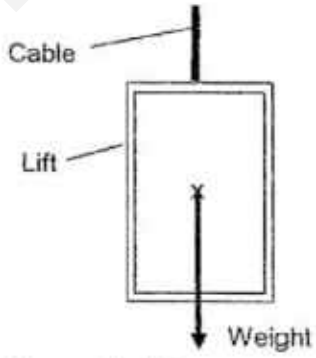
A


B


C


D


4 The diagram shows an empty lift with mass 400 kg being pulled up by a cable. It is travelling upwards with constant speed.



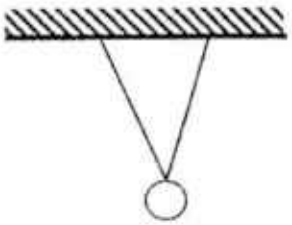
What is the resultant force acting on the lift?

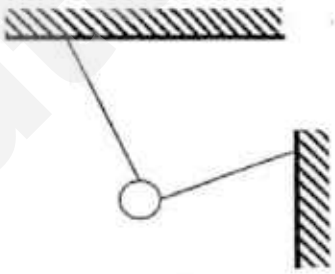
A 0 N
B 400 N
C 4000 N
D 8000 N

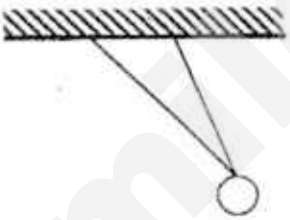
5 Which of the following statements **does not** illustrate the effect of inertia?

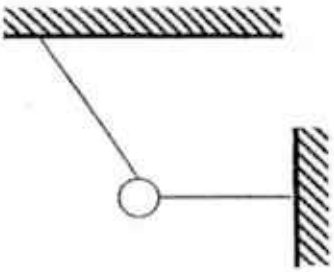
A When a bus accelerates suddenly from rest, a person sitting in the bus tends to jerk backwards.
B If a pile of coins is placed on a table, the bottom one can be flicked away without disturbing the others.
C It is easier to slide a heavy box up an incline to a certain height than to lift it vertically to the same height.
D It is difficult to stop a shopping trolley full of things when it is moving.

6 A small ball is suspended by two strings. Which of the following arrangements is **impossible?**

A


B


C


D


7 Which of the following statements about weight and mass is correct?

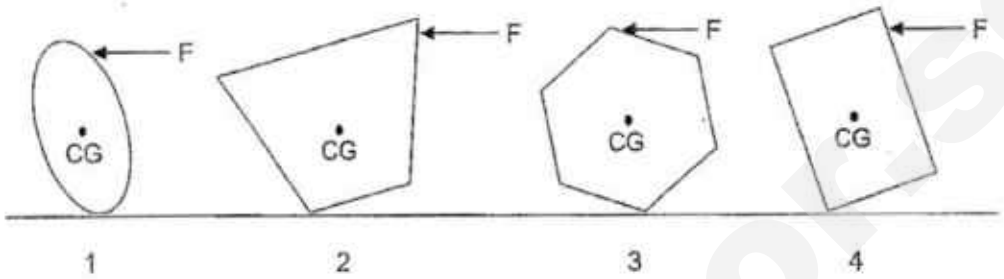
1 In a gravitational field, the weight on object is directly proportional to its mass.
2 Mass is measured in kilograms and weight in newtons.
3 Both mass and weight do not change with location.

A 1 only
B 2 only
C 1 and 2
D All of the above

8 When object A of mass 5 g is immersed in a measuring cylinder filled with water, it displaces half the volume of water as object B of 10 g. What can be deduced about the densities of A and B?

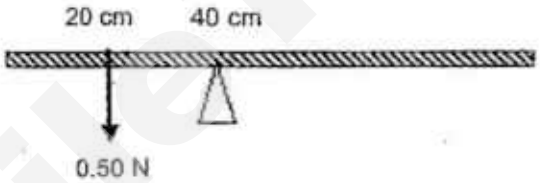
A A and B have the same density.
B Density of A is ¼ times the density of B.
C Density of A is ½ times the density of B.
D Density of A is 2 times the density of B.

9 The objects are displaced slightly to the left with a force F as shown below. Which of the following object(s) display(s) stable equilibrium when F is removed?



A 1 and 2 **B** 3 and 4
C 1 and 3 **D** 2 and 4

10 The diagram shows a uniform metre rule supported at the 40 cm mark. When a downward force of 0.50 N is applied at the 20 cm mark, the metre rule is balanced.



Determine the weight of the metre rule.

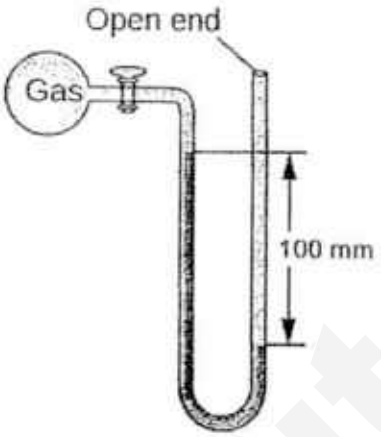
A 0.20 N **B** 0.25 N
C 0.50 N **D** 1.0 N

11 Which of the following would affect the pressure acting on a submerged submarine?

1 The depth at which the submarine is
2 The density of the seawater
3 The surface area of the submarine
4 The weight of the submarine

A 1 and 2 **B** 3 and 4
C 1, 2 and 3 **D** All of the above

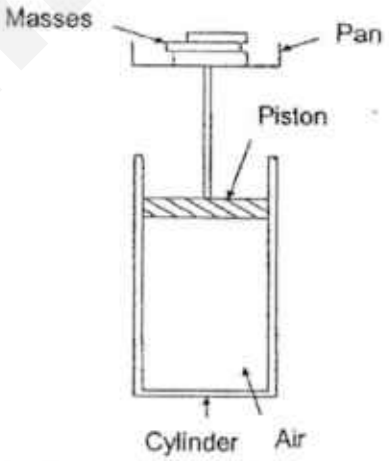
12 The diagram below shows a simple manometer that is filled with mercury.



Which of the following statements is correct?

A The pressure of the gas cylinder is 100 mmHg higher than atmospheric pressure.
B The 100 mm difference in the mercury height between the right and left arm does not change when a manometer with bigger diameter is used.
C When the mercury is replaced with a liquid with lower density, the 100 mm difference in the mercury height between the right and left arm decreases.
D When the pressure of the gas cylinder decreases, the 100 mm difference in the mercury height between the right and left arm increases.

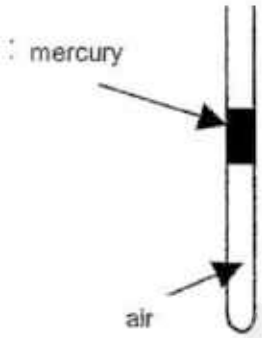
13 A cylinder with a close-fitting piston contains air at 50°C. The piston supports a small pan containing some masses.



What happens when the temperature of the air in the piston is heated to 60°C?

A The piston moves downwards as the air pressure in the cylinder decreases.
B The piston does not move as the air pressure in the cylinder remains the same.
C Masses has to be added into the small pan to keep the air pressure in the cylinder constant.
D Masses has to be added into the small pan to keep the volume of the air in the cylinder constant.

14 A small amount of mercury traps some air in a long glass tube which is sealed at one end.



When the tube is rotated slowly to a horizontal position,

A the air column increases in length because its pressure decreases.
B the air column decreases in length because its pressure increases.
C the length of the air column does not change because its pressure remains the same.
D the mercury flows out of the tube when the tube is in the horizontal position.

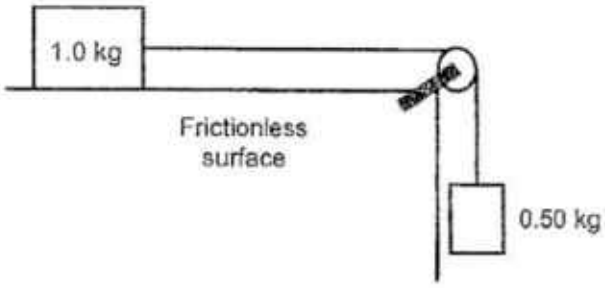
15 Which of the following is equivalent to the unit of power?

A J s
B N m
C kg m^2 s^{-2}
D kg m^2 s^{-3}

16 A ball being thrown vertically upwards reaches a height of 2.0 m. How high will the same ball reach if it is thrown with twice the initial velocity?

A 1.0 m
B 2.0 m
C 4.0 m
D 8.0 m

17 The diagram shows a trolley being pulled from rest along a frictionless horizontal table by a falling mass. The trolley's mass is 1.0 kg and the falling mass is 0.50 kg.



What is the maximum amount of kinetic energy of the trolley after the falling mass falls through a height of 0.5 m?

A 1.7 J
B 2.5 J
C 5.0 J
D 7.5 J

18 In the Brownian motion experiment, which statement best states what happens when the smoke specimen is being heated?

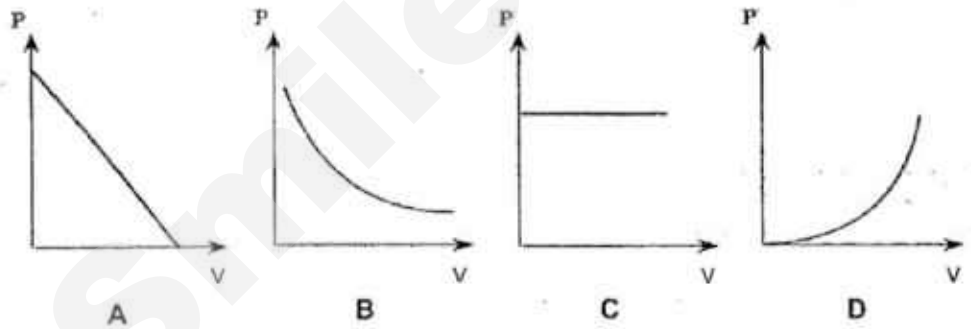
A The smoke particles expand in size.
B The smoke particles move more vigorously because the air particles bombard the smoke particles more rapidly.
C The smoke particles move more vigorously because the smoke particles gain kinetic energy with the increase in temperature.
D No observable difference in the motion of the smoke particles.

19 A gas is heated in sealed container. Which of the following does not increase?

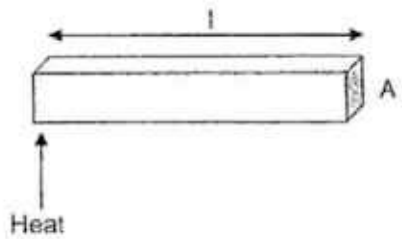
A Frequency of collisions
B Intermolecular distance between the particles
C Average force of collisions between particles and walls of container
D Average kinetic energy of particles

20 In an experiment to investigate the relationship between the volume V of a fixed mass of gas and the pressure P, a graph of P against V is plotted.

Which of the following graphs shows the correct relationship at constant temperature?



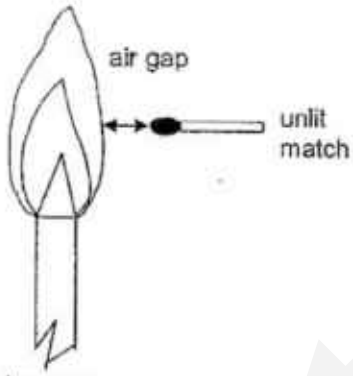
21 A metal bar with the following dimensions is heated.



Which of the following quantities does not change?

A Internal energy
B Heat capacity
C Length, l
D Cross sectional area, A

22 The diagram below shows an unlit match held near to a steady Bunsen flame.



The match does not light up because

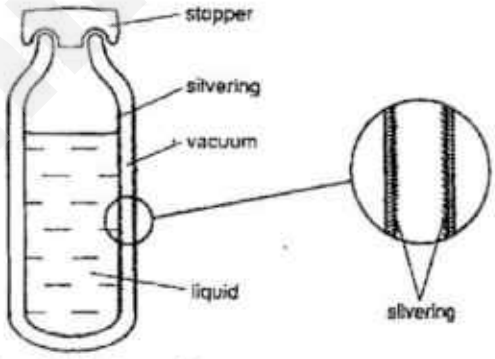
A the flame is not hot enough.

B the match head is a poor absorber of radiation.

C the flame does not radiate thermal energy sideways.

D air is a poor conductor of thermal energy.

23 The diagram shows the features of a vacuum flask that can help to keep the liquid inside hot for a longer period of time.



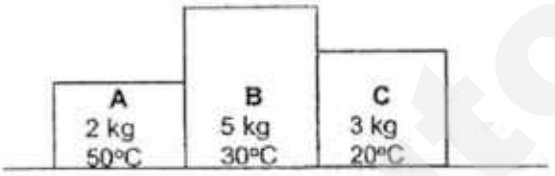
Which of the above feature(s) is/are able to prevent heat loss by conduction and convection?

A Silvering
B Vacuum
C Stopper
D All of the above

24 An uncalibrated thermometer placed alongside a ruler has the ice and steam points at the 6 mm and 206 mm marks respectively. When the mercury level in the thermometer reaches the 100 mm mark on the scale, the temperature is

A 40°C
B 47°C
C 50°C
D 100°C

25 Three objects, A, B and C, with different masses and temperatures are placed beside each other as shown.



A There is no net flow of thermal energy.
B There is a net flow of thermal energy from A to B to C.
C There is a net flow of thermal energy from B to A and C.
D There is a net flow of thermal energy from C to B to A.

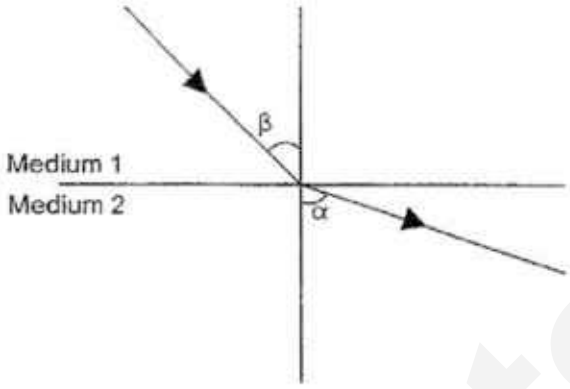
26 Heat capacity and specific heat capacity have different definitions. Which statement best describes the difference?

A Heat capacity depends on mass but not specific heat capacity.
B Heat capacity depends on the change in temperature but not specific heat capacity.
C Specific heat capacity depends on mass but not heat capacity.
D Specific heat capacity depends on the change in temperature but not heat capacity.

27 Water is used in a heat exchanger to cool the nuclear reactor in a nuclear power station. It enters the heat exchanger at 4 °C and leaves at 15 °C. Given that the specific heat capacity of water is 4200 J/(kg°C) and the rate at which thermal energy is removed is 1.2×10^8 J per second, find the rate of water flow in the heat exchanger.

A $\frac{1.2\times10^8}{4200\times11}$ kg/s
B $\frac{1.2\times10^8\times11}{4200}$ kg/s
C $\frac{4200\times11}{1.2\times10^8}$ kg/s
D $\frac{4200}{1.2\times10^8\times11}$ kg/s

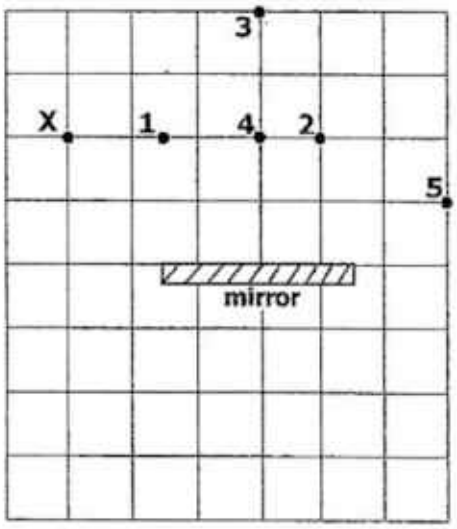
28 The diagram shows a ray of light moving from medium 1 to medium 2.



If the two media are glass and air, which of the following is correct?

	Medium 1	Medium 2	Refractive Index of Glass
A	Air	Glass	$\frac{\sin\alpha}{\sin\beta}$
B	Glass	Air	$\frac{\sin\alpha}{\sin\beta}$
C	Air	Glass	$\frac{\sin\beta}{\sin\alpha}$
D	Glass	Air	$\frac{\sin\beta}{\sin\alpha}$

29 A person stands at point X as shown in the diagram. There are 5 objects placed at various positions.



Which objects will the person be able to see in the mirror from point X?

A 1 and 4
B 2, 3 and 4
C 2, 4 and 5
D 1, 2 and 4

30 When an object is placed at O, an image is formed at I. Where should the object be placed such that the image is formed at P?

Section B (40 marks)

1 In Euro Cup 2016, Cristiano Ronaldo of Portugal tries to score a goal while the defender from the other team tries to stop him from scoring. The defender kicks the ball with a force of 100 N due south west at the same time as Ronaldo kicks the ball with a force of 160 N due North as shown in Fig. 1.1

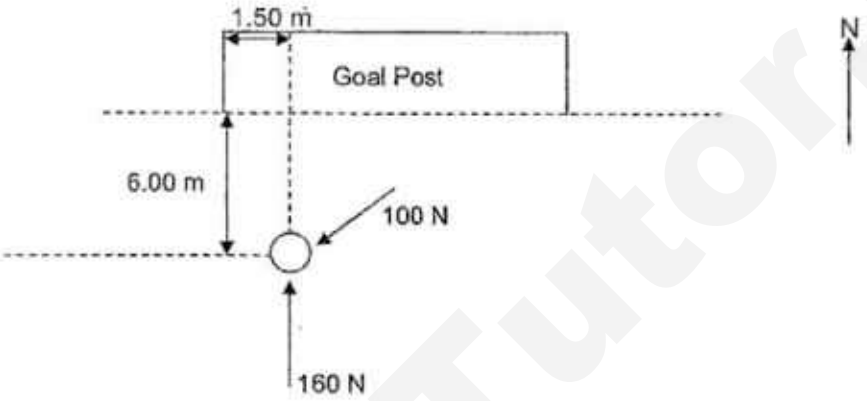


Fig. 1.1

(a) By means of a scaled diagram, find the resultant force on the ball.

Resultant Force = ... [3]

(b) Hence, determine if the ball is able to enter the goal post.

[2]

2 A skateboarder is travelling along a level road. It then moves up and down a hill. The v-t graph of the skateboarder is shown in Fig. 2.1

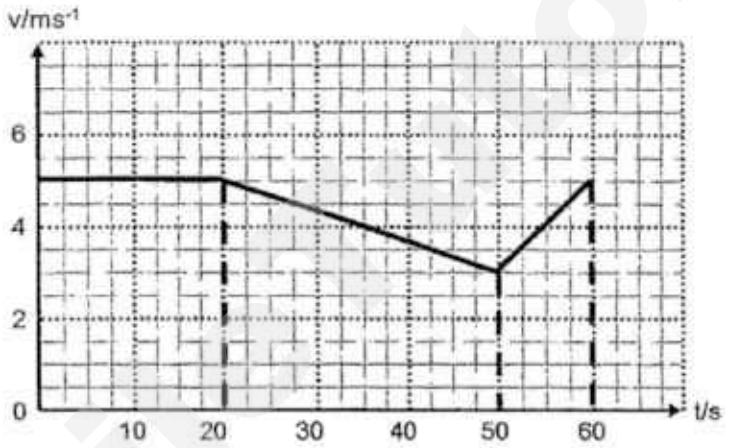


Fig. 2.1

(a) Find the deceleration of the skateboarder as he moves up the hill.

Deceleration = ... [2]

(b) Describe the motion of the skateboarder during the whole journey.

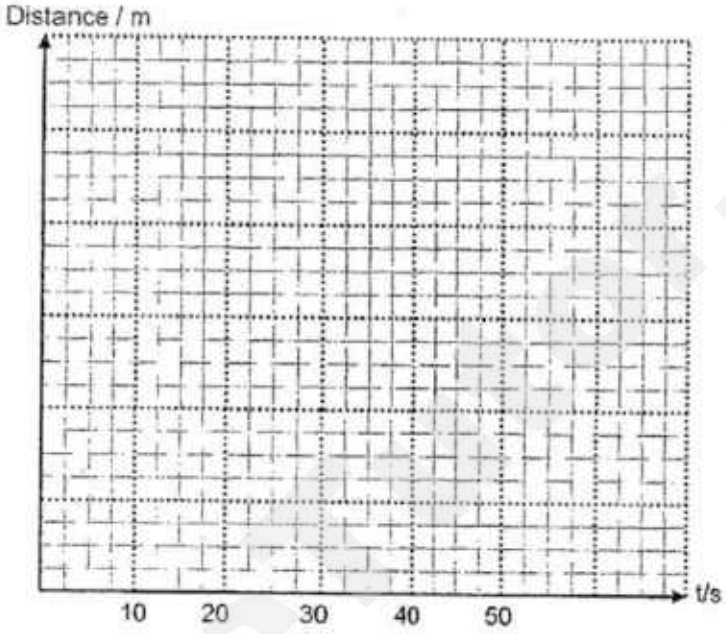
.....

.....

.....

..... [3]

(c) In Fig. 2.2, sketch the distance – time graph of the skateboarder from t = 0 s to 50 s.



[2]

Fig. 2.2

3 An astronaut wants to determine the density of a piece of rock he has found on the moon. This piece of rock has an irregular shape.

(a) He uses a beam balance on the moon to measure the mass of the rock. The mass of the rock is 440 g. Explain whether the measurement of mass will be different if he uses the beam balance on Earth.

.....

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.....

.....

[2]

(b) He then uses the water displacement method to measure the volume of the rock as shown in Fig. 3.1

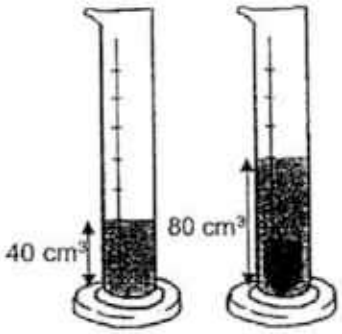


Fig. 3.1

Determine the density of the rock in SI units.

Density = ... [2]

(c) When the rock is brought to the laboratory, the density determined is lower than what is calculated in (b). Suggest a reason why is this so.

.....

.....

..... [1]

4 A uniform rule of length 1.0 m and mass 0.080 kg hangs freely from a pivot at one end. It is pulled aside by a horizontal force **F** so that the centre of the ruler is at a horizontal distance of 0.40 m and a vertical distance of 0.30 m from the pivot. The ruler is at equilibrium as shown in Fig. 4.1.

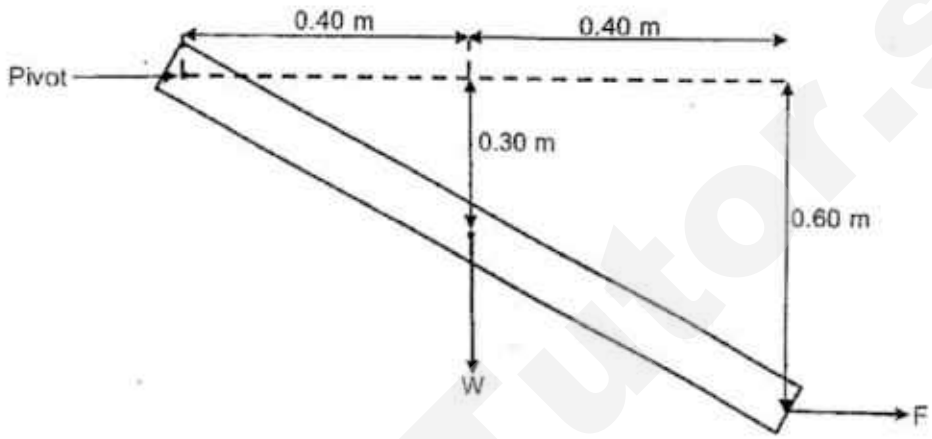


Fig. 4.1

(a) Calculate the moment due the weight about the pivot.

Moment = ... [1]

(b) Hence, calculate the force, F.

Force = ... [2]

(c) Why is the reaction force at the pivot not considered in the calculation in (b).

.....

.....

..... [2]

5 Fig. 5.1 below shows a double walled coffee cup.

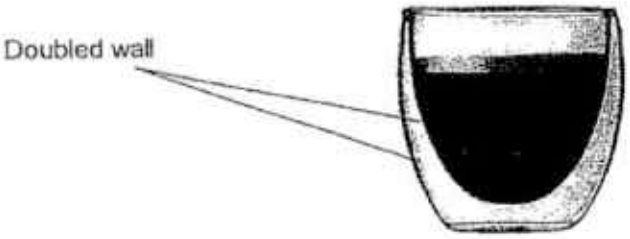


Fig. 5.1

The cup features two walls of glass with air in between.

(a) Explain how the double wall reduces the formation of condensation on the sides of the cup when it is used to contain cold drinks.

.....

.....

.....

..... [2]

(b) **(i)** Peter uses this cup daily for his coffee. He observes that the top of the coffee becomes cold quickly while the bottom is still hot. Explain his observation.

.....

.....

..... [2]

.....

(ii) Suggest and explain what Peter can do to keep the top of his coffee hot for a longer period of time.

.....

.....

.....

.....

..... [2]

6 Helium is used to inflate birthday balloons as shown in Fig. 6.1.

Fig. 6.1

(a) Using Kinetic Theory of Matter, explain how the helium exerts a pressure on the walls of the balloon.

.....

.....

.....

.....

..... [3]

(b) One of the balloons is placed inside a bell jar. The air inside the bell jar is slowly removed through a vacuum pump.

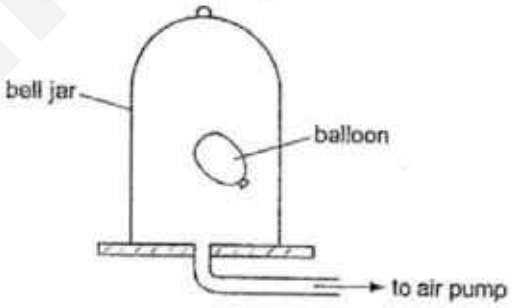


Fig. 6.2

Describe and explain what happens to the balloon as air is removed from the bell jar.

.....

.....

.....

.....

..... [3]

7 The refractive indices of three transparent materials are shown in the Fig. 7.1.

Medium	Refractive index, n
Material 1	1.70
Material 2	1.50
Material 3	1.30

Table. 7.1

(a) State and explain which material will light travel the fastest in?

.....

.....

..... [2]

(b) Blocks made of the three materials are stacked on top on another and a ray of light is shone through them. Sketch the path of light in Fig. 7.2 until it emerges into air again.

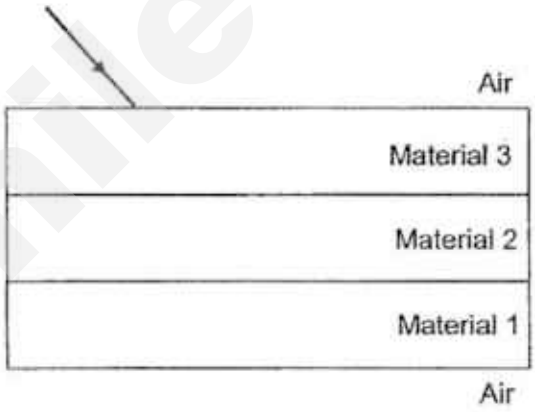


Fig. 7.2 [2]

(c) Other than refraction, another phenomenon may occur at the boundary between Material 1 and air as the ray of light emerges from the block.

Name this phenomenon and calculate the minimum angle of incidence at the boundary between Material 1 and air for this to occur.

Name of phenomenon: .....

Angle of incidence = ... [2]

Candidate Name: _____ ( ) Class: _____
Secondary Three (Express) Physics

Section C (30 marks)

Answer **all** questions. Question **10** has a choice of parts to answer.

8 A toy car with a rocket engine moves along a horizontal track as shown in Fig. 8.1.

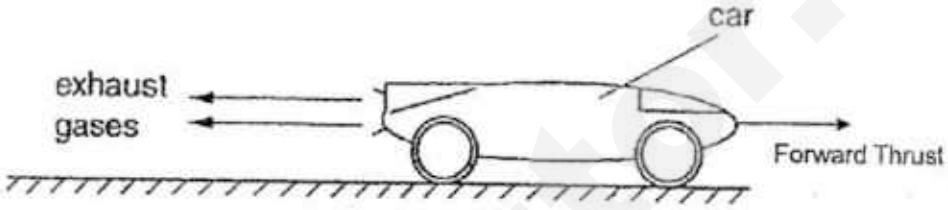


Fig. 8.1

The rocket engine produces a constant forward thrust of 4.6 N. The car loses mass continuously as exhaust gases are produced by the rocket.

The velocity – time graph of the toy car is as shown in Fig. 8.2.

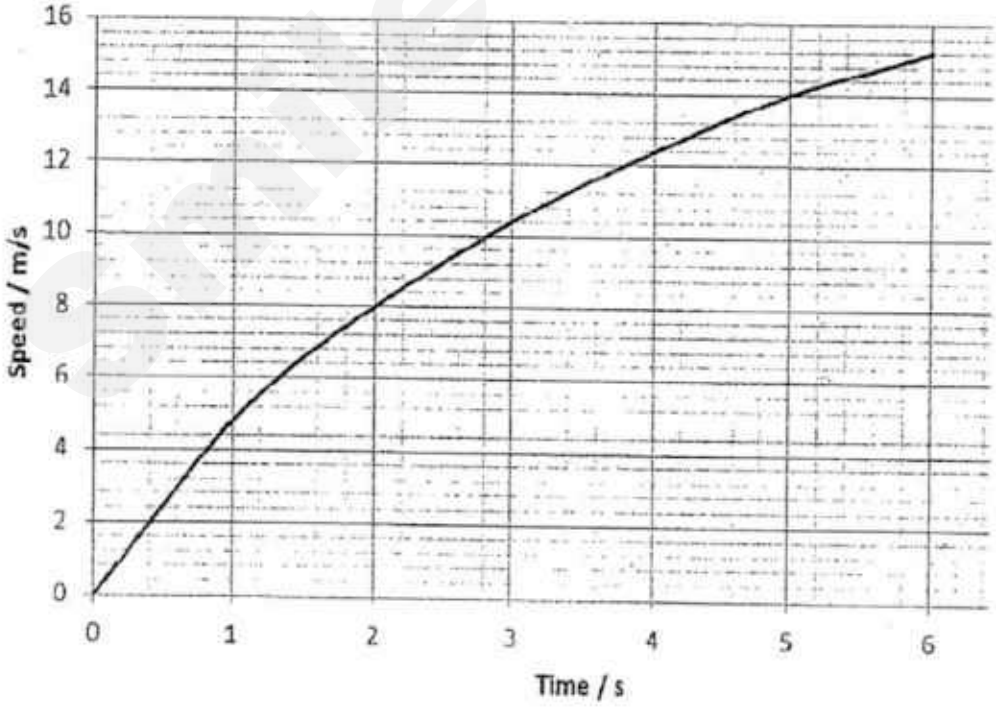


Fig. 8.2

(a) As the fuel in the rocket burns, the car pushes the exhaust gases backwards and the toy car moves forward. Identify the action and reaction pair that pushes the toy car forward.

.....

..... [1]

(b) The mass of the car is 450 g.

(i) Using Fig 8.2, determine the acceleration of the car at t = 2.0 s.

Acceleration = ... [2]

(ii) Hence, determine the magnitude of the resistive force acting on the toy car.

Resistive force = ... [2]

(c) Using Fig 8.2, explain the changes to the resistive force acting on the toy car.

.....

.....

.....

.....

.....

..... [3]

(d) The toy car is re-fuelled and placed on the ground such that it is pointing upwards.

(i) By considering the initial acceleration of the toy car at t = 0 s to be 8.0 m/s^2, calculate the mass of the toy car.

Mass = ... [1]

(ii) Hence, explain if the force produced by the rocket engine of 4.6 N is sufficient to lift the toy car off the ground vertically.

.....

.....

..... [1]

9 Fig. 9.1 shows two setups are used to determine the specific latent heat of fusion of ice as shown in Fig. 9.1.

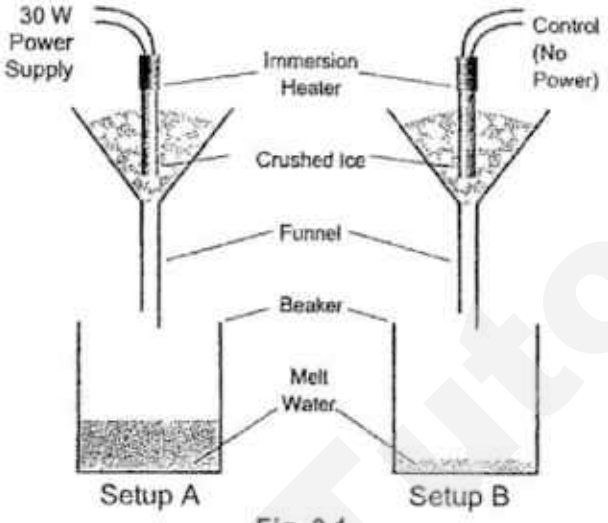


Fig. 9.1

The power supply to Setup A is turned on. After melting occurs at a constant rate for **both setups**, the melted water is collected in the beakers for a period of 10.0 mins. It is said that the ice in Setup A is melted by the heater and the surroundings.

The data shown in Fig. 9.2 are obtained.

	Mass of water / g
Setup A	64.7
Setup B	16.6

Table. 9.2

(a) What is meant by the "specific latent heat of fusion of ice"?

.....

.....

..... [1]

(b) What is the purpose of measuring the mass of melted water in Setup B?

.....

.....

..... [1]

(c) **(i)** Calculate the amount of energy supplied by the heater to Setup A.

Energy = ... [1]

(ii) Hence by considering the amount of water that is melted by **the heater only**, calculate the specific latent heat of fusion for ice.

Specific latent heat of fusion = ... [3]

(iii) Suggest and explain how your answer in c(ii) will change if a large block of ice is used instead of crushed ice.

.....

.....

.....

..... [2]

(d) When the temperature of the melting ice in the funnel is monitored, it is observed that the temperature remains at 0°C. Explain why the temperature of the melting ice does not increase even when thermal energy is supplied.

.....

.....

.....

..... [2]

10 either

The figure below provides information about three telescopes used to examine different sources of radiation from space.

Location	Objective Lens Diameter (D)	Source of radiation	Wavelength detected (λ)
Mauna Kea Observatories (Hawaii)	10.0 m	Sirius	500 nm
Mount Graham (Arizona)	8.4 m	Polaris	600 nm
McDonald Observatory (Texas)	9.5 m	Inter-stellar hydrogen	0.21 m

Table. 10.1

(a) In a telescope, there are 2 lenses (objective and eyepiece) as shown in Fig. 10.2.

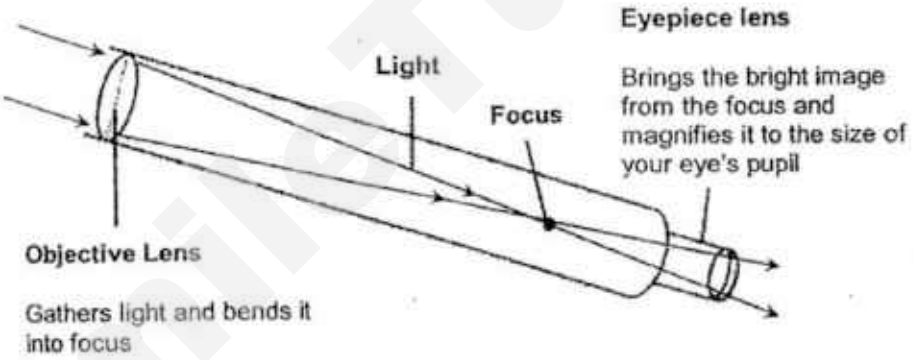
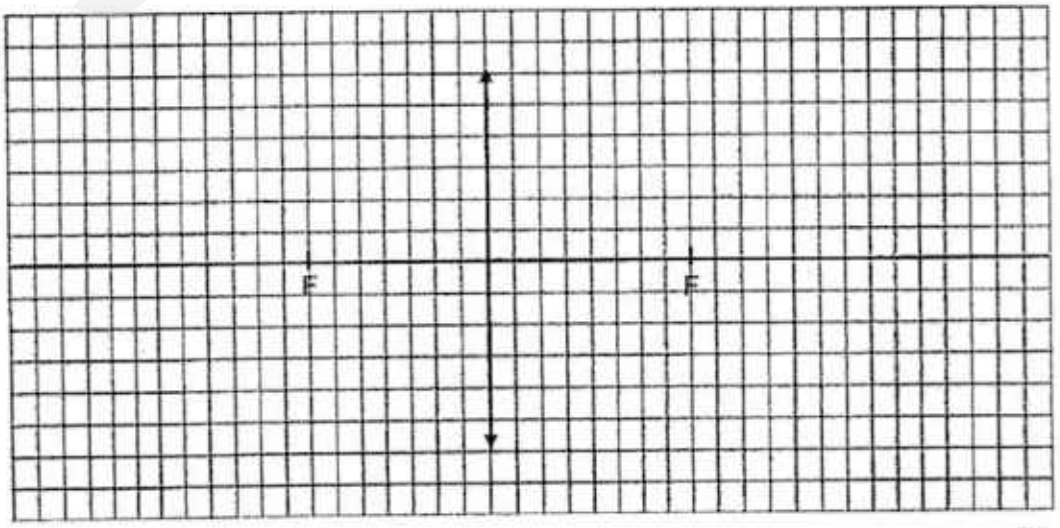


Fig. 10.2

(a) (i) In the space below, complete the ray diagram to show how the objective lens gathers light from the distant object to form an image.



[2]

(ii) How does the ray diagram show that the object is far from the objective lens?

.....

..... [1]

(iii) The image formed is said to be **REAL**. Explain what is meant by a real image.

.....

..... [1]

(iv) State two other characteristics of the image formed by the objective lens.

.....

..... [1]

(b) (i) The **smaller** the ratio of the wavelength to the objective lens diameter, the more effective is the telescope in clearly separating the images of distant sources. This ratio is called the resolving power of the telescope.

$$\text{Resolving power} = \frac{\lambda}{D}$$

Using the data from Table. 10.1, show by calculation which telescope has the best resolving power.

Telescope with best resolving power: ..... [4]

(ii) A large objective diameter improves the resolving power. By studying the features of the telescope in Fig. 10.2, suggest another reason why telescope should have a large objective diameter.

.....

..... [1]

10 **or**

Fig. 10.3 shows the setup of a reverse bungee jump. A capsule is connected by two identical elastic cords each attached to a tower 30.0 m tall. The mass of the capsule when fully loaded with three passengers has a total mass of about 300 kg. When released, the capsule will shoot up at high speed. As the capsule shoots up, the cords are stretched and unstretched depending on the position of the capsule.

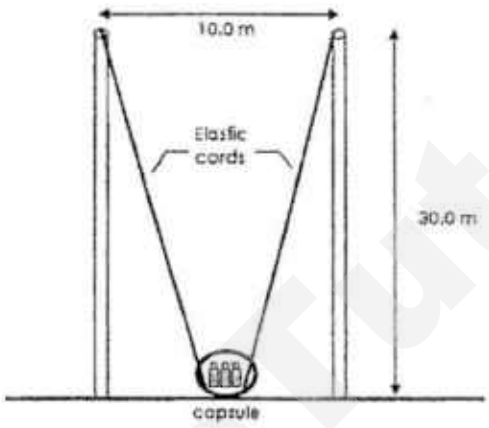


Fig. 10.3

(a) State the principle of conservation of energy.

.....

.....

.....

..... [2]

(b) Describe the energy changes as the capsule moves

(i) from the starting position to the point the cords become unstretched.

.....

.....

..... [1]

(ii) from the point the cords become unstretched to the highest point of the capsule.

.....

.....

..... [1]

(c) The elastic potential energy in the elastic cord is 510 kJ when the capsule is on the ground.

(i) When the capsule reaches the highest height, the elastic potential energy in the cords is said to be also at 510 kJ. Comment on the validity of this statement.

.....

.....

.....

..... [2]

(ii) Calculate the gravitational potential energy of the capsule when it is 30 m above the ground.

Gravitational potential energy = ... [1]

(iii) Hence, calculate the speed of the capsule 30 m above the ground.

Speed = ... [3]

~ End of Paper ~

KUO CHUAN PRESBYTERIAN SECONDARY SCHOOL

2016 END OF YEAR EXAMINATION

Secondary Express

NAME	Marking Scheme
CLASS	
REG. NO	

Physics

Oct 2016

2 Hours

Additional Materials: Multiple Choice Answer Sheet.

Mr Yap Shinn

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer all questions.
Write in soft pencil.
Do not use staples, paper clips, highlighters and glue or correction fluid.
Write your class, name and index number on the OMR Sheet in the spaces provided.

There are **thirty** questions in Section **A**. 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.

Section B
Answer all questions.
Write your class, name and index number on the work you hand in.
Write in dark blue pen.
You may use a soft pencil for any diagram, graphs or rough working.
Write your answers in the spaces provided in the Question Paper.

Section C
Answer all questions. Question **10** has a choice of parts to answer.
Write your answers in the spaces provided in the Question Paper.

For sections **A**, **B** and **C**, please assume acceleration of free fall as 10 ms^{-2}

The number of marks is given in brackets [ ] at the end of each question or part question.
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.
You are allowed to use calculators.

.....
Parent's signature/ Date

FOR EXAMINER"S USE	
Section **A**	
Section **B**	
Section **C**	
Total	

This document consists of 7 printed pages

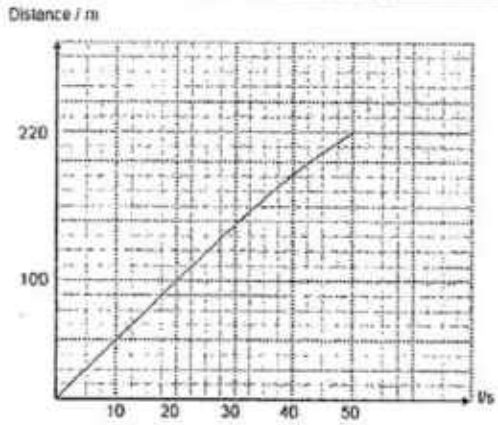
Section A (30 marks)

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

Section B

1	(a)		 Scale used : 1 cm to 20 N Correct triangle with correct arrow heads directions Resultant Force = 5.7 cm x 20 N = 114 N ± 10%	 1 1 1
	(b)		From vector diagram, angle of travel for ball = **39° from vertical** Angle of left corner of goal post from postion of ball = tan $^{-1}$(1.5/6.0) = **14°** Ball will not enter goal post.	1 1
				5

2	(a)		a = (v-u)/t = (3.0 – 5.0)/30 = - 0.067 m/s^2 Deceleration = 0.067 m/s^2	 1 1
	(b)		From 0 s to 20 s, speed is constant. From 20 s to 50 s, speed is decreasing at an uniform rate. From 50 s to 60 s, speed is increasing at an uniform rate.	1 1 1

	(c)		 Correct shape – Straight line 0s to 20s; Curve 20s to 50s Values on vertical axis	1 1
				7

3	(a)		The measurement will be the same. Mass is independent on location. Hence, the measurement of mass will be the same.	1 1
	(b)		Volume = 80 – 40 cm^3 = 40 cm^3 = 40 x 10^{-6} m^3 Density = mass/volume = 0.44 / (40 x 10^{-6}) = 11 000 kg/m^3	1 1
	(c)		When the rock is lowered into the measuring cylinder, some of the water may have splashed on the sides of the measuring cylinder. Hence, the measured volume is lower than actual.	1
				5

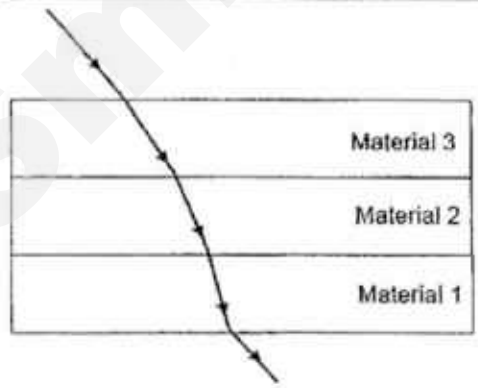
4	(a)		Moment = 0.80 x 0.40 = 0.32 Nm	1
	(b)		Taking moments about pivot, ACW = CW F (0.60) = 0.32 F = 0.53 N	1 1
	(c)		The perpendicular distance between line of action of reaction force and pivot is zero. Hence, moments due to reaction force is zero.	1 1
				5

5	(a)		Thermal energy needs to be conducted away from air surrounding cup to cause condensation. Air between walls is a poor conductor of heat. Thermal energy cannot be conducted quickly enough away from air surrounding sides of cup.	1 1
	(b)	(i)	Thermal energy still can be lost quickly from the top of the coffee via radiation and convection	1

1>6

			Heat loss via sides of cup is very slow.	1
		(ii)	Cover the top with a cap. This prevents the set up of convection currents so heat loss by convection can be reduced.	1 1
				6

6	(a)		Helium particles are moving randomly and continuously. They collide with the walls of balloon, exerting a force. Average forcer per unit area gives rise to pressure,	1 1 1
	(b)		Pressure of bell jar decreases as air is removed. Since pressure in balloon is higher, volume of balloon increases. Pressure in balloon decreases. As the pressure of bell jar decreases, volume of balloon increases and will burst eventually.	1 1 1
				6

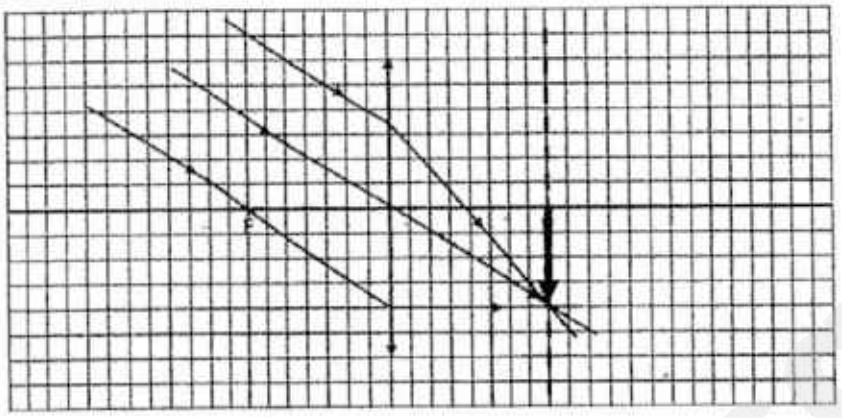
7	(a)		Material 3. It has the lowest optical density as Material 3 has the lowest refractive index so **light will slow down the least when it travels into material 3.** Alternative answer: Since v = c/n and the speed of light in vacuum is constant at 3.0 x 10^8 m/s, light will travel the fastest in the material with the lowest n.	1 1
	(b)		 Bend towards normal at each boundary Emergent ray parallel to incident ray.	1 1
	(c)	(i)	Total internal reflection n = 1 / sin c 1.70 = 1 / sin c c = 36.1°	1 1
				6

Section C (30 marks)

8	(a)		Force on exhaust gas by car Force on car by exhaust gas	1
	(b)	(i)	Tangent drawn correctly at 2.0 s a = gradient of tangent = 2.68 m/s²	1 1
		(ii)	Resultant force = 0.450(2.68) = 1.206 N Resultant force = Forward thrust – resistive force 1.206 = 4.6 – Resistive force Resistive force = 3.40 N	1 1
	(c)		Fig 9.2 shows the gradient of graph decreasing. The acceleration of toy car decreases. Resultant force decreases. Resistive force increases since forward thrust is constant.	1 1 1
	(d)	(i)	At t = 0s, 4.6 N = m(8.0) m = 0.575 kg	1
		(ii)	Since the initial weight of the toy car is greater than 4.6 N, the toy car cannot be lifted off.	1
				10

9	(a)		It is the amount of thermal energy needed to change 1 kg of ice from solid to liquid state or vice versa without a change in temperature.	1
	(b)		To determine the amount of water melted by the surroundings / without the use of heater.	1
	(c)	(i)	Q = Pt = 30(10 x 60) = 18000 J	1
		(ii)	Mass of water melted by heater alone = 64.7 – 16.6 = 48.1 g L_f = (mass of water melted by heater alone)(l_f) 18000 = (48.1)(l_f) L_f = 374 J/g	1 1 1
		(iii)	The value will increase. Less mass of water is collected in the beaker if the same amount of energy is used. / More energy is needed to melt the same amount of ice.	1 1
	(d)		The thermal energy absorbed by ice is used to overcome the forces of attraction between the particles so that the ice change its state into water. Average kinetic energy does not increase so temperature does not increase.	1 1
				10

137

10 either	(a)	(i)	 Image formed on focal plane Correct refracted rays	1 1
		(ii)	The incident rays are parallel to each other.	1
		(iii)	The image can be captured on a screen.	1
		(iv)	Inverted, diminished	1
	(b)	(i)		

Location	Objective Lens Diameter (D)	Wavelength detected (λ)	Resolving power	
Mauna Kea Observatories (Hawaii)	10.0 m	500 nm = 500 x 10^{-9}m	5.0 x 10^{-8}	1
Mount Graham (Arizona)	8.4 m	600 nm = 600 x 10^{-9} m	7.1 x 10^{-8}	1
McDonald Observatory (Texas)	9.5 m	0.21 m	0.022	1

			Mauna Kea	1
		(ii)	The image will be brighter as more light rays will pass through the lens.	1
				10

10 or	(a)		Energy cannot be created or destroyed but must be converted from one form to another. The total energy of the system remains constant.	1 1
	(b)	(i)	Elastic potential energy in the elastic cords is converted to gravitational potential energy and kinetic energy of the capsule.	1
		(ii)	Kinetic energy of the capsule is converted to gravitational potential energy and elastic potential energy.	1
	(c)	(i)	The elastic potential energy should be lower than 510 KJ. When the capsule is at the highest height, it would have gained GPE. Some of the initial elastic PE would have been converted to GPE	1

				1
		(ii)	Gain in GPE = mgh = 300(10)(30) = 90000 J	1
		(iii)	Elastic potential energy at the start = GPE + KE at 30 m 510000 = 90000 + KE KE = 420000 J KE = 1/2 m v^2 420000 = ½ (300) v^2 v = 52.9 m/s	1 1 1
				10

Take $g = 10\ m/s^2$ for all relevant questions.

1 A pair of vernier calipers is used to measure the thickness of a dictionary. Fig. 1.1 shows the reading when the outside jaws closed without the dictionary. Fig. 1.2 shows the reading when the dictionary is held between the outside jaws.

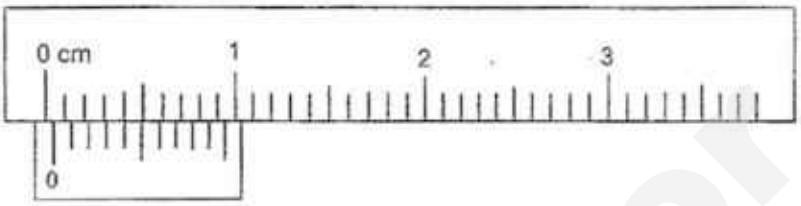


Fig. 1.1

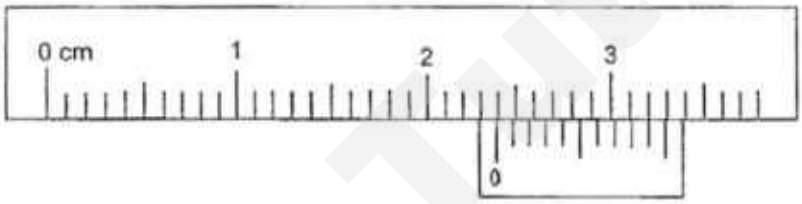


Fig. 1.2

What is the actual thickness of the dictionary?

A 2.18 cm **B** 2.25 cm
C 2.28 cm **D** 2.35 cm

2 Fig. 2.1 shows the reading on a micrometer screw gauge when the anvil and spindle are fully closed. Fig. 2.2 shows the reading when measuring the thickness of a coin.

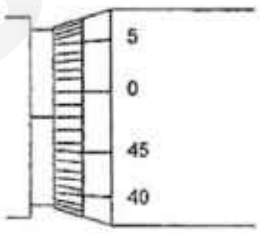


Fig. 2.1

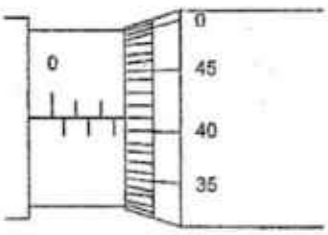
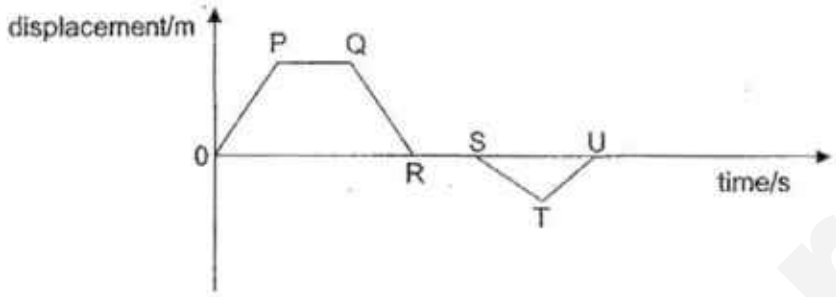


Fig. 2.2

What is the thickness of the coin?

A 2.89 mm **B** 2.93 mm
C 5.41 mm **D** 5.43 mm

3 The graph below shows how the displacement of an object varies with time.



Which of the following statements about the motion of the object is **correct**?

A The object is travelling with constant velocity during the interval PQ.
B The object is moving away from its starting point during the interval QR.
C The object is travelling with constant velocity during the interval ST.
D The object has constant acceleration during the interval TU.

4 A gravitational field is

A a region is which a mass experiences a gravitational force.
B a gravitational force which is exerted on a mass.
C a force which acts against gravity.
D a region in which a mass experiences inertia which affects its state of rest or motion.

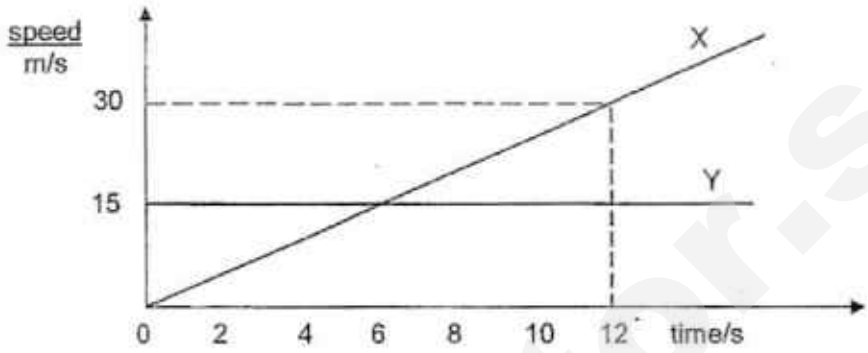
5 A parachutist falling vertically opens his parachute. Immediately after opening his parachute, he decelerates uniformly for a short interval of time. Which of the following statements correctly describes what happens during this short interval?

A His weight is lesser than the air resistance force opposing his motion.
B As he decelerates, the air resistance opposing his motion increases.
C His weight is greater than the air resistance force opposing his motion.
D As he decelerates, the air resistance opposing his motion remains equal in magnitude to his weight.

6 A rover sent to the planet Mars has a weight of 532 N on Mars where the gravitational field strength is 3.8 N/kg. What is the weight of the rover on earth if the gravitational field strength of the earth is 10 N/kg?

A 53 N
B 140 N
C 200 N
D 1400 N

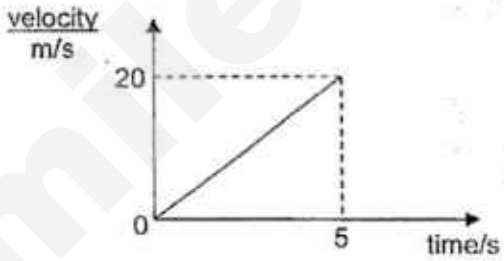
7 Two motorcycles X and Y start from the same point on a level road at different speeds, as shown in the graph below. The motorcycles travel in a straight line.



What is the time that the two motorcycles meet?

A 4 s
B 6 s
C 8 s
D 12 s

8 The diagram below shows the velocity-time graph of a 1500 kg car that moves off from rest from a traffic junction.



What is the total frictional force acting against the car in the first 2 s if the forward engine force of the car is 6500 N?

A 60 N
B 500 N
C 6000 N
D 12500 N

9 A brass ring is used to imitate a real gold ring. It has a composition of 12 g of copper and 4 g of zinc. If the density of copper is 9.0 g/cm^3 and the density of zinc is 7.1 g/cm^3, what is the density of the ring?

A 6.5 g/cm^3
B 8.1 g/cm^3
C 8.6 g/cm^3
D 17 g/cm^3

130

10 The table shows the result of an experiment in which a solid object is placed in four different liquids. The solid object does not dissolve in the liquids.

liquid	density of liquid / kgm^{-3}	observation
mercury	13600	floats
water	1000	floats
kerosene	810	sinks
organic compound	450	sinks

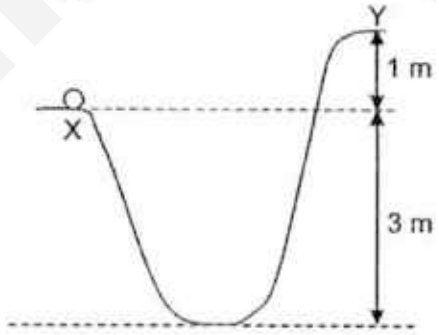
What is the density of the solid object?

A Between 1000 kg/m^3 and 13600 kg/m^3
B Between 810 kg/m^3 and 1000 kg/m^3
C Exactly 1000 kg/m^3
D Exactly 810 kg/m^3

11 Two constant forces of magnitude 3.0 N and 9.0 N act on a body at rest. Which of the following forces cannot be the resultant force of these two forces?

A 5.1 N
B 7.5 N
C 9.9 N
D 11 N

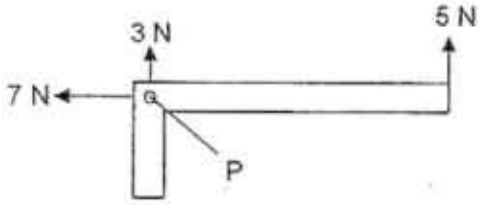
12 The diagram below shows a marble of mass 25 g at the top of a slope at point X. Assume that friction is negligible. Gravitational field strength is 10 N/kg.



What is the amount of kinetic energy that must be given to the marble such that it can reach point Y?

A 0.10 J
B 0.25 J
C 0.75 J
D 1.0 J

13 The diagram shows three forces acting on an L-shaped uniform metal bar pivoted at P.



Assuming the weight of the bar is negligible, the bar will

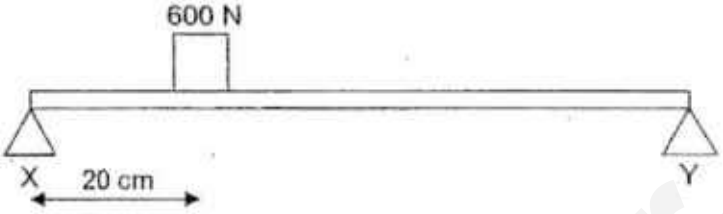
A turn anti-clockwise.
B remain in equilibrium.
C turn clockwise.
D turn clockwise followed by anti-clockwise.

14 The diagram below shows a tightrope walker carrying a long pole.

Why does he carry the long pole?

A To raise his centre of gravity to make him more stable.
B To allow him to keep his centre of gravity over the rope.
C So that his contact with the rope is greater, preventing him from toppling over.
D To increase the frictional force between him and the rope.

15 An object of weight 600 N is placed on a uniform, rigid, horizontal plank supported at points X and Y as shown below. The plank weighs 900 N and is 1.2 m long.



What is the force exerted on the plank by support X?

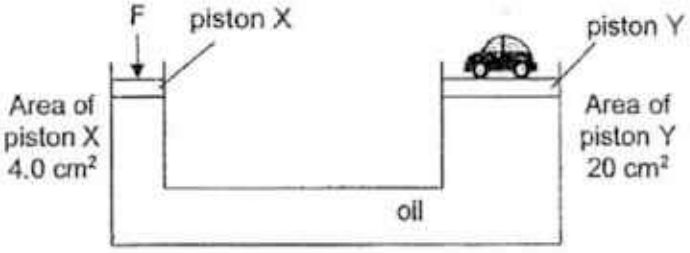
A 150 N
B 450 N
C 950 N
D 1100 N

16 The diagram shows a plane circular lamina with three equal-sized holes drilled in it. In which quadrant is the center of gravity most likely to be?

17 A car moves at a constant speed of 18 m/s on a road. The frictional force opposing the car's motion is 150 N. What is the power developed by the engine of the car?

A 8.3 W
B 130 W
C 160 W
D 2700 W

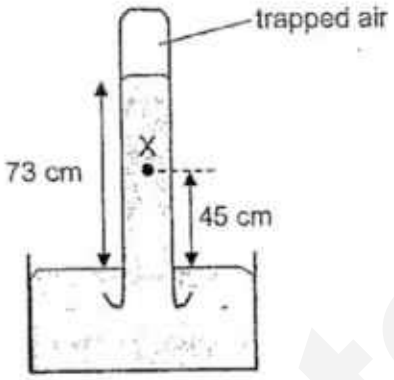
18 The diagram shows a simple hydraulic jack used to lift a car of mass 2000 kg. Gravitational field strength is 10 N/kg.



What is the force F required to lift the car?

A 1000 N
B 2000 N
C 4000 N
D 8000 N

19 The diagram below shows a faulty mercury barometer that has some air trapped at the top. The atmospheric pressure is 76 cmHg. What is the pressure at point X?



A 28 cmHg
B 31 cmHg
C 73 cmHg
D 79 cmHg

20 The diagram shows a man lying flat across the thin ice and crawling to rescue his dog that has fallen into the icy water.

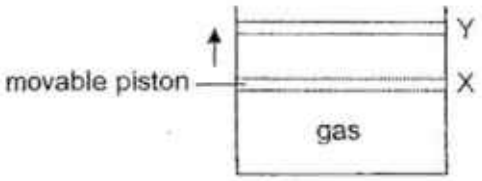
Why does the man lie down on the ice as he crawls across it?

A To lower his centre of gravity to make him more stable.
B To increase the rate of conduction of heat away from him.
C So that the line of action of his weight is within his base area.
D To reduce his pressure exerted on the ice.

21 Which of the following is **not** a suitable thermometric property?

A Weight of a fixed mass of solid at constant pressure
B Volume of a fixed mass of liquid
C Electrical resistance of a piece of metal
D Pressure of a fixed mass of gas at constant volume

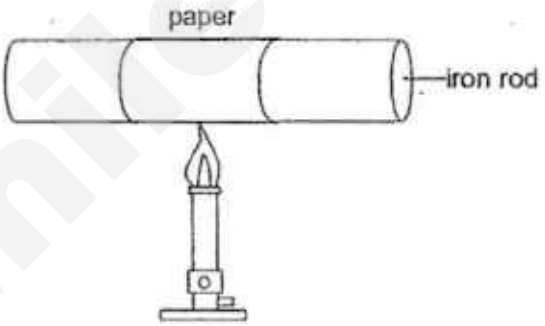
22 The diagram shows a gas enclosed in a container with a movable piston. The weight of the piston is negligible. Homer notices that when the gas is heated, the piston moves from X to Y.



Which of the following statements about Homer's observation is correct?

A The average distance between the gas molecules remains constant.
B The average kinetic energy of the gas molecules remains constant.
C The pressure of the gas remains constant.
D The average size of the gas molecules has increased.

23 The diagram shows a piece of paper wrapped around an iron rod and placed above a luminous Bunsen flame. Bart notices that the paper does not catch fire although it is placed above the flame for some time.



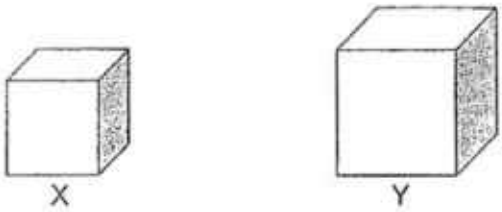
Which of the following statement best describes why the paper does not catch fire?

A The paper radiates thermal energy away.
B The iron rod conducts thermal energy away from the paper.
C Convection currents in the air carry thermal energy away from the paper.
D Air at high pressure near the paper moves towards the low pressure air around the rod, carrying thermal energy away.

24 A liquid is heated and its temperature rises. Which of the following statements about the particles of the liquid is correct?

A The kinetic energy and internal energy of the liquid particles remain constant.
B The kinetic energy of the liquid particles remains constant but the internal energy of the liquid particles increases.
C The kinetic energy of the liquid particles increases but the internal energy of the liquid particles remains constant.
D The kinetic energy and internal energy of the liquid particles increase.

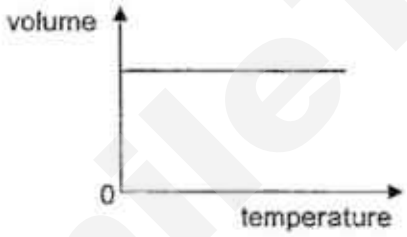
25 The diagram shows two cubes made of the same material but of different masses. Cube Y has twice the mass of cube X.



Which of the following statements is correct?

A Both cubes have the same heat capacities.
B Cube X has a larger heat capacity than cube Y.
C Cube Y has a larger specific heat capacity than cube X.
D Both cubes have the same specific heat capacities.

26 The graph below shows how the volume of gas in a container varies with temperature.



Which of the following statements correctly describes the gas?

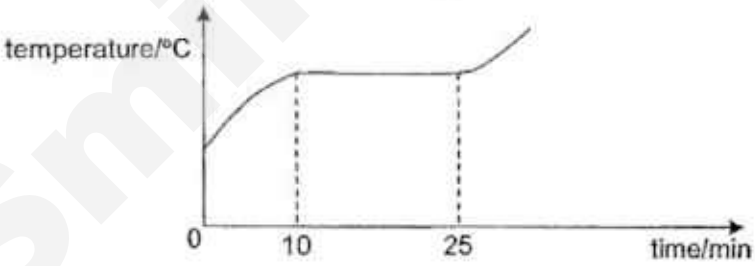
A The pressure of the gas is decreasing.
B The pressure of the gas remains constant.
C The pressure of the gas is increasing.
D The pressure of the gas remains constant for a while and then decreases.

27 A man stands beside a small fire to warm his legs and hands.

How does **most** of the thermal energy reach his legs and hands?

	Legs	Hands
A	radiation	convection
B	convection	radiation
C	conduction	radiation
D	radiation	radiation

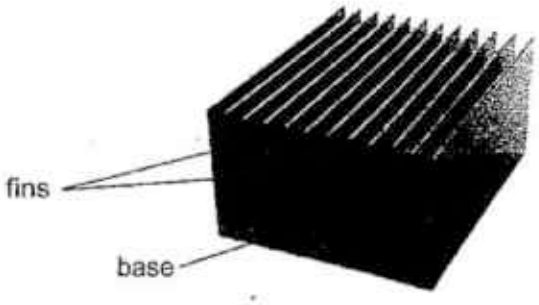
28 The graph shows how the temperature of a solid X of mass 400 g varies as it is heated by a heater of power 200 W.



What is the specific latent heat of fusion of X?

A 5000 J/kg
B 12500 J/kg
C 300000 J/kg
D 450000 J/kg

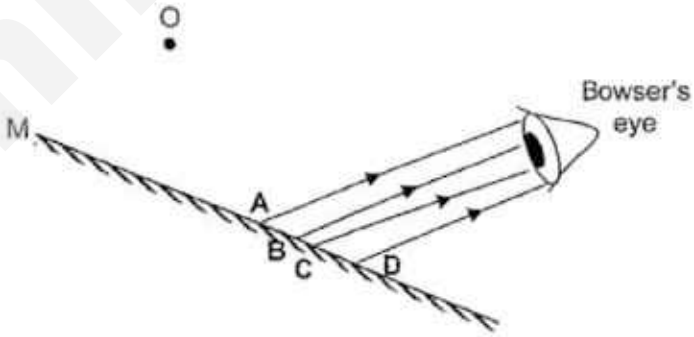
29 The diagram shows a heat sink that is used to cool hot components in a computer. The sink is attached by its base to the components and consists of protruding fins.



What is the purpose of the fins?

A To allow more thermal energy to be conducted from the base.
B To increase the surface area and rate of radiation of thermal energy.
C To increase the surface area so that more thermal energy can be absorbed from the surrounding air.
D To allow more thermal energy to be conducted from the surrounding air to the surface of the fins.

30 The diagram shows an object O placed in front of a plane mirror M. Bowser sees the image of O in the mirror M. Which of the reflected rays drawn is correct?



End of Paper

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For Examiner's Use

SECTION A

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

1 A remote-controlled car starts from rest at t = 0 s and travels in a straight line. Fig. 1 shows the velocity-time graph for the car for the starting part of its journey.

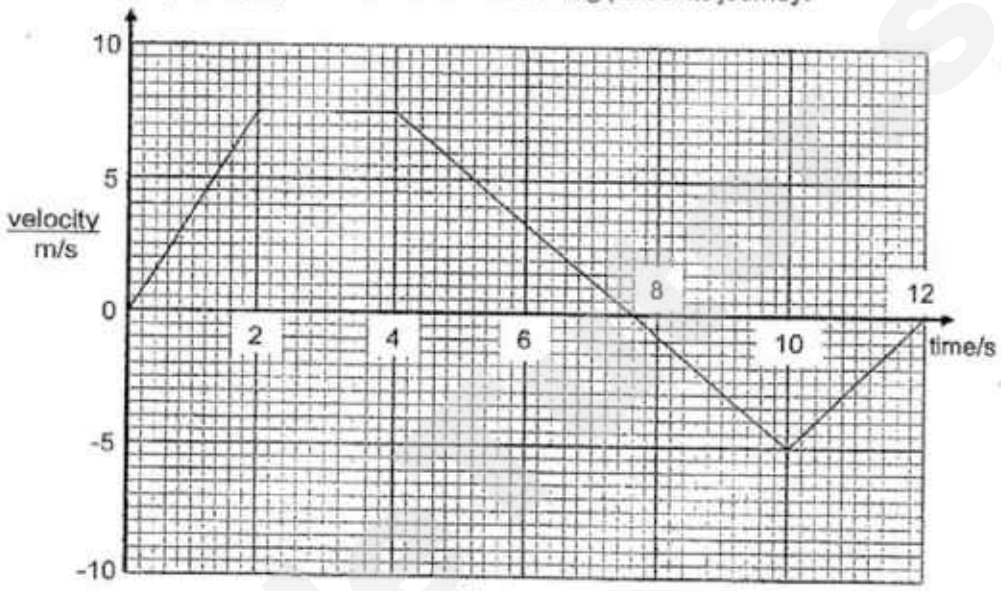

Fig. 1

(a) Define acceleration.

..... [1]

(b) Calculate the acceleration of the car from t = 0 s to t = 2 s.

acceleration = ... [2]

(c) Describe the motion of car from t = 4 s to t = 10 s, **stating all relevant values of velocity and time.**

.....

.....

.....

.....

.....

..... [2]

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(d) Calculate the total displacement of the car from t = 0 s to t = 12 s.

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total displacement = ... [2]

2 Fig. 2 shows a man pushing two boxes X and Y across a rough floor by exerting an 8.0 N constant horizontal force on box X.

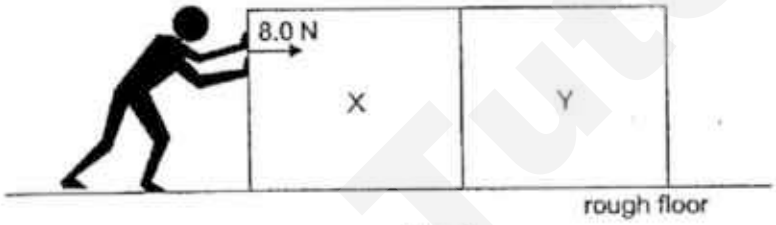

Fig. 2

Box X has a mass of 1.8 kg and box Y has a mass of 0.60 kg. The boxes accelerate uniformly along the rough floor. The frictional force acting on box X is 2.0 N and the frictional force acting on box Y is 1.2 N.

(a) In the space below, draw the free body diagrams for both box X and box Y, showing only the **horizontal** forces. [2]

(b) Calculate the acceleration of the boxes.

acceleration = ... [2]

(c) Determine the force that box Y exerts box X.

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force = ... [2]

3 Fig. 3 shows a 5.0 kg block at rest on an incline at X. A constant force of 50 N is used to push the block 6.0 m up the incline and it reaches the top at Y with a speed of 2.5 m/s. Point Y is 4.0 m vertically above point X. Gravitational field strength is 10 N/kg.

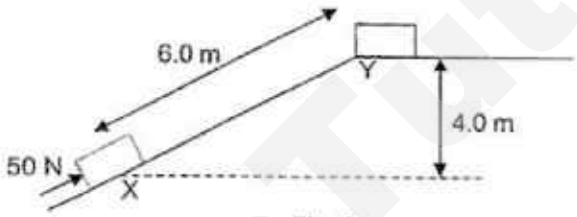

Fig. 3

(a) Calculate the total work done by the 50 N force.

work done = ... [1]

(b) Calculate the gain in kinetic energy of the block from X to Y.

gain in kinetic energy = ... [2]

(c) Calculate the gain in gravitational potential energy of the block from X to Y.

gain in gravitational potential energy = ... [2]

(d) Calculate the frictional force opposing the motion of the block, assuming it is constant.

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frictional force = ... [2]

4 Fig. 4 shows a mercury manometer used to measure the gas pressure of a gas container. The density of mercury is 13600 kg/m^3, gravitational field strength is 10 N/kg and atmospheric pressure is 1 x 10^5 Pa.

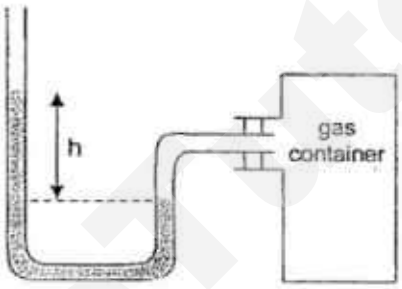

Fig. 4

(a) The pressure of the gas container is 140000 Pa.
Determine h.

h = ... [2]

(b) Describe and explain, using the Kinetic Model of Matter, the change to h, if any, when the gas in the container is heated.

.....

.....

.....

.....

..... [3]

5 Fig. 5 shows a retort stand with a mass holder held at the clamp. The centre of gravity of the stand is at X.

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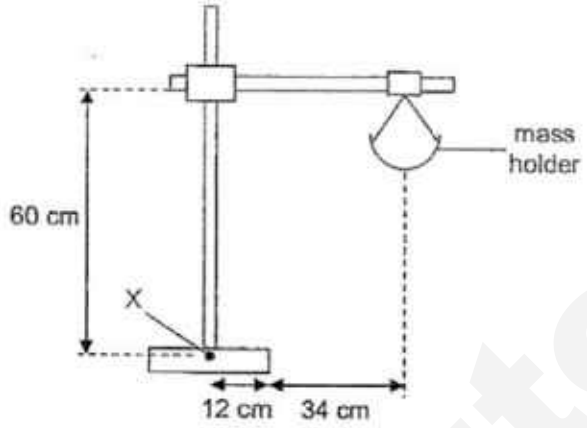

Fig. 5

(a) State the Principle of Moments.

.....

.....

..... [1]

(b) Mario notices that the retort stand is about to topple when the mass added is 600 g. Calculate the mass of the retort stand.

mass = ... [2]

(c) State one assumption that was made when answering part (b).

..... [1]

(d) Luigi suggests lowering the mass holder so that the retort stand is able to hold more than 600 g in the holder. Explain why this will not work.

.....

.....

..... [1]

(e) State two methods that the student can use to allow the retort stand to hold more mass in the holder without toppling over.

.....

.....

[2]

For Examiner's Use

6 Rosalina observed the motion of pollen particles suspended in water through a microscope. Fig. 6 shows her observation of one pollen particle.

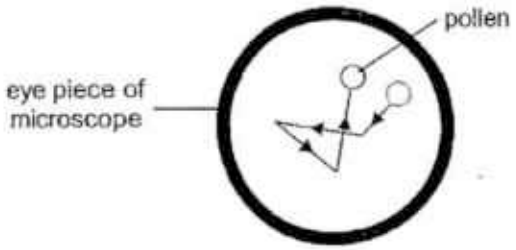

Fig. 6

(a) Rosalina observed one pollen particle and noticed that it moved continuously and randomly. Explain why the particles move about in such a manner.

.....

.....

..... [2]

(b) State what Rosalina would observe if the pollen particles were larger.

..... [1]

7 When one junction of a thermocouple is removed from melting ice and placed in steam above boiling water, the voltage reading of the thermocouple changes from 0.24 mV to 3.33 mV.

(a) Explain why the thermocouple must be placed **above** the boiling water, and not in the boiling water.

..... [1]

(b) Determine the voltage reading of the thermocouple when it is placed in a liquid of temperature 58°C.

voltage = ... [2]

(c) Thermocouples are known to have low heat capacities.

(i) Define *heat capacity* of a substance.

.....

..... [1]

(ii) Explain how this is an advantage in the use of thermocouples as thermometers.

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.....

.....

..... [1]

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For Examiner's Use

SECTION B

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

8 A 550 g copper block is heated to a temperature of 100 °C. The copper block is then immediately transferred to a polystyrene cup containing water at a room temperature of 26°C as shown in Fig. 8.1 below.

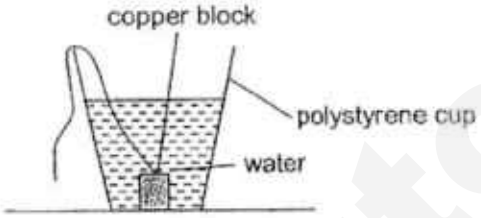

Fig. 8.1

Readings of the water temperature are taken at intervals of 10 s immediately after the copper block is lowered into the water. The mass of water in the cup is 130 g. Fig. 8.2 shows the graph of the variation of the temperature of water in the cup against time. The specific heat capacity of water is 4200 J/(kg°C).

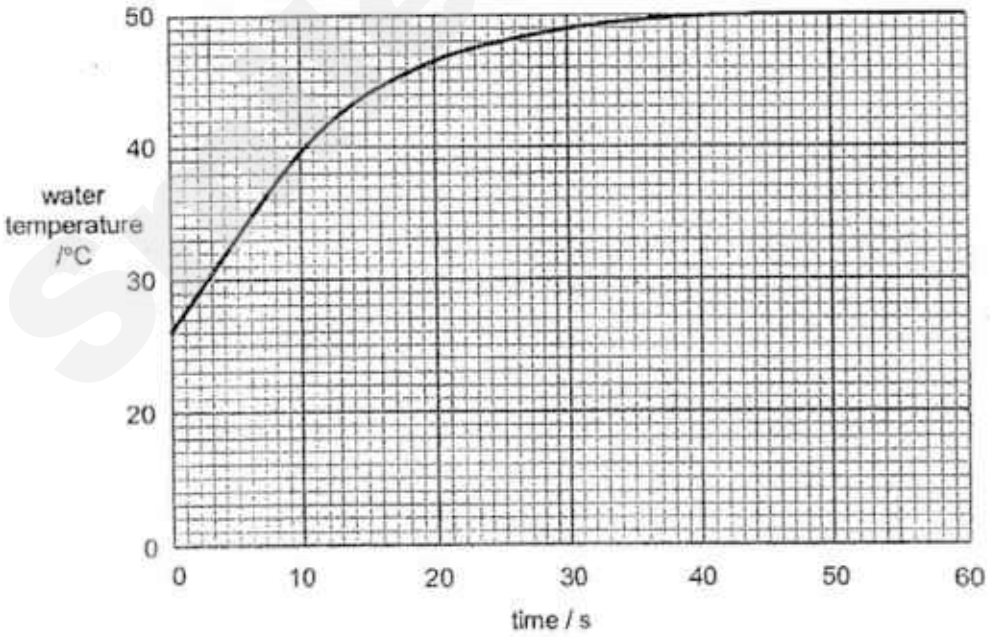

Fig. 8.2

(a) Explain, in terms of heat transfer, why the water temperature remains constant after 50 s.

.....

..... [1]

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(b) Explain why polystyrene is chosen as the material for the cup.

.....

.....

..... [2]

(c) Describe how heat is transferred in the water as the water is heated up by the copper block.

.....

.....

.....

.....

..... [2]

(d) Calculate the heat gained by the water in the cup.

heat gained by water = ... [2]

(e) Hence, calculate the specific heat capacity of the copper block, assuming that the initial temperature of the copper block was 100 °C.

heat capacity of copper = ... [2]

(f) State one assumption in your calculations in part (e).

.....

..... [1]

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For Examiner's Use

9 Fig. 9 shows a ray of light entering a transparent prism ABCD at X, totally internally reflected at Y and then travelling along side CD after being incident at Z.

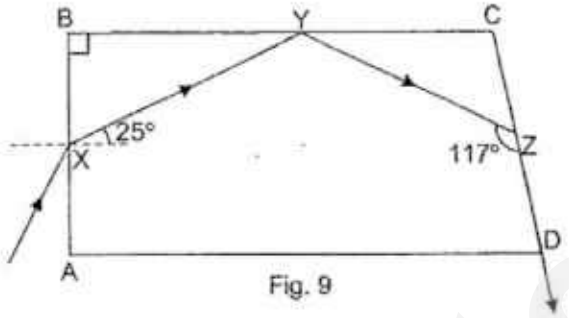

Fig. 9

(a) Define *critical angle*. [1]

.....

.....

(b) Determine the critical angle of the prism.

critical angle = ... [1]

(c) Hence, calculate the refractive index of the prism.

refractive index = ... [2]

(d) Calculate the angle of incidence of the light ray at X.

angle of incidence = ... [2]

(e) Determine the speed of the light ray through the prism.

speed = ... [2]

(f) State the two conditions for the light ray to be totally internally reflected at Y.

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.....

.....

.....

..... [2]

10 Fig. 10 shows an air bubble 55 m below the surface of a lake.

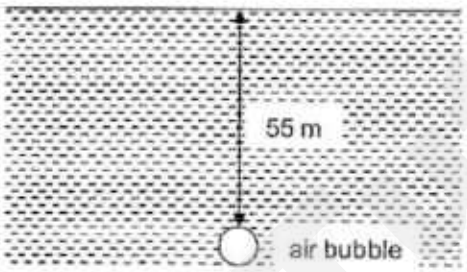

Fig. 10

The atmospheric pressure is 74 cmHg, density of the lake water is 1050 kg/m^3, the density of mercury is 13500 kg/m^3 and the gravitational field strength is 10 N/kg.

(a) Calculate the atmospheric pressure in Pa.

atmospheric pressure = ... [2]

(b) Calculate the pressure exerted on the air bubble when it is 55 m below the surface of the lake.

pressure = ... [2]

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(c) The bubble then rises to the surface of the lake and remains there. Describe and explain the change, if any, to the **pressure exerted by the water** on the air bubble as it rises.

.....

.....

.....

..... [2]

(d) The volume of the air bubble increases and the **air pressure inside** the bubble decreases as it rises up the lake.
Explain, in terms of the kinetic model of matter, why the air pressure inside the bubble decreases as the volume of the bubble increases. Assume the temperature of the lake water is constant throughout.

.....

.....

.....

..... [2]

(e) The volume of the air bubble 55 m below the surface of the lake is 0.50 cm^3. Calculate the volume of the air bubble at the surface of the lake.

volume = ... [2]

End of Paper

Take $g = 10\ m/s^2$ for all relevant questions.

1 A pair of vernier calipers is used to measure the thickness of a dictionary. Fig. 1.1 shows the reading when the outside jaws closed without the dictionary. Fig. 1.2 shows the reading when the dictionary is held between the outside jaws.

Zero error = + 0.04 cm
Actual reading = 2.39 – (+0.04) = 2.35 cm

Fig. 1.1

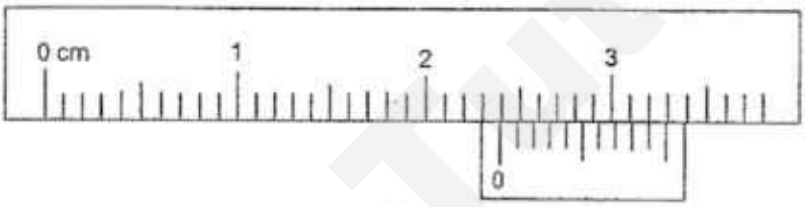

Fig. 1.2

What is the actual thickness of the dictionary?

A 2.18 cm
B 2.25 cm
C 2.28 cm
D 2.35 cm

2 Fig. 2.1 shows the reading on a micrometer screw gauge when the anvil and spindle are fully closed. Fig. 2.2 shows the reading when measuring the thickness of a coin.

Thickness = 2.91 – (-0.02) = 2.93 mm

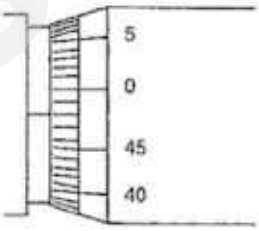

Fig. 2.1

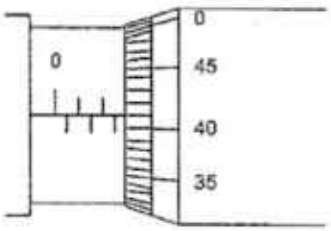

Fig. 2.2

What is the thickness of the coin?

A 2.89 mm
B 2.93 mm
C 5.41 mm
D 5.43 mm

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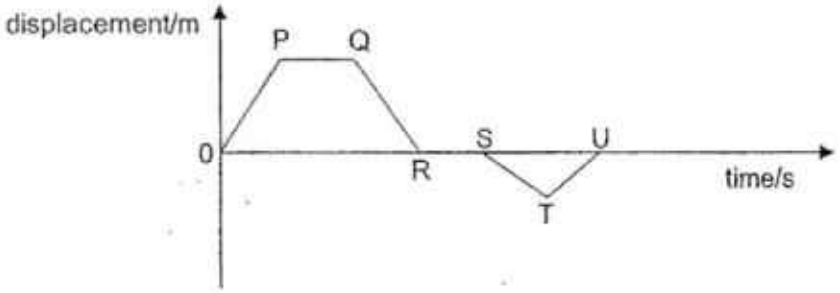
3 The graph below shows how the displacement of an object varies with time.



Which of the following statements about the motion of the object is **correct**?

A The object is travelling with constant velocity during the interval PQ.
B The object is moving away from its starting point during the interval QR.
C The object is travelling with constant velocity during the interval ST.
D The object has constant acceleration during the interval TU.

4 A gravitational field is

A a region in which a mass experiences a gravitational force.
B a gravitational force which is exerted on a mass.
C a force which acts against gravity.
D a region in which a mass experiences inertia which affects its state of rest or motion.

5 A parachutist falling vertically opens his parachute. Immediately after opening his parachute, he decelerates uniformly for a short interval of time. Which of the following statements correctly describes what happens during this short interval?

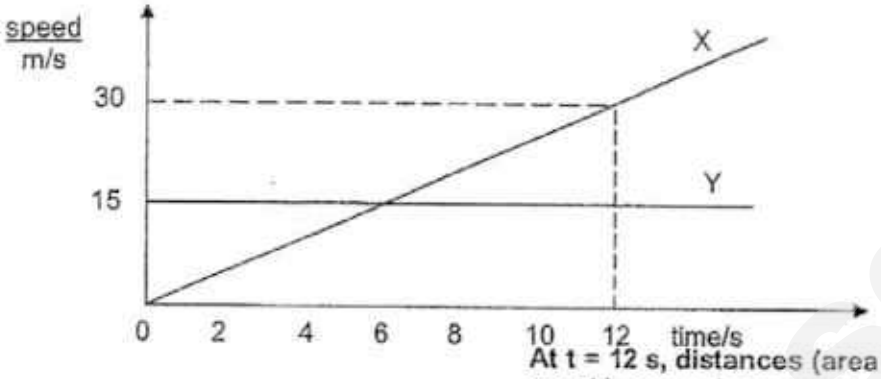
A His weight is lesser than the air resistance force opposing his motion.
B As he decelerates, the air resistance opposing his motion increases.
C His weight is greater than the air resistance force opposing his motion.
D As he decelerates, the air resistance opposing his motion remains equal in magnitude to his weight.

6 A rover sent to the planet Mars has a weight of 532 N on Mars where the gravitational field strength is 3.8 N/kg. What is the weight of the rover on earth if the gravitational field strength of the earth is 10 N/kg?

A 53 N
B 140 N
C 200 N
D 1400 N

W = mg
532 = m x 3.8
m = 140 kg
W = mg
W = 140 x 10 = 1400 N

7 Two motorcycles X and Y start from the same point on a level road at different speeds, as shown in the graph below. The motorcycles travel in a straight line.



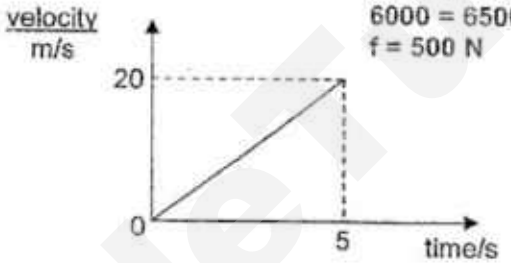
At t = 12 s, distances (area under graph) covered are equal.

What is the time that the two motorcycles meet?

A 4 s
B 6 s
C 8 s
D 12 s

8 The diagram below shows the velocity-time graph of a 1500 kg car that moves off from rest from a traffic junction.

F = ma = 1500 x 20/5 = 6000 N
6000 = 6500 – f
f = 500 N



What is the total frictional force acting against the car in the first 2 s if the forward engine force of the car is 6500 N?

A 60 N
B 500 N
C 6000 N
D 12500 N

9 A brass ring is used to imitate a real gold ring. It has a composition of 12 g of copper and 4 g of zinc. If the density of copper is 9.0 g/cm³ and the density of zinc is 7.1 g/cm³, what is the density of the ring?

volume of copper = 12/9 = 1.3 cm³
volume of zinc = 4/7.1 = 0.56
density = 16/(1.3 + 0.56) = 8.6 g/cm³

A 6.5 g/cm³
B 8.1 g/cm³
C 8.6 g/cm³
D 17 g/cm³

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10 The table shows the result of an experiment in which a solid object is placed in four different liquids. The solid object does not dissolve in the liquids.

liquid	density of liquid / kgm^{-3}	observation
mercury	13600	floats
water	1000	floats
kerosene	810	sinks
organic compound	450	sinks

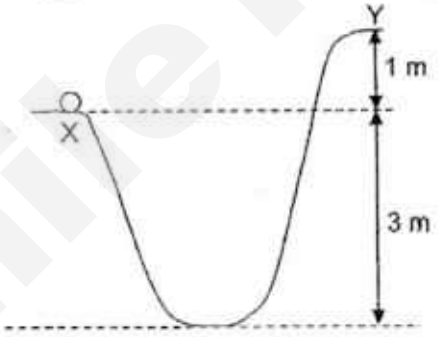
What is the density of the solid object?

A Between 1000 kg/m^3 and 13600 kg/m^3
B Between 810 kg/m^3 and 1000 kg/m^3
C Exactly 1000 kg/m^3
D Exactly 810 kg/m^3

11 Two constant forces of magnitude 3.0 N and 9.0 N act on a body at rest. Which of the following forces cannot be the resultant force of these two forces?

A 5.1 N
B 7.5 N
C 9.9 N
D 11 N

12 The diagram below shows a marble of mass 25 g at the top of a slope at point X. Assume that friction is negligible. Gravitational field strength is 10 N/kg.

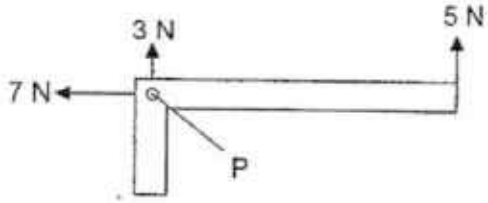


KE given = gain in GPE = 0.025 x 10 x 1 = 0.25 J

What is the amount of kinetic energy that must be given to the marble such that it can reach point Y?

A 0.10 J
B 0.25 J
C 0.75 J
D 1.0 J

13 The diagram shows three forces acting on an L-shaped uniform metal bar pivotec at P.



Assuming the weight of the bar is negligible, the bar will

A turn anti-clockwise.
B remain in equilibrium.
C turn clockwise.
D turn clockwise followed by anti-clockwise.

14 The diagram below shows a tightrope walker carrying a long pole.

Why does he carry the long pole?

A To raise his centre of gravity to make him more stable.
B To allow him to keep his centre of gravity over the rope.
C So that his contact with the rope is greater, preventing him from toppling over.
D To increase the frictional force between him and the rope.

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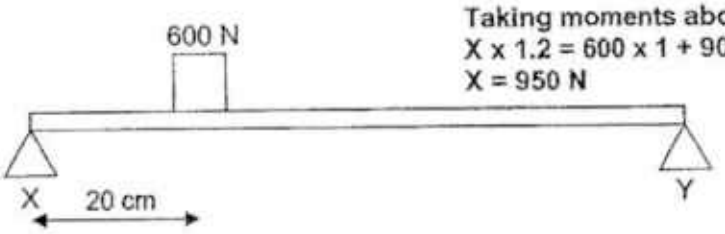
15 An object of weight 600 N is placed on a uniform, rigid, horizontal plank supported at points X and Y as shown below. The plank weighs 900 N and is 1.2 m long.



Taking moments about X,
X x 1.2 = 600 x 1 + 900 x 0.6
X = 950 N

What is the force exerted on the plank by support X?

A 150 N
B 450 N
C 950 N
D 1100 N

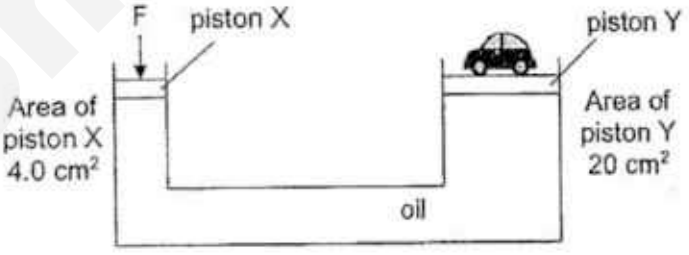
16 The diagram shows a plane circular lamina with three equal-sized holes drilled in it. In which quadrant is the center of gravity most likely to be?

17 A car moves at a constant speed of 18 m/s on a road. The frictional force opposing the car's motion is 150 N. What is the power developed by the engine of the car?

A 8.3 W
B 130 W
C 160 W
D 2700 W

P = Wd/t
P = (f x d)/t = f x d/t = f x v
P = 150 x 18 = 2700 N

18 The diagram shows a simple hydraulic jack used to lift a car of mass 2000 kg. Gravitational field strength is 10 N/kg.

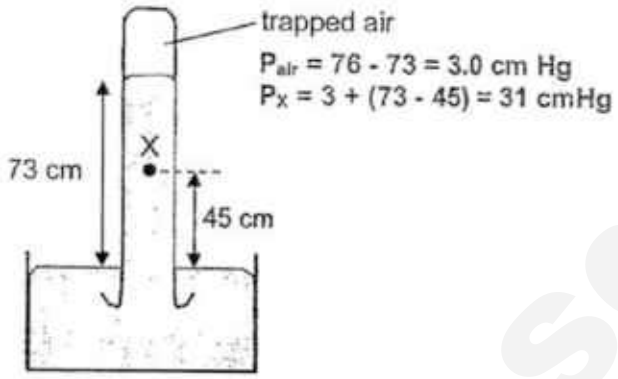


F/4 = 20000/20
F = 4000 N

What is the force F required to lift the car?

A 1000 N
B 2000 N
C 4000 N
D 8000 N

19 The diagram below shows a faulty mercury barometer that has some air trapped at the top. The atmospheric pressure is 76 cmHg. What is the pressure at point X?



A 28 cmHg
B 31 cmHg
C 73 cmHg
D 79 cmHg

20 The diagram shows a man lying flat across the thin ice and crawling to rescue his dog that has fallen into the icy water.

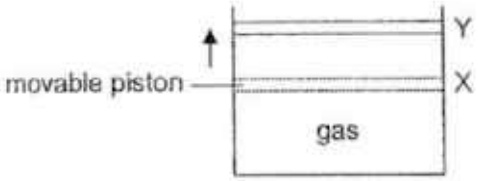
Why does the man lie down on the ice as he crawls across it?

A To lower his centre of gravity to make him more stable.
B To increase the rate of conduction of heat away from him.
C So that the line of action of his weight is within his base area.
D To reduce his pressure exerted on the ice.

21 Which of the following is **not** a suitable thermometric property?

A Weight of a fixed mass of solid at constant pressure
B Volume of a fixed mass of liquid
C Electrical resistance of a piece of metal
D Pressure of a fixed mass of gas at constant volume

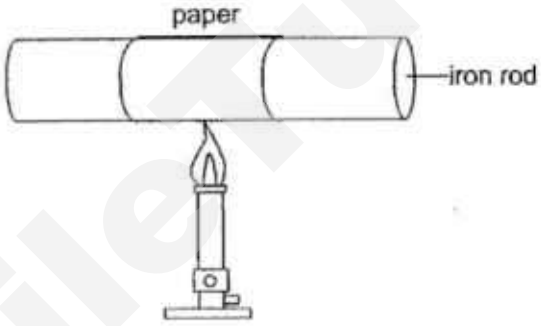
22 The diagram shows a gas enclosed in a container with a movable piston. The weight of the piston is negligible. Homer notices that when the gas is heated, the piston moves from X to Y.



Which of the following statements about Homer's observation is correct?

A The average distance between the gas molecules remains constant.
B The average kinetic energy of the gas molecules remains constant.
C The pressure of the gas remains constant.
D The average size of the gas molecules has increased.

23 The diagram shows a piece of paper wrapped around an iron rod and placed above a luminous Bunsen flame. Bart notices that the paper does not catch fire although it is placed above the flame for some time.



Which of the following statement best describes why the paper does not catch fire?

A The paper radiates thermal energy away.
B The iron rod conducts thermal energy away from the paper.
C Convection currents in the air carry thermal energy away from the paper.
D Air at high pressure near the paper moves towards the low pressure air around the rod, carrying thermal energy away.

24 A liquid is heated and its temperature rises. Which of the following statements about the particles of the liquid is correct?

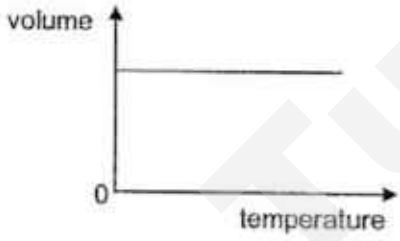
A The kinetic energy and internal energy of the liquid particles remain constant.
B The kinetic energy of the liquid particles remains constant but the internal energy of the liquid particles increases.
C The kinetic energy of the liquid particles increases but the internal energy of the liquid particles remains constant.
D The kinetic energy and internal energy of the liquid particles increase.

25 The diagram shows two cubes made of the same material but of different masses. Cube Y has twice the mass of cube X.

Which of the following statements is correct?

A Both cubes have the same heat capacities.
B Cube X has a larger heat capacity than cube Y.
C Cube Y has a larger specific heat capacity than cube X.
D Both cubes have the same specific heat capacities.

26 The graph below shows how the volume of gas in a container varies with temperature.



Which of the following statements correctly describes the gas?

A The pressure of the gas is decreasing.
B The pressure of the gas remains constant.
C The pressure of the gas is increasing.
D The pressure of the gas remains constant for a while and then decreases.

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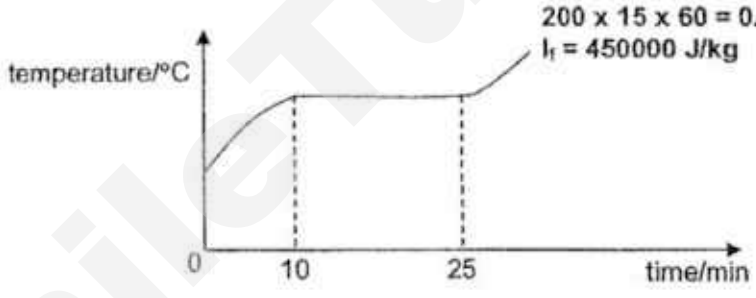
27 A man stands beside a small fire to warm his legs and hands.

How does **most** of the thermal energy reach his legs and hands?

	Legs	Hands
A	radiation	convection
B	convection	radiation
C	conduction	radiation
D	radiation	radiation

28 The graph shows how the temperature of a solid X of mass 400 g varies as it is heated by a heater of power 200 W.

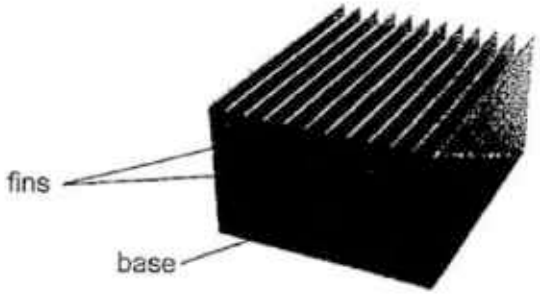
$Q = Pt = ml_f$
$200 \times 15 \times 60 = 0.4 \times l_f$
$l_f = 450000$ J/kg



What is the specific latent heat of fusion of X?

A 5000 J/kg
B 12500 J/kg
C 300000 J/kg
D 450000 J/kg

29 The diagram shows a heat sink that is used to cool hot components in a computer. The sink is attached by its base to the components and consists of protruding fins.



What is the purpose of the fins?

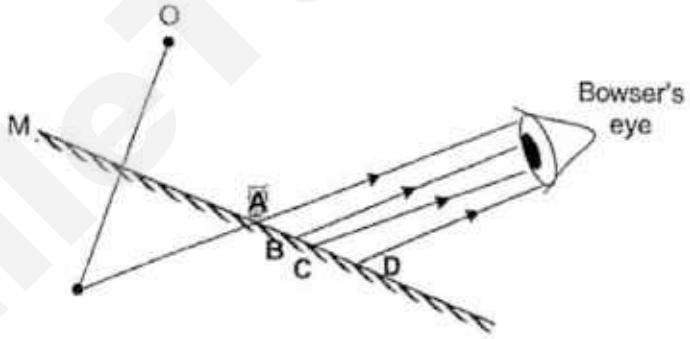
A To allow more thermal energy to be conducted from the base.

B To increase the surface area and rate of radiation of thermal energy.

C To increase the surface area so that more thermal energy can be absorbed from the surrounding air.

D To allow more thermal energy to be conducted from the surrounding air to the surface of the fins.

30 The diagram shows an object O placed in front of a plane mirror M. Bowser sees the image of O in the mirror M. Which of the reflected rays drawn is correct?



End of Paper

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SECTION A

For Examiner's Use

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

1 A remote-controlled car starts from rest at t = 0 s and travels in a straight line. Fig. 1 shows the velocity-time graph for the car for the starting part of its journey.

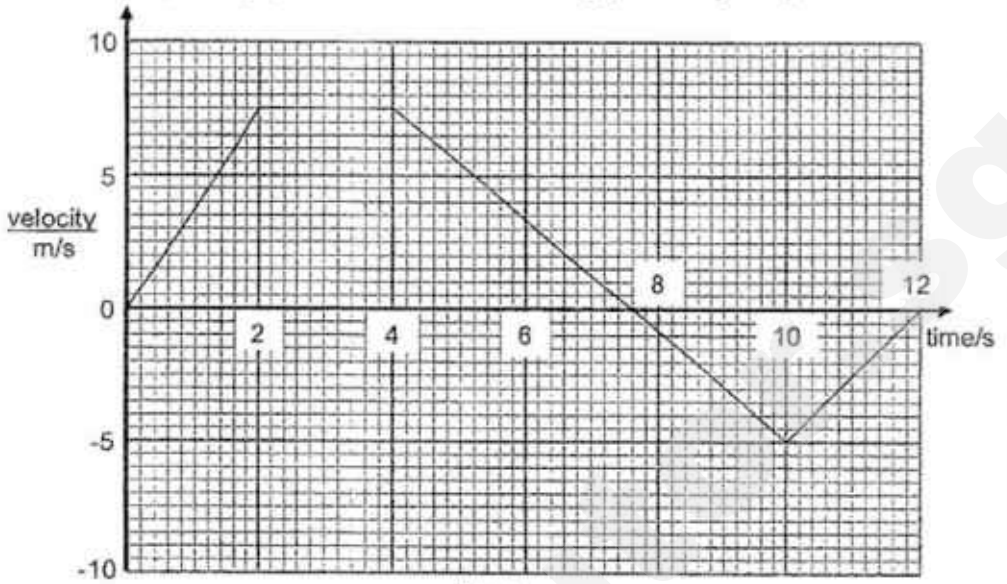


Fig. 1

(a) Define acceleration.

Rate of change of velocity/change of velocity per unit time. ..... [1]

(b) Calculate the acceleration of the car from t = 0 s to t = 2 s.

a = (v - u)/t
a = 7.5 / 2 [1]
a = 3.8 m/s² [1]

acceleration = ... [2]

(c) Describe the motion of car from t = 4 s to t = 10 s, **stating all relevant values of velocity and time.**

From t = 4 s to t = 5.6 s, the car decelerates uniformly from 7.5 m/s to rest. [1]
It then reverses direction and accelerates uniformly from rest to a velocity of 5 m/s [1]

[4]

..... [2]

For Examiner's Use

(d) Calculate the total displacement of the car from t = 0 s to t = 12 s.

displacement 1 = 1/2 x 7.5 x (2 + 7.6) = 36 m } [1]
displacement 2 = - 1/2 x 5 x 4.4 = -11 m
Total displacement = 36 - 11 = 25 m [1]

total displacement = ... [2]

2 Fig. 2 shows a man pushing two boxes X and Y across a rough floor by exerting an 8.0 N constant horizontal force on box X.

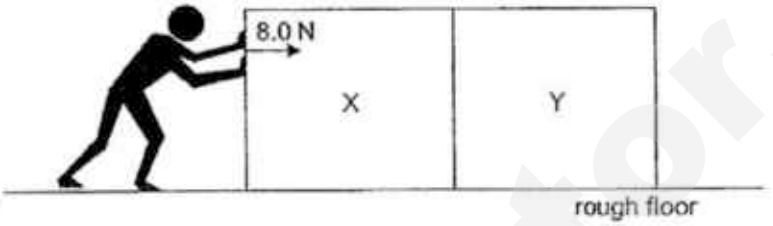
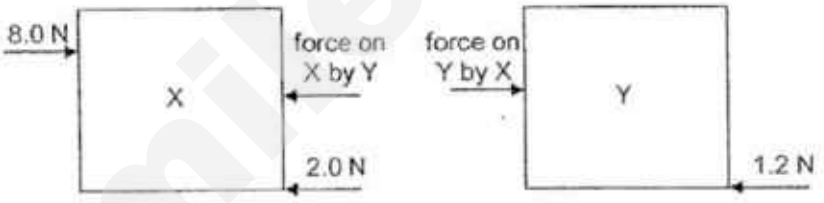


Fig. 2

Box X has a mass of 1.8 kg and box Y has a mass of 0.60 kg. The boxes accelerate uniformly along the rough floor. The frictional force acting on box X is 2.0 N and the frictional force acting on box Y is 1.2 N.

(a) In the space below, draw the free body diagrams for both box X and box Y, showing only the **horizontal** forces. [2]



(b) Calculate the acceleration of the boxes.

F = 8 – 2 – 1.2 = 4.8 N [1]
F = ma
4.8 = (1.8 + 0.6) x a
a = 2.0 m/s² [1]

acceleration = ... [2]

(c) Determine the force that box Y exerts box X.

For Examiner's Use

F = ma
F = 0.6 x 2 = 1.2 [1]
f – 1.2 = 1.2
f = 2.4 N

force = ... [2]

3 Fig. 3 shows a 5.0 kg block at rest on an incline at X. A constant force of 50 N is used to push the block 6.0 m up the incline and it reaches the top at Y with a speed of 2.5 m/s. Point Y is 4.0 m vertically above point X. Gravitational field strength is 10 N/kg.

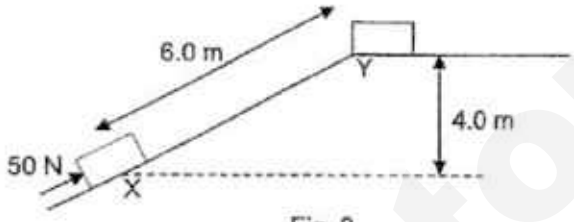


Fig. 3

(a) Calculate the total work done by the 50 N force.

Wd = f x d
Wd = 50 x 6 = 300 J

work done = ... [1]

(b) Calculate the gain in kinetic energy of the block from X to Y.

Gain in KE = ½ x m x v^2
= ½ x 5 x 2.5^2 [1]
= 16 J [1]

gain in kinetic energy = ... [2]

(c) Calculate the gain in gravitational potential energy of the block from X to Y.

Gain in GPE = mgh
= 5 x 10 x 4 [1]
= 200 J [1]

gain in gravitational potential energy = ... [2]

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(d) Calculate the frictional force opposing the motion of the block, assuming it is constant.

For Examiner's Use

Wd against friction = 300 – 200 – 16 = 84 J [1]
84 = f x 6
f = 14 N [1]

frictional force = ... [2]

4 Fig. 4 shows a mercury manometer used to measure the gas pressure of a gas container. The density of mercury is 13600 kg/m^3, gravitational field strength is 10 N/kg and atmospheric pressure is 1 x 10^5 Pa.

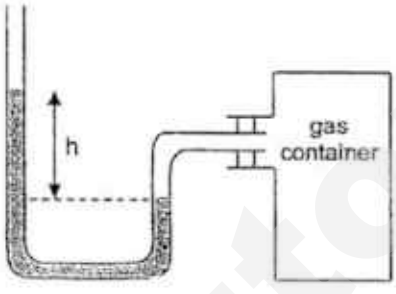

Fig. 4

(a) The pressure of the gas container is 140000 Pa.
Determine h.

100000 + P_L = 140000
P_L = 40000 Pa [1]
40000 = ρhg
40000 = 13600 x h x 10
h = 0.29 m [1]

h = ... [2]

(b) Describe and explain, using the Kinetic Model of Matter, the change to h, if any, when the gas in the container is heated.

h will increase [1]. The gas molecules will gain KE and move at greater speeds [1], colliding against the walls of the container more frequently and vigorously, exerting a greater force per unit area and pressure [1].

..... [3]

5 Fig. 5 shows a retort stand with a mass holder held at the clamp. The centre of gravity of the stand is at X.

For Examiner's Use

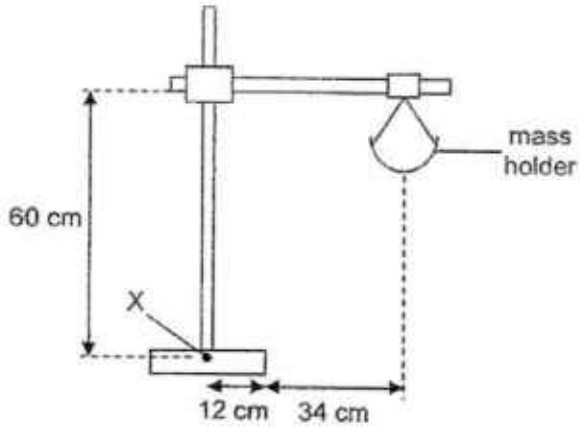

Fig. 5

(a) State the Principle of Moments.

For a body in equilibrium, the sum of the clockwise moments about a pivot is equal to the sum of the anticlockwise moments about the same pivot.

..... [1]

(b) Mario notices that the retort stand is about to topple when the mass added is 600 g. Calculate the mass of the retort stand.

acw = cw
m x g x 12 = 0.6 x g x 34 [1]
m = 1.7 kg [1]

mass = ... [2]

(c) State one assumption that was made when answering part (b).

The mass of the mass holder is negligible/the weight of the mass is at the centre of the holder [1]

(d) Luigi suggests lowering the mass holder so that the retort stand is able to hold more than 600 g in the holder. Explain why this will not work.

The perpendicular distance from the line of action of the weight of the mass remains the same. Hence the clockwise moments is still the same.

..... [1]

(e) State two methods that the student can use to allow the retort stand to hold more mass in the holder without toppling over.

Adjust the mass holder nearer to X / increase the base area of the stand / add more weight to the base of the stand

..... [2]

For Examiner's Use

6 Rosalina observed the motion of pollen particles suspended in water through a microscope. Fig. 6 shows her observation of one pollen particle.

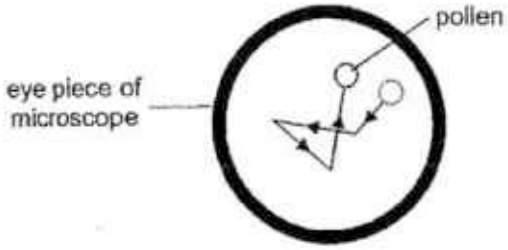

Fig. 6

(a) Rosalina observed one pollen particle and noticed that it moved continuously and randomly. Explain why the particles move about in such a manner.

The water molecules are moving continuously and randomly [1], and they are bombarding/colliding against the bigger pollen particles continuously and randomly [1]. ..... [2]

(b) State what Rosalina would observe if the pollen particles were larger.

The pollen particles would move slower/appear to be less agitated. ..... [1]

7 When one junction of a thermocouple is removed from melting ice and placed in steam above boiling water, the voltage reading of the thermocouple changes from 0.24 mV to 3.33 mV.

(a) Explain why the thermocouple must be placed **above** the boiling water, and not **in** the boiling water.

The temperature of the boiling water may not be 100°C at every point. ..... [1]

(b) Determine the voltage reading of the thermocouple when it is placed in a liquid of temperature 58°C.

$\theta = (V_\theta - V_0)/(V_{100} - V_0)$
$58 = (V_\theta - 0.24)/(3.33 - 0.24) \times 100$ [1]
$V_\theta = 2.0$ mV [1]

voltage = ... [2]

(c) Thermocouples are known to have low heat capacities.

(i) Define *heat capacity* of a substance.

The amount of thermal energy required to change the temperature of the substance by 1 K. ..... [1]

(ii) Explain how this is an advantage in the use of thermocouples as thermometers.

For Examiner's Use

A small change in thermal energy supplied to or removed from the thermocouple will cause a large change in temperature shown by the thermocouple, making it responsive OR it can detect small changes in temperature quickly.

[1]

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For Examiner's Use

SECTION B

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

8 A 550 g copper block is heated to a temperature of 100 °C. The copper block is then immediately transferred to a polystyrene cup containing water at a room temperature of 26°C as shown in Fig. 8.1 below.

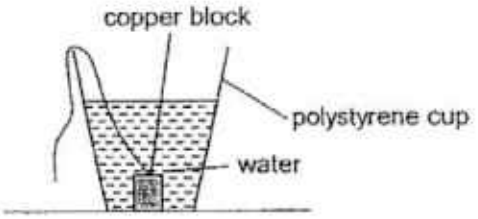

Fig. 8.1

Readings of the water temperature are taken at intervals of 10 s immediately after the copper block is lowered into the water. The mass of water in the cup is 130 g. Fig. 8.2 shows the graph of the variation of the temperature of water in the cup against time. The specific heat capacity of water is 4200 J/(kg°C).

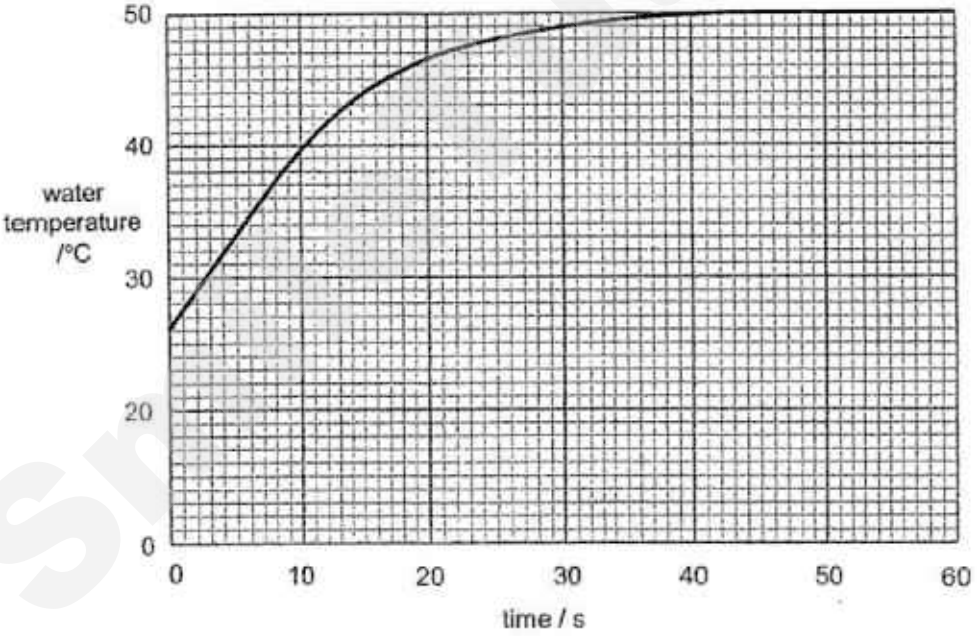

Fig. 8.2

(a) Explain, in terms of heat transfer, why the water temperature remains constant after 50 s.

There is no net gain or loss of heat energy by the water.

..... [1]

For Examiner's Use

(b) Explain why polystyrene is chosen as the material for the cup.

Polystyrene is a poor conductor of heat [1] and reduces the conduction of heat from the water to the surroundings [1].

..... [2]

(c) Describe how heat is transferred in the water as the water is heated up by the copper block.

The heated water at the bottom expands, becomes less dense and rises [1], while the cooler water at the top, being denser, sinks to replace it, forming convection currents [1].

..... [2]

(d) Calculate the heat gained by the water in the cup.

$Q = mc\Delta\theta$
$Q = 0.13 \times 4200 \times (50 - 26)$ [1]
$Q = 13000$ J [1]

heat gained by water = ... [2]

(e) Hence, calculate the specific heat capacity of the copper block, assuming that the initial temperature of the copper block was 100 °C.

$Q = mc\Delta\theta$
$13000 = 0.55 \times c \times (100 - 50)$ [1]
$c = 470$ J/(kg °C) [1]

heat capacity of copper = ... [2]

(f) State one assumption in your calculations in part (e).

There is no heat transfer from the water to the surroundings/no heat is gained by the polystyrene cup.

..... [1]

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For Examiner's Use

9 Fig. 9 shows a ray of light entering a transparent prism ABCD at X, totally internally reflected at Y and then travelling along side CD after being incident at Z.

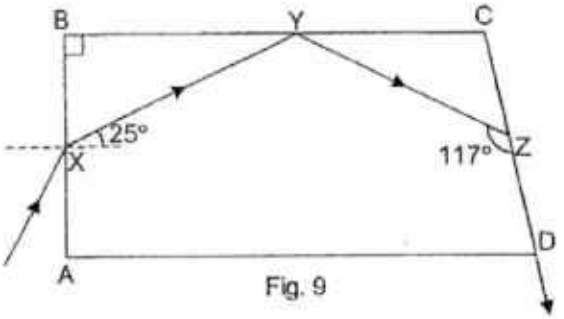

Fig. 9

(a) Define *critical angle*. [1]

The angle of incidence of the light ray in the optically denser medium which gives an angle of refraction of 90° in the optically less dense medium.

.....

(b) Determine the critical angle of the prism.

c = 117° - 90° = 27°

critical angle = ... [1]

(c) Hence, calculate the refractive index of the prism.

n = 1/sin c
n = 1/sin 27° [1]
n = 2.2 [1]

refractive index = ... [2]

(d) Calculate the angle of incidence of the light ray at X.

n = sin i / sin r
2.2 = sin i / sin 25° [1]
i = 68° [1]

angle of incidence = ... [2]

(e) Determine the speed of the light ray through the prism.

n = c / v
2.2 = 3 x 10^8 / v [1]
v = 1.4 x 10^8 m/s [1]

speed = ... [2]

For Examiner's Use

(f) State the two conditions for the light ray to be totally internally reflected at Y.

The light ray must be travelling from an optically denser medium towards an optically less dense medium [1].

The angle of incidence at Y must be greater than the critical angle of the material of the prism [1].

..... [2]

10 Fig. 10 shows an air bubble 55 m below the surface of a lake.

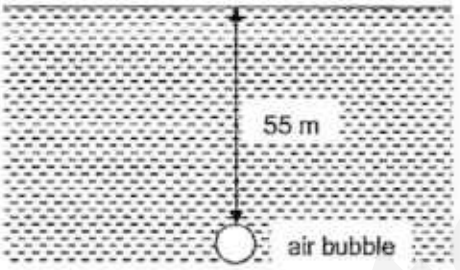

Fig. 10

The atmospheric pressure is 74 cmHg, density of the lake water is 1050 kg/m^3, the density of mercury is 13500 kg/m^3 and the gravitational field strength is 10 N/kg.

(a) Calculate the atmospheric pressure in Pa.

$P = \rho hg$
$P = 13500 \times 10 \times 0.74$ [1]
$P = 100000$ Pa [1]

atmospheric pressure = ... [2]

(b) Calculate the pressure exerted on the air bubble when it is 55 m below the surface of the lake.

$P = 100000 + (1050 \times 55 \times 10)$ [1]
$P = 680000$ Pa [1]

pressure = ... [2]

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For Examiner's Use

(c) The bubble then rises to the surface of the lake and remains there. Describe and explain the change, if any, to the **pressure exerted by the water** on the air bubble as it rises.

The pressure exerted by the water on the bubble decreases [1].
As the bubble rises, the height of the water above the bubble decreases [1], causing the water pressure on the bubble to decreases too.

..... [2]

(d) The volume of the air bubble increases and the **air pressure inside** the bubble decreases as it rises up the lake.
Explain, in terms of the kinetic model of matter, why the air pressure inside the bubble decreases as the volume of the bubble increases. Assume the temperature of the lake water is constant throughout.

As the volume increases the number of air molecules per unit volume decreases, and the air molecules collide against the wall of the bubble less frequently [1], exerting lesser force per unit area [1].

..... [2]

(e) The volume of the air bubble 55 m below the surface of the lake is 0.50 cm^3. Calculate the volume of the air bubble at the surface of the lake.

$P_1V_1 = P_2V_2$
$100000 \times V_1 = 680000 \times 0.50$ [1]
$V_1 = 3.4\ cm^3$ [1]

volume = ... [2]

End of Paper

Class	Register Number

Candidate Name _____

PEIRCE SECONDARY SCHOOL

Department of Science

Second Semestral Examination for Secondary Three Express

PHYSICS **5059**

Wednesday **12 October 2016** **0800 – 1000**

Additional Material:
OTAS Answer Sheet

Time: 2 hours

INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page and on the separate OTAS Answer Sheet.

Section A: Multiple Choice (30 marks)
There are thirty multiple choice questions in this section.
Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**. Choose the one you consider correct and record your answer in the OTAS provided.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B: Structured Questions (40 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

Section C: Free Response Questions (30 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.

PARENT'S SIGNATURE

FOR EXAMINER'S USE	
Section A	/ 30
Section B	/ 40
Section C	/ 30
TOTAL	/ 100

This paper consists of **25** printed pages.

Setter: Miss Chua Soh Ann

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Section A: Multiple Choice (30 marks)

Answer **all** the questions in the OTAS Answer Sheet provided.

1 Which of the following is a suitable estimate for the radius of the Earth?

A 6 nm B 6 μm C 6 Mm D 6 Gm

2 Fig. 2.1 shows the reading of a pair of vernier calipers when its jaws are totally closed. Fig. 2.2 shows the reading on the same pair of vernier calipers when it measures the diameter of a rod.

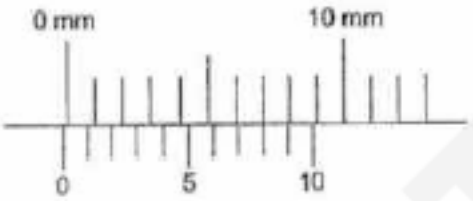


Fig. 2.1

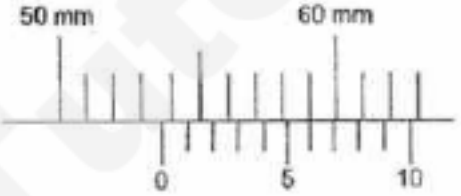


Fig. 2.2

What is the diameter of the rod?

A 5.34 cm B 5.38 cm C 50.34 cm D 50.38 cm

3 Brownian motion can be observed in illuminated smoke particles contained in a sealed transparent cell using a low power microscope. Which of the following statements is **incorrect**?

A The speed of the observed motion is affected by temperature.

B The observed motion is caused by random motion of the smoke particles moving by themselves.

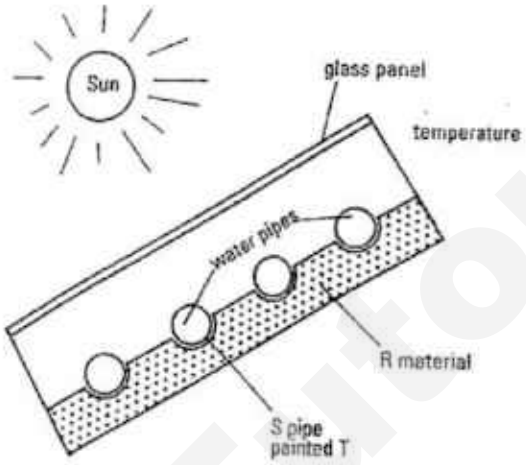
C The observed motion is caused by random motion of the air molecules hitting the smoke particles.

D Air molecules are too tiny to be observed through the microscope.

4 A mercury column is 5.0 cm long at 0 °C and 30.0 cm long at 100 °C. When it is placed in a convection oven, the mercury column was measured to be 40.0 cm long. What is the temperature in the convection oven?

A 100 °C B 140 °C C 133 °C D 167 °C

5 A cross-section of a solar panel is shown below. In the labelling, three key words have been replaced by the letters, R, S and T.



Which of the following best describes R, S and T?

	R	S	T
A	conducting	lead	black
B	insulating	iron	white
C	insulating	copper	black
D	conducting	zinc	silver

6 Thermal energy is supplied at the same rate to 100 g of paraffin and 100 g of water in similar containers. Why does the temperature of the paraffin rise more quickly?

A The paraffin is less dense than water.

B The paraffin is more dense than water.

C The paraffin has a larger specific heat capacity than water.

D The paraffin has a smaller specific heat capacity than water.

7 A vibrating source moves up and down in a ripple tank. What will happen if the vibrating frequency is increased?

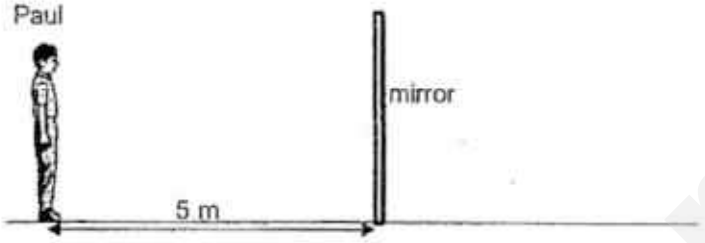
A The wave peaks will be higher and the troughs lower.

B The waves will be closer together.

C The waves will be further apart.

D The waves will move faster across the tank.

8 The diagram shows Paul standing in front of a plane mirror at a distance of 5 m.



What is the distance between Paul's initial position and his final image if Paul moves backwards by another 5 m?

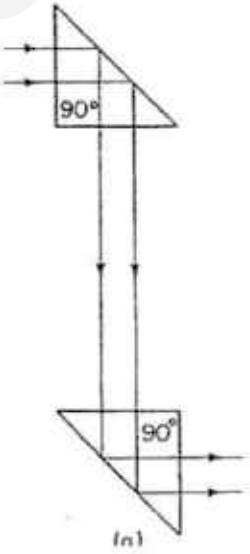
A 5 m

B 10 m

C 15 m

D 20 m

9 A periscope uses two 45° prisms to reflect the light ray into the observer's eye. Which of the following is a possible refractive index of the prism's material?



A 1.00

B 1.39

C 1.41

D 1.44

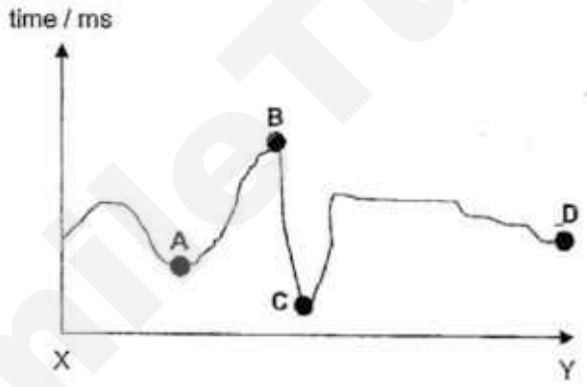
10 Below are four statements about the applications of the components in the electromagnetic spectrum.

- Gamma rays are used to treat cancer.
- Infrared radiation is used in intruder alarms.
- Microwaves are used in satellite televisions.
- X-rays are used in medical imaging.

How many of these statements are **correct**?

A 1 B 2 C 3 D 4

11 The diagram below shows the duration for ultrasound to return back to the receiver on a ship. The ship travelled from point X to point Y along the surface of the water. At which position is the water deepest?



12 What is the approximate range of audible frequencies for a healthy adult?

A 20 Hz to 100 Hz

B 2 Hz to 20 000 Hz

C 20 Hz to 20 000 Hz

D 200 Hz to 2000 Hz

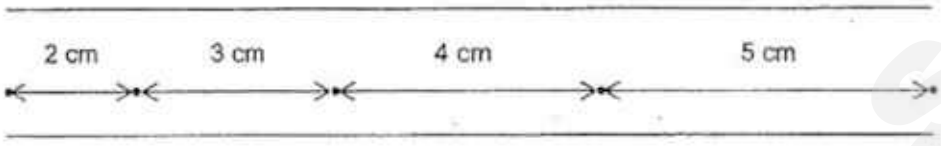
13 A tuning fork produces a sound wave with a frequency of 1 kHz. If the speed of sound is 340 m/s in air, what is the distance between the centre of a rarefaction and the centre of an adjacent compression on the wave?

A 0.085 m B 0.17 m C 0.34 m D 0.68 m

14 A circular disc has 100 holes. It rotates at 300 revolutions per minute and air is blown across the holes. What is the frequency of the sound produced?

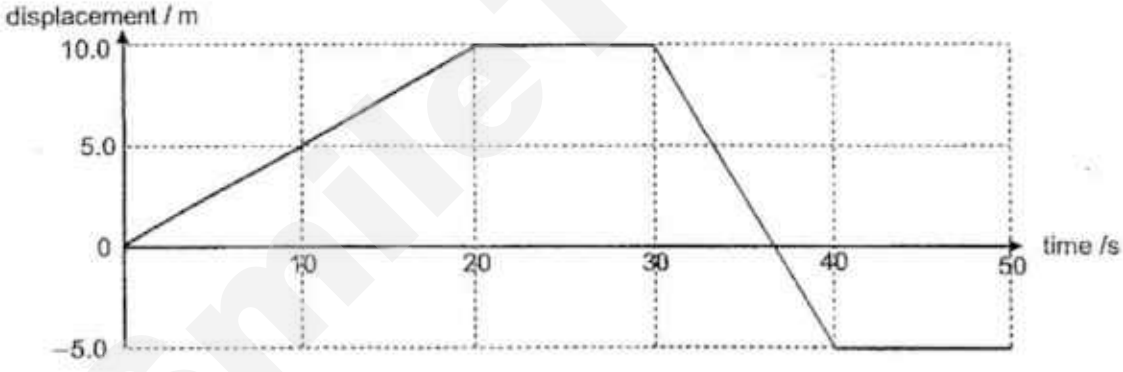
A 5 Hz B 180 Hz C 300 Hz D 500 Hz

15 A ticker tape timer vibrates at 100 Hz. The tape in the diagram below shows the distance moved by a trolley. What is the average speed of the trolley for the whole interval?



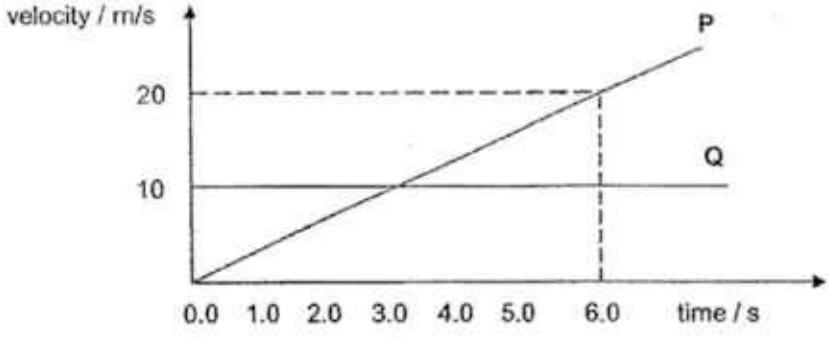
A 0.14 cm/s
B 0.56 cm/s
C 25 cm/s
D 350 cm/s

16 The displacement-time graph of a man travelling along a straight, horizontal road is shown below. What is the total distance travelled by the man in 50 s?



A 3.5 m B 5.0 m C 13.5 m D 25.0 m

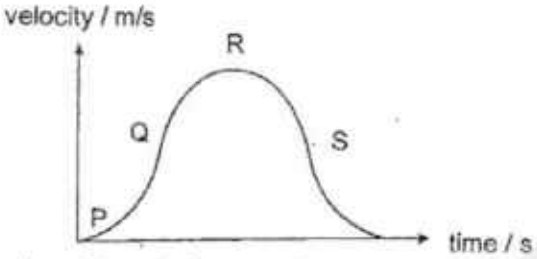
17 Two cars **P** and **Q** started from the same point on a level road at different velocities. Their velocities are shown in the graph below.



What is the time that the two cars meet?

A 3.0 s B 4.0 s C 5.0 s D 6.0 s

18 The diagram below shows the velocity-time graph of a truck travelling along a straight road.



Which of the following statements is correct?

A The truck is moving backwards from R to S.

B The truck moved back to the original position.

C The truck accelerated uniformly throughout.

D The truck moved at zero acceleration at R.

19 When the trigger of a rifle is pulled, the force exerted on the recoiling rifle is just as great as the force that drives the bullet along the barrel.

Why does the bullet undergo more acceleration than the rifle?

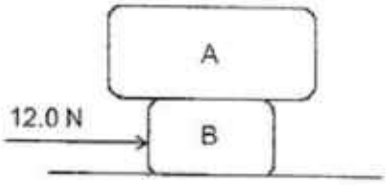
A The bullet is smaller in size.

B The bullet has a smaller mass.

C The bullet is free to move while the rifle is held down.

D The bullet explodes before it leaves the rifle.

20 Box A of mass 4.0 kg is stacked on top of box B of mass 2.0 kg. A force of 12.0 N is applied on box B. Assume that the surface between the boxes and the table top are both frictionless. What will happen to the motion of boxes?



A Box A accelerates to the right at 3.0 m/s² while box B accelerates at 6.0 m/s².

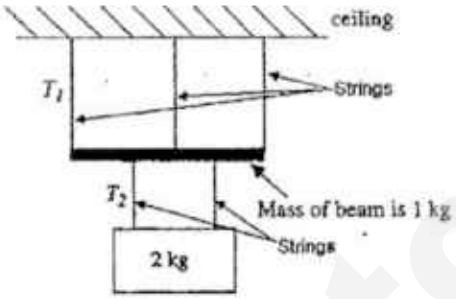
B Box B accelerates to the right at 6.0 m/s² while box A drops down vertically.

C Both box A and box B accelerate to the right at 2.0 m/s².

D Both box A and box B accelerate to the right at 6.0 m/s².

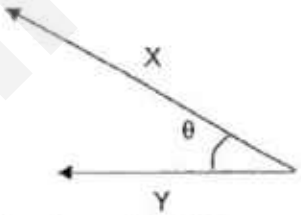
156

21 The diagram below shows a system of 5 strings and a beam of mass 1 kg holding a 2 kg mass. What are the tensions T_1 and T_2 in the two strings shown below?
[Take g = 10 N/kg]



	T_1 / N	T_2 / N
A	6.7	10
B	6.7	20
C	10	10
D	10	20

22 Two forces X and Y of constant magnitudes act at the same point as shown below.



When the angle θ between the forces X and Y increases from 0° to 180°, the magnitude of the resultant force

A increases and then decreases.

B decreases.

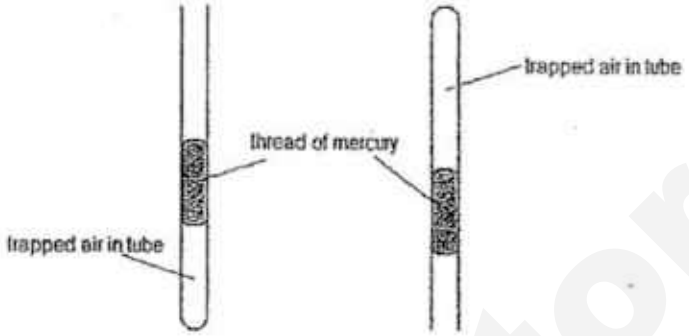
C increases.

D decreases and then increases.

23 The pressure on the tyres of a sedan car is P. The contact surface of each tyre with the floor is A. Calculate the new contact surface of each tyre when air is released from the tyre and the pressure of the car is reduced to 0.75 P.

A 0.333 A B 1.33 A C 4 A D 6 A

24 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to atmospheric pressure.



When the tube is turned upside down, the volume of the trapped air increases. Which of the following statements explains this?

A The pressure in the trapped air is reduced.

B The air gets hotter when the tube is turned upside down.

C The atmospheric pressure is less when it acts upwards on the mercury.

D The trapped air molecules hit the mercury harder when travelling downwards.

25 Fig. 25a and Fig. 25b show an open-ended and a closed tube manometer respectively connected to the same gas cylinder.

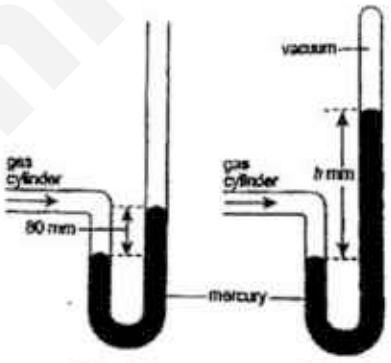


Fig. 25a Fig. 25b

The atmospheric pressure is 760 mmHg. What is the height, h, of the mercury in Fig. 25b?

A 80 mmHg

B 760 mmHg

C 800 mmHg

D 840 mmHg

26 A glass, full of water, is covered with a card and then inverted. When the glass is held in the air, the card will not fall off and the water will not escape. What is the reason for this?

A The atmospheric pressure prevents the card from falling off.

B The card makes a water tight seal to prevent the water from escaping.

C The pressure in the glass is raised because it is filled with water.

D The water remains in its position because of inertia.

27 Which of the following statements is incorrect?

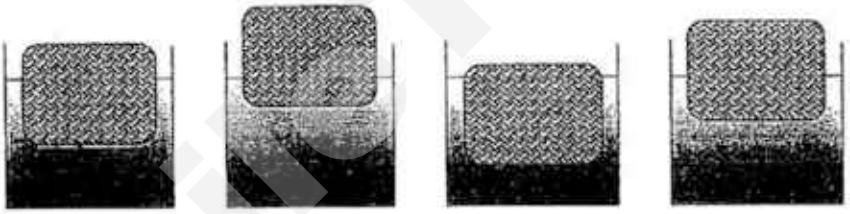
A A 2 kg iron block has twice as much inertia as a 1 kg block of iron.

B A 2 kg iron block has twice as much volume as a 1 kg block of iron.

C A 2 kg bunch of bananas has twice as much volume as a 1 kg loaf of bread.

D A 2 kg bunch of bananas has twice as much mass as a 1 kg loaf of bread.

28 Identical pieces of wood are placed in four different liquids, P, Q, R and S.



Which liquid has the largest density?

A P B Q C R D S

29 A mass of liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. The two mixtures are immiscible (they do not mix). What is the density of the composite liquid?

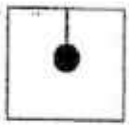
A $\frac{4}{3}\rho$

B $\frac{3}{2}\rho$

C $\frac{5}{3}\rho$

D ρ

30 A pendulum hangs from the ceiling of a stationary bus.



The bus suddenly starts to move towards the left. Which of the following diagrams show the position of the pendulum immediately after the bus starts to move?

A 

B 

C 

D 

End of Section A

Class	Register Number

Candidate Name _____

Section B: Structured Questions (40 marks)

Answer **all** the questions in the spaces provided.

1 A student has an open tank for storing water outside her house. The tank is painted black and is in direct sunlight.

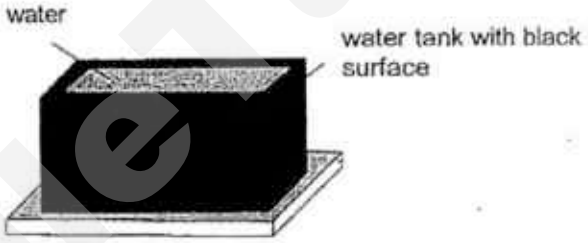
The cross-sectional area of the tank is 3.0 m^2.

The density of the water is 1000 kg/m.

The specific heat capacity of water is 4.2 kJ/kg°C.

The specific latent heat of vaporization of water is 2.2×10^6 J/kg.

The specific heat capacity of the metal cup is 462 J/kg°C.



(a) State how the thermal energy is transferred from the sun to the water.

_____ [1]

(b) If the water tank was used to store heated water instead, state two changes you would make to reduce heat loss.

_____

_____

_____ [2]

(c) The student notices that the water level in the tank falls by 0.50 cm in 11 hours.

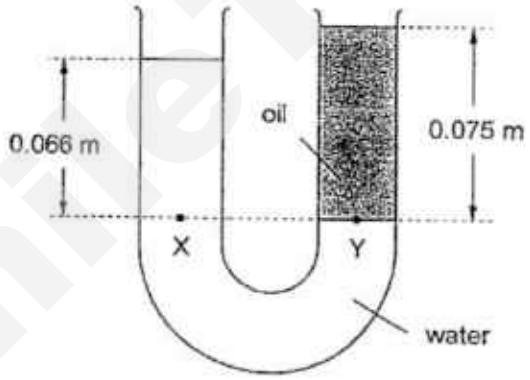
(i) Calculate the energy used to evaporate the water.

energy = ... [2]

(ii) A 1200 W microwave is used to heat 0.7 kg of water at 30 °C in a 13 g cup. The final temperature of the water and the cup is 82 °C. Find the time required to heat the water to this temperature.

time required = ... [3]

2 A U-shaped tube, with a constant cross-sectional area, contains some water of density 1000 kg/m³. Oil is then poured into the right-hand side of the tube and does not mix with the water. The diagram below shows the levels of the water and the oil when equilibrium is reached.



(a) Points X and Y are at the same horizontal level. X is 0.066 m below the top surface of the water and Y is 0.075 m below the top surface of the oil. Calculate the pressure at point Y due to the liquid above it.

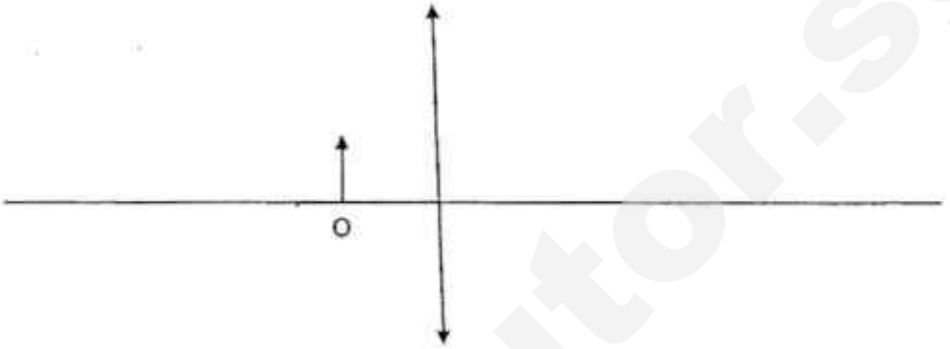
pressure = ... [2]

(b) Hence, calculate the density of the oil.

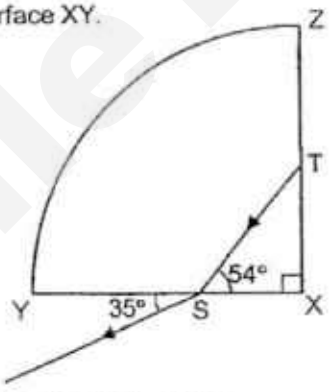
,59

density = ... [2]

3 The diagram below shows a ray diagram with an object, O, in front of a converging lens, drawn to scale. Given that the image formed is virtual, upright and double in height, complete the ray diagram to find the focal point of the lens. Label the image I and the focal point of the lens with an F. [2]



4 The figure below shows a glass block XYZ in the shape of a quadrant with centre at X. A ray of light is incident at T on side XZ and travels through the glass block before hitting side XY at S and emerging from surface XY.



(a) Calculate the refractive index of the glass.

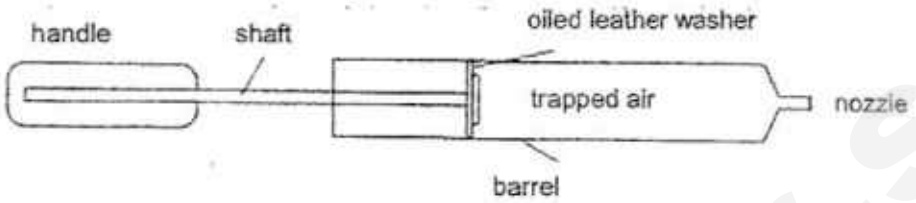
refractive index = ... [2]

(b) Calculate the critical angle of the glass block.

critical angle = ... [2]

(c) On the diagram above, complete the path of the light ray on XZ before it hits T. [1]

5 The diagram below shows a bicycle pump.



(a) Explain in terms of molecular motion, how trapped air creates a pressure on the oiled leather washer.

_____

_____

_____ [2]

(b) When the nozzle is blocked and the handle is slowly pushed in, the pressure of the trapped air increases. Explain why the pressure increases if the temperature of the air in the barrel remains constant and there is no leakage of air.

_____

_____

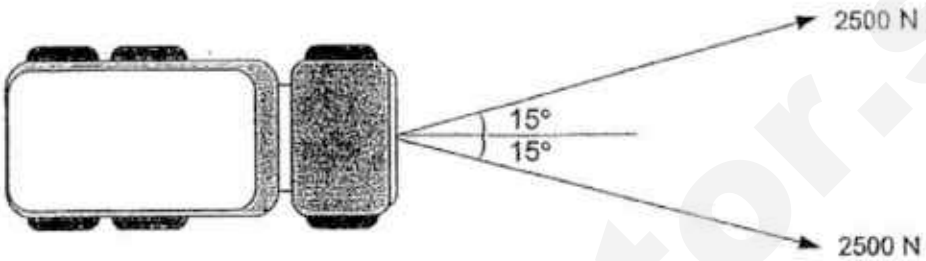
_____ [2]

(c) A force of 75 N is applied on the pump handle when it is pushed into the barrel. What is the pressure of the trapped air if the cross sectional area of the barrel is 250 mm^2 and the atmospheric pressure is 1.0×10^5 Pa?

pressure = ... [2]

160

6 The diagram below shows a lorry of mass 6500 kg. It is stuck in soft ground. Two jeeps are used to pull the lorry forward. Each jeep exerts a force of 2500 N at an angle of 15° in the direction in which the lorry is supposed to move.



Draw a suitable scaled diagram, stating the scale used, to determine the magnitude and direction of the resultant force that is pulling the lorry forward.

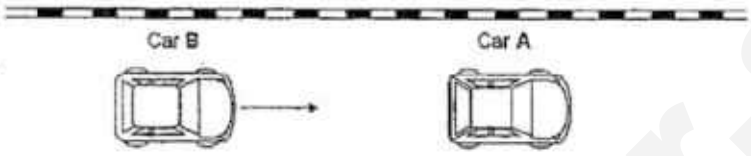
scale = ...

magnitude of resultant force = ...

direction of resultant force = ...

[4]

7 For safety reasons, the minimum separation between two moving cars is determined by the reaction time of the drivers, the speed and deceleration produced by the braking systems of the cars.



Car B is moving at a constant speed of 12 m/s. The driver notices that car A stops suddenly. Car B travels 18 m before the driver applies the brake and decelerates uniformly for a further 30 m before it stops.

(a) Calculate the reaction time of the driver of car B.

reaction time = ... [2]

(b) Calculate the total time taken for car B to stop from the moment he saw the car A stops suddenly.

total time taken = ... [2]

8 (a) The following waveforms are produced when different instruments are played in front of the microphone. Each instrument is played in the same place each time.

(i) Which instrument is producing the loudest sound? Explain your answer.

_____ [1]

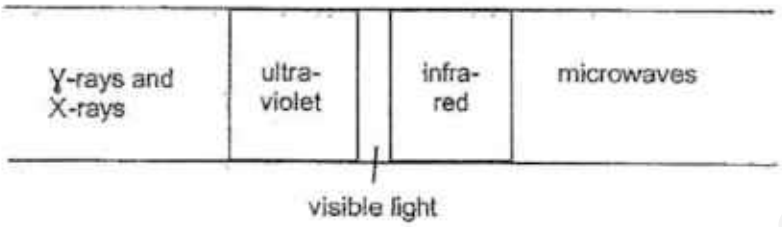
(ii) From the waveforms produced, how do we know that all instruments are producing a note of the same pitch?

_____ [1]

(b) There are two walls X and Y which are 120 m apart from each other. A boy standing at 40 m away from wall X claps his hands once. If the speed of sound in air is 330 m/s, what is the time interval between the first and the second echo that he hears?

time interval = ... [2]

9 The diagram below shows part of the electromagnetic spectrum.



(a) Name one type of radiation that has a lower frequency than visible light.

_____ [1]

(b) The speed of the radiation is halved as it enters a medium of different density. State if the medium is denser or less dense, and explain how the wavelength is affected.

_____

_____

_____ [2]

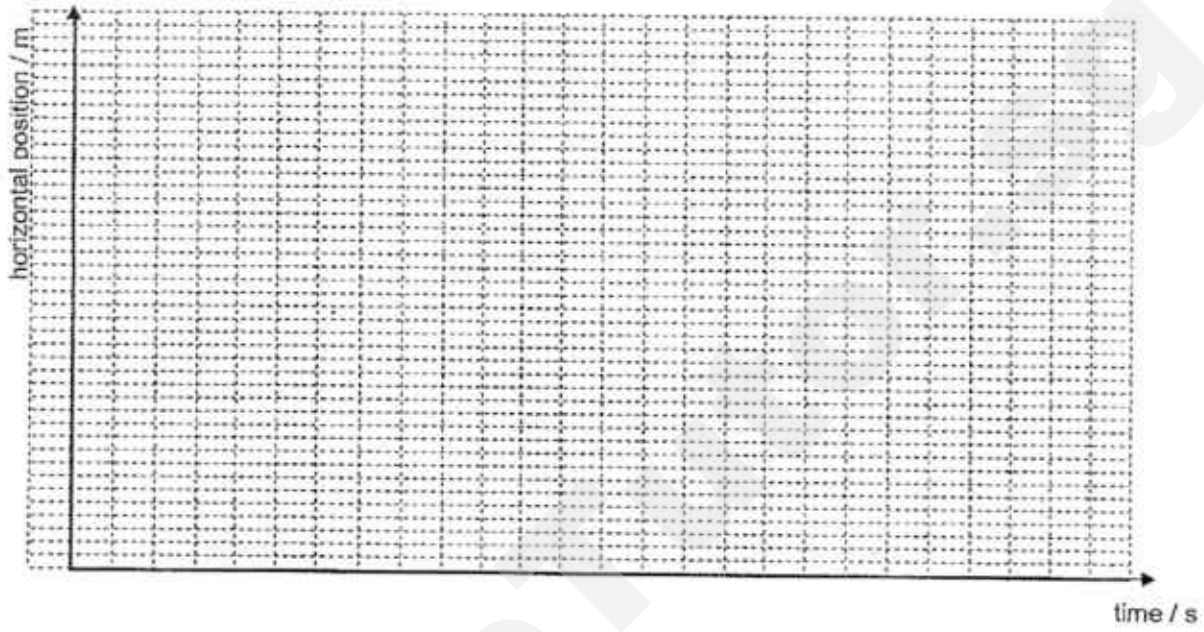
Section C: Free Response Questions (30 marks)

Answer **all** the questions in the spaces provided.

10 The position-time information shown below is for a trip on a very small roller coaster. The position information describes horizontal movement parallel to the ground and vertical movement up in the air.

time / s	horizontal position / m	vertical position / m
1	0	11
2	1	11
3	2	11
4	4	8
5	7	5
6	11	1
7	17	0
8	21	2
9	22	5
10	21	8
11	17	10
12	13	8
13	12	5
14	13	2
15	17	0
16	21	0
17	24	0
18	27	3
19	29	5
20	31	7
21	33	7
22	35	5
23	38	2
24	40	0

(a) Plot the horizontal position-time graph in the space below. [2]



(b) Describe the horizontal velocity of the rollercoaster during the 24 s.

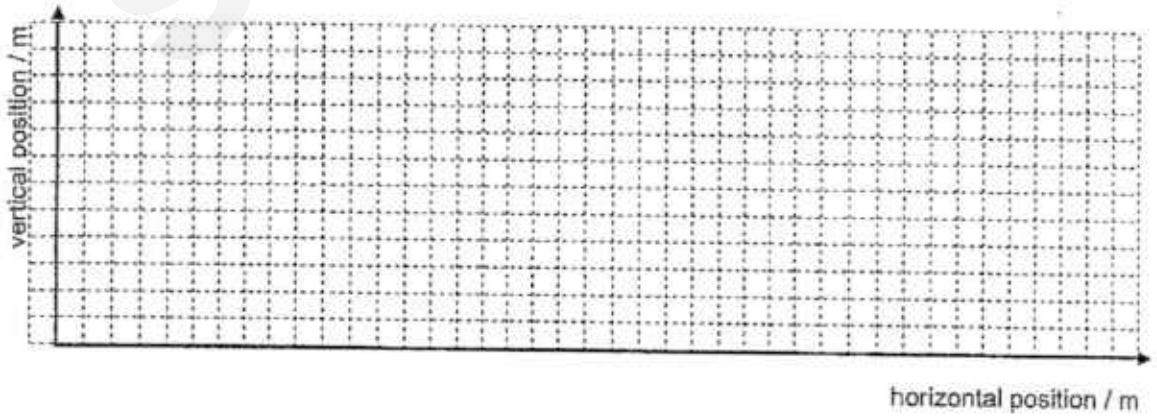
_____

_____

_____

_____ [3]

(c) Plot the vertical position – horizontal position graph in the space below. [2]



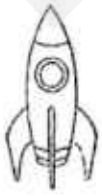
(i) What does the shape of this graph represent?

_____ [1]

(ii) At t = 24 s, a constant braking force was applied to the rollercoaster that brought it to a stop in 4 s. Given that the deceleration is 10.79 m/s^2, calculate the braking force given that the rollercoaster has a mass of 3500 kg.

braking force = ... [2]

11 During lift off, a rocket produces 7 x 10^6 N of thrust. The rocket has a mass of 3.2 X 10^4 kg. The gravitational field strength on Earth is taken as 10 N/kg.



(a) On the diagram above, draw and label the forces acting on the rocket upon lift off.[2]

(b) Determine the weight of the rocket.

weight = ... [2]

(c) Calculate the initial acceleration of the rocket upon lift off.

initial acceleration = ... [3]

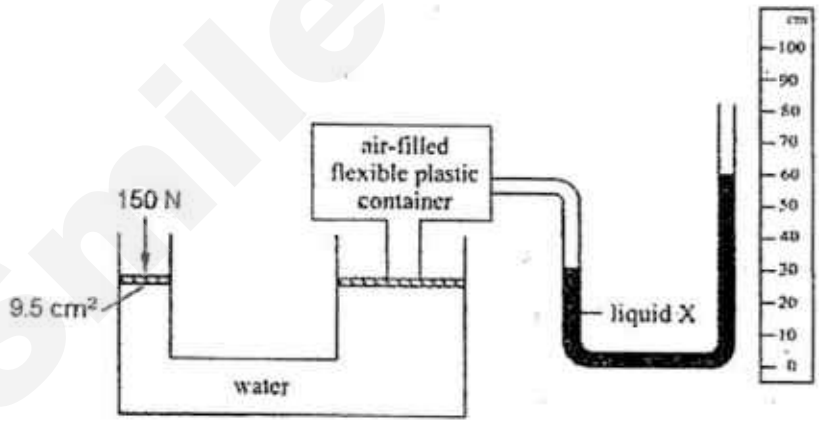
(d) The rocket descends vertically toward the surface of planet X with a constant speed of 2.0 m/s. Assume that the gravitational strength on planet X is 0.7 N/kg. Calculate the upward thrust on the rocket as it descends.

upward thrust = ... [2]

(e) The rocket has landed on the surface of planet X. State the reaction force of the planet X on the rocket.

reaction force = ... [1]

12 (a) The diagram shows a hydraulic press with a force of 150 N being exerted on a smaller piston with a cross-sectional area of 9.5 cm².



As the smaller piston is depressed downwards, the larger piston moves up and compresses an air-filled flexible plastic container attached to it. A manometer filled with liquid X is connected to the plastic container to measure the pressure difference between the air inside and the atmospheric pressure outside.

(i) Explain how pressure is transmitted in the hydraulic press above.

_____

_____ [1]

(ii) Calculate the pressure in Pa exerted on the air-filled flexible plastic container.

pressure = ... [2]

(iii) If the atmospheric pressure is 10^5 Pa, calculate the density of liquid X in the manometer.

density of liquid X = ... [3]

(b) The full scale diagram on the next page shows how the positions of particles in a medium changes with time while a longitudinal wave, travelling from left to right, passes through the medium. At time t = 0 s, before the arrival of the wave, all the particles are at their original undisturbed positions.

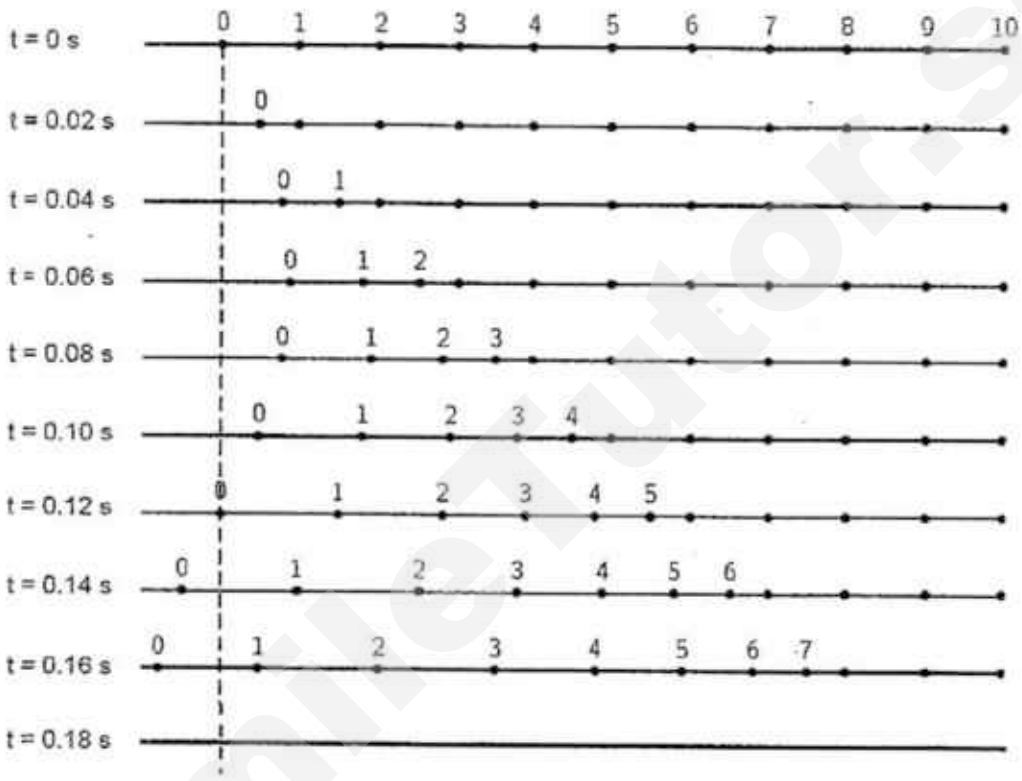
(i) State the amplitude of the wave.

amplitude = ...[1]

(ii) On the diagram on the next page, indicate the position of particle 2 at t = 0.18 s. [1]

(iii) Determine the period of the wave.

period = ...[2]



End of Paper

Candidate Name	Class	Register Number

PEIRCE SECONDARY SCHOOL

Department of Science

Second Semestral Examination for Secondary Three Express

PHYSICS **5059**

Monday **12 Oct 2016** **0800 – 1000**

Additional Material:
OTAS Answer Sheet

Time: **2 hours**

INSTRUCTIONS TO CANDIDATES

Section A: Multiple Choice (30 marks)
There are thirty multiple choice questions in this section.
Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**. Choose the one you consider correct and record your answer in the OAS provided.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B: Structured Questions (40 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

Section C: Free Response Questions (30 marks)
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.
The number of marks is given in brackets [ ] at the end of each question or part question.

This paper consists of **22** printed pages.

Setter: Miss Chua Soh Ann

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Section A: [30 marks]

Answer **all** the questions in the OTAS Answer Sheet provided.

1 Which of the following is a suitable estimate for the radius of the Earth?

A 6 nm B 6 μm C 6 Mm D 6 Gm

2 **Fig. 2.1** shows the reading of a pair of Vernier Calipers when its jaws are totally closed. **Fig. 2.2** shows the reading on the same pair of Vernier Calipers when it measures the diameter of a rod.

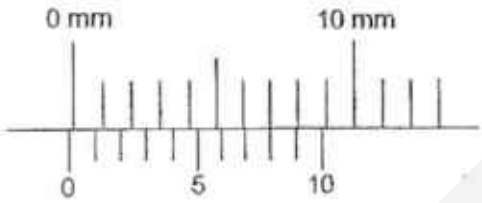


Fig. 2.1

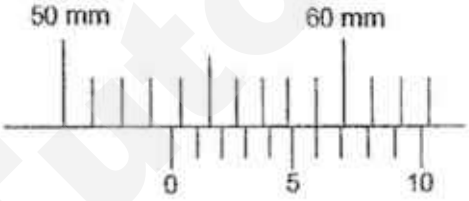


Fig. 2.2

What is the diameter of the rod?

A 5.34 cm B 5.38 cm C 50.34 cm D 50.38 cm

3 Brownian motion can be observed in illuminated smoke particles contained in a sealed transparent cell using a low power microscope. Which of the following statements is **incorrect**?

A The speed of the observed motion is affected by temperature.

B The observed motion is caused by random motion of the smoke particles moving by themselves.

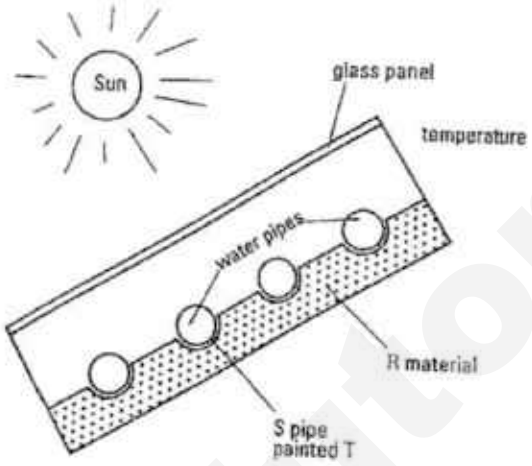
C Air molecules are observed to be moving about in random motion.

D Air molecules are too tiny to be observed through the microscope.

4 A mercury column is 5.0 cm long at 0 °C and 30.0 cm long at 100 °C. When it is placed in a convection oven, the mercury column was measured to be 40.0 cm long. What is the temperature in the convection oven?

A 125 °C B 140 °C C 150 °C D 167 °C

5 A cross-section of a solar panel is shown below. In the labelling, three key words have been replaced by the letters, **R**, **S** and **T**.



What are the best words to replace these letters?

	R	S	T
A	conducting	lead	black
B	insulating	iron	white
C	insulating	copper	black
D	conducting	zinc	silver

6 Thermal energy is supplied at the same rate to 100 g of paraffin and 100 g of water in similar containers. Why does the temperature of the paraffin rise more quickly?

A The paraffin is less dense than water.

B The paraffin is more dense than water.

C The paraffin has a larger specific heat capacity than water.

D The paraffin has a smaller specific heat capacity than water.

7 A vibrating source moves up and down in a ripple tank. What will happen if the vibrating frequency is increased?

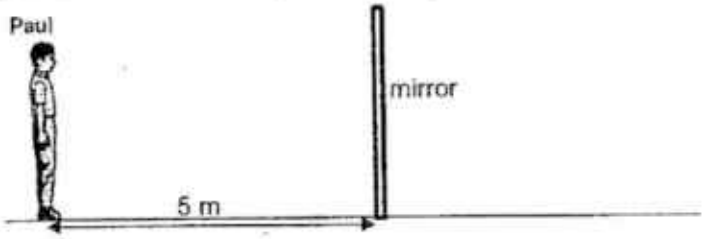
A The wave peaks will be higher and the troughs lower.

B The waves will be closer together.

C The waves will move slower across the tank.

D The waves will move quicker across the tank.

8 The diagram shows Paul standing in front of a plane mirror at a distance of 5 m.



What is the distance between Paul's initial position and his final image if Paul moves backwards by another 5 m?

A 5 m

B 10 m

C 15 m

D 20 m

9 A periscope uses two 45° prisms to reflect the light ray into the observer's eye. What is/are the possible refractive index of the prism's material?

A 1.00

B 1.39

C 1.41

D 1.44

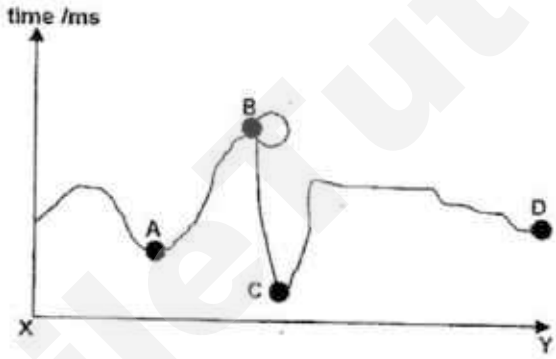
10 Below are four statements about the uses of electromagnetic radiation.

- Gamma rays are used to treat cancer.
- Infrared are used in intruder alarms.
- Microwaves are used in satellite televisions.
- X-rays are used in medical imaging.

How many of these statements are **correct**?

A 1 B 2 C 3 D 4

11 The diagram below shows the duration for ultrasound to return back to the receiver on a ship. The ship travelled from point X to point Y along the surface of the water. At which position is the water deepest?



12 What is the approximate range of audible frequencies for a healthy adult?

A 20 Hz to 100 Hz

B 2 Hz to 20 000 Hz

C 20 Hz to 20 000 Hz

D 200 Hz to 2000 Hz

13 A tuning fork produces a sound wave with a frequency of 1000 Hz. If the speed of sound is 340 ms^{-1} in air, what is the distance between the centre of a rarefaction and the centre of an adjacent compression on the wave?

A 0.085 m B 0.17 m C 0.34 m D 2.9 m

14 A circular disc has 100 holes. It rotates at 300 revolutions per minute and air is blown across the holes. What is the frequency of the sound produced?

A 20 Hz B 180 Hz C 300 Hz D 500 Hz

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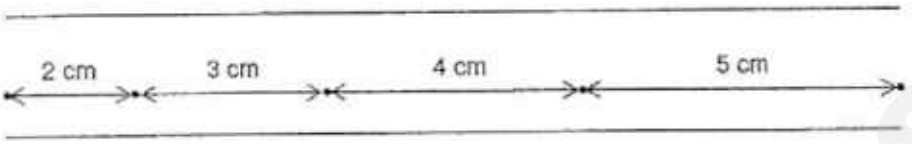
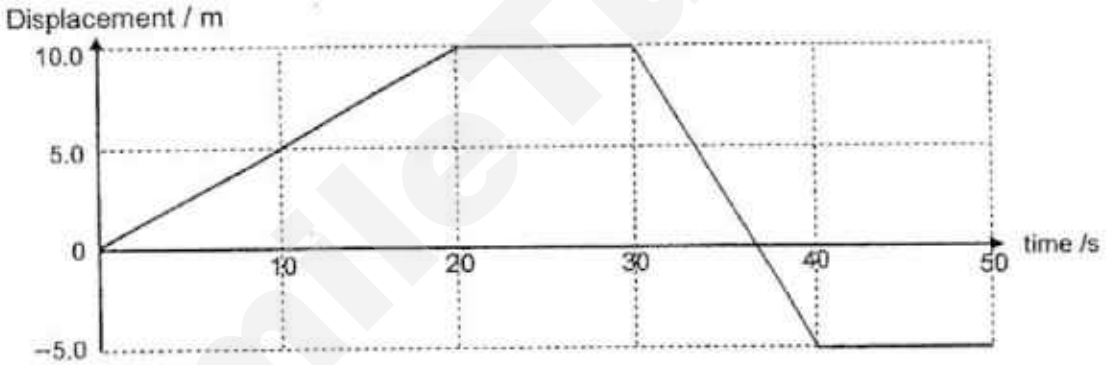
15 A ticker tape timer vibrates at 100 Hz. The tape in the diagram below shows the distance moved by a trolley. What is the average speed of the trolley for the whole interval?



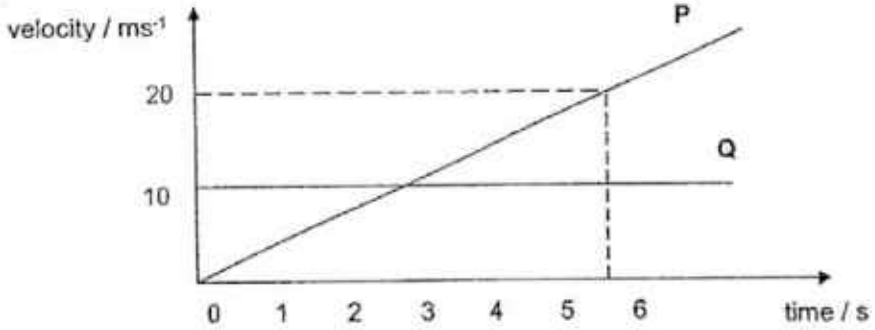
A 0.14 cm/s
B 0.56 cm/s
C 25 cm/s
(D) 350 cm/s

16 The displacement-time graph of a man travelling along a straight, horizontal road is shown below. What is the total distance travelled by the man in 50 s?



A 3.5 m B 5.0 m C 13.5 m (D) 25.0 m

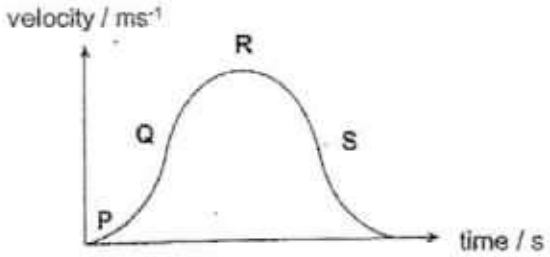
17 Two cars P and Q started from the same point on a level road at different speeds. Their speeds are shown in the graph below.



What is the time that the two cars meet?

A 3.0 s B 4.0 s C 5.0 s (D) 6.0 s

18 The figure below shows the velocity-time graph of a truck travelling along a straight road.



Which of the following statement is correct?

A The truck is moving backwards from **R** to **S**.

B The truck moved back to the original position.

C The truck accelerated uniformly throughout.

(D) The truck moved at zero acceleration at **R**.

19 When the trigger of a rifle is pulled, the force exerted on the recoiling rifle is just as great as the force that drives the bullet along the barrel.

Why does the bullet undergo more acceleration than the rifle?

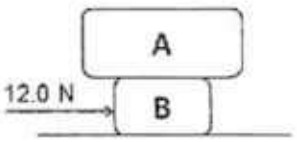
A The bullet is smaller in size.

(B) The bullet has a smaller mass.

C The bullet is free to move while the rifle is held down.

D The bullet explodes before it leaves the rifle.

20 A 4.0 kg box **A** is stacked on top of a 2.0 kg box **B**. A force of 12.0 N is applied on box **B**. Assume that the surface that the surfaces between the boxes and the table top are both frictionless. What will happen to the motion of boxes?



A Box **A** accelerates to the right at 3.0 ms^{-2} while box **B** accelerates at 6.0 ms^{-2}.

(B) Box **B** accelerates to the right at 6.0 ms^{-2} while box **A** drops down vertically.

C Both box **A** and box **B** accelerate to the right at 2.0 ms^{-2}.

D Both box **A** and box **B** accelerate to the right at 6.0 ms^{-2}.

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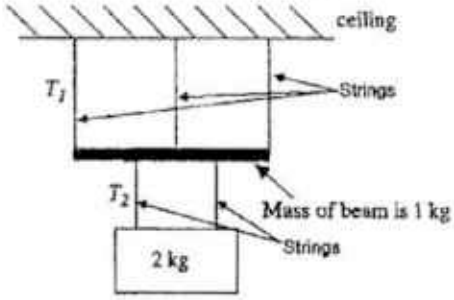
21 The diagram below shows a system of 5 strings and a beam of mass 1 kg holding a 2 kg mass. What are the tensions T_1 and T_2 in the two strings shown below? Take g = 10 N/kg



	T_1 / N	T_2 / N
A	6.7	5
B	6.7	10
C	10	5
D	10	10

22 Two forces X and Y of constant magnitudes act at the same point as shown below.

When the angle θ between the forces X and Y increases from 0° to 180°, the magnitude of the resultant force

A increases and then decreases.

B decreases.

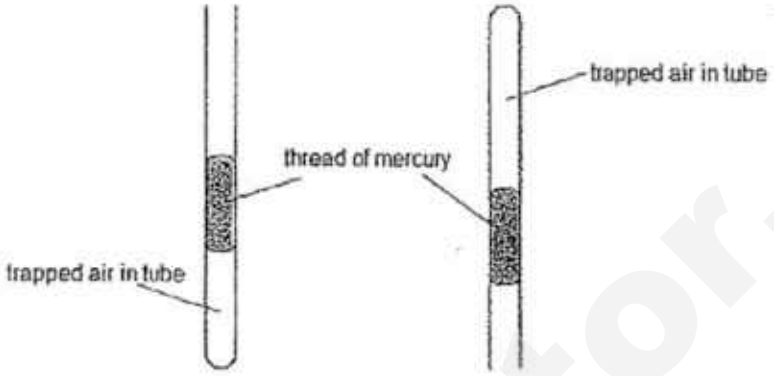
C increases.

D decreases and then increases.

23 The pressure on the tyres of a sedan car is P. The contact surface of each tyre with the floor is A. Calculate the new contact surface of each tyre when air is released from the tyre and the pressure of the car is reduced to 0.75 P.

A 1.25 A B 4.0 s C 5.0 s D 6.0 s

24 A thin tube contains a thread of mercury which traps air at the end of the tube. The other end of the tube is open to the atmosphere.



When the tube is turned upside down, the volume of the trapped air increases. Which statement explains this?

(A) The pressure in the trapped air is reduced.

B The air gets hotter when the tube is turned upside down.

C The atmosphere pushes less when it acts upwards on the mercury.

D The trapped air molecules hit the mercury harder when travelling downwards.

25 Fig. 25a and Fig. 25b show an open-ended and a closed tube manometer respectively connected to the same gas cylinder.

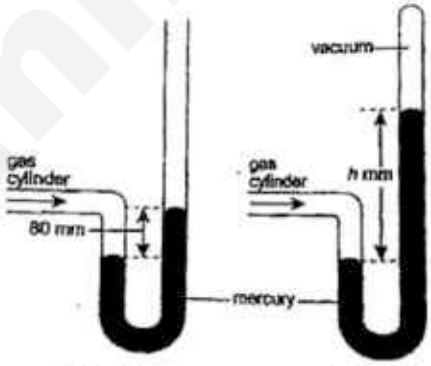


Fig. 25a Fig. 25b

The atmospheric pressure is 760 mmHg. What is the height, *h*, of the mercury in Fig. 23b?

A 60 mmHg

B 760 mmHg

C 800 mmHg

(D) 820 mmHg

26 A glass full of water is covered with a card and then inverted. When the glass is held in the air, the card will not fall off and the water will not escape. What is the reason for this?

(A) The atmospheric pressure prevents the card from falling off.

B The card makes a water tight seal to prevent the water from escaping.

C The pressure in the glass is raised because it is filled with water.

D The water remains in its position because of inertia.

27 Which of the following statements is **incorrect**?

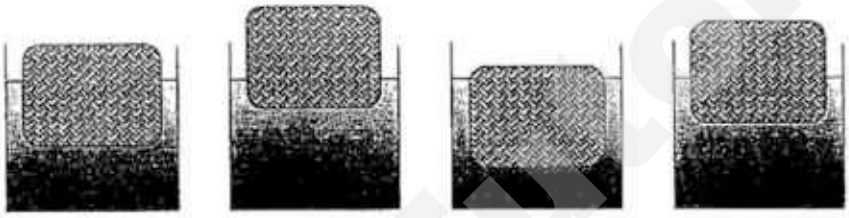
A A 2 kg iron block has twice as much inertia as a 1 kg block of iron.

B A 2 kg iron block has twice as much volume as a 1 kg block of iron.

C A 2 kg bunch of bananas has twice as much volume as a 1 kg loaf of bread.

D A 2 kg bunch of bananas has twice as much mass as a 1 kg loaf of bread.

28 Identical pieces of wood are placed in four different liquids, P, Q, R and S.



Which liquid has the biggest density?

A P B Q C R D S

29 A mass of liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ. No change of the total volume occurs. What is the density of the liquid mixture?

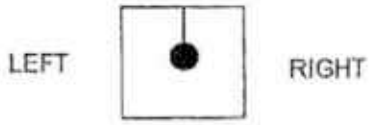
A $\frac{4}{3}\rho$

B $\frac{3}{2}\rho$

C $\frac{5}{3}\rho$

D ρ

30 A pendulum hangs from the ceiling of a stationary bus.



The bus suddenly starts to move towards the **left**. Which of the following diagrams show how the pendulum will be hanging immediately after the bus starts to move?

A 

B 

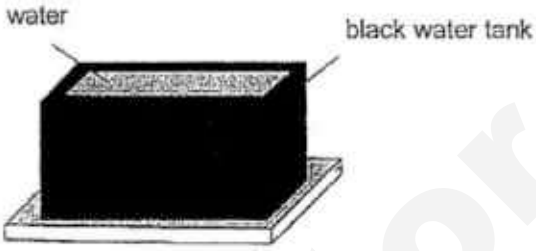
C 

D 

Section B [40 marks]

Answer **all** the questions in the spaces provided.

1 A student has an open tank for storing water outside her house. The tank is painted black and is in direct sunlight



(a) State and explain how the water is transferred from the sun to the water. [1]

Radiation

f the water tank was used to store heated water instead, state two changes you would make to reduce heat loss. [2]

Paint tank white – white/ silver is a bad emitter of radiation
Lid – reduce evaporation
Use Styrofoam – bad conductor of heat (any two answers with principle)

(b) The student notices that the water level in the tank falls by 0.0050 m in 11 hours.

The cross-sectional area of the tank is 3.0 m^2.

The density of the water is 1000 kgm^{-3}.

The specific heat capacity of water is 4.2 kJ kg^{-1} $°C^{-1}$.

The specific latent heat of vaporization of water is 2.2×10^6 Jkg^{-1}.

The specific heat capacity of the metal cup is 462 J kg^{-1} $°C^{-1}$.

(i) Calculate the average rate at which the energy is used to evaporate the water. [2]

Volume = 0.005 x 3 = 0.015m^3 (1/2m)
Mass = density x volume = 1000 x 0.015 = 15 kg (1/2m)
Energy = ml = 15 x 2.2 x 10^6 = 33 000 000J (1m)

(ii) A 1200 W microwave is used to heat 0.7 kg of water at 30 °C in a13 g metal cup. The final temperature of the water is 82 °C. Find the time taken to reach this temperature. [3]

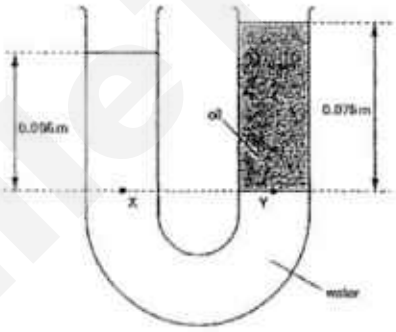
Heat provided by the microwave = Heat absorbed by the water + heat absorbed by the metal cup

$P \times t = mc\Delta\theta + mc\Delta\theta$

$1200 \times t$ (1m) $= (0.7 \times 4.2 \times 1000 \times 32) + (0.013 \times 462 \times 32)$ (1m)

t = (1m)

2 A U-shaped tube, with a constant cross-sectional area, contains some water of density 1000 kg/m³. Oil is then poured into the right-hand side of the tube and does not mix with the water. The figure below shows the levels of the water and the oil when equilibrium is reached.



Points **X** and Y are at the same horizontal level. **X** is 0.066 m below the top surface of the water and **Y** is 0.075 m below the top surface of the oil.

a) Calculate the pressure at point **Y** due to the liquid above it. [2]

Pressure at Y = Pressure at X
= hρg
= 0.066 x 1000 x 10
= 660 Pa (accept 660 N/m²)

(students can write 660 Pa above atmospheric pressure. However, not to guess the value of atmospheric pressure)

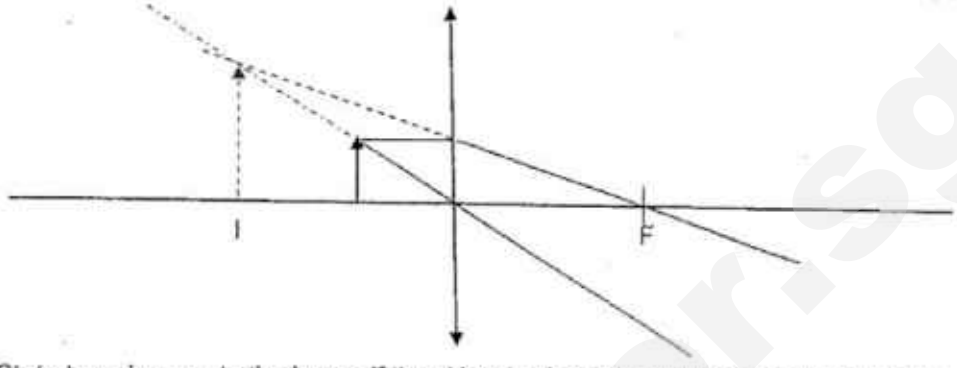
b) Hence, calculate the density of the oil. [2]

$p_y = h\rho g$

$660 = (0.075)\rho(10)$

$\rho_{oil} = \frac{660}{(0.075)(10)} = 880\ \text{kg/m}^3$

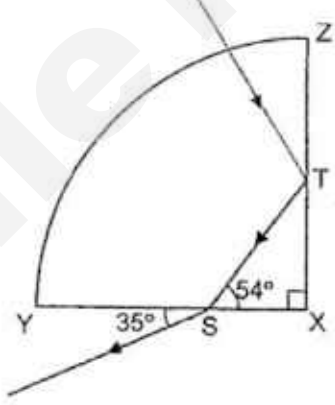
3 (a) The diagram below shows a ray diagram with an object, O, in front of a converging lens, drawn to scale. Given that the image formed is virtual, upright and double in height, complete the ray diagram to find the focal point of the lens. Label the image I and the focal point of the lens with an F. [3]



(b) State two changes to the image if the object is placed beyond the focal point of the lens.

Diminished/ inverted/ real (any two one mark) [1]

4 The figure below shows a glass block XYZ in the shape of a quadrant or a quarter of a circle, with centre X. A ray of light is incident at S on side XY and travels through the glass block, striking side ZX at T.



a) Calculate the refractive index of the glass. [2]

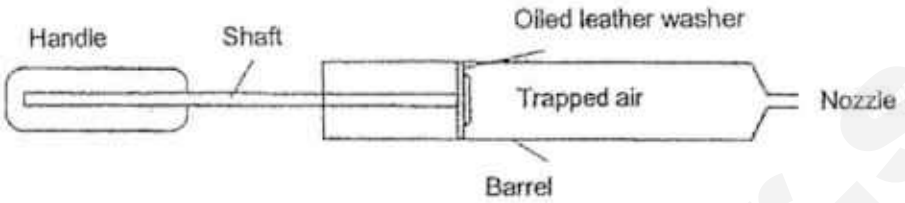
n = sin i / sin r
n = sin 55°/sin 36° [1]
n = 1.39 [1]

b) Calculate the critical angle of the glass block. [2]

sin c = 1/n
sin c = 1/1.4 [1]
c = 44.9° [1]

c) Draw the incident ray on TZ on the figure above. [1]

5 The diagram below shows a bicycle pump.



a) Explain in terms of molecular motion, how trapped air creates a pressure on the oiled leather washer. [2]

The trapped air molecules collide with the walls of the washer [1m] and the average forced exerted per unit area on the walls is pressure. [1m]

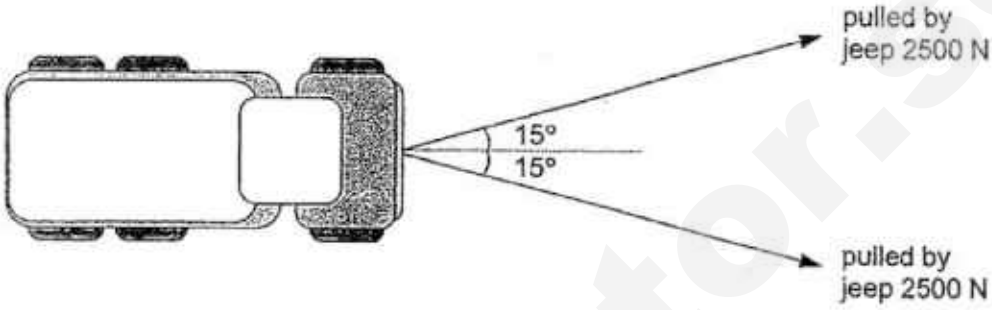
b) When the nozzle is blocked and the handle is slowly pushed in, the pressure of the trapped air increases. Explain why the pressure increases if the temperature of the air in the barrel remains constant and the there is no leakage of air. [2]

When the handle is pushed in, the volume of trapped air decreases. [1m] This increases the frequency of collisions of air molecules against the walls of the barrel, [1m] hence increasing the pressure.

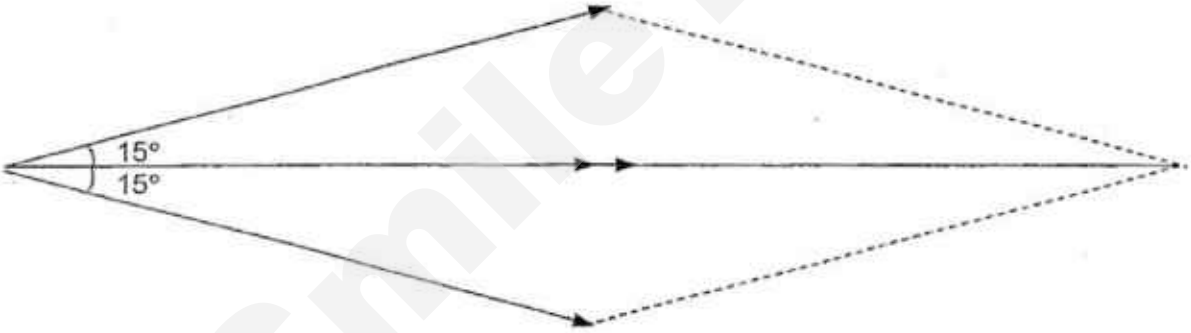
c) A force of 75 N is applied on the pump handle when it is pushed into the barrel. What is the pressure of the trapped air if the cross sectional area of the barrel is 250 mm^2 and the atmospheric pressure is 1.0×10^5 Pa? [2]

Pressure = Force / Area
Let trapped air pressure be P
$(P - 1.0 \times 10^5) = 75 / (250 \times 10^{-6})$
$P = 4.0 \times 10^5$ Pa

6 The figure below shows a lorry of mass 6500 kg. It is stuck in soft ground. Two jeeps are used to pull the lorry forward. Each jeep exerts a force of 2500 N at an angle of 15° in the direction in which the lorry is supposed to move.



Draw a suitable scaled diagram, stating the scale used, to determine the magnitude and direction of the resultant force that is pulling the lorry forward. [4]



Scale 1cm:250 N (1m)
Shape/ arrows/ double arrows (1m)
All forces labelled with correct units (1m)
Answer + direction (1m) 4800 N

Scale = ...

Magnitude of resultant force = ...

Direction of resultant force = ...

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7 For safety reasons, the minimum separation between two moving cars is determined by the reaction time of the drivers, the speed and deceleration produced by the braking systems of the cars.

Car **B** is moving at a constant speed of 12 ms^{-1}. The driver notices that car **A** stops suddenly. Car **B** travels 18 m before the driver applies the brake and decelerates uniformly for a further 30 m before it stops.

a) Calculate the reaction time of the driver of car B. [2]

Reaction time = d / s
= 18 / 12
= 1.5 s

b) Calculate the time taken for car B to stop from the moment he saw the car **A** stops suddenly. [2]

½ (12) (t) = 30
t = 5 s
Total time taken = 1.5 + 5 = 6.5 s

8 a) The following wavefronts are produced when different instruments are played in front of the microphone. Each instrument is played in the same place each time.

The oscilloscope controls remain unaltered.

i) Which instrument is producing the loudest sound? How can you tell?

Saxophone, largest amplitude [1]

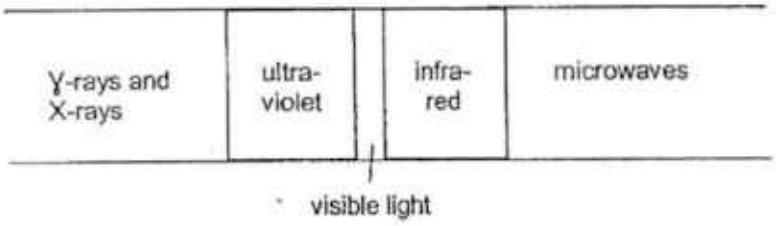
ii) How can you tell that all instruments are producing a note of the same pitch?

They have the same frequency of 2.5 squares.
The waveform is repeated every 2.5 squares. [1]

b) There are two walls **X** and **Y** which are 120 m apart from each other. A boy standing at 40 m away from wall **X** claps his hands once. If the speed of sound in air is 330 ms^{-1}, what is the time interval between the first and the second echo that he hears? [2]

Time interval $= \frac{160}{330} - \frac{80}{330} = 0.242s (to\ 3s.f.)$

9 The diagram below shows part of the electromagnetic spectrum.



a) Name one type of radiation that has a lower frequency than visible light, and state an application for it.

Infrared – tv control / sunbeds
Microwave – cooking/ satellite communication

[2]

b) State a difference between the waves in the electromagnetic spectrum and sound waves.

Longitudinal/ transverse / Direction of vibration of particle/ speed in vacuum [1]

c) The speed of the radiation is halved as it enters a medium of different density. State if the medium is denser or less dense, and explain how the wavelength is affected.

Denser (1m) V = fλ, wavelength halved

[2]

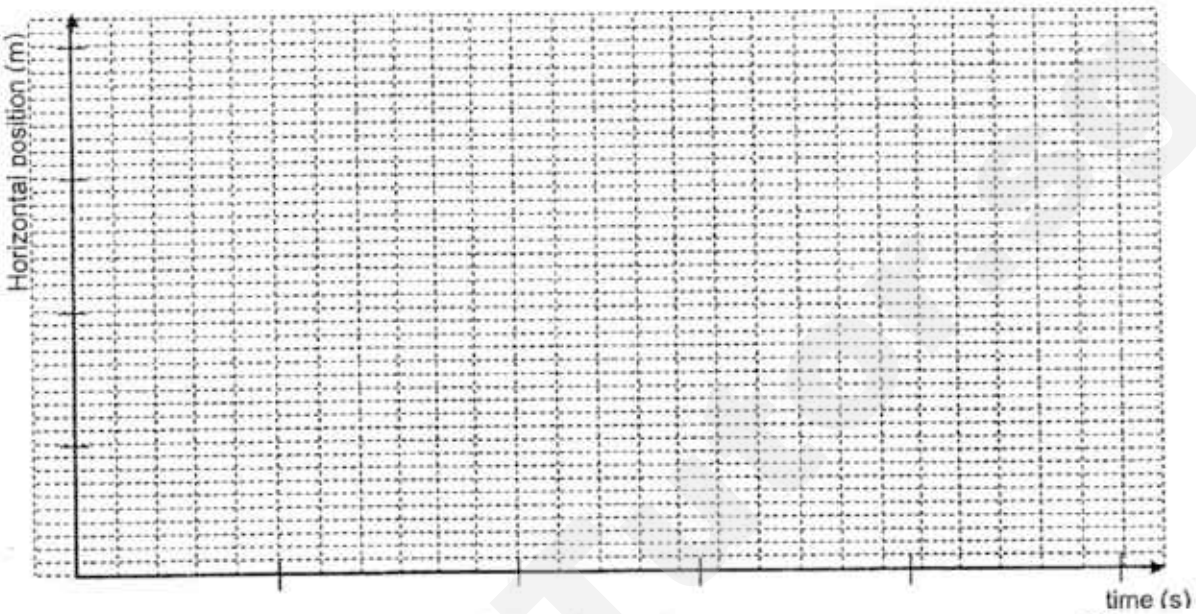
Section C [30 marks]

Answer **all** the questions in the spaces provided.

10 The position-time information shown is for a trip on a very small roller coaster. The position information describes horizontal movement parallel to the ground and vertical movement up in the air.

Time (s)	Horizontal position (m)	Vertical position (m)
1	0	11
2	1	11
3	2	11
4	4	8
5	7	5
6	11	1
7	17	0
8	21	2
9	22	5
10	21	8
11	17	10
12	13	8
13	12	5
14	13	2
15	17	0
16	21	0
17	24	0
18	27	3
19	29	5
20	31	7
21	33	7
22	35	5
23	38	2
24	40	0

a) Plot the horizontal position-time graph in the space below. [2]



(b) Describe the horizontal velocity of the rollercoaster. [3]

i) 0 s to 10 s:

_____

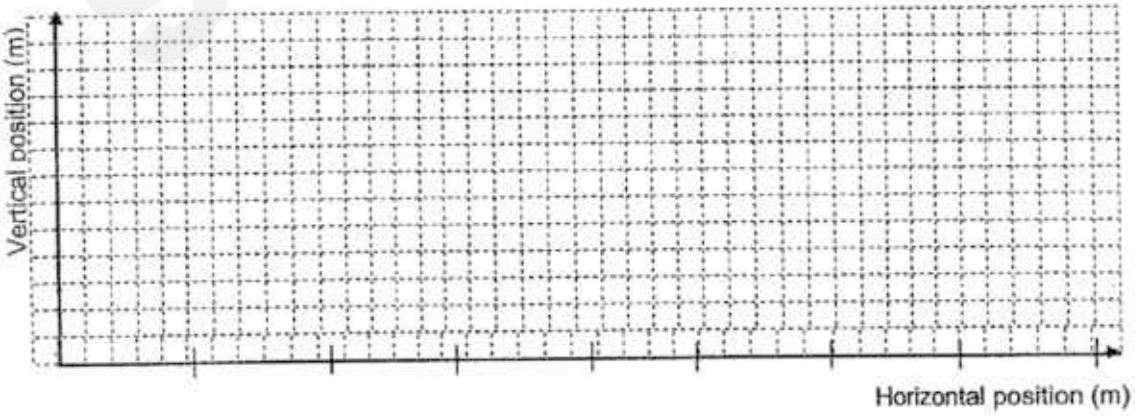
ii) 11 s to 14 s:

_____

iii) 15 s to 24 s:

_____

(c) Plot the vertical position – horizontal position graph in the space below. [2]



i) What does the shape of this graph represent? [1]

_____

ii) At t = 24 s, a constant braking force was applied to the rollercoaster that brought it to a stop in 4 s. Given that the deceleration is 10.79 ms^{-2}, calculate the braking force. [2]

Weight = mg = (3.2 x 104)(10) = 3.2 x 10^5 N

11 During lift off, a rocket produces 7 x 10^6 N of thrust. The rocket has a mass of 3.2 X 10^4 kg. The gravitational field strength on Earth is taken as 10 Nkg^{-1}.

a) On the figure above, draw and label the forces acting on the rocket upon lift off. [2]

b) Determine the weight of the rocket.

Weight = mg = (3.2 x 104)(10) = 3.2 x 105 N

Weight = ... [2]

c) Calculate the initial acceleration of the rocket upon lift off. [3]

$F_R = 7 \times 10^6 - 3.2 \times 10^5 = 6.68 \times 10^6$ N

$F_R = ma$
$6.68 \times 10^6 = 3.2 \times 10^4 \times a$
$a = 209$ m/s² (3 s.f.)

d) The rocket descends vertically toward the surface of Planet X with a constant speed of 2.0 ms^{-1}. Assume that the gravitational strength on Planet X is 0.7 Nkg^{-1}. Calculate the upward thrust on the rocket as it descends. [2]

Upward thrust = 3.2 x 10^4 x 0.7 = 22400 N

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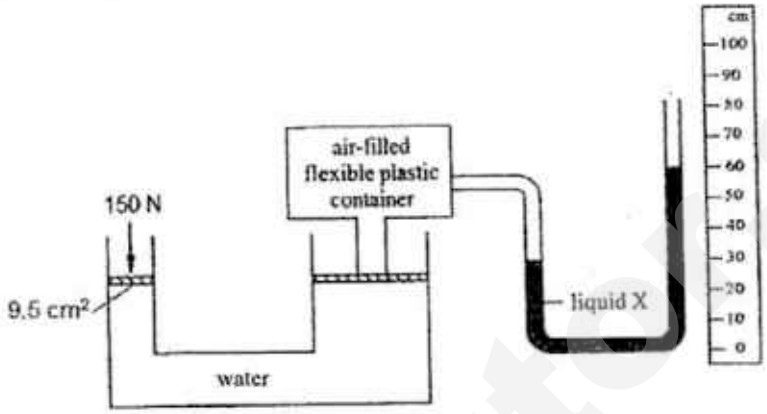
e) The rocket has landed on the surface of Planet **X**. State the reaction force of the Planet **X** on the rocket.

Reaction force ..... 22400 N ..... [1]

12 a) The diagram shows a hydraulic press with a force of 150 N being exerted on a smaller piston with a cross-sectional area of 9.5 cm².



As the smaller piston is depressed downwards, the larger piston moves up and compresses an air-filled flexible plastic container attached to it. A liquid X manometer is connected to the plastic container to measure the pressure difference between the air inside and the atmospheric pressure outside.

i) Explain how pressure is transmitted in the hydraulic press above. [1]

When the 150 N force is exerted on the small piston, a pressure is applied in the water. The pressure is then transmitted uniformly throughout the water to the larger piston.

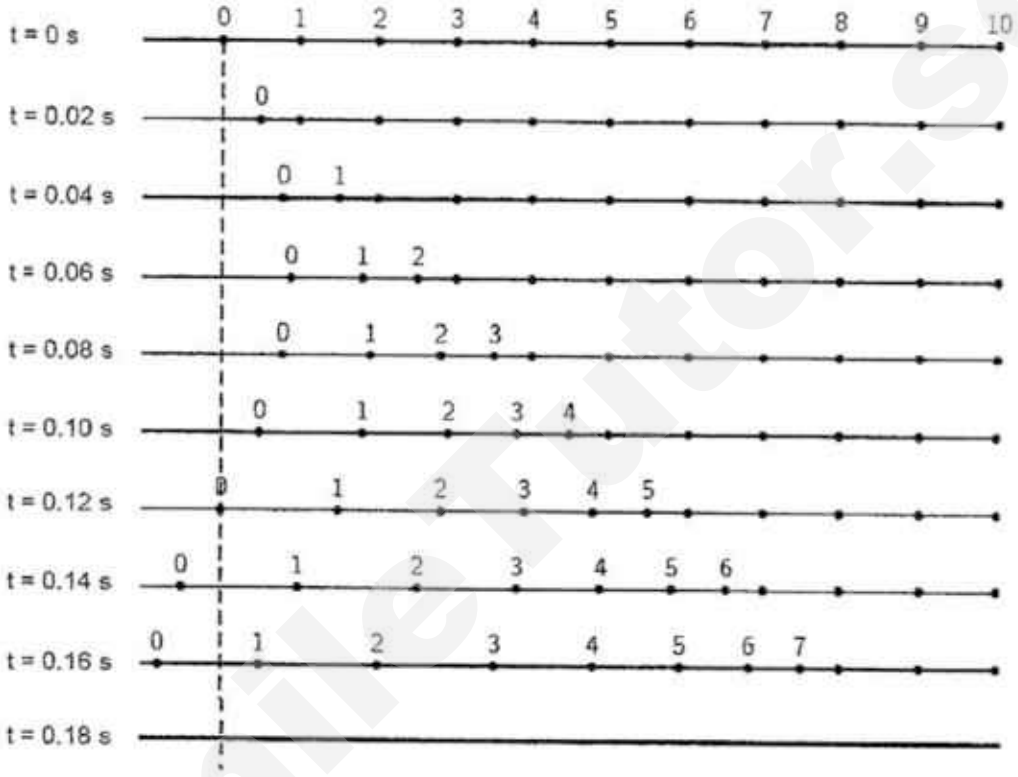
ii) Calculate the pressure in **Pa** exerted on the air-filled flexible plastic container. [2]

Pressure applied at the small piston = Pressure applied at the large piston (Pressure in the air-filled plastic container)
P = F / A
= 150 / (9.5 ÷ 10 000) [1]
= 1.58×10^5 Pa [1]

iii) If the atmospheric pressure is 10^5 Pa, calculate the density of liquid X in the manometer. [3]

Since pressure is transmitted uniformly, a pressure of 1.58×10^5 Pa is applied on the left side of the manometer.
Using **P =hρg,**
$10^5 + (\rho \times 10 \times 0.30) = 1.58 \times 10^5$
$3\rho = 0.58 \times 10^5$
$\rho = 19\ 333$ kg/m³

b) The full scale diagram below shows how the positions of particles in a medium changes with time whilst a longitudinal wave, travelling from left to right, passes through the medium. At time t = 0 s, before the arrival of the wave, all



i) State the amplitude of the wave.

1.1 cm ± 0.1 cm

amplitude = ...[1]

ii) On the figure above, indicate the position of particle 2 at t = 0.18 s. [1]

iii) Determine the period of the wave.

Directly below particle 1 when particle 1 is at t = 0.12 s

half oscillation = 0.12 s one oscillation = 0.12 x 2 = 0.24 s

period = ...[2]

- End of Paper-

Name: _____ Class: _____ Index No. : _____

ST JOSEPH'S INSTITUTION

SECONDARY 3 (O-LEVEL PROGRAMME)
2016 END OF YEAR EXAMINATION

PHYSICS

5059

28 September 2016

2 hrs 30 min

(0800 – 1030)

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 dark blue or black pen on the Question Paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions by indicating your choice on the Multiple Choice Answer Sheet.

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.
Electronic calculators may be used in this paper.
Unless otherwise stated, take gravitational field strength, g, to be 10 N/kg.

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 of this Question Paper consists of 14 printed pages.

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Section A (30 marks)

Answer **all** questions in this section. For each question, there are four possible answers A, B, C and D. Shade your choice in pencil on the Multiple Choice Answer Sheet.

1 A pair of vernier calipers is used to measure the outer diameter of a metal ring. Fig. 1.1 shows the jaws closed with no metal ring, and Fig. 1.2 shows the jaws closed around the metal ring.

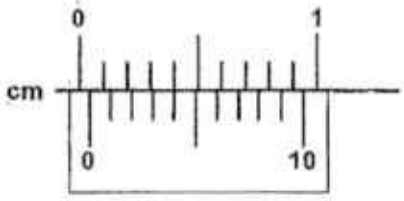


Fig. 1.1

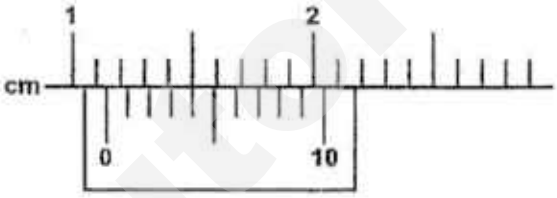
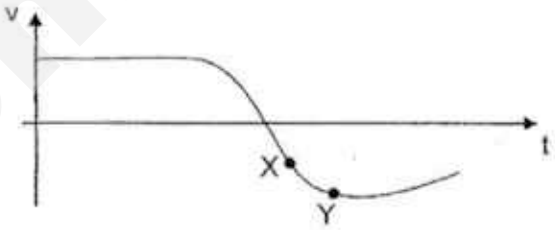


Fig. 1.2

What is the outer diameter of the ring?

A 1.00 cm
B 1.08 cm
C 1.10 cm
D 1.18 cm

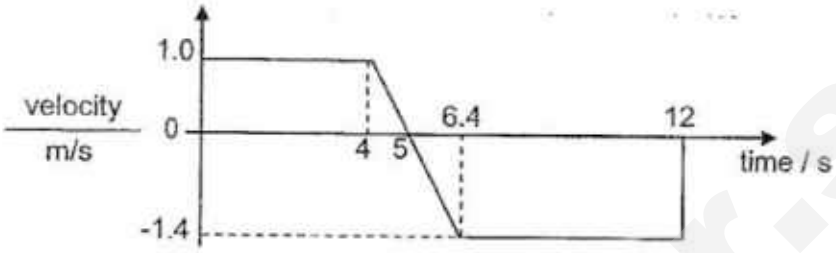
2 The figure shows the velocity-time graph of a body.



In the section XY of the graph, the body is

A accelerating with decreasing acceleration.
B decelerating with decreasing deceleration.
C accelerating with increasing acceleration.
D decelerating with increasing deceleration.

3 The figure represents the velocity of a body over time.



What is the average velocity of the body over the 12 seconds period?

A - 0.18 m/s B - 0.36 m/s C 1.08 m/s D 1.11 m/s

4 Which of the following statements is true?

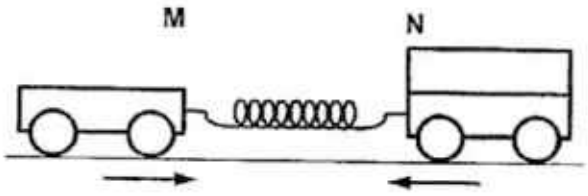
A If a body travels at constant speed, its velocity will be constant
B If a body is speeding up, its acceleration will be increasing
C A body with zero acceleration will be at zero velocity
D A body whose acceleration is decreasing, will still be speeding up

5 The figure shows the dots made on a ticker tape that was pulled by a toy car moving towards the right.

Which of the following statements correctly describes the motion of the toy car?

A It accelerates then moves at constant speed.
B It decelerates than moves at constant speed.
C It moves at constant speed then accelerates.
D It moves at constant speed then decelerates.

6 Two toy cars, M and N, are joined by a stretched spring. Car N has twice the mass of car M.



When the cars are released, car N accelerates to the left at 2.0 m/s². What is the initial acceleration of car M to the right?

A 1.0 m/s²
B 2.0 m/s²
C 3.0 m/s²
D 4.0 m/s²

7 A tennis ball, with a mass of 0.060 kg, is thrown vertically upwards with a force of 20 N. At a particular point in time, the ball is travelling with an acceleration of -15 m/s^2.

What is the total air resistance acting on the ball at that instance?

A 0.30 N
B 1.5 N
C 19.7 N
D 20.3 N

8 The mass of an object A is 200 g and its volume is 60 cm^3. A molten substance B has a density of 2.5 g/cm^3. Object A is melted down, and is mixed with 0.10 kg of substance B.

What is the density of the resulting mixture, assuming that there is no substantial change in volume as a result of melting or solidification?

A 0.97 g/cm^3 B 1.9 g/cm^3 C 2.9 g/cm^3 D 3.0 g/cm^3

9 Which of the following quantities will change when the gravitational field strength changes?

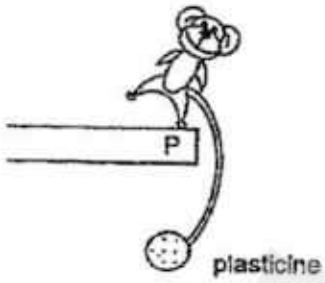
(I) Mass (II) Weight (III) Inertia (IV) Acceleration of free fall

A (I) and (II)
B (II) and (III)
C (II) and (IV)
D (II), (III) and (IV)

10 An irregular shaped lamina is suspended from a pivot point P as shown. The object is at rest.

Which of the following points is its centre of gravity (CG)?

11 The figure shows a toy monkey left on the edge of a table, by a girl, at point P. By attaching a lump of plasticine at the end of its tail, the girl is able to balance the toy. When displaced, it oscillates and comes to rest at this position.

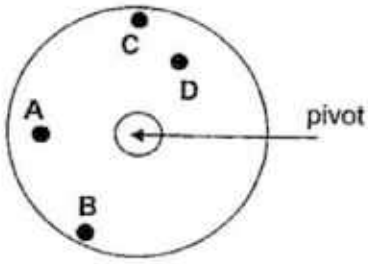


How does the plasticine help the toy to attain this state of equilibrium?

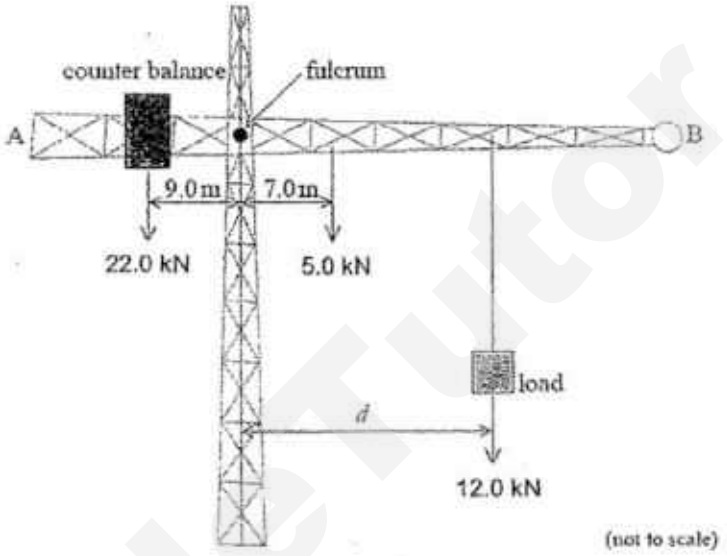
A It increases the weight of the toy.
B It moves the centre of gravity to be located exactly at P.
C It moves the centre of gravity directly above P.
D It moves the centre of gravity to be directly below P.

12 The figure shows a CD-ROM pivoted at the centre so that it stays at rest in a vertical plane.

At which position can a piece of plasticine be attached to the CD-ROM to generate the greatest turning effect about the pivot?



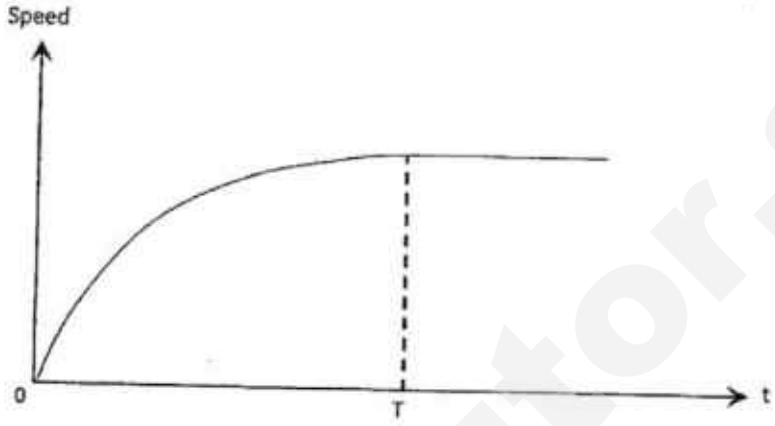
13 The figure shows a crane that can carry a heavy load. The jib (horizontal section AB) of the crane has a weight of 5.0 kN, and its centre of gravity is 7.0 m from the fulcrum (pivot). The weight of the counterbalance is 22.0 kN, and it is 9.0 m from the fulcrum. The counterbalance keeps the load and the weight of the jib of the crane in equilibrium.



What is the distance, d, of the load from the fulcrum?

A 13.6 m
B 16.5 m
C 16.8 m
D 19.4 m

14 The diagram shows the variation of the speed of a ball falling through air with time.



Which of the following statements best describes the relationship between the change in gravitational potential energy, kinetic energy and work done against air resistance as the ball falls?

A The loss in gravitational potential energy is more than the gain in kinetic energy.
B The loss in gravitational potential energy is equal to the gain in kinetic energy.
C The loss in gravitational potential energy is the work done against air resistance.
D The loss in gravitational potential energy is less than the work done against air resistance.

15 A motor takes 8 minutes to raise a 3500 kg load through a height of 5 m. Which of the following gives the power of the motor in watts?

A $\frac{3500 \times 5}{8}$

B $\frac{3500 \times 10}{8 \times 60}$

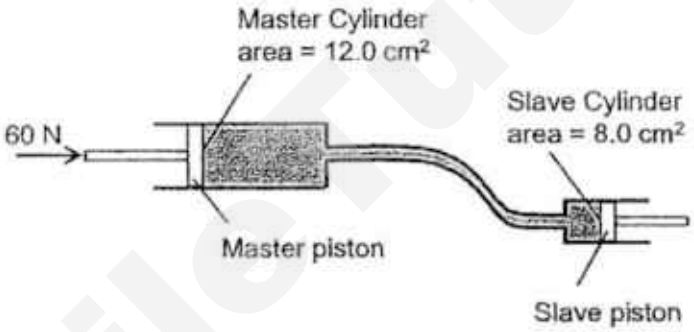
C $\frac{3500 \times 10 \times 5}{8}$

D $\frac{3500 \times 10 \times 5}{8 \times 60}$

16 A ball is thrown vertically downwards, with an initial velocity of 3 m/s from a height of 24 m. Applying the principle of conservation of energy, what is the velocity of the ball just before it reaches the ground, assuming negligible air resistance?

A 11.1 m/s
B 15.6 m/s
C 21.7 m/s
D 22.1 m/s

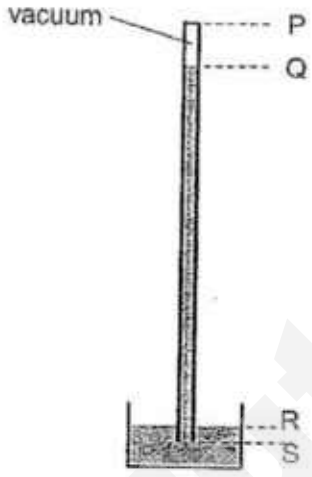
17 The diagram shows a hydraulic system, where the cross-sectional area of the master cylinder is 12.0 cm^2 and that of the slave cylinder, 8.0 cm^2. A 60 N force is applied to the master piston.



What is the force experienced by the slave piston and the pressure experienced by the slave cylinder?

	Pressure at slave cylinder / Ncm^{-2}	Force at slave cylinder / N
A	3.3	40
B	3.3	90
C	5.0	40
D	5.0	90

18 The figure shows a mercury barometer. The space above the top of the mercury inside the tube is a vacuum.

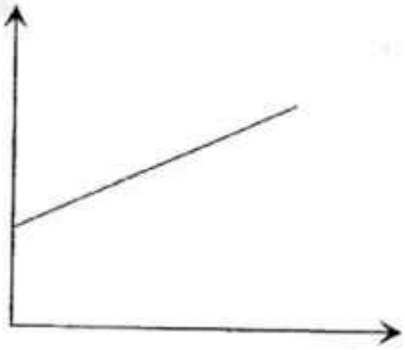


The barometer is brought to a mine shaft 3.5 kilometres below sea level.

Which of the following lengths will increase?

A PQ
B QR
C RS
D PS

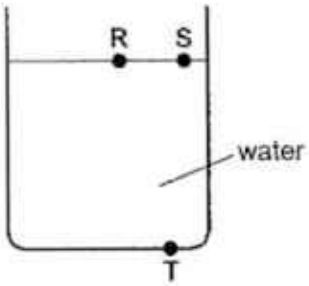
19 The graph indicates properties of a fixed mass of gas.



Which of the following could describe what is plotted on the graph?

	Vertical axis	Horizontal axis	Condition
A	Density	Temperature	Constant pressure
B	Pressure	Volume	Constant temperature
C	Volume	Temperature	Constant pressure
D	Volume	Density	Constant temperature

20 A student has a beaker of water, and he wants to set up a convection current.



Which of the following would do this?

A Heating at R
B Heating at S
C Cooling at S
D Cooling at T

21 An experiment was carried out by using four bars, all having the same size, and with each placed one end in water that is at 90 °C. The time taken for the temperature to rise by 2 °C on the other end of the bars are recorded:

Material	Time for 2 °C rise / s
Aluminium	10
Copper	5
Fibreglass	600
Polystyrene	1000

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

	Tank	Insulation
A	Aluminium	Fibreglass
B	Aluminium	Polystyrene
C	Copper	Fibreglass
D	Copper	Polystyrene

22 The resistance of a resistance thermometer is 8.0 Ω when the temperature is 10°C, and 45 Ω when the temperature is 100°C.

Determine the temperature of a cup of water if the resistance is 30 Ω when the thermometer is inserted into the water.

A 43.5°C B 53.5°C C 59.5°C D 63.5°C

23 Which of the following best defines specific heat capacity of a substance?

A Specific heat capacity is the amount of thermal energy required to change the temperature of a unit mass of the substance by 1 K or 1 °C.

B Specific heat capacity is the amount of thermal energy required to change the temperature of a unit mass of the substance.

C Specific heat capacity is the amount of thermal energy required to change the temperature of the substance by 1 K or 1 °C.

D Specific heat capacity is the amount of thermal energy required to change the temperature of the substance.

24 A substance which is originally a solid is being heated strongly for some time. At one stage, the energy given to it is used as latent heat of vaporisation.

What change does the energy cause at that stage?

A It makes the molecules move faster and so the temperature rises.

B It makes the molecules move faster but there is still a strong attraction between them.

C It breaks the bonds holding the molecules together. The solid becomes liquid.

D It breaks the bonds holding the molecules together. Molecules escape from the liquid.

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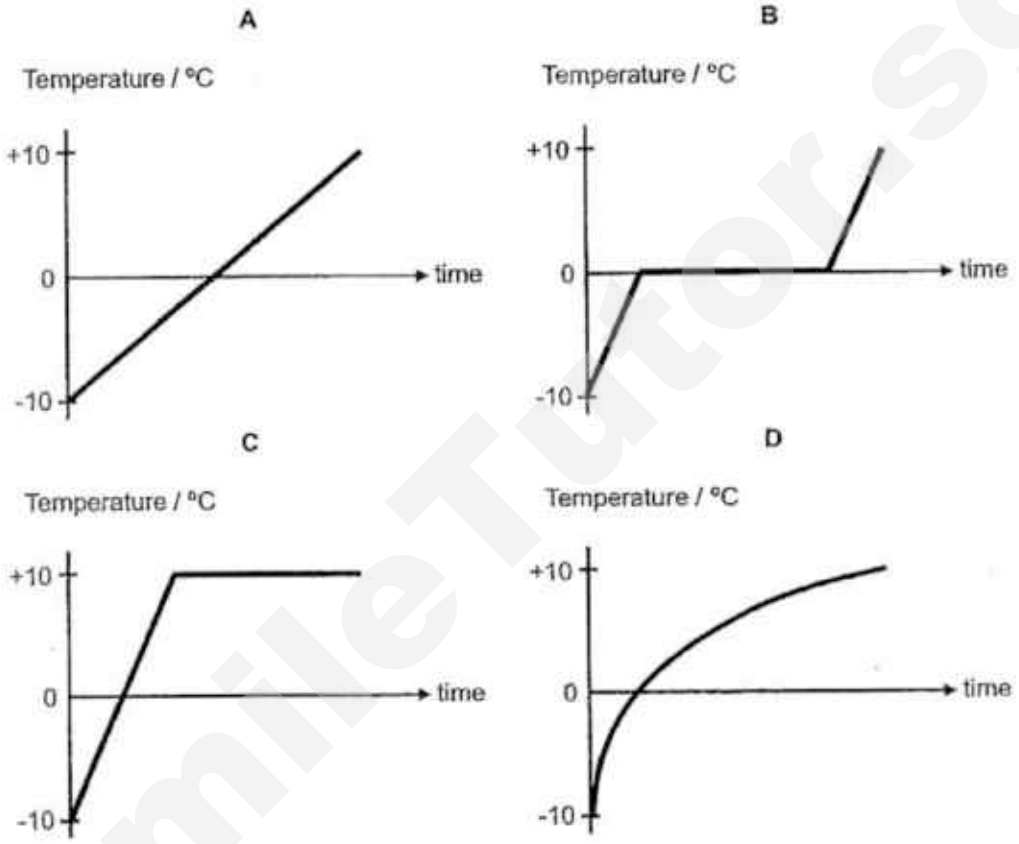
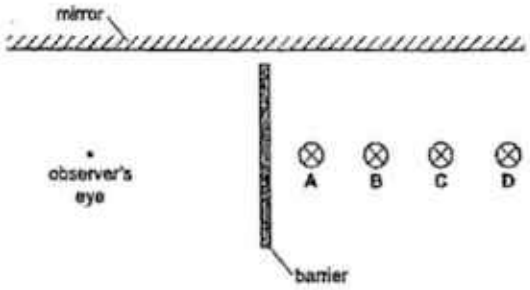
25 Ice at -10 °C is being heated at a constant rate until it is water at +10 °C.

Which graph shows how temperature changes with time?



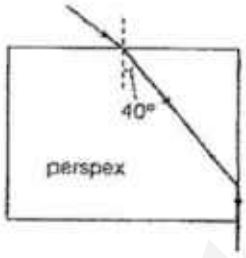
26 The diagram shows a barrier placed at right angles to a plane mirror with four lamps placed at positions A, B, C and D.

Which of the lamps can be seen by the observer's eye?



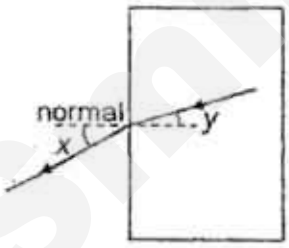
27 A ray of light passes through a block of Perspex.

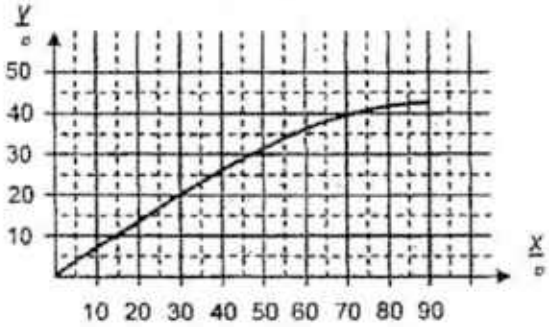
What is the refractive index of the rectangular Perspex block shown in the diagram?



A 1.15
B 1.31
C 1.50
D 1.56

28 A student conducts an experiment to determine the angle of incidence y for light exiting a glass block at various angles of refraction x as shown. A graph of angle y against angle x was plotted.





What is the critical angle of the glass used in the experiment?

A 0°
B 29°
C 43°
D 90°

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29 A converging lens is used to focus the light rays from a distant tree. The nature of focused image would be

A inverted, real, and diminished.

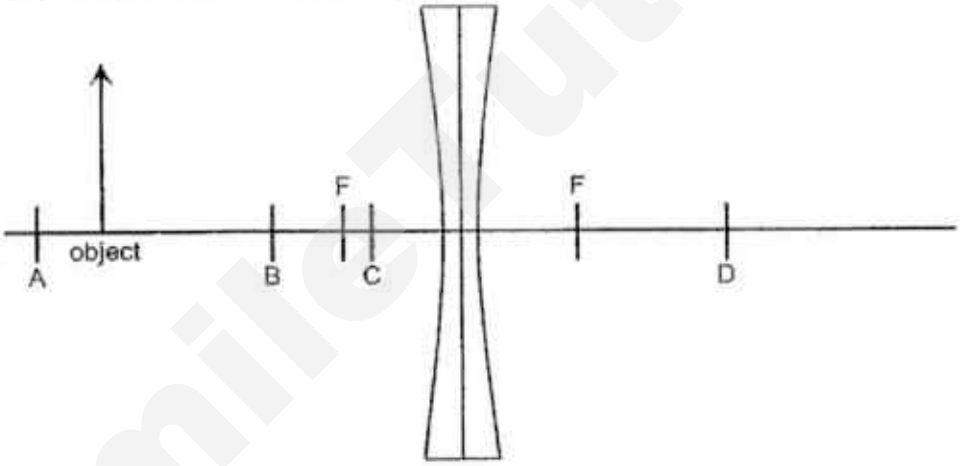
B inverted, virtual, and diminished.

C upright, real, and diminished.

D upright, virtual, and diminished.

30 An object is placed in front of a diverging lens, as shown in the scaled diagram. The principal focus F is marked on each side of the lens.

At which position will the image be formed?



Name: _____ Class: _____ Index No. : _____

ST JOSEPH'S INSTITUTION

SECONDARY 3 (O-LEVEL PROGRAMME)
2016 END OF YEAR EXAMINATION

PHYSICS **5059**

28 September 2016
2 hrs 30 min
(0800 – 1030)

Additional Materials: Multiple Choice Answer Sheet

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Section B			
1	2	3	4
5	6	7	
Section C			
8	9	10	

For Examiner's Use	
Section A	/ 30
Section B	/ 40
Section C	/ 30
Total	/ 100

Sections B and C of this Question Paper consists of 30 printed pages.

Section B (40 marks)
Answer all questions in this section.

1 A small spacecraft is about to land on planet Mars.

The spacecraft enters the planet's atmosphere, and when it is reaches a speed of 1600 km/h, it deploys a parachute to slow its fall. The spacecraft eventually reaches a steady speed, and finally hits the surface.

(a) In the graph provided in Fig.1.1, complete the speed-time graph for the spacecraft. The parachute opens at time t_1, and the spacecraft hits the surface of Mars at time t_2.

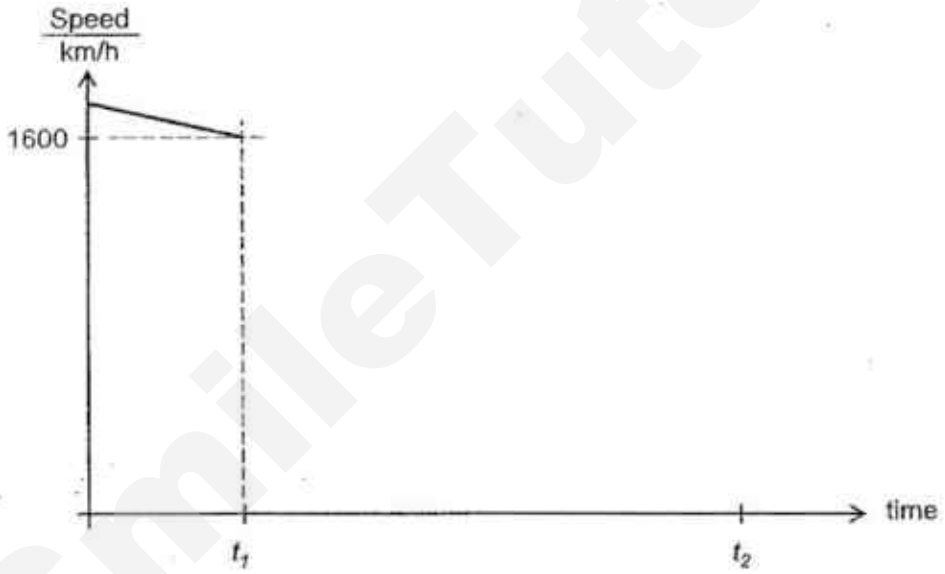
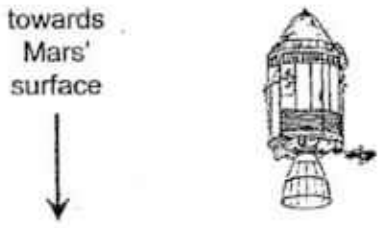


Fig. 1.1 [2]

(b) The mass of the spacecraft is 70 kg. The gravitational field strength of Mars is 3.0 N/kg and the total upwards force on the spacecraft is 500 N.

(i) In Fig. 1.2, draw the two forces representing the spacecraft's weight and atmospheric resistance it experiences. Label the vectors W and F, respectively.



[1]

Fig. 1.2

(ii) Determine the weight of the spacecraft.

weight = ... [1]

(iii) Determine the resultant force on the spacecraft.

resultant force = ... [1]

(iv) Determine the deceleration of the spacecraft.

deceleration = ... [2]

2 Fig. 2.1 shows two men, X and Y, carrying a load using a uniform pole that is 4.0 metres long, and has a mass of 5.0 kg. The ends of the pole rest on each man's shoulder, and the pole is kept in a horizontal position.

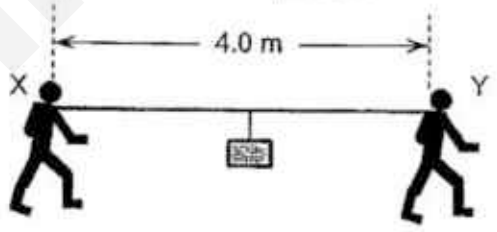


Fig. 2.1

The load has a mass of 16 kg, and is suspended by a rope of negligible mass.

(a) Explain what is meant by *moment of a force*.

.....

..... [1]

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(b) **(i)** Along the journey, Y injures his foot, so X adjusts the position of the load such that the vertical force on his shoulder is twice as great as the vertical force on Y's shoulder.

Fig. 2.2 shows the load being shifted to the new position.

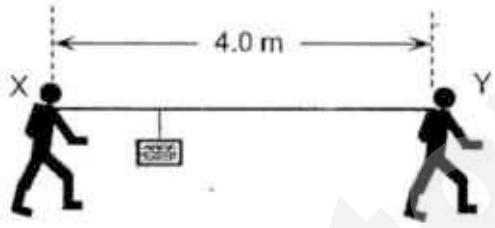

Fig. 2.2

Fig. 2.3 is a free-body diagram showing the contact forces of the men on the pole.

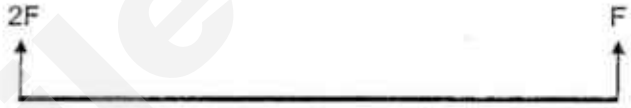

Fig. 2.3

In Fig. 2.3, draw the two forces, representing the weight of the pole, and the approximate position of the load. Label them W and L, respectively. [2]

(ii) Calculate the value of F.

F = ... [1]

(iii) Let l be the distance from the CG of the pole, to the point where the load is fixed. Taking moments about X, calculate the value of l.

l = ... [2]

3 Fig. 3 shows a diving platform at a height of 10 m above the water surface of a swimming pool. A platform diver of mass 65 kg jumps up into the air before diving vertically towards the water. The height between the highest point he reached and the diving platform is 0.8 m, as shown. Assume air resistance is negligible.

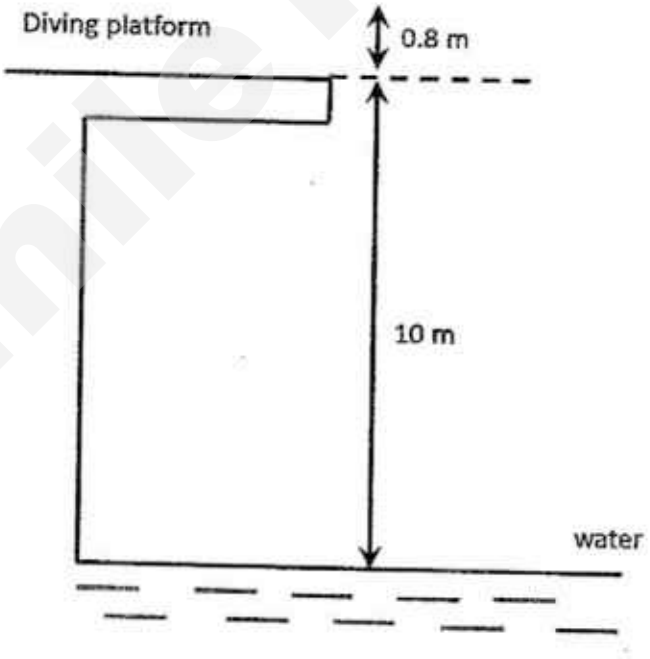

Fig. 3

(a) State the energy conversions involved from the point the diver takes off, to the point just before he enters the water. Take the water surface to be the reference level.

.....

.....

..... [2]

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(b) Calculate the total energy of the diver when he is at the highest point of his dive.

total energy = ... [2]

(c) If he reaches a depth of 4.0 m in the water, determine the resistive force acting on the diver.

resistive force = ... [2]

4 Fig. 4 shows a manometer used to measure the pressure of air inside a flexible plastic container. A pressure difference of 100 Pa causes a one centimetre difference in water levels.

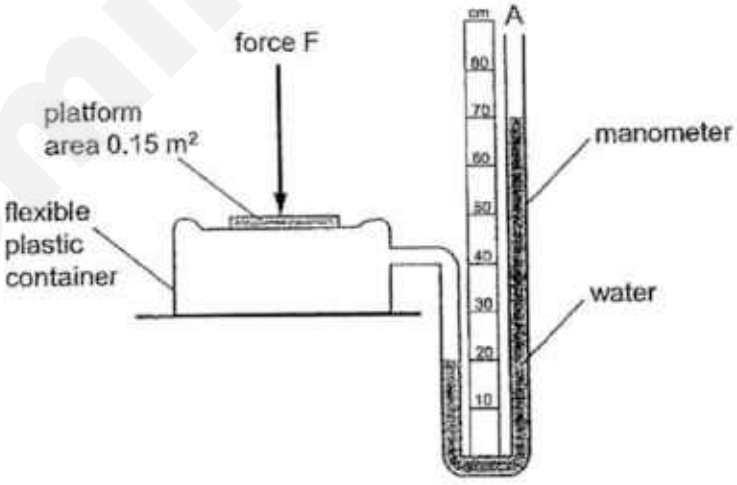

Fig. 4

(a) (i) Using Fig. 4, determine the pressure difference in Pa shown by the manometer.

pressure difference = ... [1]

(ii) The pressure difference measured by the manometer is caused by the force F. This force is the weight of a boy standing on the platform. The area of the platform is 0.15 m^2.

Calculate the weight of the boy.

weight = ... [2]

(iii) State what changes, if any, occur to the difference in fluid level if a liquid denser than water is used in the manometer.

.....[1]

(b) The water in the manometer is now replaced with oil, and attached to the same plastic container. Taking the density of the oil as 833 kg/m^3, calculate the new height difference in the oil levels.

height difference = ... [2]

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5 Fig. 5 shows the side view of a black colour metal heat sink firmly attached to the top of a computer chip. The heat sink keeps the computer chip cool. The computer chip is mounted on a printed circuit board.

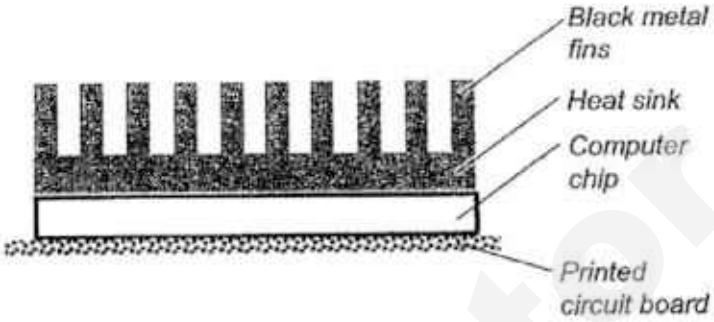

Fig. 5

(a) Describe one way in which thermal transfer process via conduction is different from radiation.

.....

.....[1]

(b) State how the design and material of the heat sink enable greater thermal transfer via

(i) conduction .....

.....[1]

(ii) convection .....

.....[1]

(iii) radiation .....

.....[1]

6 A 200 W immersion heater is used to heat 180 g of liquid benzene in an insulated container. The temperature of the benzene increases from room temperature of 22°C to 80°C in 1.5 minutes. The heater is removed and the benzene cools to room temperature in 10 minutes.

(a) Fig. 6 shows the cooling curve of the benzene.

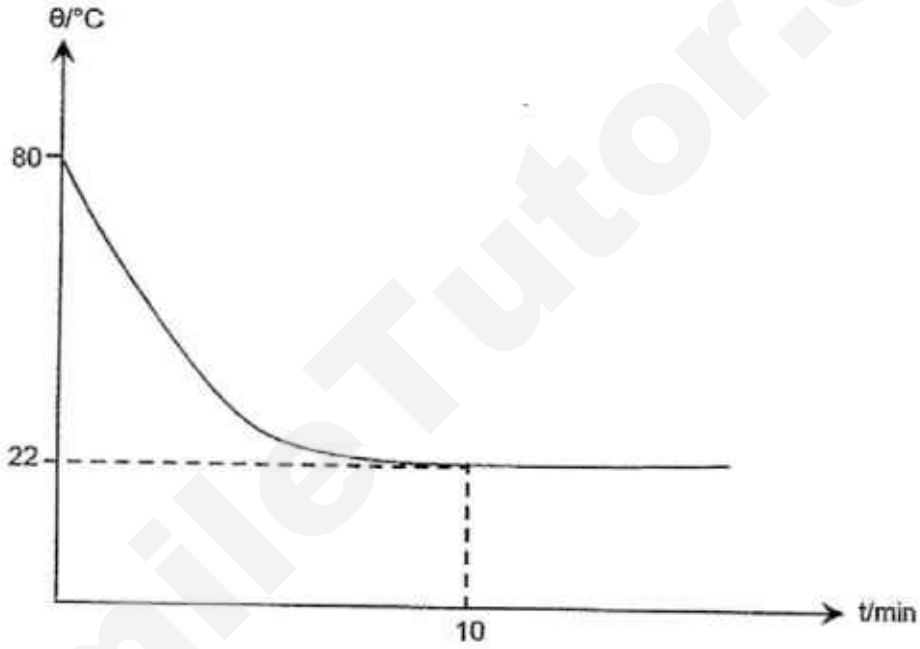

Fig. 6

(i) With reference to Fig. 6, explain why the temperature changes with time as shown.

.....

.....[1]

(ii) Explain what is meant by thermal equilibrium, and suggest how the curve shows that thermal equilibrium is reached.

.....

.....

.....[2]

(iii) Describe the change in molecular behavior as liquid benzene cools.

.....

.....[1]

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(b) Calculate the heat capacity of the benzene.

heat capacity = ... [2]

7 Fig. 7 shows a cross-sectional view of a simple digital camera, used to photograph an object.

The lens forms a focused image of the object on the CCD (charge-coupled device).

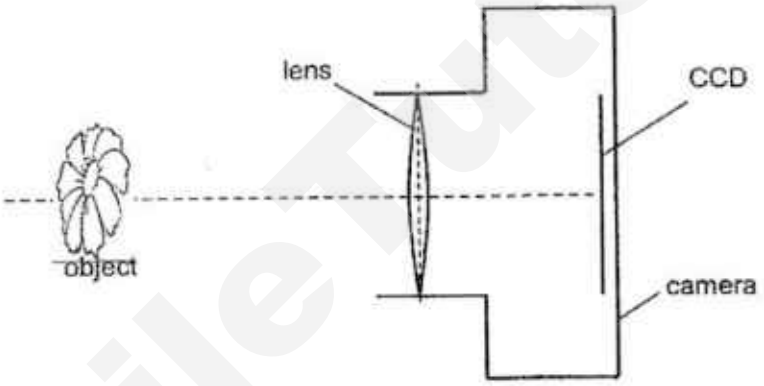

Fig. 7

(a) Explain what is meant by the term *focal length*.

.....

.....[1]

(b) (i) Draw two rays from the top of the object to show how the lens forms the image on the CCD. [2]

(ii) Locate the focal point of the lens, and label it "F". [1]

(c) The object is moved closer to the camera. State how the lens will need to be adjusted to keep the image in focus.

.....

.....[1]

Section C (30 marks)
Answer all questions in this section.

8 Two motorcyclists, A and B, set out on the road. Fig. 8.1 shows the distance travelled over a 20 second interval.

Time / s	Distance travelled / m	
	Motorcyclist A	Motorcyclist B
0	0	0
5	80	60
10	170	120
15	270	240
20	380	380

Fig. 8.1

(a) State and explain briefly how the average speed of motorcyclist B compares with that of motorcyclist A over the 20 seconds interval shown in Fig. 8.1.

.....

.....[2]

(b) Motorcyclist A was accelerating from t = 0 s till t = 20 s. At 20 s, he started moving at constant speed.

On Fig. 8.2, mark with an 'X', a possible position of the centre of the front wheel of the motorcycle at t = 25 s. With a dotted line, indicate clearly the position of X relative to the scale shown. [1]

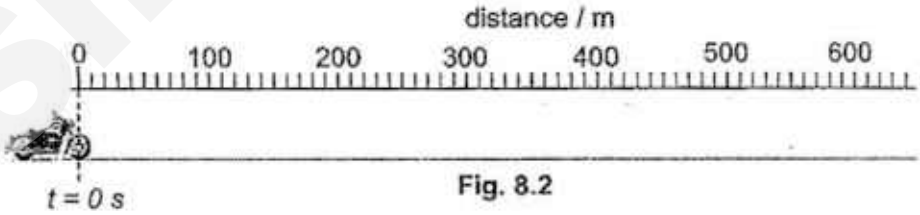

Fig. 8.2

190

(c) At t = 25 s, when motorcyclist A was moving at constant speed of 22 m/s, he saw a child run onto the road in front of him. He applied the brakes after a reaction time of 0.80 s. His motion is shown in Fig. 8.3.

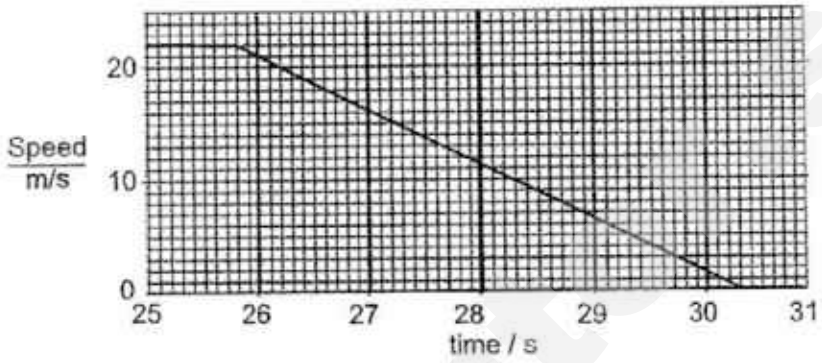

Fig. 8.3

(i) Calculate the distance he travelled from the moment he saw the child till he stopped his motorcycle.

distance travelled = ... [2]

(ii) Calculate the deceleration of the motorcyclist after he applied his brakes.

deceleration = ... [2]

(iii) In Fig. 8.4, with the help of the values obtained in (c)(i) and (ii), sketch the displacement-time graph of the motorcycle from t = 25 s to t = 30.3 s, indicating clearly the significant timings and corresponding displacement values. [3]

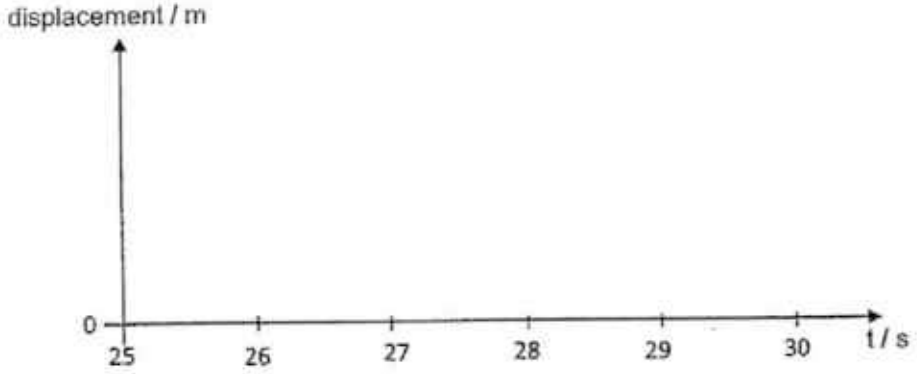

Fig. 8.4

9 Fig. 9 shows the apparatus used to observe Brownian motion using pollen grains suspended in a liquid.

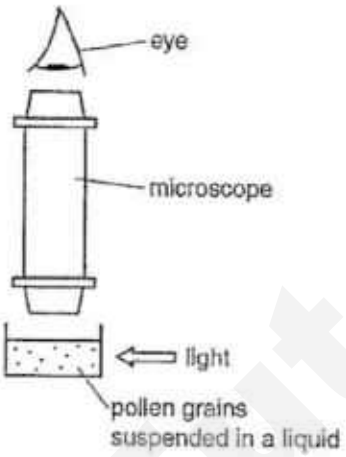

Fig. 9

(a) (i) In the space below, draw the motion of one pollen grain, as seen by the observer under the microscope. [1]

(ii) State two conclusions that may be deduced about the liquid, from the motion of the pollen grains observed with the microscope.

.....

.....

..... [2]

(iii) Suggest how the motion of the pollen grains could be increased.

.....

..... [1]

(b) In 1924, Howard Somervell and Edward Norton set a new altitude record when attempting to climb Mount Everest. They managed to climb to a vertical height of 8570 m above sea level by breathing naturally.

(i) Using ideas about molecules, describe and explain the relationship between pressure and volume of a gas at constant temperature as volume increases.

.....

.....

.....

.....

.....[3]

(ii) Explain why it is challenging to breathe in natural air at a height of 8570 m.

.....

.....

.....[2]

(iii) The air temperature was measured to be -33 °C. The thermometer used to measure the temperature on the mountain reads 2°C in pure melting ice and 102°C in steam above boiling water at sea level. State the correct temperature of the air on the mountain.

temperature = ... [1]

10 Fig.10.1 shows a boy and a girl standing in front of a shop window. The boy stands at point A. He sees the reflection of a girl standing at point B in the shop window.

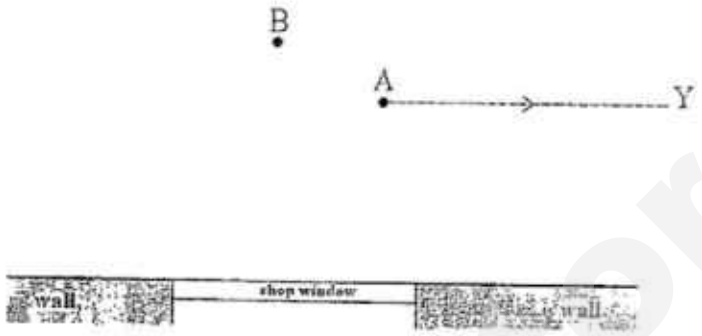

Fig. 10.1

(a) **(i)** On Fig. 10.1, mark accurately, with a letter I_M, the position of the image of the girl formed by reflection in the shop window. Ignore the thickness of the shop window - reflection happens at the front surface of the shop window. [1]

(ii) On Fig. 10.1, draw a ray of light to show how, by reflection, the boy sees the girl. [1]

(iii) The boy moves further away from the girl, in the direction shown, towards Y. By means of a ray diagram, indicate the point P in Fig. 10.1, the furthest position where the boy can move, such that the girl and he can still see each other by reflection in the shop window. [2]

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(b) Fig. 10.2 shows a spherical droplet of water in air. A ray of yellow light is incident at the water droplet as shown. Water has a refractive index of 1.33 for yellow light.

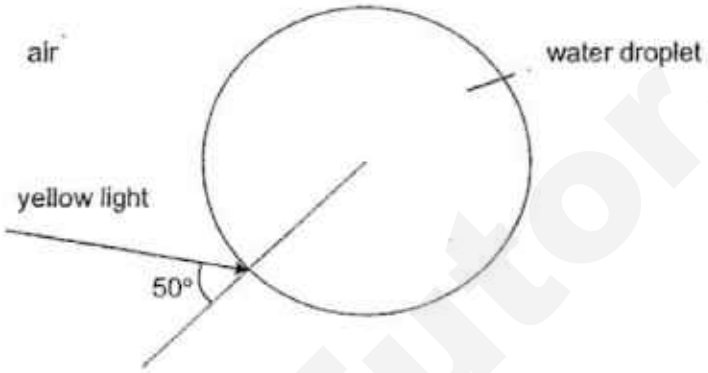


Fig. 10.2

(i) State the criteria for which total internal reflection can occur.

.....

.....[1]

(ii) Calculate the angle of refraction in the water droplet.

angle of refraction:.....[2]

(iii) Calculate the critical angle, c_{water}.

critical angle:.....[2]

(iv) Fig. 10.3 shows the same yellow ray incident (at the same angle) on a spherical air bubble in water. Show how the ray moves after hitting the air bubble. State all necessary angles. [1]

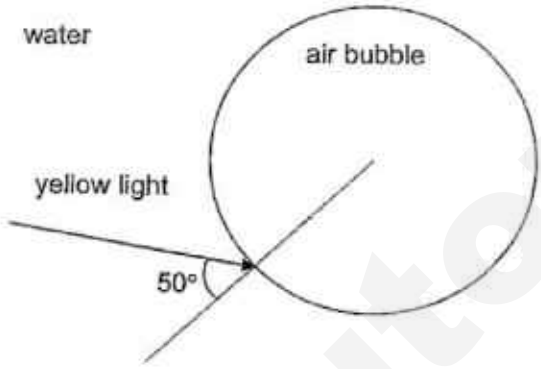


Fig. 10.3

- End of Paper -

st. Joseph's

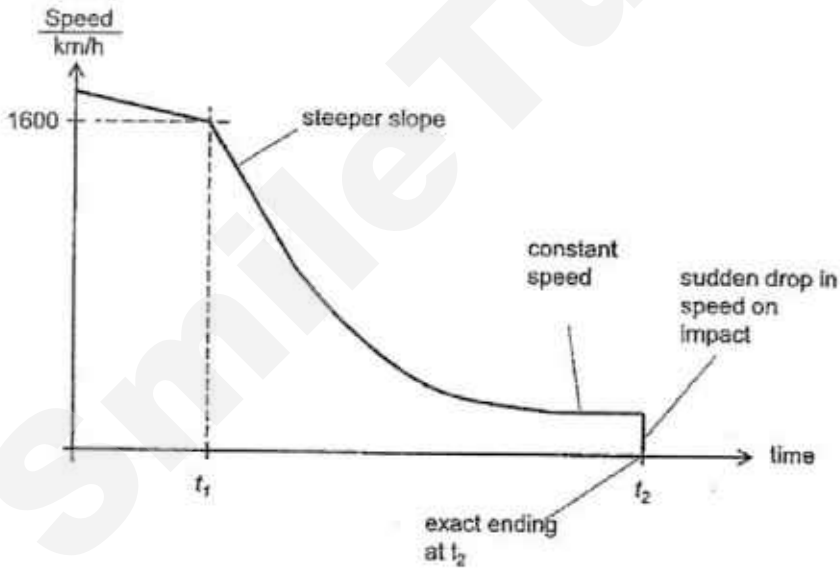
Answer

Section A

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

Section B

1a.



b(i).

1b(ii). weight = 70 kg x 3.0 N/kg = **210 N**

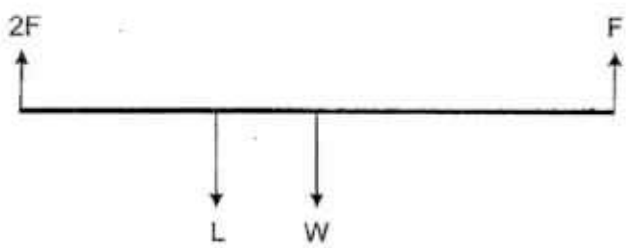
1b(iii). resultant force = 210 – 500 N = **-290 N**

.94

1b(iv). deceleration = 290 N / 70 kg
= **4.14 m/s²**

2a. The moment of a force is the product of the force and the **perpendicular** distance from the **line of action** (of the force) to the **pivot**.

2bi.



2bii. 2F + F = 50N + 160N
3F = 210 N
F = **70 N**

2biii. Let *l* be the unknown distance from CG to rope.
Taking moments about X,
Sum of clockwise moments = sum of anti-clockwise moments
[160N x (2 - *l*)m] + [50N x 2.0m] = [70N x 4.0m]
320Nm – 160*l*Nm + 100Nm = 280Nm
140Nm = 160*l*Nm
l = **0.875 m**

3a. As the diver jumps, his KE is converted to GPE. At the highest point, all his KE is converted to GPE. When he starts falling, GPE is converted back to KE. At the surface of the water, his total GPE at the highest point is converted to KE.

3b. Energy = mgh
= 65kg x 10N/kg x 10.8m
= **7020 J**

3c. KE of diver just before he hits surface of water = 65kg x 10N/kg x 10.8m = 7020 J
GPE of diver at water surface = 65kg x 10N/kg x 4.0 m = 2600 J
Work done against water resistance = -F x 4.0 m
-F x 4.0m = Loss in GPE + loss in KE = -2600J – 7020J = -9620 J
F x 4.0m = 9620 J
Resistive force, F = 2405 N = **2400 N**

4ai. Pressure difference = 50cm x 100 Pa/cm = **5000 Pa**

4aii. Pressure = F / area
5000 Pa = weight / 0.15 m²
Weight = **750 N**

4aiii. The difference in fluid level will be **less/lower**.

4b. Pressure difference = 5000 Pa = $\rho \times g \times h$

5000 Pa = 833 kg/m^3 x 10 N/kg x h

h = **0.60 m** or **60 cm**

5a. Conduction takes place **through a medium** while radiation can take place **without a medium**.

5bi Thermal energy is conducted quickly **through the metal** from the computer chip **to the air particles** next to the heat sink fins.

5bii The metal fins have more **surface area of contact** with the air, hence increasing the rate of thermal transfer.

5biii Black surface is a **good emitter** of radiation.

6ai As temperature difference between benzene and surroundings decreases/temperature of benzene decreases, the rate of cooling would also decrease hence curve slopes more gently.

6aii When thermal equilibrium is achieved, the net transfer of thermal energy is zero. This is shown by the steady temperature reached.

6aiii As the temperature of the benzene decreases, the internal KE of benzene molecules decreases and their speeds would also decrease.

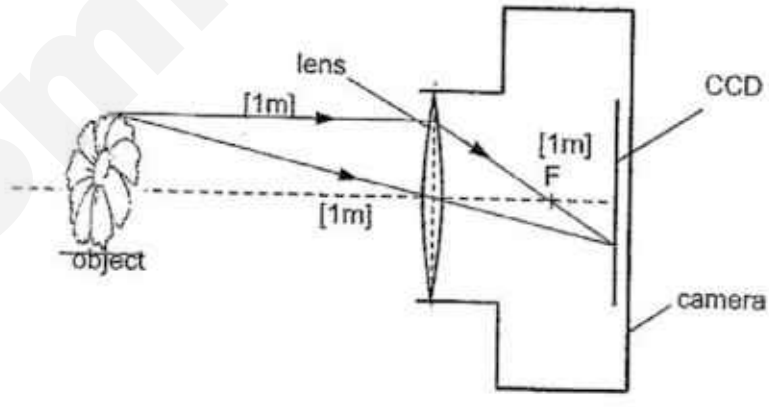
6b. $Pt = C \times \Delta\theta$

$200W \times (1.5 \times 60)s = C \times (80 - 22)°C$

C = **310 J/kg**

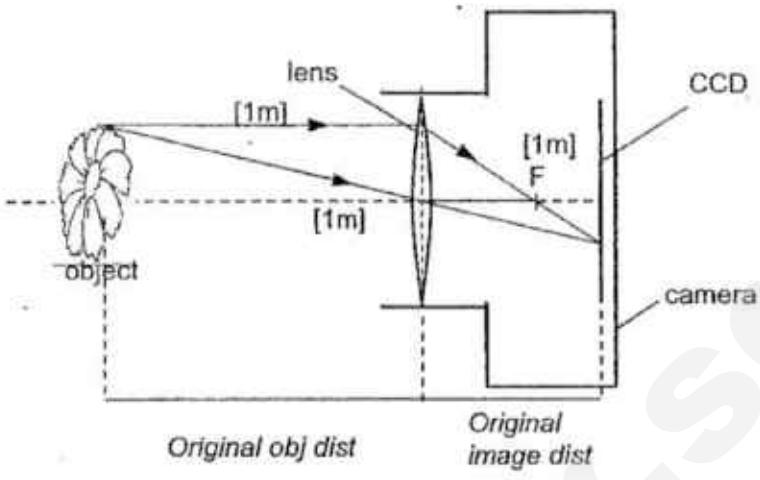
7a. The focal length is the distance between the **optical centre** of the lens to the **focal point**.

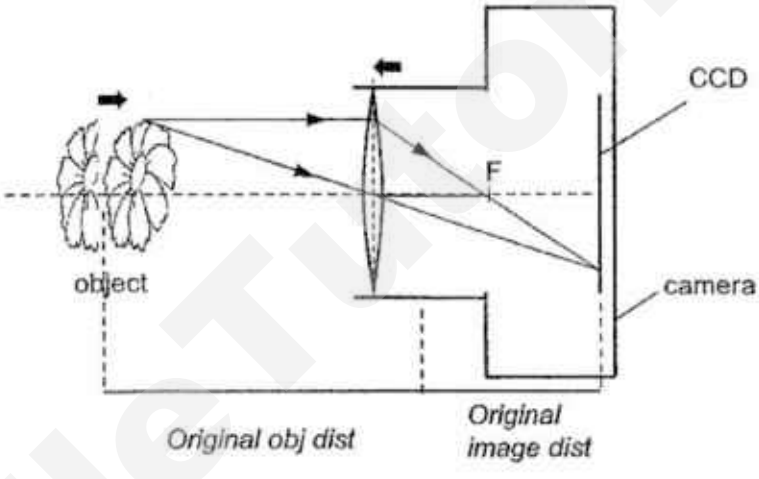
7bi & ii.



.95

7c. The lens will have to move **towards the object** (further **away from the CCD**).





8a. They have the same average speed.
They travelled the same distance in the 20 seconds.

8b.

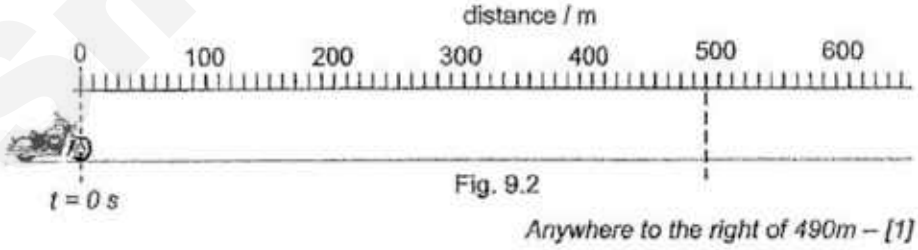


Fig. 9.2

Anywhere to the right of 490m – [1]

8ci Distance travelled = ½ x (0.8 + 5.3)s x 22m/s
= **67.1 m**

8cii Deceleration = (22 – 0)m/s / 4.5s
= **4.89 m/s²**

8ciii

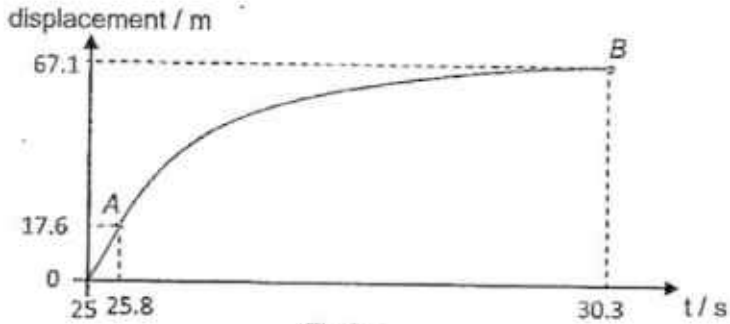
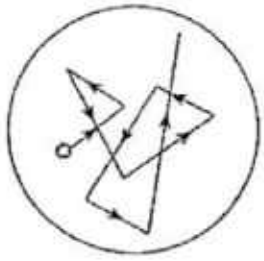


Fig 9.4

Correct time & displacement values at A & B – [1]

OA is a straight line – [1]

9ai.



9aii. Liquid is made up of particles/molecules
Molecules are in constant random motion

9aiii. Increase the temperature of the liquid.

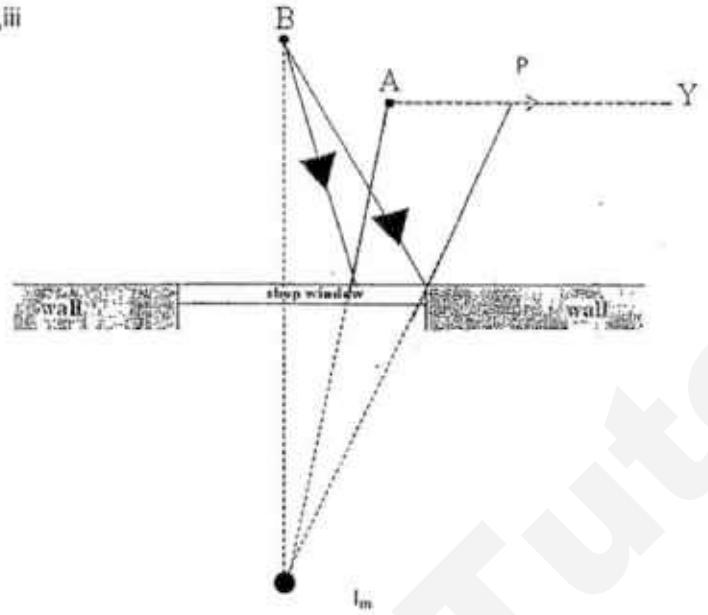
9bi. The pressure of a gas is inversely related to its volume. When volume increases, the number of particles per unit volume decreases, frequency of collisions decrease, force per unit area, which is pressure, therefore decreases.

9bii. The air pressure at this height is about 1/3 (much lower) of that at sea level. This means that the number of air molecules (oxygen molecules) per unit volume is also 1/3 (fewer than) that at sea level. The lack of oxygen would cause the climber to inhale more frequently which would tire him out more easily.

9biii. Correct temperature = 0°C – 35°C = **<u>–35°C</u>**

.96

10ai,ii,iii

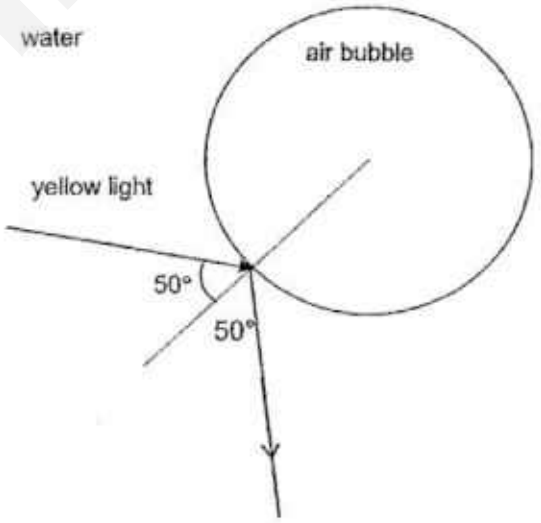


10bi Total internal reflection happens in the **optically denser medium** and the angle of incidence in the denser medium is **greater than the critical angle**.

10bii $n = \sin i / \sin r$
$1.33 = \sin 50 / \sin r$
$r =$ **35.2 °**

10biii $c = \sin^{-1} (1/1.33)$
$=$ **48.8 °**

10biv



NAME	CLASS	INDEX NO.

ST. PATRICK'S SCHOOL
END-OF-YEAR EXAMINATIONS 2016

SUBJECT : PHYSICS 5059 DATE : 10 OCT 2016

LEVEL : SECONDARY 3 EXPRESS DURATION : 2 HOURS

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

1. Write your name, class and index number on the **Question Paper** and the **Optical Answer Sheet** in the spaces provided. **It is also required that you WRITE and SHADE your index number on the Optical Answer Sheet.**
2. Answer **ALL** questions in **Section A** on the **Optical Answer Sheet** provided.
3. Answer **ALL** questions in **Section B** in the spaces provided.
4. Answer **ALL** questions in **Section C** on the spaces provided. Question **11** is an **EITHER / OR QUESTION. SELECT ONLY ONE PART OF THIS QUESTION.**
5. Throughout the paper, the **acceleration due to gravity on Earth** is taken as 10 N/kg **unless stated otherwise.**
6. Calculators may be used where necessary. **Where numerical answers are not exact, give answers to THREE (3) significant figures.**
7. **DO NOT DETACH** any sections from this paper.
8. Submit the **Optical Answer Sheet** and this **paper SEPARATELY** at the end of the examination.

For Examiner's Use Only

Section	A [20 m]	B [50 m]	C [30 m]	Total [100 m]	Grade
Score					

This paper consists of 26 printed pages, including the cover page

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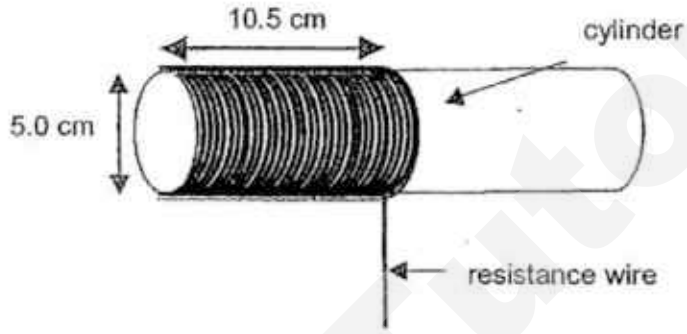
SECTION A : [20 marks]

*Each question is provided with **four** possible answers (**A**, **B**, **C** and **D**). Select the most appropriate answer and **shade** your choice on the **Optical Answer Sheet** provided.*

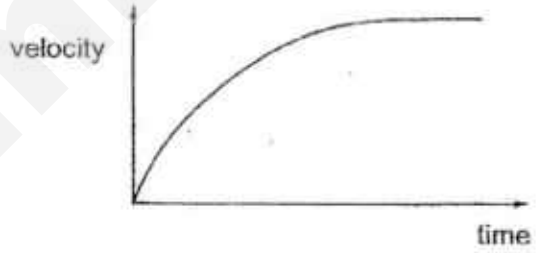
1 Joyce wanted to measure the thickness of a resistance wire. She wound the wire around a cylinder, of diameter 5.0 cm, 50 times and took the following measurements as shown in the figure.



Which one of the following is the thickness of the wire?

A 0.050 cm **B** 0.100 cm **C** 0.105 cm **D** 0.210 cm

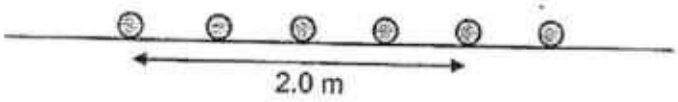
2 The graph shows how the velocity of a car changes with time.



Which one of the following can be deduced from the graph?

A The car decelerates until it stops.
B The car accelerates at an increasing rate.
C The car first accelerates and then moves with a steady velocity.
D The car first decelerates and then moves with a steady velocity.

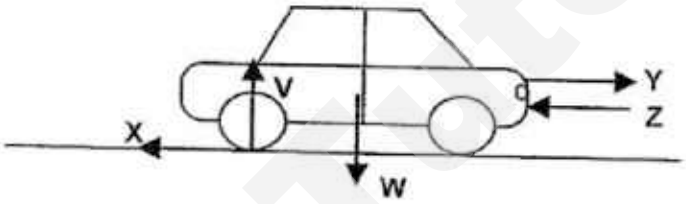
3 The figure shows a series of photographs of a ball rolling with constant velocity. The camera was capturing images at a constant rate of 10 per second.



What was the speed of the ball?

A 1.0 m/s B 2.0 m/s C 4.0 m/s D 8.0 m/s

4 The figure shows a car moving to the right. Some forces are acting on the car.



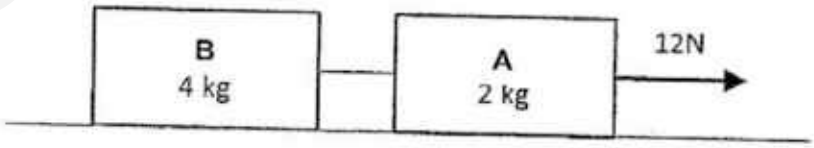
The reduction of which force(s) will cause the speed of the car to decrease?

A Y only B Z only C X and Z only D W and V

5 The total weight of a gas-filled balloon is 1200 N. The balloon rises at a constant speed of 2 m/s. What is the resultant force acting on the balloon when it is rising?

A 0 N B 60 N C 600 N D 2 400 N

6 A force of 12 N acts on block **A** and block **B** of mass 2 kg and 4 kg respectively as shown.



Given that the floor is smooth, what is the tension of the string between block **A** and block **B**?

A 2.0 N
B 4.0 N
C 8.0 N
D 12.0 N

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7 The table shows the density of some substances.

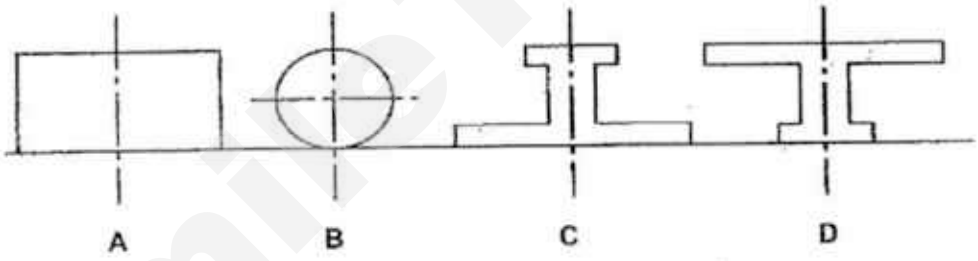
substance	density (kg/m^3)
ebonite	1150
glass	2500
glycerine	1260
kerosene	800
rubber	1300

Which one of the following statements is not true?

A Rubber sinks in glycerine.
B Glycerine floats on top of kerosene.
C Glass sinks in both glycerine and kerosene.
D Ebonite solid sinks in kerosene but floats in glycerine.

8 The figure shows four shapes, cut from the same piece of card.

Which shape has its centre of mass nearest to the base line?

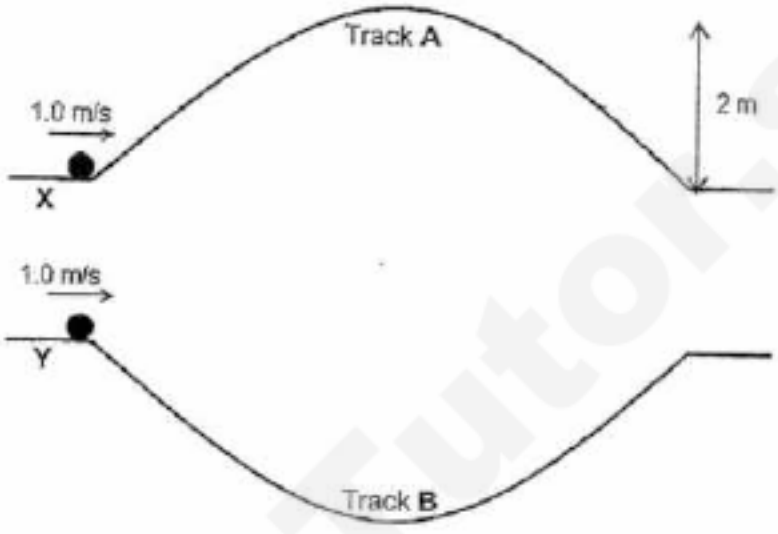


9 Randy pushes a shopping cart of mass 14 kg for 10 m. The work done by Randy is 2 kJ.

Calculate the force exerted by Randy on the cart.

A 0.20 N **B** 14.3 N **C** 140 N **D** 200 N

10 The figure shows two identical marbles **X** and **Y** enter two types of trajectory **A** and **B** respectively with the same initial speed of 1.0 m/s. Assume all the surfaces involved are frictionless.



Given that Track **A** and Track **B** are mirror images of each other, which one of the following statements is true?

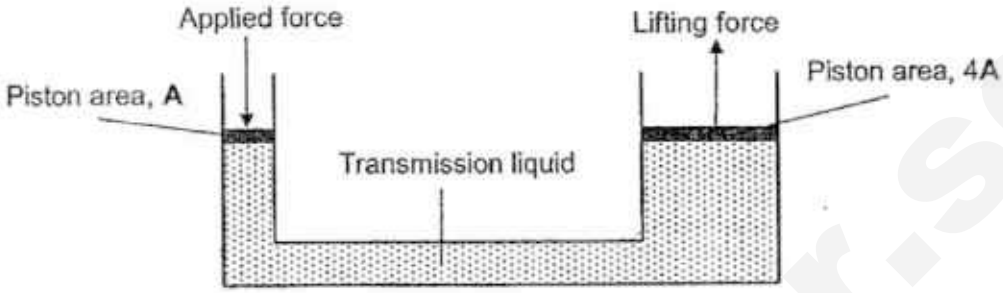
A The final speed of **X** is higher than **Y**.
B **X** reaches the other end of the track before **Y**.
C **Y** reaches the other end of the track before **X**.
D Both **X** and **Y** reaches the other end of the track at the same time.

11 Which of the following statement(s) is/are correct?

I. Power is the rate of work done.
II. Power is created in the power station.
III. Power is only found in electrical circuits.
IV. Power is a measure of the efficiency of objects.

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

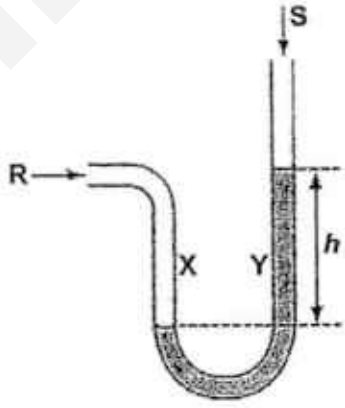
12 The figure shows a hydraulic press used in a workshop to lift up heavy objects.



Which one of the following could be a correct combination of the applied force, lifting force and the distance moved by both pistons?

	Applied force	Lifting force	Distance moved by small piston	Distance moved by large piston
A	10 N	40 N	2 cm	8 cm
B	10 N	40 N	8 cm	2 cm
C	40 N	10 N	2 cm	8 cm
D	40 N	10 N	8 cm	2 cm

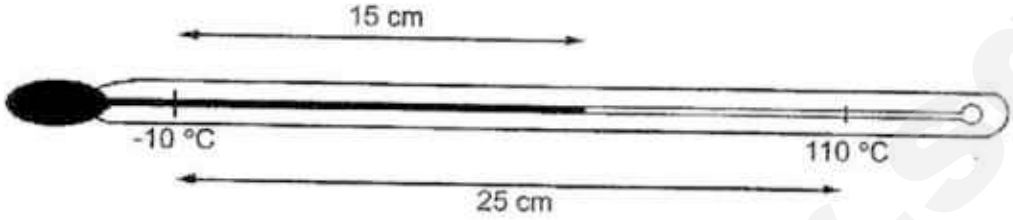
13 The figure shows a simple manometer. Side **X** is connected to a gas supply. Side **Y** is open to the atmosphere.



What pressure is the length ***h*** used to measure?

A The gas pressure **R**.
B The atmospheric pressure **S**.
C The sum of the gas pressure **R** and the atmospheric pressure **S**.
D The difference between the gas pressure **R** and the atmospheric pressure **S**.

14 The figure shows a mercury-in-glass thermometer. The distance between the -10 °C and the 110 °C markings is 25 cm.



At which temperature is the end of the mercury thread 15 cm from the -10 °C mark?

A 50 °C **B** 60 °C **C** 62 °C **D** 72 °C

15 Three liquids with their respective freezing and boiling points are shown in the table.

	Freezing Point / °C	Boiling Point / °C
Aniline	-6	184
Alcohol	-180	78
Mercury	-39	357

A thermometer that can record both -40 °C and 42 °C should be filled with _____.

A alcohol only **B** aniline only **C** mercury only **D** alcohol or mercury

16 Pauline gave some description on how a vacuum flask minimise heat loss.

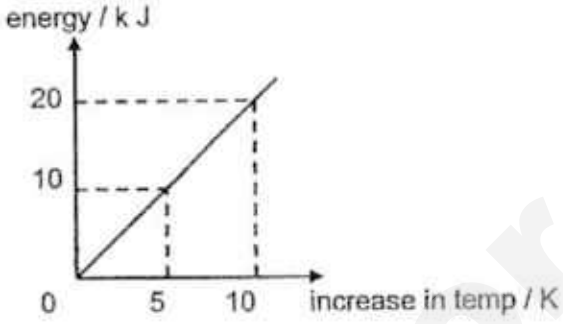
Which of the following statements does not describe how a vacuum flask minimise heat loss?

I The double-glass walls prevent heat loss through radiation.
II The stopper is made of plastic which is a poor conductor of heat.
III The vacuum flask is sealed to reduce heat loss through evaporation.
IV Heat loss by convection is negligible as it only occurs when the plastic stopper is removed during use.

A I and II **B** I and III **C** I, II and III **D** All of the above

200

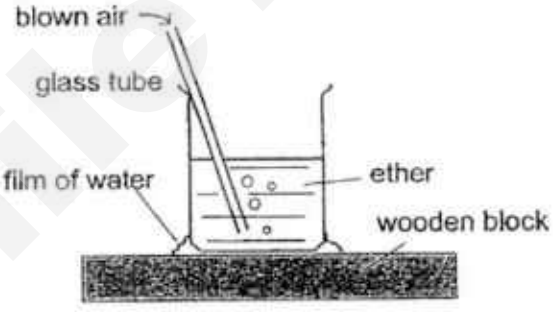
17 The graph shows the amount of energy used to heat up a liquid **X** and the corresponding increase in temperature. The mass of the liquid is 0.40 kg.



What is the specific heat capacity of liquid **X**?

A 2.0 J/ kgK **B** 5.0 J/ kgK **C** 2 000 J/ kgK **D** 5 000 J/ kgK

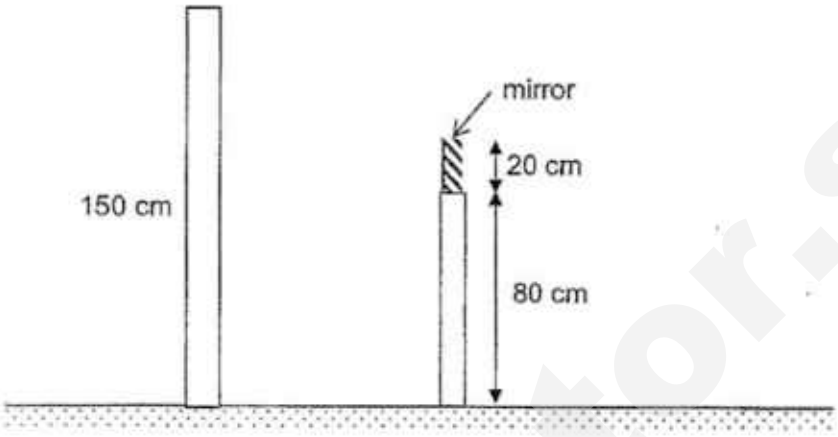
18 Air is blown into ether through a tube as shown in the figure. After some time, it is observed that the film of water freezes into ice.



Which of the following best describes the processes that result from the blown air?

	rate of evaporation of ether	average energy of remaining molecules	temperature of ether
A	increases	increases	rises
B	decreases	increases	falls
C	increases	decreases	falls
D	decreases	decreases	rises

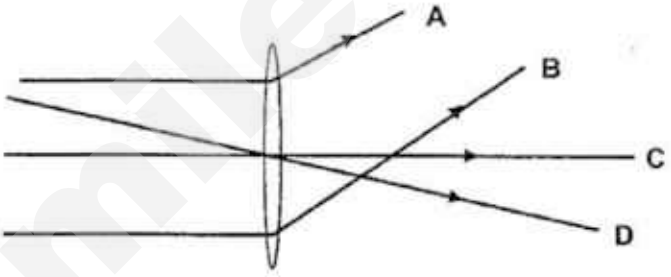
19 A 150 cm tall pillar stands in front of a 20 cm plane mirror which is 80 cm above the ground as shown in the figure.



How much of the image of the pillar could be seen through the mirror?

A 20 cm **B** 40 cm **C** 140 cm **D** 150 cm

20 The figure shows some light rays as they pass through a converging lens.



Which light ray is drawn wrongly?

201

SECTION B : [50 marks]

Answer **ALL** *questions in this section. Show your working and write your answers in the space provided.*

1 (a) **Fig. 1.1** shows the reading of a pair of vernier calipers when its jaws are totally closed. **Fig. 1.2** shows the reading of the same pair of vernier calipers when it measures the diameter of a steel rod.

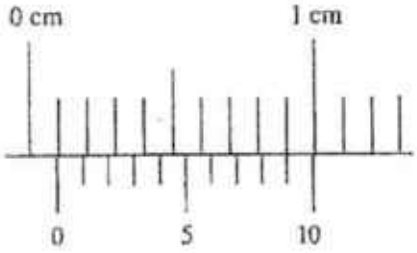


Fig. 1.1

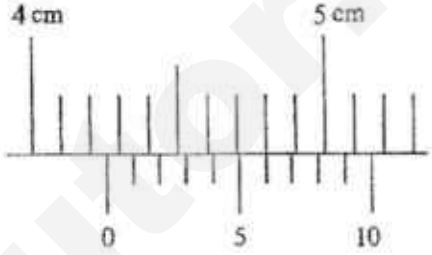


Fig. 1.2

(i) State the purpose of closing the jaws of the vernier calipers before measuring the diameter of the steel rod.

_____

_____ [1]

(ii) State the reading shown in **Fig. 1.1**.

reading = _____ [1]

(iii) What is the diameter of the steel rod?

diameter = _____ [2]

(b) State the effects (decreases, increases or unchanged) on the period of an oscillating pendulum in **Table 1.3**. [3]

Table 1.3

change made to the pendulum	effect on period
angle of oscillation increases	
length of pendulum decreases	
mass of bob decreases	

2 A powerboat is used to pull a parascender at a constant speed and height.

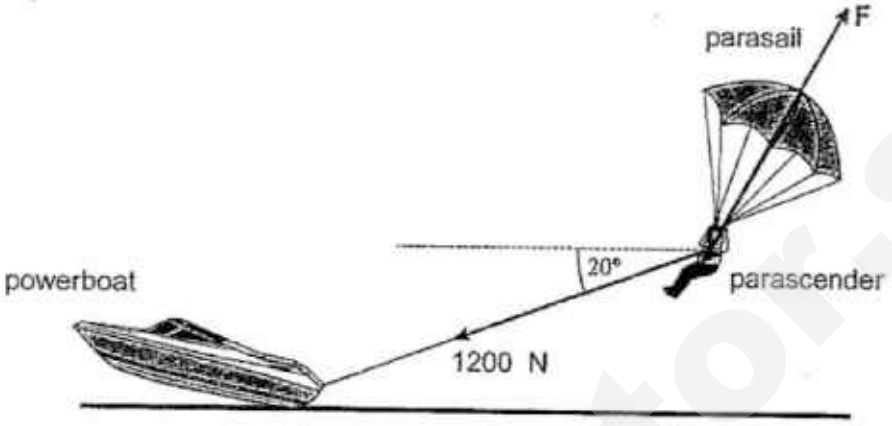


Fig. 2.1 (Diagram not drawn to scale)

The weight of the parascender is 900 N. A rope exerts a force of 1200 N on the parascender at an angle of 20° to the horizontal. Another force, **F**, is exerted on the parascender by the parasail.

(a) The resultant force acting on the parascender is 0 N.

(i) State what is meant by the *resultant of a number of forces.*

_____

_____ **[1]**

(ii) By scale drawing or otherwise, determine the magnitude and direction of, **F**, the force exerted on the parascender by the parasail.

magnitude of force = _____

202 direction of force = _____ [4]

(b) The parascender releases the rope and initially rises higher.

Explain, in terms of the forces acting, why the parascender rises.

_____

_____

_____ [2]

3 While on Planet **X**, a goldsmith checks the purity of a small, uniform bar of gold by measuring its density.

The mass of the bar as 176.8 g and the weight of the bar as 1.80 N.

The dimensions of the bar are as shown on **Fig. 3.1**.

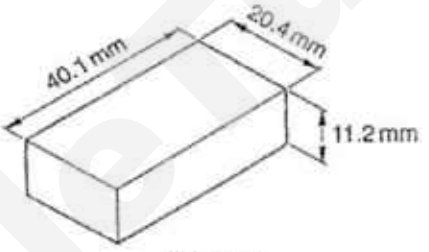


Fig. 3.1

(a) Define *gravitational field strength*.

_____ [1]

(b) Calculate the gravitational field strength of Planet **X**.

gravitational field strength = _____ [2]

(c) Calculate the density of the bar. Give your answer in g/cm^3.

density = _____ [3]

(d) The density of pure gold is 19.281 g/cm³. It is concluded that the bar is made of pure gold.
Suggest a reason for this conclusion to be valid.

_____

_____

_____ [1]

4 **Fig. 4.1** shows a system for raising a heavy piece of metal into a vertical position. A man pulls on the rope with a horizontal force ***T***. The piece of metal has a weight of 2000 N and is freely pivoted at **A**. The system is in equilibrium.

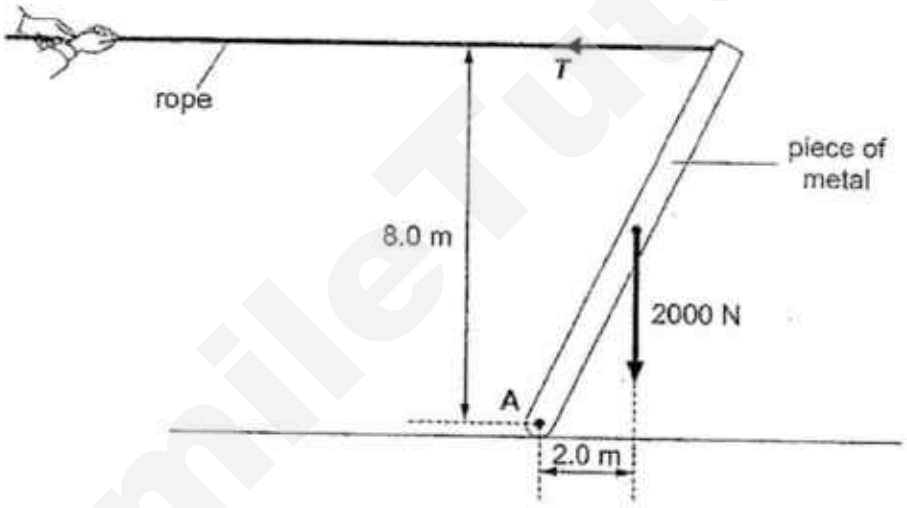


Fig. 4.1

(a) Explain what is meant by the *moment of a force*.

_____

_____ [1]

(b) By taking moments about **A**, calculate ***T***.

203

_____ [2]

(c) The force T and the force that the rope exerts on the man are related by Newton's third law. State the relationship between these forces.

_____

_____

_____

_____ [2]

5 (a) Jen is helping her mother decorate her restaurant. She places two glass ornaments on a display shelf. One of the ornaments is empty while the other is filled with coloured glass marbles as shown in **Fig. 5.1**.

Fig. 5.1

State which ornament is more stable. Explain your answer.

_____

_____

_____

_____ [2]

(b) A waiter in the restaurant places two wooden boxes filled with coffee beans standing on a counter top with a rough surface. The counter top is hinged so that it can be flipped open to allow servers to access the kitchen as shown in **Fig. 5.2**.

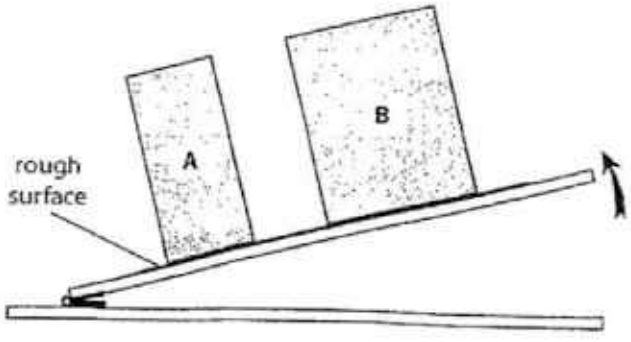


Fig. 5.2

When the counter top is slowly tilted, the boxes do not slip.
State which box falls over first and explain why.

_____

_____

_____

_____

_____ [3]

6 **Fig. 6.1** shows an illuminated smoke cell to demonstrate the Brownian motion of smoke particles.

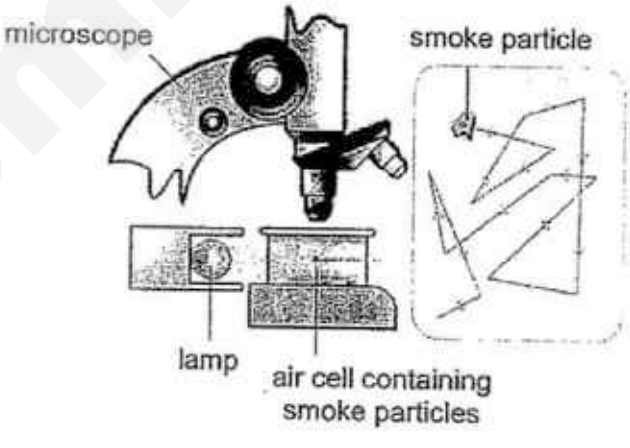


Fig. 6.1

204

(a) State two reasons why collisions between air molecules and smoke particles result in the haphazard motion of the smoke particles.

_____

_____

_____

_____ [2]

(b) When the temperature of the air in the cell increases, the air molecules move faster. Explain why this increases the pressure of the air.

_____

_____

_____

_____ [2]

7 (a) The Celsius scale is commonly used in calibrating liquid-in-glass thermometers. Simple experimental procedures are often carried out to determine the ice point and steam point.

(i) Explain the term "ice point".

_____

_____ [1]

(ii) In determining the ice point, crushed ice are used during the experiment instead of ice cubes. Explain why this is so.

_____

_____ [1]

(b) Scientist uses thermocouple thermometers to measure the temperature of volcanic lava.

(i) State two advantages of a thermocouple thermometer other than the scientist being able to obtain indirect reading.

_____

_____

_____ [2]

(ii) When one junction of a thermocouple is placed inside melting ice, and the second junction in steam, the millivoltmeter registers a reading of 24 mV. The reading changes to 40 mV when the second junction is placed inside the lava, with the first junction still inside melting ice.

Calculate the temperature of the lava.

temperature = _____ [2]

(iii) If another substance X is found to be 30 °C, calculate the reading that should be shown on the millivoltmeter.

reading = _____ [2]

8 A pot of water is heated on an electric stove, as shown in **Fig. 8.1**.

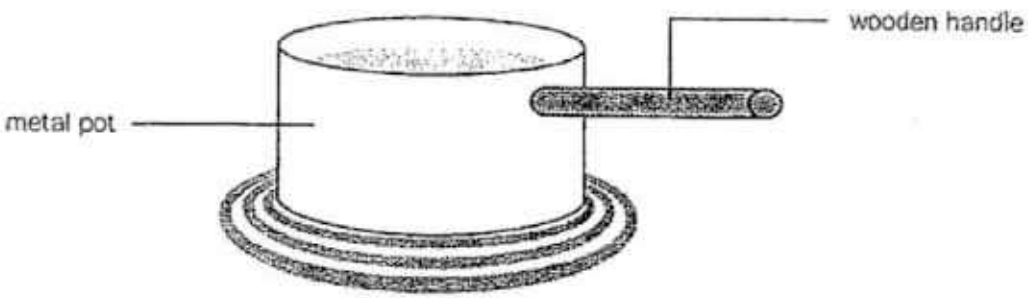


Fig. 8.1

205

(a) Explain why the outer surface of the metal pot is often polished.

_____

_____

_____ [2]

(b) "Although both metal and wood are thermal conductors, metal is a much better conductor of thermal energy than wood."

Discuss this statement in terms of thermal energy transfer at the molecular level for both metal and wood conductors.

_____

_____

_____

_____

_____ [3]

(c) Describe the process of convection by which the water in the pot is heated.

_____

_____

_____ [2]

SECTION C : [30 marks]

Each question is worth **10 marks**. *Answer* **ALL** *questions in this section.* **Question 3** *is an* **EITHER / OR QUESTION**. ***SELECT ONLY ONE PART OF THIS QUESTION***. *Show your working and write your answers on the spaces provided.*

9 An experiment is set up to determine the relationship between the angle of elevation of a 2 m long ramp and the final speed achieved at **B** when a 20 kg block is released from rest at **A**. The efficiency of energy conversion from gravitational potential energy to kinetic energy is also determined.

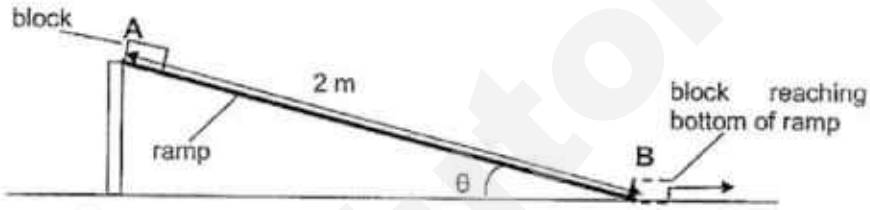


Fig. 9.1

θ / °	time t / s	average speed / m s^{-1}	final speed / m s^{-1}	GPE at A / J	KE at B / J	efficiency / %
20	1.61	1.24	2.48	137	62	45.3
30	1.11	1.80	3.60	200	p	65.0
40	0.90	2.22	q	257	197	76.7
50	0.79	2.53	5.06	306	256	r
60	0.72	2.78	5.56	346	309	89.3

Fig. 9.2

In this experiment, the raw data measured are the angle of elevation θ and the time taken t. The rest of the data are processed data.

(a) Explain how the average speed and final speed are determined.

_____

_____

_____

_____ **[2]**

206

(b) Find the missing data in **Fig. 9.2**. Show your workings in the space provided below. Follow the precision of the data found in the same column.

p = _____

q = _____

r = _____ [4]

(c) The efficiency of the experiment is not 100 %. Suggest why the efficiency of the experiment is not 100 %.

_____

_____ [1]

(d) (i) Based on **Fig. 9.2**, what can be said about the Kinetic Energy at **B** as the angle of inclination, θ, increases?

_____ [1]

(ii) Explain why this is so even though the same ramp is used throughout the experiment?

_____

_____

_____ [2]

10 **Fig. 10.1** shows an electric food steamer.

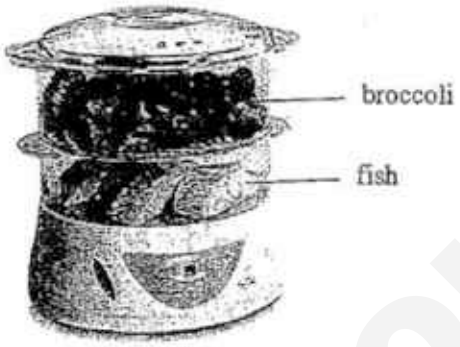


Fig. 10.1

To cook food, some water is placed in the lower compartment so that the steamer will heat the water automatically. The steamer changes the water to steam. Steam rises through the holes in the base of the food compartment and the food will be steamed.

(a) May poured 0.40 kg of water of 25 °C in the lower compartment of the steamer. Determine the amount of energy necessary to raise the temperature of the water from 25 °C to 100 °C.
(Specific heat capacity of water = 4200 J/kg°C)

amount of energy = _____ **[2]**

(b) Broccoli and fish need 600 kJ of energy to be steamed. Given that the power rating of the steamer is 800 W and that the specific latent heat of vaporisation is 2.3×10^6 J/kg, calculate

(i) the time required to steam the broccoli and fish after the water has reached 100 °C,

207 time taken = _____ **[2]**

(ii) the mass of water that has been converted to steam during this period of time.

mass of water = _____ [2]

(c) Will the fish be cooked evenly? Explain.

_____

_____

_____

_____ [2]

(d) Do you think the food will cook faster if it is placed in boiling water instead of using the steaming method? Explain your answer.

_____

_____

_____

_____ [2]

EITHER

11 **Fig. 11.1** shows a simplified brake mechanism that utilises a hydraulic system.

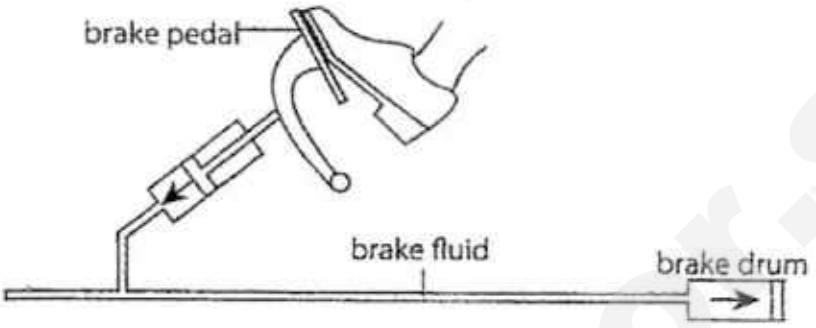


Fig. 11.1

(a) If a driver exerts a force of 50 N on the brake pedal, and given the ratio of the cross sectional area of the larger piston at the brake drum to the small piston located at the brake pedal is 24:1, calculate the force exerted on the brakes.

force = _____ **[1]**

(b) Explain why the presence of air bubbles in the brake fluid will cause the system to be inefficient.

_____

_____

_____

_____

_____ **[2]**

20

(c) Atmospheric pressure can be measured using a simple mercury barometer.

Draw a labelled diagram of a simple mercury barometer. Explain clearly how the value of the atmospheric pressure is read from the barometer.

_____

_____

_____

_____ [3]

(d) State how the value of the atmospheric pressure is affected

(i) if the cross sectional area of the tube is increased.

_____ [1]

(ii) if the barometer is taken to the bottom of a deep quarry below ground level. (Assumption: temperature remains constant)

_____ [1]

(e) Using the concept of atmospheric pressure, explain how we are able to drink water from a cup using a straw.

_____

_____

_____ [2]

OR

11 (a) **Fig. 11.2** shows a simplified diagram of a **projector** used to project the slide **AB** onto a screen.

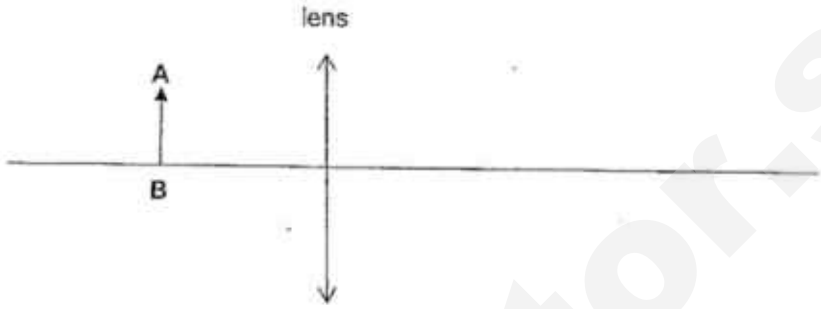


Fig. 11.2

(i) By using a suitable focal point, complete the ray diagram. Indicate the possible position of the image as **A'B'**. [3]

(ii) When the projector is turned on, the image is out of focus.

What can be done to bring the image into focus?

_____

_____ [1]

(b) **Fig 11.3** shows a small light source placed at the bottom of a 2 m deep swimming pool.

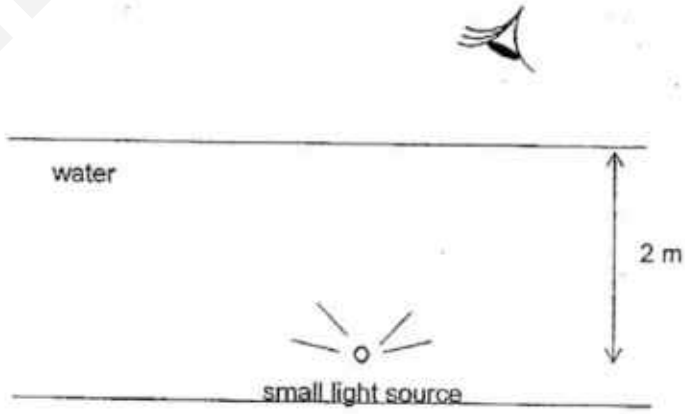


Fig. 11.3

The small light source emits light in all directions. However, due to total internal reflection, the light emitted forms only a circular spot on the water surface.

309

(i) Explain what is *total internal reflection*.

_____

_____

_____ [2]

(ii) Given that the refractive index of water is 1.33, determine the critical angle of water.

critical angle = _____ [2]

(iii) Explain using the idea of total internal reflection, why a circular spot of light is formed instead of an illumination of the whole water surface.

_____

_____

_____

_____ [2]

END OF PAPER

ST. PATRICK'S SCHOOL
END-OF-YEAR EXAMINATIONS 2016

SUBJECT	:	PHYSICS SPA 5059	DATE	:	10 OCT 2016
LEVEL	:	SECONDARY 3 EXPRESS	DURATION	:	2 HRS

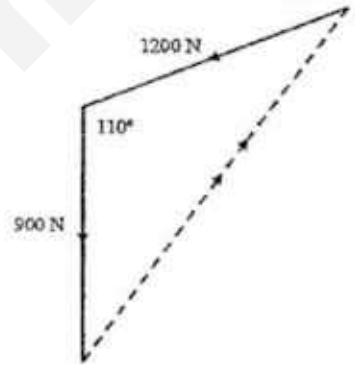
ANSWER SCHEME

SECTION A

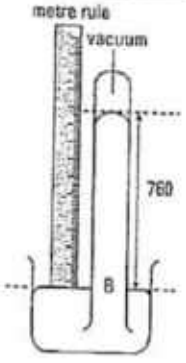
1	2	3	4	5	6	7	8	9	10
D	C	C	A	A	C	B	C	D	D

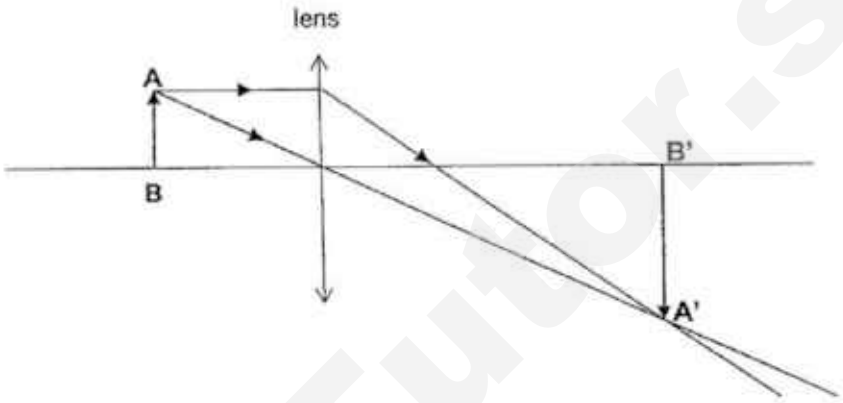
11	12	13	14	15	16	17	18	19	20
A	B	D	C	A	B	D	C	B	A

PAPER 2

					ttl
1	(a)	(i)	To check for any zero error.	1	7
		(ii)	0.09 cm	1	
		(iii)	4.26 – 0.09	1	
			= 4.17 cm	1	
	(b)	unchanged		1	
		decreases		1	
		unchanged		1	
2	(a)	(i)	A single force which will have the same effect as all the other forces.	1	7
		(ii)			
			Scale	1	
			Correct diagram	1	
			1730 ± 30N	1	
			41 ± 2° from vertical OR 49 ± 2° from horizontal	1	

	(b)		The upward force exceeds the weight Which results in an upward resultant force.	1 1	
3	(a)		Gravitational field strength is defined as gravitational force per unit mass.	1	7
	(b)		m = 176.8 g = 0.1768 kg W = mg 1.80 = 0.1768 x g g = 10.18 N/kg = 10.2 N/kg	 1 1	
	(c)		volume = 4.01 x 2.04 x 1.12 = 9.162048 cm^3 density = mass/volume = 176.8/9.162048 = 19.2969956062225388908680679254 25 = 19.3 g/cm^3	1 1 1	
	(d)		There could be error in the measurement of length of the gold bar and the dimensions used to calculate the density are only given to 3 significant figures and that some error is possible.	1	
4	(a)		Moment of a force is the product of the force F and the perpendicular distance d from the pivot to the line of action of the force.	1	5
	(b)		T x 8.0 = 2000 x 2.0 T = 500 N	1 1	
	(c)		The forces are equal in magnitude, act in opposite direction on mutually opposite bodies.	1 1	
5	(a)		The empty glass The glass marbles in the glass has raised its centre of gravity, causing it to be less stable.	1 1	5
	(b)		Box A The line of action of the weight of box A will lie outside the base area first. Once the line of action of the force lies outside the base area, it results in an anti-clockwise moment about the pivot which topples the box.	1 1 1	
6	(a)		The air molecules are moving at random directions. Thus when they collide with the smoke particles from different directions, the resultant force will be random in magnitude and direction.	1 1	4
	(b)		The molecules hit the walls of the container more frequently. They also exert a larger force when they hit the walls.	1 1	
7	(a)	(i)	"Ice point" is the temperature which pure ice melts.	1	8
		(ii)	Crushed ice has a greater surface area which will enable the bulb of the thermometer to be fully covered with the ice.	1	
	(b)	(i)	It can measure high temperature. It is sensitive to temperature change.	1 1	
		(ii)	40/24 x 100 = 167°C	1 1	
		(iii)	Θ/24 x 100 = 30 Θ = 7.2 V	1 1	
8	(a)		Polished surface is a poor emitter of radiation which this would minimise thermal energy loss to the surroundings by radiation.	1 1	7

	(b)		In both metal and wood, molecules at the heated end will gain kinetic energy and vibrate more vigorously, colliding with the neighbouring molecules and transferring thermal energy. Metal has free electron which helps to transfer thermal energy faster.	1 1 1	
	(c)		Water nearer the bottom of the pot is heated, becomes less dense and rises to the top while water near the top of the pot is cooler is denser and sinks to the bottom. The difference in density sets up a convention current.	1 1	
9	(a)		Average speed = distance divided by time Average speed = (final speed – 0) ÷ 2	1 1	**10**
	(b)		v = 2.22 x 2 = 4.44 m/s KE = 0.5 x 20 x 3.6^2 = 130 J Efficiency = 256/306 x 100% = 83.7% All working shown	1 1 1 1	
	(c)		Some energy is used to do work against friction.	1	
	(d)	(i)	K.E. increase as θ increases.	1	
		(ii)	As θ increases, the vertical height of the point of release increases. This leads to the block possessing a higher G.P.E, resulting in a higher K.E. at the end of the ramp.	1 1	
10	(a)		Q = (0.40) (4200) (100-25) =126 000 J	1 1	**10**
	(b)	(i)	600 000 = 800t t = 750s	1 1	
		(ii)	600 000 = m (2.3 x 10^6) m = 0.26 kg	1 1	
	(c)		It will be evenly cooked as a convection current is set up in the compartment.	1 1	
	(d)		Food will cook faster using the steaming method. Steam has more energy than boiling water of the same mass.	1 1	
11	(a)		50 x 24 = 1200 N	1	**10**
	(b)		Air bubbles are compressible. Therefore the pressure transmitted to the brake drum will be lesser that the pressure applied by the pedal, hence the system will be inefficient.	1 1	
	(c)		 Diagram indication of vacuum P = density x g x height of mercury	1 1 1	

	(d)	(i)	No change	1	
		(ii)	Increase	1	
	(e)		Suction causes the pressure at the mouth to decrease. Atmospheric pressure, which is higher will exert a force which pushes the water into the mouth.	1 1	
11	(a)	(i)	 Suitable focal point Correct ray diagram (with arrow) Image imverted and magnified	1 1 1	10
		(ii)	Move the screen further or closer to the lens.	1	
	(b)	(i)	It is the reflection of light within the denser medium, when light travels from a denser medium to a less dense medium, such that the incident angle is larger than critical angle.	1 1	
		(ii)	Sin c = 1/n c = sin-1 (1/1.33) c = 48.8°	1 1	
		(iii)	The circular spot is formed when light emits at an angle of incidence smaller than the critical angle as light is refracted out of the water surface. Beyond the critical angle, light is reflected back into the water, resulting in no light emerging from the water surface.	1 1	

Name:	Index Number:	Class:

YIO CHU KANG SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2016
SECONDARY THREE EXPRESS

PHYSICS

Paper 1 Multiple Choice

5059/01

Friday 7 October 2016 45 minutes

Additional Material: Optical Answer Sheet (OAS)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil on the OAS.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and class on the OAS in the spaces provided.

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

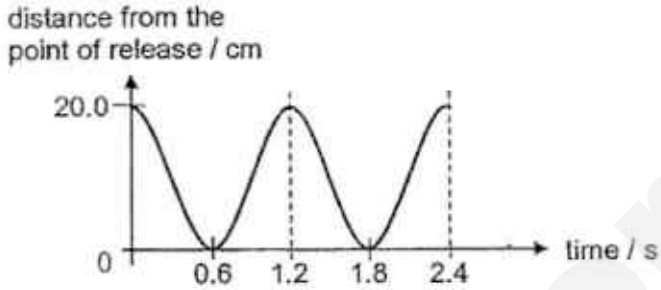
Read the instructions on the OAS very carefully.

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

Name of Setter: Ms Teo HH 2/10

This document consists of **13** printed pages and **1** blank page.

1 The bob of a simple pendulum is pulled to one side and released. A portion of the motion during its swing is shown on the graph below.

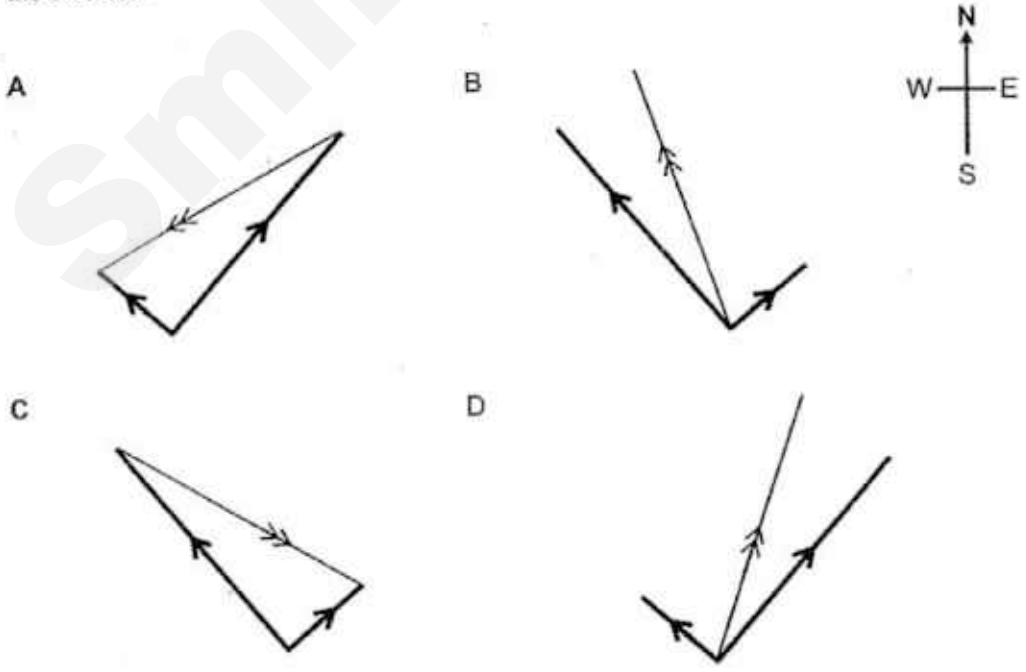


What is the period for this pendulum bob?

A 0.6 s
B 1.2 s
C 1.8 s
D 2.4 s

2 An aircraft heads north-west at 400 km/h. The wind is blowing from south-west at 150 km/h.

Which vector diagram represents the correct way to obtain the resultant velocity of the aircraft?

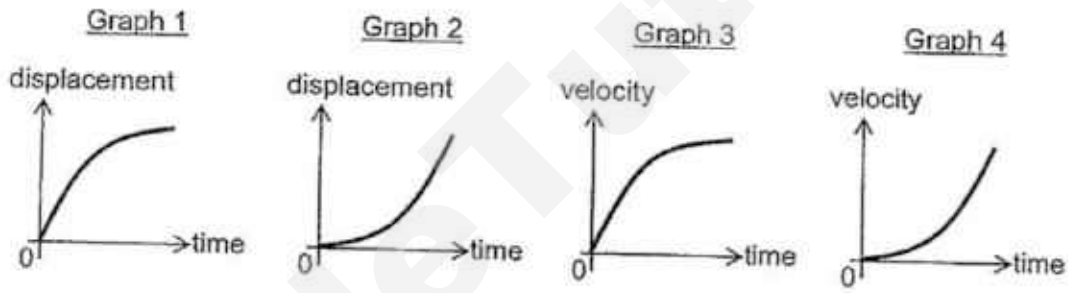


3 What is the order for the diameter of a coin and the diameter of the Earth?

	diameter of coin	diameter of Earth
A	22 mm	10 Gm
B	22 nm	10 Mm
C	22 mm	10 Mm
D	22 nm	10 Gm

4 A coconut is dropped from a tree. As the coconut falls, air resistance has a noticeable effect on its motion.

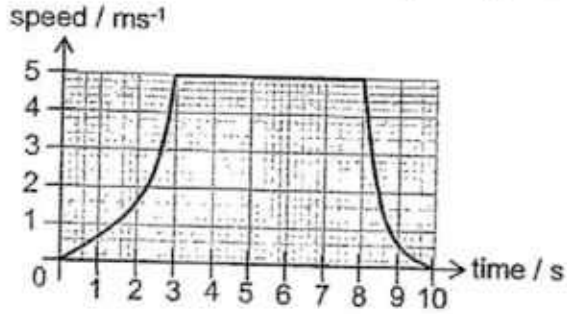
Graph 1 and 2 are displacement-time graphs. Graph 3 and 4 are velocity-time graphs.



Which graphs represent the motion of the coconut?

A graph 1 and 3
B graph 1 and 4
C graph 2 and 3
D graph 2 and 4

5 The graph shows how the speed of a trolley changes as it moves across a floor.



What is the distance travelled when the trolley is moving at constant speed?

A 7.5 m
B 25 m
C 37.5 m
D 50 m

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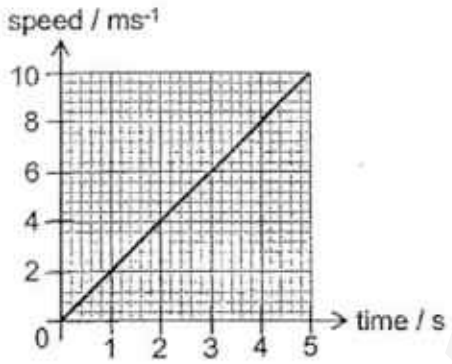
6 The graph shows how the speed of a model car varies with time.

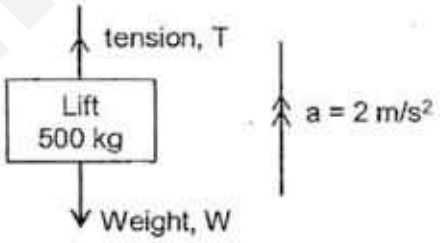


The resultant force on the model car is 0.60 N.

What is the mass of the car?

A 0.03 kg
B 0.06 kg
C 0.3 kg
D 1.2 kg

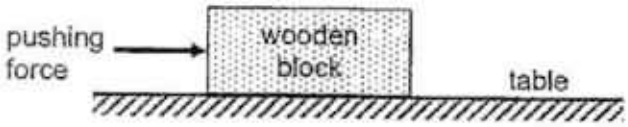
7 A lift moves upwards at a constant acceleration of 2 m/s². The mass of the lift is 500 kg and the gravitational field strength is 10 N/kg.



What is the tension in the cable holding the lift?

A 1000 N
B 4000 N
C 5000 N
D 6000 N

8 A wooden block is pushed across a table at constant speed.



Which statement is correct?

A The frictional force increases as the block moves at constant speed.
B The frictional force is equal and opposite to the pushing force.
C The frictional force is greater than the pushing force.
D The frictional force is less than the pushing force.

9 A car, initially at constant speed along a road, drives onto a large patch of oil. The driver applies the brake to stop the car.

Compared to braking on a *dry* road, which of the following statements is true?

A The car takes a longer time to decelerate to a stop because of the increased friction between the tyres and the road.

B The car takes a longer time to decelerate to a stop because of the reduced friction between the tyres and the road.

C The car takes a shorter time to decelerate to a stop because of the increased friction between the tyres and the road.

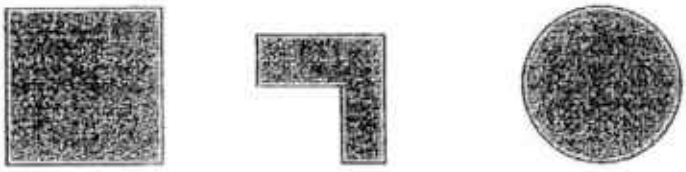
D The car takes a shorter time to decelerate to a stop because of the reduced friction between the tyres and the road.

10 Which property of a body resists a change in its state of rest or motion?

A acceleration
B mass
C velocity
D weight

214

11 Three objects are cut from the same sheet of metal. They are of different shapes but they all have the same mass.



square 7-shape disc

Which object has the greatest density?

A the square
B the 7-shape
C the disc
D they all have the same density

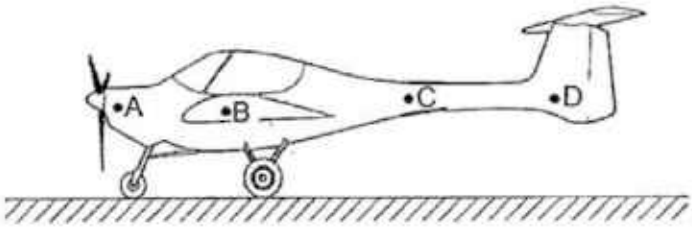
12 An object has a weight of 250 N on Earth and 575 N on Jupiter.

What is the mass of the object and the gravitational field strength on the surface of Jupiter?

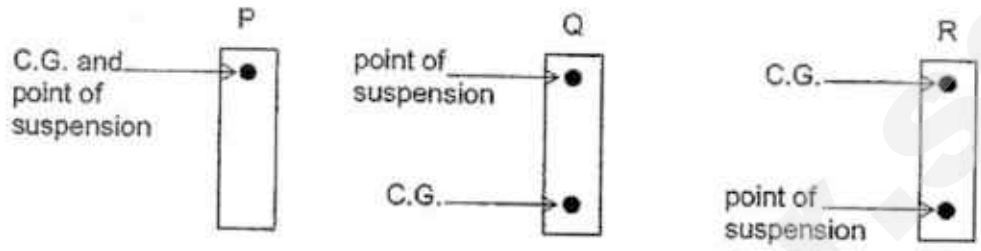
	mass / kg	gravitational field strength / Nkg^{-1}
A	25	10
B	25	23
C	57.5	10
D	57.5	23

13 A light aircraft stands at rest on the ground. It stands on three wheels, one at the front and two further back.

Which point could be its centre of mass?



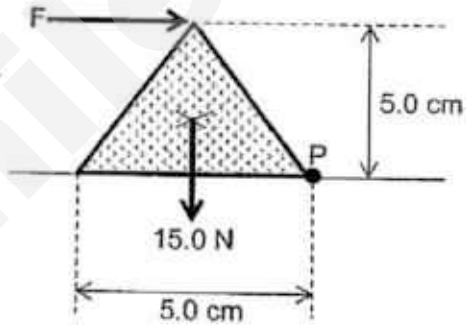
14 An object can be suspended in equilibrium from three different positions as shown.



Which of the following matches the figures with their respective types of equilibrium?

	P	Q	R
A	neutral	stable	unstable
B	stable	neutral	unstable
C	stable	unstable	neutral
D	unstable	stable	neutral

15 The diagram below shows the cross-section of a regular pyramid of weight 15.0 N.

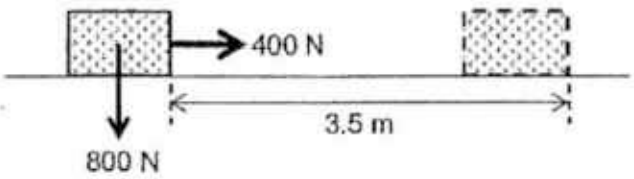


What is the **minimum** value of the force F that is required to just tilt the pyramid about the pivot point P?

A 0.133 N
B 7.5 N
C 15 N
D 30 N

215

16 When a 400 N force is applied to a box weighing 800 N, the box moves 3.5 m horizontally in 20 s.



What is the average power?

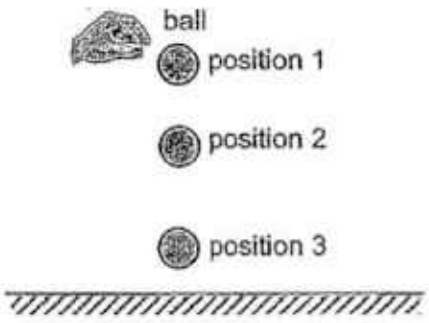
A 70 W
B 140 W
C 1400 W
D 2800 W

17 A battery supplies 500 J of electrical energy to a motor. The motor produces 200 J of heat.

What is the maximum efficiency of the motor?

A 40 %
B 60 %
C 67 %
D 100 %

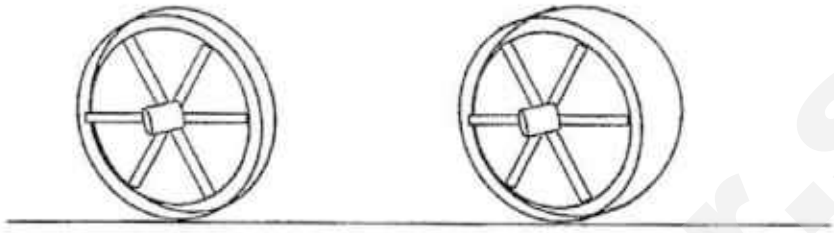
18 A ball is dropped from a height as shown.



Ignoring the effects of air resistance, the **total** energy of the ball is

A greatest at position 1.
B greatest at position 2.
C greatest at position 3.
D the same at all positions.

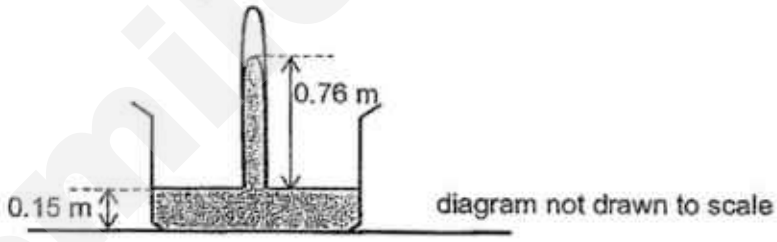
19 A farmer has two carts. The carts have the same weight, but one has four narrow wheels and the other has four wide wheels.



Which cart wheel sinks more into soft ground, and what is the reason?

	cart wheels	reason
A	narrow	greater pressure on the ground
B	narrow	lesser pressure on the ground
C	wide	greater pressure on the ground
D	wide	lesser pressure on the ground

20 The diagram shows a simple barometer.



The density of mercury is 13 600 kg/m^3.

If the base of the container is 2.0×10^{-3} m^2, find the force exerted on the base of the barometer.

A 4.08×10^1 N
B 1.66×10^2 N
C 2.07×10^2 N
D 2.48×10^2 N

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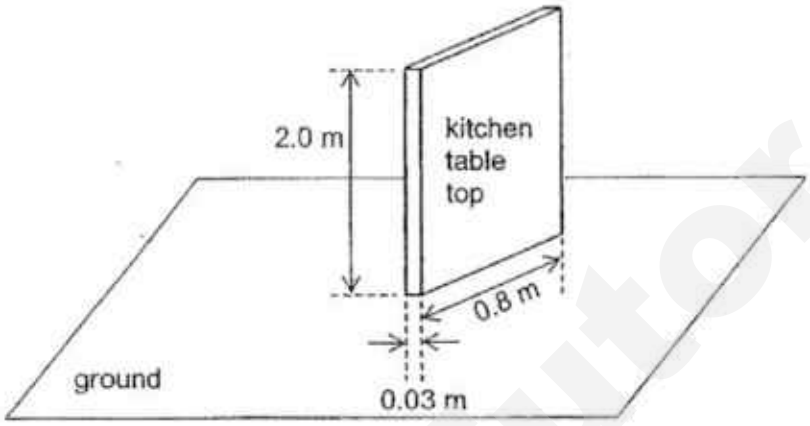
21 A worker is preparing a granite table top for a kitchen. The table top has dimensions of 2.0 m by 0.8 m by 0.03 m and has a weight of 1300 N.

The worker rests the table top on the ground as shown.



What is the pressure that the table top exerts on the kitchen floor?

A $\frac{0.03 \times 0.8}{1300}$ Pa

B $\frac{0.8 \times 2.0}{1300}$ Pa

C $\frac{1300}{0.03 \times 0.8}$ Pa

D $\frac{1300}{0.8 \times 2.0}$ Pa

22 A wave moves across the surface of the water in a ripple tank. In 1.0 minute, a wavefront moves a distance of 24 wavelengths.

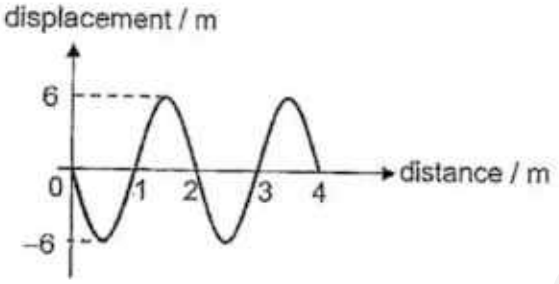
What is the frequency of the wave?

A 0.2 Hz
B 0.4 Hz
C 2.5 Hz
D 1440 Hz

23 Which of the following gives an example of a transverse wave and longitudinal wave?

	transverse wave	longitudinal wave
A	light	radio
B	radio	light
C	sound	water wave
D	water wave	sound

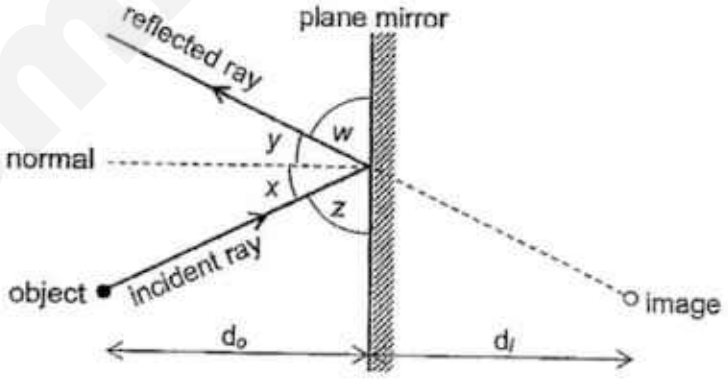
24 The diagram shows how displacement varies with time and distance as a wave passes a fixed point.



Which of the following correctly shows the amplitude and wavelength of the wave?

	amplitude / m	wavelength / m
A	6	2
B	6	4
C	12	2
D	12	4

25 An image is formed in a plane mirror as shown.

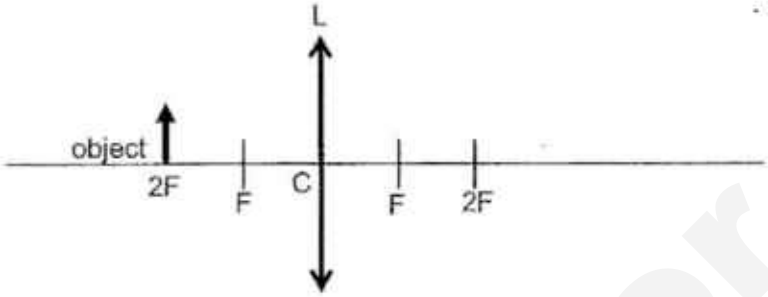


Which statement is correct?

A Angle w is equal to angle z.
B Distance d_i is more than distance d_o.
C The image formed is real.
D The sum of angle x and angle z is 180°.

217

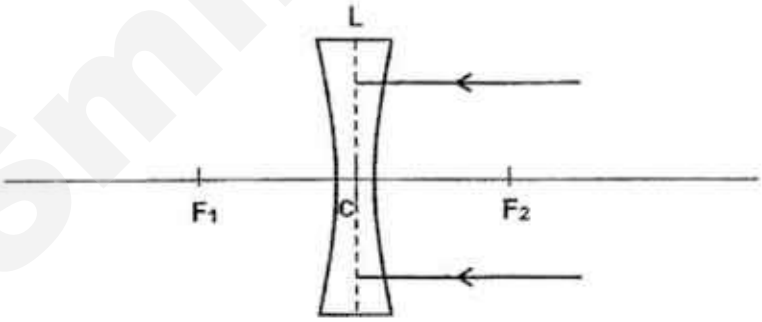
26 An object is placed at the 2F position from a thin converging lens as shown.



What are the application and characteristics of the image formed by this thin converging lens?

	application	image
A	camera	real, inverted and diminished
B	eye	virtual, upright and magnified
C	photocopier	real, inverted and same size as object
D	projector	real, inverted and magnified

27 Two rays of light strikes a diverging lens, L, as shown.



Which statement about the rays after they have passed through the lens is correct?

A They appear to come from F_1
B They appear to come from F_2.
C They appear to come from **C**.
D They meet at F_1.

28 The diagram below shows different regions of the electromagnetic spectrum.

radio waves		P	visible light			gamma rays

Which of the following statements about **P** is correct?

A P has a higher frequency than radio waves.
B P has a higher speed in glass than in air.
C P has a shorter wavelength than gamma rays.
D P is damaging to health.

29 Given that the wavelength of the infra-red radiation is 2×10^{-5} m in vacuum, calculate the frequency of this infra-red radiation.

A 6.7×10^{-14} Hz
B 2×10^{-5} Hz
C 3×10^{8} Hz
D 1.5×10^{13} Hz

30 Which of the following is **not** a property of electromagnetic waves?

A All electromagnetic waves can be reflected and refracted.
B All electromagnetic waves carry charges.
C All electromagnetic waves carry energy.
D All electromagnetic waves obey the wave equation.

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Name:	Index Number:	Class:

YIO CHU KANG SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2016
SECONDARY THREE EXPRESS

PHYSICS
Paper 2

5059/02

Friday 7 October 2016 1 hour 30 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the cover page.
Write in dark blue or black ink.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all** questions in the spaces provided.

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.

The number of marks is given in brackets [ ] at the end of each question or part question.
You are advised to spend no longer than one hour on Section A and no longer than 30 minutes on Section B. At the end of the examination, fasten all your work securely together.

For Examiner's Use

Section A	/ 50
Section B	/ 20
Total	/ 70

Parent's / Guardian's signature

Name of Setter: Ms Teo HH

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

SECTION A

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

1 **(a)** A student uses a metre rule to determine the diameter of a golden sphere. Fig. 1.1 shows five golden spheres lined up beside each other with two wooden blocks supporting them at the sides.

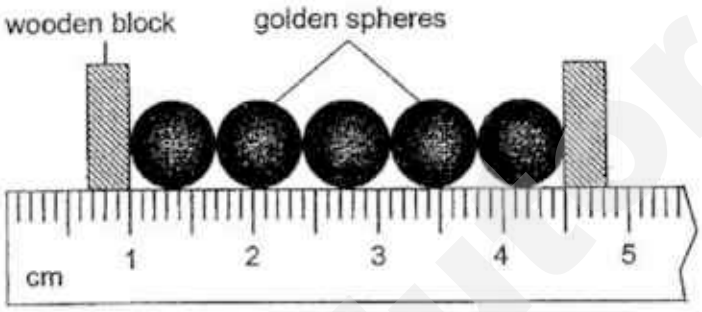

Fig. 1.1

(i) Determine the average diameter of one golden sphere.

average diameter = ... [1]

(ii) He realised that this method is not accurate.

State the instrument he should use instead and explain why it is better to use this instrument to measure the diameter of one golden sphere.

.....

.....

.....

..... [2]

1 **(b)** Fig. 1.2 shows the dimensions of a gold bar.

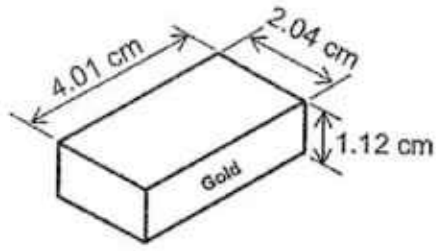

Fig. 1.2

The mass of the bar is 77.9 g and the weight of the bar is 0.779 N.

(i) Explain the difference between *mass* and *weight*.

.....

.....

.....

.....

..... [2]

(ii) Using the data from Fig. 1.2, calculate the density, in g/cm³, of the bar.

density of bar = ... g/cm³ [2]

(iii) The density of pure gold is 19.3 g/cm³.

State and explain whether the bar is made of pure gold.

.....

.....

..... [1]

2. Fig. 2.1 shows a car of mass 2000 kg moving to the right with a forward driving force and air resistance acting on it.

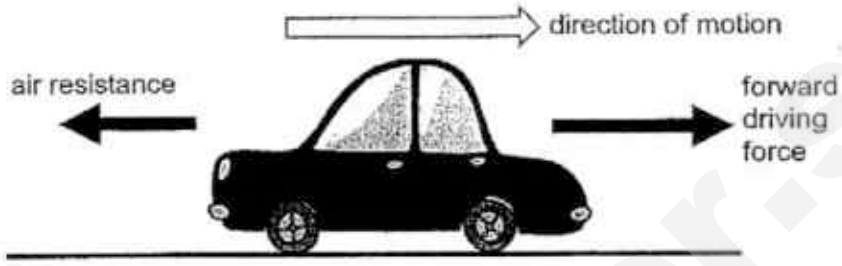

Fig. 2.1

Fig. 2.2 shows the variation of the forward driving force and resistive force that acts on the car with time.

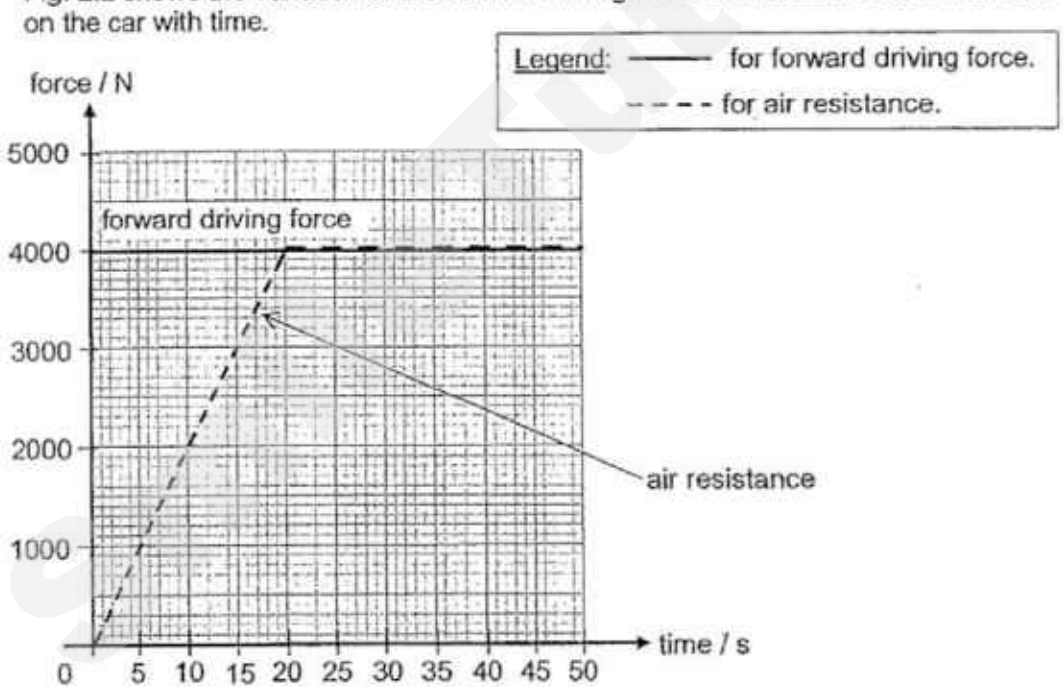

Fig. 2.2

(a) The car is initially at rest.

Calculate the initial acceleration of the car.

initial acceleration = ... [3]

2 (b) The air resistance acting on the car increases uniformly in the first 20 s.

Describe and explain how the acceleration of the car changes in the first 20 s.

.....

.....

.....

.....

.....

..... [2]

(c) (i) State the resultant force acting on the car after 20 s.

resultant force = ... N [1]

(ii) Describe the acceleration and the velocity of the car after 20 s.

.....

.....

.....

.....

.....

..... [2]

3 Fig. 3.1 shows an arrow being fired vertically upward into the air by an archer.

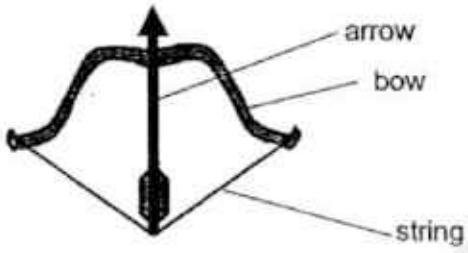

Fig. 3.1

The string of the bow is pulled back a distance of 55.0 cm using an average force of 120 N. The arrow has a mass of 0.18 kg.

(a) State the *Principle of Conservation of Energy*.

.....

.....

.....

.....

..... [1]

(b) Calculate the work done in pulling back the string in the bow.

work done = ... [2]

3 (c) When the string is released, **75%** of the energy stored in the bow is transferred to the arrow. The gravitational field strength, g = 10 N/kg.

Ignoring air resistance, determine

(i) the initial speed with which the arrow leaves the bow,

speed of arrow = ... [2]

(ii) the maximum height reached by the arrow.

maximum height = ... [2]

4 Fig. 4.1 shows a mercury manometer being used to measure the pressure in a chamber containing gas and water. The height of the mercury column is 50 mm.

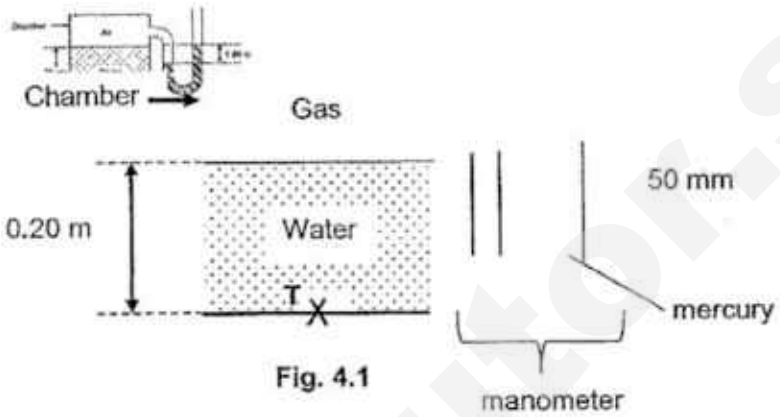

Fig. 4.1

(a) State what is meant by *atmospheric pressure*.

.....

.....[1]

(b) If the pressure due to the gas trapped in the chamber is 810 mmHg, calculate the atmospheric pressure in mmHg.

atmospheric pressure = ... mmHg [1]

(c) If the height of water in the chamber is 0.20 m and the density of water is 1000 kg/m^3, calculate the pressure at T, in Pascal, due to the water only. The gravitational field strength, g = 10 N/kg.

pressure at T due to water = ... Pa [2]

4 (d) The manometer tube is now replaced with another tube with a diameter *half* that of the original.

State if the new height of the mercury column is *greater than*, *smaller than* or *equal to* the original height of mercury column in the manometer.
Explain your choice of answer.

.....

.....

.....

.....

.....

..... [2]

5 Fig. 5.1 shows a series of floating buoys connected to a light string and are 1.5 m apart.

A sea wave is approaching the buoys as shown.

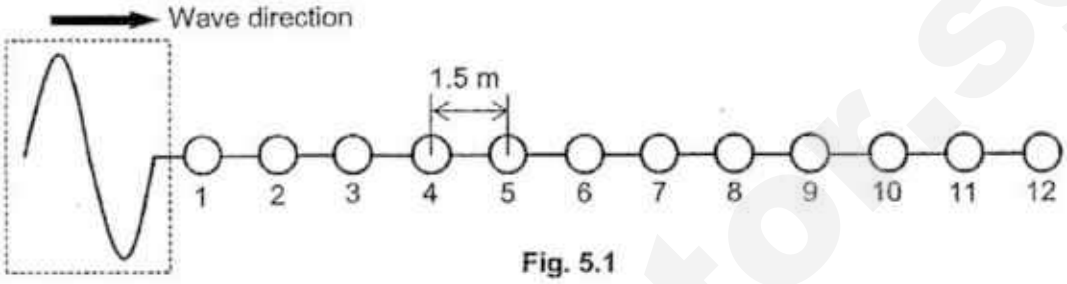

Fig. 5.1

(a) Sea wave is a type of transverse wave. Part of the sea wave is shown in the dotted box in Fig. 5.1.

(i) Explain what is meant by a *transverse wave*.

.....

.....

.....

..... [2]

(ii) Explain what is meant by a *wavefront*.

.....

..... [1]

(b) Indicate in Fig. 5.1, the direction that buoy **1** will move when the sea wave reaches it. [1]

(c) It is observed that buoy **1** takes 5.0 s to make 6 complete oscillations.

Determine the frequency of the wave.

frequency = ... Hz [1]

5 (d) Buoy **8** starts to move when buoy **1** just finishes a complete oscillation.

Determine

(i) the wavelength of the wave,

wavelength = ... [2]

(ii) the velocity of the sea wave.

224

velocity = ... [2]

6 Fig. 6.1 is drawn to scale. A thin converging lens, L, is used to produce a virtual image, which is 5 cm from the lens L.

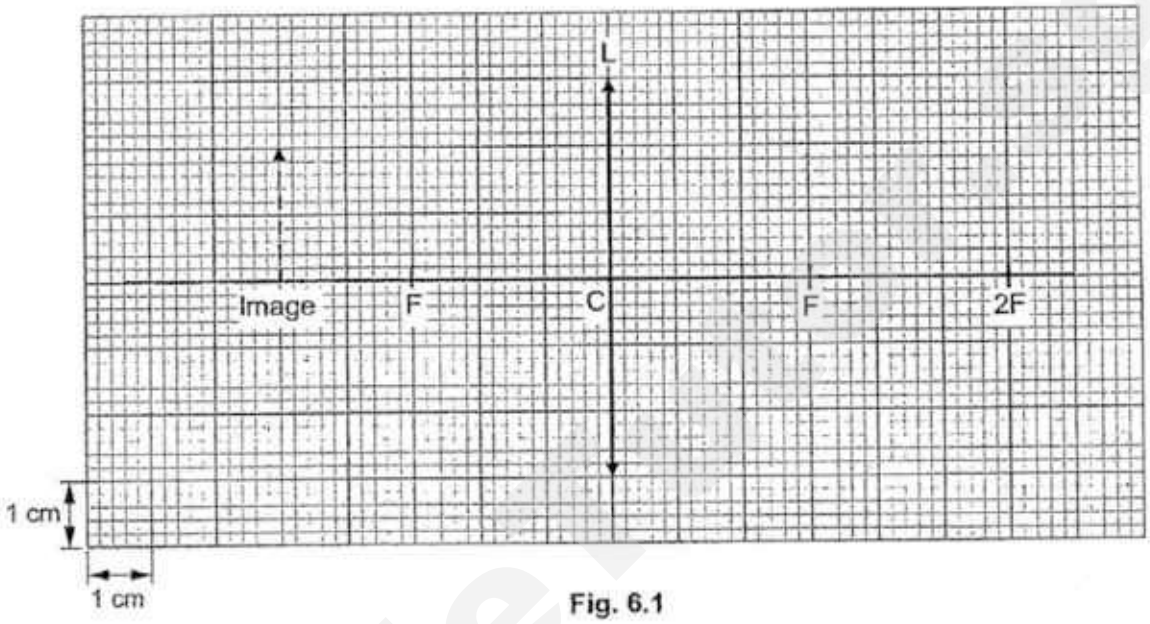

Fig. 6.1

(a) The lens has a focal length of 3 cm.

State what is meant by *focal length*.

.....

.....

..... [1]

(b) On Fig. 6.1, draw rays from the top of the image to locate the position of the object. Label the object clearly in your drawing. [3]

(c) **(i)** Describe the image formed.

.....

..... [1]

6 (c) (ii) State **one** application of the thin converging lens as shown in Fig. 6.1.

..... [1]

(d) The object is now moved closer to the lens.

State **one** change to the image formed.

.....

.....

..... [1]

7 (a) Electromagnetic radiation can be used for sending television signals to different parts of the Earth.

Fig. 7.1 shows two methods of sending television signals to points on the surface of the Earth.

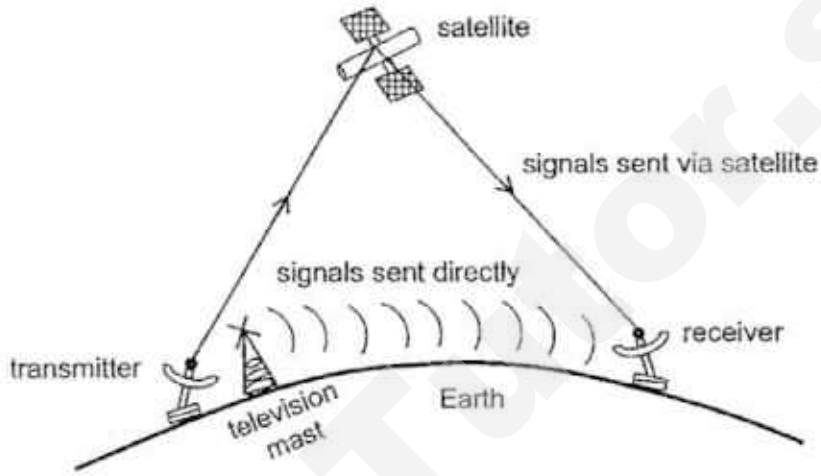

Fig. 7.1 (not to scale)

One method is to transmit waves *directly* to the receiver by a television mast.

A second method is to send the signals *via satellite* in space by a transmitter.

(i) State which region of the electromagnetic spectrum is used for each method of transmitting television signals.

First method: ..... [1]

Second method: ..... [1]

(ii) Between the two types of electromagnetic radiation which you have stated in **(a)(i)**, which one has a *higher* frequency?

..... [1]

7 (a) (iii) A transmitter on Earth sends out signals of frequency 6000 MHz. The speed of electromagnetic waves in vacuum is 3×10^8 m/s.

Calculate the wavelength of the signal from the transmitter.

wavelength = ... [2]

(b) Describe **one** harmful effect if too much electromagnetic radiation is absorbed by a human body.

.....

.....

..... [1]

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SECTION B

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

8 **(a)** State the *Principle of Moments for a body in equilibrium.*

.....

.....

..... [1]

(b) Fig. 8.1 shows the essential features of a vehicle's hydraulic braking system.

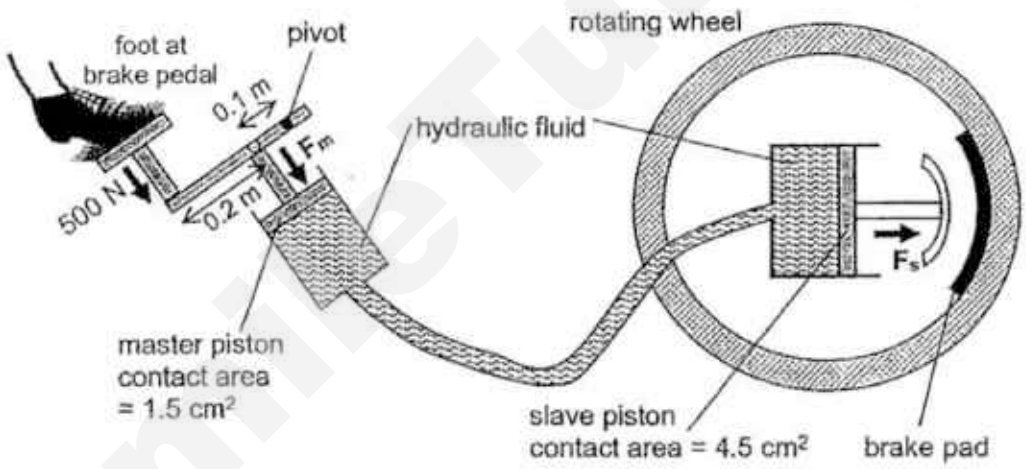

Fig. 8.1

A force of 500 N is applied by the driver on the brake pedal.

(i) Show that the moment produced by this 500 N force about the pivot is 150 Nm.

[1]

8 (b) (ii) The moment produced by this 500 N force is translated to the moment produced by the force, F_m, on the master piston.

Using the answer obtained in **(b)(i)** and applying the Principle of Moments, calculate the force, F_m, exerted on the master piston when the driver exerts a force of 500 N on the brake pedal.

force, F_m = ... [2]

(iii) Hence, calculate the pressure in N/cm², exerted on the fluid by the master piston.

pressure on fluid = ... N/cm² [2]

(iv) The hydraulic fluid is effective in transmitting the pressure exerted by the master piston to the slave piston.
State the pressure exerted on the slave piston.

pressure on slave piston = ... [1]

(v) Hence, calculate the force, F_s, exerted on the brake pad.

F_s = ...[2]

(vi) Suggest **one** modification to this system to minimise the force exerted by foot at brake pedal to brake the car.

.....

.....

.....[1]

9 Fig. 9.1 shows two light rays travelling through an optical fibre made of glass.

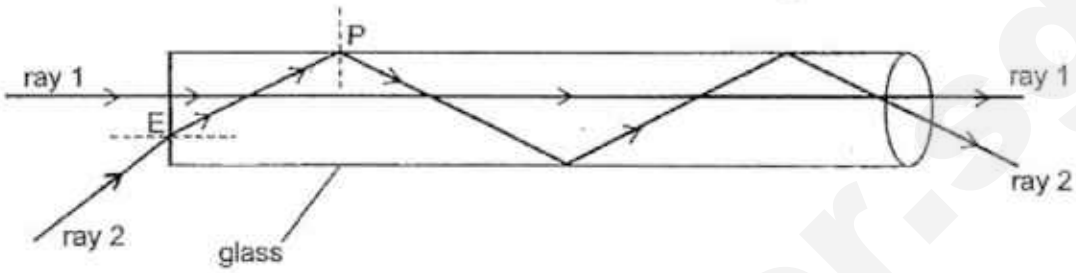

Fig. 9.1 (not drawn to scale)

The two rays travel in different paths as they enter the optical fibre with different angles of incidence. Fig. 9.2 gives information about the angles of the two rays and their paths in the optical fibre.

	angle of incidence / °	angle of refraction / °
ray 1	0	x
ray 2	35	y

Fig. 9.2

(a) The refractive index of the glass is 1.49.

Using the data in Fig. 9.2, determine the angle of refraction for

(i) ray 1,

angle of refraction, x = ...° [1]

(ii) ray 2.

angle of refraction, y = ...° [2]

9 (b) (i) State what is meant by *critical angle*.

.....

.....

..... [1]

(ii) Determine the critical angle of optical fibre.

critical angle = ...° [2]

(c) State and explain what happens to **ray 2**

(i) at point E,

.....

.....

..... [1]

(ii) at point P.

.....

.....

.....

.....

.....

.....

..... [3]

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YIO CHU KANG SECONDARY SCHOOL
MARKING SCHEME

Exam: End-of-Year Exam 2016 Subject: 5059 Pure Physics Level: 3E

PAPER ONE (MCQ):

1.	B	Time taken for 1 complete oscillation = Time between 2 successive crests (or trough) = (1.2 – 0) = 1.2 s.
2.	B	
3.	C	Diameter of coin = 2.2 cm = 22 mm Diameter of Earth = 1×10^7 m = 10×10^6 m = 10 Mm
4.	C	Gradient of displacement-time graph gives velocity while gradient of velocity-time graph gives acceleration. As coconut falls from the tree, **velocity increases from zero** (graph 2). As coconut falls, **acceleration due to gravity decreases** until it reaches **terminal velocity where acceleration is zero** (graph 3).
5.	B	Constant speed from time = 3 s to 8 s. Distance = Area under speed-time graph = 5 × (8 – 3) = 25 m.
6.	C	Acceleration = gradient = $\frac{v-u}{t} = \frac{10-0}{5-0}$ = 2 m/s². Since resultant force = ma, mass = $\frac{F}{a} = \frac{0.60}{2}$ = 0.3 kg
7.	D	Weight of lift in downward direction = mg = 500 × 10 = 5000 N. Since lift is moving upwards, resultant force = ma ⇒ Tension in upward direction – weight = ma ⇒ Tension – 5000 = 500 (2) ⇒ Tension = 1000 + 5000 = 6000 N
8.	B	Constant speed ⇒ zero acceleration So resultant force acting on the block is zero. The frictional force is equal and opposite to the pushing force.
9.	B	Oil reduces friction between tyres and ground as compared to braking on a dry road. It will take longer to come to a stop.
10.	B	Inertia is directly proportional to the mass of an object to resist a change in its state of rest or motion. The greater the mass, the greater the inertia.
11.	D	The density of all the 3 objects will be the same as they are made of the same material.
12.	B	Mass of object = $\frac{W}{g} = \frac{250}{10}$ = 25 kg. Mass on Earth is same as mass on Jupiter. ∴ g on Jupiter = $\frac{\text{Weight on Jupiter}}{\text{mass}} = \frac{575}{25}$ = 23 N/kg
13.	B	C.G. must be within the base between the wheels.
14.	A	P: Object is in neutral position since C.G. and point of suspension coincides. Q: Object is stable if the vertical line through the C.G. of the object is through the point of suspension and C.G. is below the point of suspension.
15.	B	The perpendicular distance between weight and pivot = $\left(\frac{0.05}{2}\right)$ = 0.025 m By Principle of Moments, S.C.M. = S.A.M. F × 0.05 = 15 × 0.025 Min. F = $\left(\frac{15 \times 0.025}{0.05}\right)$ = 7.5 N 229

16.	A	Power = $\frac{\text{Work done}}{\text{time taken}} = \frac{\text{Force} \times \text{distance in direction of force}}{\text{time taken}} = \frac{400 \times 3.5}{20} = 70$ W
17.	B	Efficiency = $\frac{\text{Useful output energy}}{\text{Total input energy}} \times 100\% = \frac{(500-200)}{500} \times 100\% = 60$ %
18.	D	By the Principle of Conservation of energy, total energy remains **constant** at any point of the drop.
19.	A	Narrow wheel: Base area in contact with the ground is small, so greater pressure is exerted by the wheel as compared to the wide wheel since both type of wheels have the same weight.
20.	D	Force exerted on base of barometer = Pressure × Area in contact = $h_{Hg} \times \rho_{Hg} \times g \times$ Base area of container = $(0.76 + 0.15) \times 13\,600 \times 10 \times (2 \times 10^{-3})$ = 247.52 N = 2.4752×10^2 N ≈ 2.48×10^2 N (to 3 s.f.)
21.	C	Pressure = $\frac{\text{Weight of worktop}}{\text{Area in contact with floor}}$
22.	B	24 wavelengths in 1 min ⇒ In 60 s, 24 complete waves are produced. ⇒ In 1 s, $\frac{24}{60} = 0.4$ complete wave produced. ∴ f = 0.4 Hz
23.	D	Sound wave is a longitudinal wave. The rest are transverse waves.
24.	A	Amplitude is the maximum height of crest from the rest position. A = 6 m Wavelength is the horizontal distance between 2 successive crests (or troughs). $\lambda = 2$ m.
25.	A	By Laws of reflection, angle of incidence = angle of reflection. So angle w = angle z.
26.	C	If object is placed at 2F position, image formed is also at 2F position on the other side of the lens ⇒ real, inverted and same size as the object.
27.	B	The parallel rays will diverge (split) after going through the diverging lens and the rays appears to come from F_2 position.
28.	A	P is an Infra-red radiation. Radio waves have the longest wavelength and lowest frequency in the EM spectrum.
29.	D	Speed of EM waves = Speed of light = 3×10^8 m/s. $f = \frac{v}{\lambda} = \frac{3 \times 10^8}{2 \times 10^{-5}} = 1.5 \times 10^{13}$ Hz
30.	B	Electromagnetic waves do NOT carry any charge.

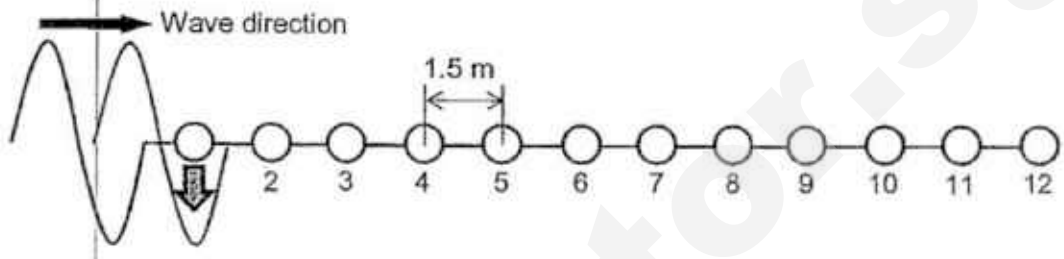
PAPER TWO

[−1 mark] from OVERALL for missing working or poor presentation without formula;
[−1 mark] from OVERALL for missing 3 s.f. or units.

Section A:

1	(a)(i)	Average diameter of one golden sphere = $\frac{(4.5-1)}{5}$ = 0.7 cm	[1]
	(ii)	He should be using a micrometer screw gauge as it is more precise or can measure up to 0.01 mm or 0.001 cm. Or Vernier calipers as it is more precise or can measure up to 0.01 cm .	[1] [1]
	(b)(i)	Mass is the amount of matter in the object. Weight is a force due to gravitational pull.	[1] [1]
	(ii)	Volume = (4.01 × 2.04 × 1.12) = 9.1620 cm^3. ∴ density of bar = $\frac{mass}{volume} = \frac{77.9}{9.1620}$ = 8.5025 ≈ 8.50 g/cm^3 (to 3 s.f.)	[1] for working [1]
	(iii)	Since density of bar is less than the density of pure gold given, this bar is NOT made of pure Gold.	[1]
			8 mks
2	(a)	Resultant F = ma ∴ Initial acceleration = $\frac{resultant\ force}{mass}$ $= \frac{4000}{2000}$ = 2 m/s^2	[1] [1]
	(b)	As air resistance increases, the resultant force acting on the car decreases. Since resultant force = ma, therefore the resultant acceleration of the car decreases.	[1] [1]
	(c)(i)	After time = 20 s: Since forward driving force has the same value (4000 N) as the air resistance, the resultant force acting on the car is 0 N.	[1]
	(c)(ii)	Resultant acceleration is zero. ⇒The car is moving with constant velocity.	[1] [1]
			7 marks
		230	

3	(a)	Principle of conservation of energy states that energy cannot be created nor destroyed, but can be converted from one FORM to another. The total energy in an isolated system is constant.	[1]
	(b)	Work done in pulling back the string in the bow = Pulling force × distance in the direction of force $= 120\ \text{N} \times \frac{55}{100}\ \text{m}$ = 66 J	[1] [1]
	(c)(i)	By Conservation of energy, Gain in K.E. for arrow = $\frac{75}{100}$ × Energy stored in the bow $\frac{1}{2}mv^2 = \frac{75}{100} \times 66$ $\frac{1}{2} \times 0.18 \times v^2 = 49.5$ $v = \sqrt{\left[\frac{49.5 \times 2}{0.18}\right]}$ = 23.452 ≈ 23.5 m/s (to 3 s.f.) ∴Speed of arrow = 23.5 m/s	[1] with ecf for working [1] with ecf
	(c)(ii)	By Conservation of energy, Gain in GPE = Loss in KE $mgh = \frac{75}{100} \times 66$ $0.18 \times 10 \times h = 49.5$ $h = \frac{49.5}{(0.18 \times 10)}$ = 27.5 m ∴Maximum height reached by arrow = 27.5 m	[1] with ecf for working [1] with ecf
			7 marks
4	(a)	Atmospheric pressure is the pressure exerted by the air molecules on the surface of Earth.	[1]
	(b)	Height of mercury column = 50 mm Pressure = 810 mm Hg $P_{atm} + P_{Hg}$ = 810 mm Hg ∴ P_{atm} = (810 – 50) mm Hg = 760 mm Hg	[1] with working
	(c)	Pressure at T due to water only $= h_{water} \times \rho_{water} \times g$ = 0.20 × 1000 × 10 = 2000 Pa	[1] [1]
	(d)	The new height of mercury column is equal to the original height of mercury column in the tube. Reason: Since pressure in liquid = $h_{Hg} \times \rho_{Hg} \times g$, pressure is independent of the diameter of the tube in manometer.	[1] [1]

			6 marks
5	(a)(i)	A transverse wave is a wave which transfers energy by vibrations from one place to another without transferring the medium. The transverse wave travels in a direction perpendicular to the direction of the vibrations.	[1] [1]
	(ii)	Wavefront is an imaginary line on a wave that joins all adjacent points that are in phase.	[1]
	(b)	Ball 1 will move downwards when the wave reaches it.  	[1]
	(c)	In 5 s, 6 complete oscillations are produced. $\Rightarrow$ In 1 s, $\frac{6}{5}$ = 1.2 complete oscillations are produced. $\therefore$ f = 1.2 Hz ← MUST write this	[1]
	(d)(i)	Distance between buoy 1 and 8 = one wavelength No. of gaps between buoy 1 and 8 = 7 gaps. Wavelength = 7 × 1.5 m = 10.5 m.	[1] [1]
	(ii)	$v = f\lambda$ = 1.2 × 10.5 = 12.6 m/s	[1] with ecf [1] with ecf
			9 marks

231

6	(a)	Focal length is the distance between the optical centre of the lens and the focal point.	[1]

(b)

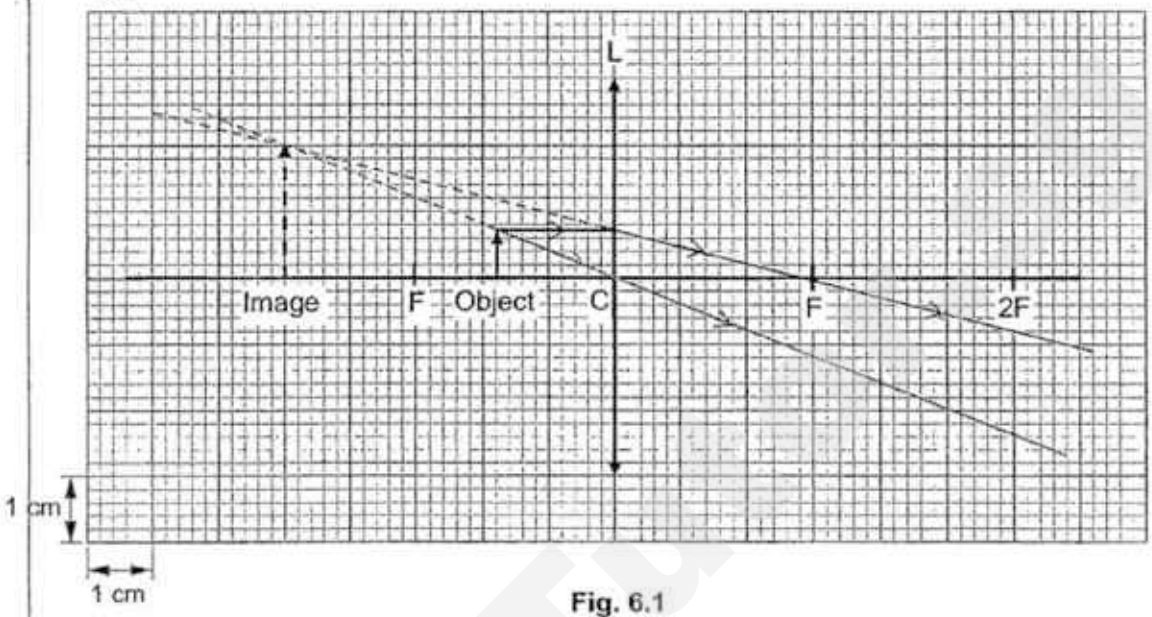


Fig. 6.1

[1] for ray through optical centre of L.
[1] for ray through F on the right of L.
[1] for position of object WITH labelling.
[-1] for wrong types of line (dotted or solid line) or missing (or wrong) arrows.

	(c)(i)	Image formed is virtual, upright and magnified.	[1]
	(c)(ii)	Magnifying glass. Note: Only magnifying glass will produce a virtual, upright and magnified image.	[1]
	(d)	When object is moved closer to the lens, height of image will decrease.	[1]
			7 marks

7	(a)(i)	First method: Radio waves Second method: Microwaves	[1] [1]
	(ii)	Microwaves have higher frequency as compared to radio waves.	[1] with ecf
	(iii)	f = 6000 MHz = 6000 × 10^6 Hz = 6 × 10^9 Hz $\lambda = \frac{v}{f} = \frac{3 \times 10^8}{6 \times 10^9}$ = 0.05 m	[1] [1] with ecf
	(b)	The ionising effect of some electromagnetic waves will damage the cells and tissues when the human is overexposed to it, causing health problems such as cancer.	[1]
			6 marks
Section B:			
8	(a)	The Principle of Moments states that when a body is in equilibrium, the sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot.	[1]
	(b)(i)	Moment produced by 500 N force = Force × maximum ⊥ distance from force to pivot = 500 N × 0.3 m = 150 Nm (Shown)	[1]
	(ii)	Moment by F_m on master piston = Moment by 500 N force $F_m \times 0.1 = 150$ $\therefore F_m = \frac{150}{0.1}$ = 1 500 N ∴ Force F_m = 1 500 N.	[1] [1]
	(iii)	Pressure exerted on fluid by master piston $= \frac{Force}{Area\ in\ contact} = \frac{1\,500\ N}{1.5\ cm^2}$ = 1 000 N/cm²	[1] with ecf [1] with ecf
	(iv)	Pressure on slave piston = Pressure from master piston = 1 000 N/cm²	[1] with ecf
	(v)	Pressure on slave piston = Pressure by master piston $\frac{Force\ on\ brake\ pad}{Base\ area\ of\ slave\ piston} = 1\,000\ N/cm^2$ $\frac{F_s}{4.5} = 1\,000$ $\therefore F_s = 4.5 \times 1000$ = 4 500 N	[1] with ecf [1] with ecf
		332	

8	(b)(vi)	To minimise the force required to brake the car: • Increase perpendicular distance between brake pedal and pivot; • Decrease the contact area of master piston; • Increase the contact area of slave piston.	Either one [1]
			10 marks
9	(a)(i)	Ray 1: Since ∠ i = 0°, ∠ r = 0°	[1]
	(ii)	Ray 2: ∠ i = ∠ in air = 35°, $n = \frac{\sin(\angle \text{ in air})}{\sin(\angle \text{ in glass})}$ $1.49 = \frac{\sin 35°}{\sin r}$ $\sin r = \frac{\sin 35°}{1.49}$ $\angle r = \sin^{-1}\left(\frac{\sin 35°}{1.49}\right)$ = 22.640° ≈ 22.6° (to 1 d.pl.)	[1] [1]
	(b)(i)	Critical angle is the angle of incidence in an optically denser medium for which the angle of refraction in the optically less dense medium is 90°.	[1]
	(ii)	$n = \frac{1}{\sin c}$ $\angle c = \sin^{-1}\left[\frac{1}{n}\right]$ $= \sin^{-1}\left[\frac{1}{1.49}\right]$ = 42.155 ° ≈ 42.2° (to 1 d.pl.)	[1] [1]
	(c)(i)	At point E, Ray 2 will bend towards the normal as it enters an optically denser medium.	[1]
	(ii)	At point P, Ray 2 undergoes total internal reflection, as it is travelling from an optically denser medium to an optically less dense medium. The angle of incidence is greater than the critical angle.	[1] [1] [1]
			10 marks

YUYING SECONDARY SCHOOL
END-OF-YEAR EXAMINATION
Secondary 3 Express

NAME

CLASS

REG. NO

PHYSICS

5059

14 October 2016

2 hour

Setter: Mr Alvin Peh

Candidates answer on the Question Paper.
Additional Materials: Multiple Choice Answer Sheet,
Plain Paper and Graph Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on this question booklet and the separate Answer Sheet.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
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.

Section B
Answer **all** questions in the spaces provided.

Section C
Answer **all** questions in the spaces provided.
Question 10 has a choice of parts to answer.

The number of marks is given in brackets [ ] at the end of each question or part question.
The use of an approved calculator is expected, where appropriate.

For Examiner's Use	
Total	100

This document consists of **30** printed pages.

D 33

Section A

Answer **all** the questions in this paper.
The total mark for this section is 30.

1. The dimensions of a rectangular block of wood are measured as 130 mm, 4.0 mm and 3.21 mm. What are the measuring instruments used to obtain such readings?

   (i) metre rule
   (ii) vernier calipers
   (iii) micrometer screw gauge

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

2. Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant. Which of the following is the unit for G?

   A. $kg^3\,m^3\,s^2$
   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
   D. $kg^3\,m^3 / s^2$

3. A cyclist, riding at a speed of 5 m/s, brakes with uniform deceleration and stops in 3 m. How long does the cyclist take to stop?

   A. 0.6 s
   B. 1.2 s
   C. 1.33 s
   D. 3.0 s

4. A stone is thrown vertically upwards from the top of a building with a speed of 10 m/s. The stone reaches the ground below after 3 s.
   What is the height of the building?

   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

Section A

Answer **all** the questions in this paper.
The total mark for this section is 30.

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   (ii) vernier calipers
   (iii) micrometer screw gauge

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

2. Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant.
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   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
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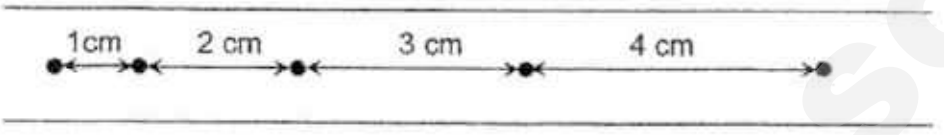
   What is the height of the building?

   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

7. A ticker tape timer vibrates at 50 Hz. The tape in the figure shows the distance moved by a trolley.



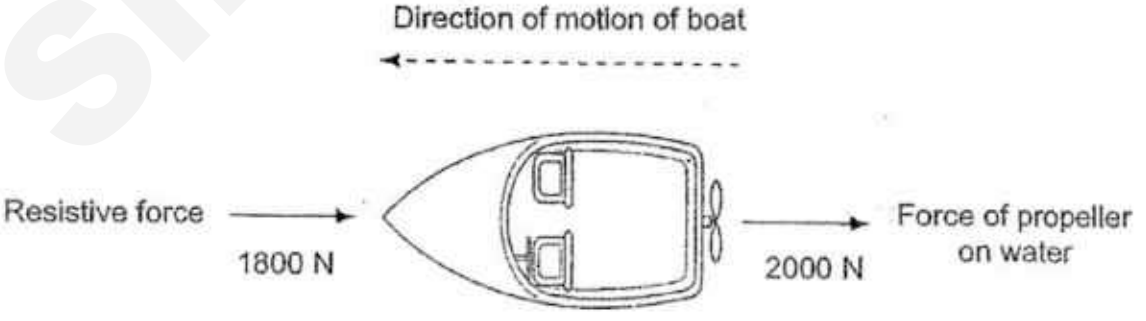
What is the average speed of the trolley for the interval shown?

A. 0.5 cm s^{-1}
B. 12 cm s^{-1}
C. 20 cm s^{-1}
D. 125 cm s^{-1}

8. A child of mass 20 kg slides down a rope which hangs vertically from a tree. If her acceleration is 2.0 ms^{-2}, what is the frictional force between the child and the rope? (Take the gravitational force on a mass of 1 kg to be 10 N.)

A. 40 N
B. 100 N
C. 160 N
D. 200 N

9. The propeller on a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.



Using Newton's Third Law of Motion, what would be the forward force on the propeller due to the water?

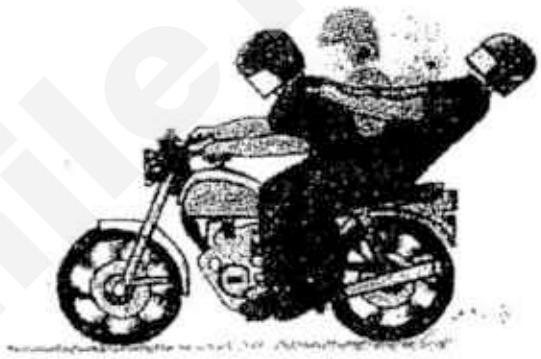
A. 200 N
B. 1800 N
C. 2000 N
D. 3800 N

10. An object is moving under the influence of F_1 on a smooth surface. A while later, an opposing force F_2 of the same magnitude acts on it.

What will happen to the object?

A. It will slow down.
B. It will move in the opposite direction.
C. It will come to rest immediately after the opposing force acts on it.
D. It will continue to move but with a constant velocity.

11. The diagram shows a pillion rider moving backwards when the motorcycle accelerates. Which option correctly explains the backward movement of the pillion rider?

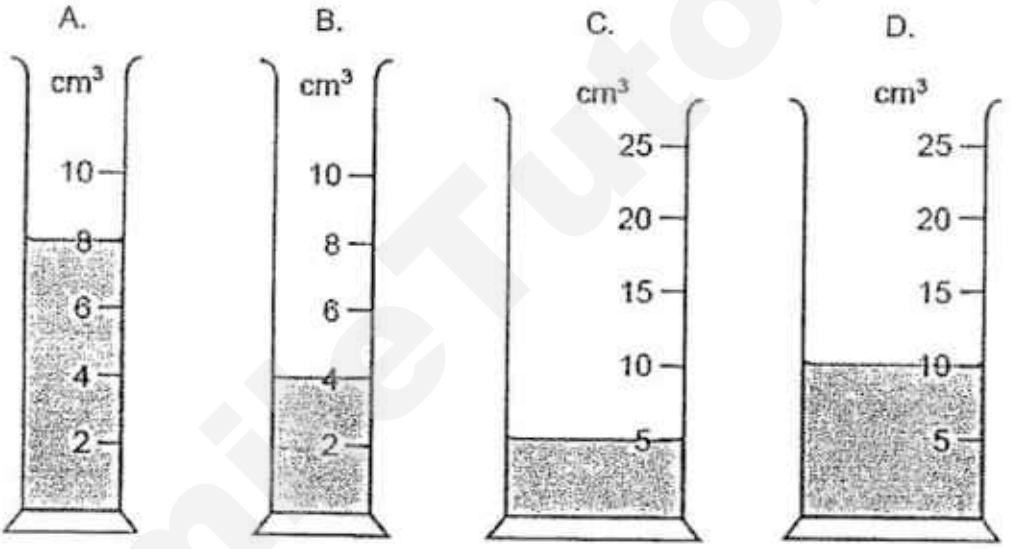


A. the pillion rider having an inertia
B. the forces on the riders being zero
C. the moment of the pillion rider
D. the conservation of total energy of the riders

15. Which of the following statements about a bag of rice on the Earth is correct?

A. Its weight is measured in kilograms.
B. Its weight is one of the forces acting on it.
C. Its mass is inversely related to its inertia.
D. Its mass at the North Pole is different from its mass at the Equator.

16. The same mass of four different liquids is placed in some measuring cylinders.

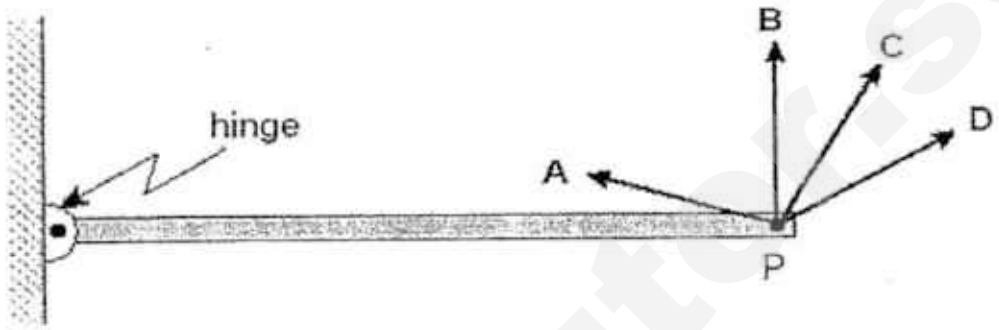


Which measuring cylinder contains the liquid with the greatest density?

17. The density of a silver bar, of volume 10 cm^3, is 10.0 gcm^{-3}. What will be the density of the silver bar when a hole of volume 1.0 cm^3 is drilled into the bar?

A. 9.0 g cm^{-3}
B. 10.0 g cm^{-3}
C. 10.5 g cm^{-3}
D. 11.0 g cm^{-3}

18. The diagram below shows a force applied in several different directions at the point P on a hinged beam. In which direction will the force produce the largest moment about the hinge?



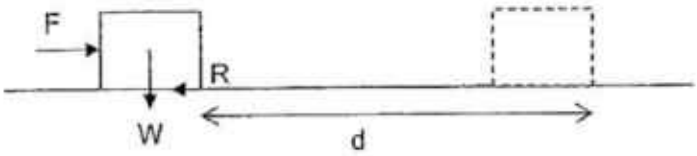
19. The diagram illustrates three uniform objects of the same external diameter.

(1) hollow sphere	(2) solid sphere	(3) hollow sphere
mass 100 g	mass 100 g	mass 200 g

Which objects have the centre of gravity at a similar point?

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

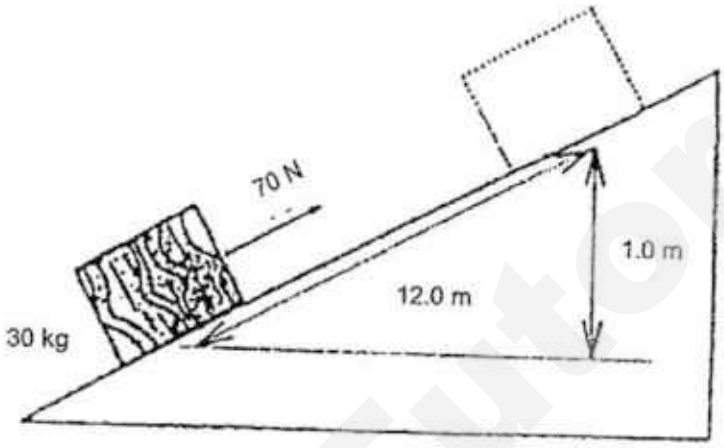
20. The figure below shows a box being pushed using a constant force of F through a distance d. The box has a weight of W and there is a total resistive force R acting against the box.



What is the useful work done on the box?

A. Fd – Rd – Wd
B. Fd + Rd + Wd
C. Fd – Rd
D. Fd – Wd

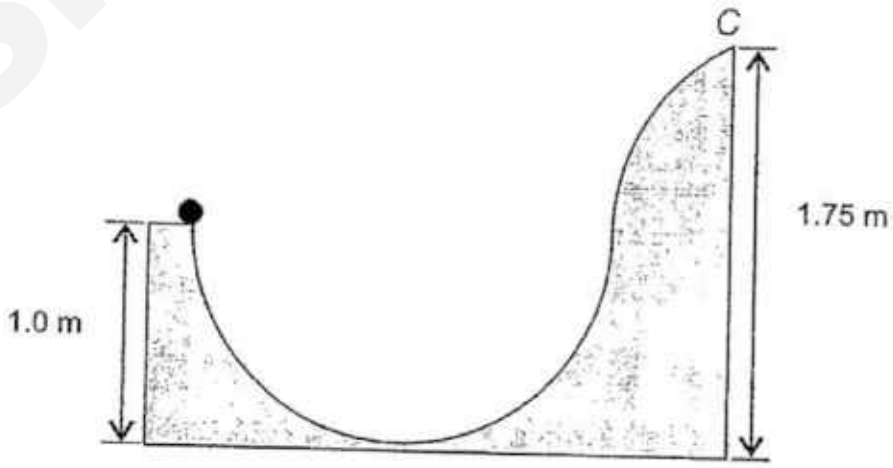
21. A wooden block of mass 30 kg is pulled up a rough inclined plane at a constant speed by a force of 70 N. When the distance moved along the plane is 12.0 m, the increase in height is 1.0 m.



What is the work done against friction for every 1.0 m increase in height?

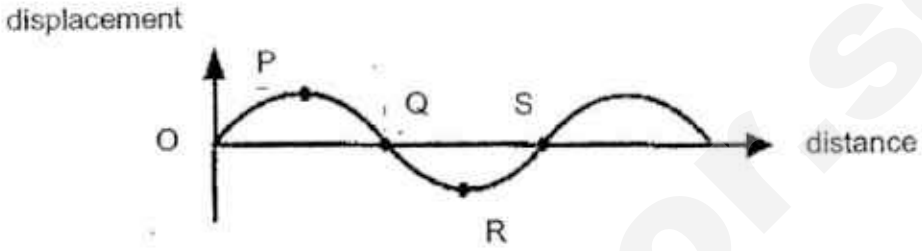
A. 300 J
B. 360 J
C. 540 J
D. 840 J

22. Assuming that there is no energy loss, calculate the minimum value of initial speed required for the ball to reach point C as shown in the figure.



A. 2.06 m s^{-1}
B. 3.87 m s^{-1}
C. 4.50 m s^{-1}
D. 5.21 m s^{-1}

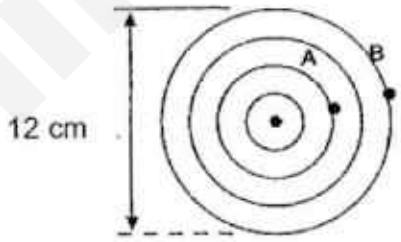
23. The diagram below shows the displacement-distance graph of a transverse wave traveling to the right at a certain instant.



Which of the following statements is correct?

A. Particle P is moving downwards.
B. Particle Q is momentarily at rest.
C. Particle R is moving to the right.
D. Particle S is moving downwards.

24. Circular water waves are produced by a dot vibrator. The wave pattern at a certain instant is as shown in the diagram below.



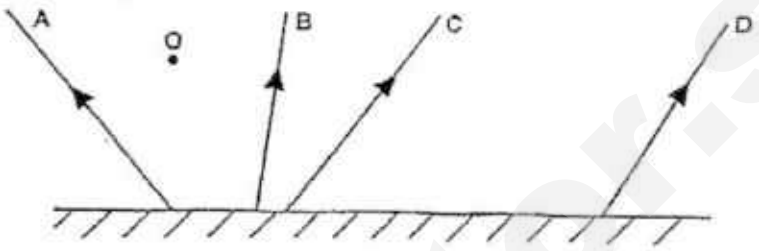
If the speed of the water waves is 0.6 ms^{-1}, what is the time taken for the wave to travel from A to B?

A. 0.05 s
B. 0.67 s
C. 5.0 s
D. 6.7 s

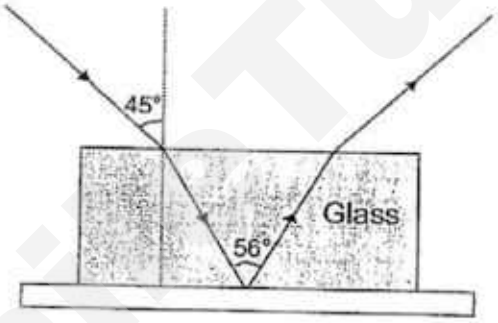
25. Which of the following devices does **not** make use of electromagnetic waves in its operation?

A. camera
B. loudspeaker
C. television remote control
D. sun-tanning machine

26. The diagram below shows the plan view of an object O in front of a plane mirror. Which one of the reflected rays of light appears to come from the image of O?



27. A piece of glass was placed on top of a polished mirror surface as shown in the figure below. What is the critical angle of glass?



A. 28.1°
B. 41.6°
C. 45.0°
D. 58.5°

28. A pupil did an experiment on a thin converging lens. The distance between the illuminated object to the centre of the lens is recorded as the object distance. He measured and recorded the image height as shown in the table. All the images obtained are real and inverted.

Object height / cm	3.0	3.0
Object distance / cm	9.0	11.0
Image height /cm	3.7	2.5

Which length is most probably the focal length of the lens?

A. 5.0 cm
B. 9.0 cm
C. 10.0 cm
D. 11.0 cm

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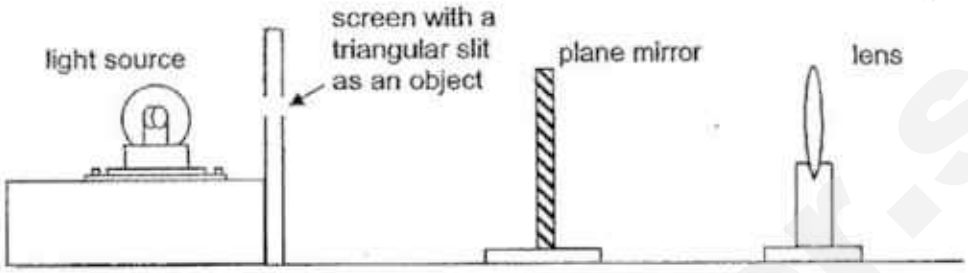
29. The diagram below shows some apparatus set up in a Physics Laboratory.



The following is a list of steps taken by a pupil to find the focal length of a convex lens.

(1) Move the object to and fro until a sharp image is formed side by side with it on the screen.
(2) Place a plane mirror behind the lens.
(3) Measure the distance between the lens and the screen.
(4) Measure the distance between the light source and the plane mirror.

Which is the correct order of steps for the pupil to take in order to find the focal length of a convex lens?

A. (1), (2), (3)
B. (2), (1), (3)
C. (2), (1), (4)
D. (4), (1), (3)

30. Which option correctly describes what happens when sound waves pass through a liquid?

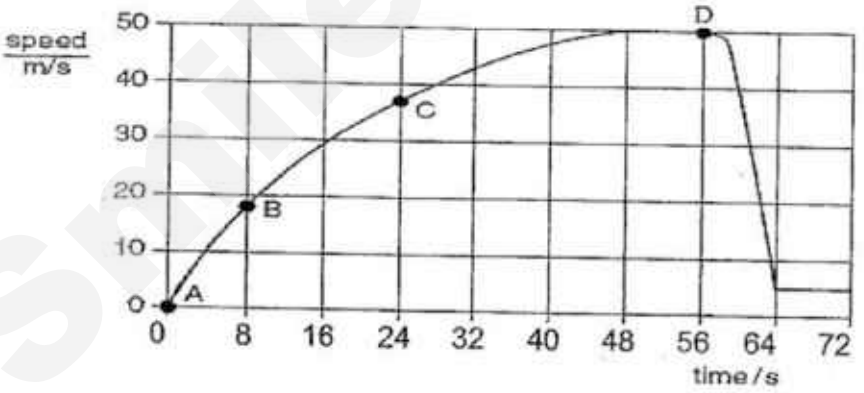
A. A convection current is produced throughout the liquid.
B. Molecules vibrate faster about fixed points.
C. Molecules vibrate perpendicularly to the direction of travel of the waves.
D. Molecules vibrate parallel to the direction of travel of the waves.

Section B

Answer **all** the questions in this section.
The total mark for this section is 40.

1. During the National Day Parade, parachutists from the Red Lions free fall vertically downwards from a height of 10 000 ft (3 048 m). The figure below shows a parachutist during his descent after his parachute has opened.

The graph shows how the speed of the parachutist varies with time for a section of the flight in the air.



a. State the value of the terminal velocity before and after the opening of the parachute.

i. before opening of the parachute, terminal velocity = ... [1]

ii. after opening of the parachute, terminal velocity = ... [1]

b. Describe the motion of the parachutist between points A and D.

[2]

_____

_____

_____

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c. Explain how the velocity changes from the point the parachutist began his descent till just before the parachute was opened.

[3]

_____

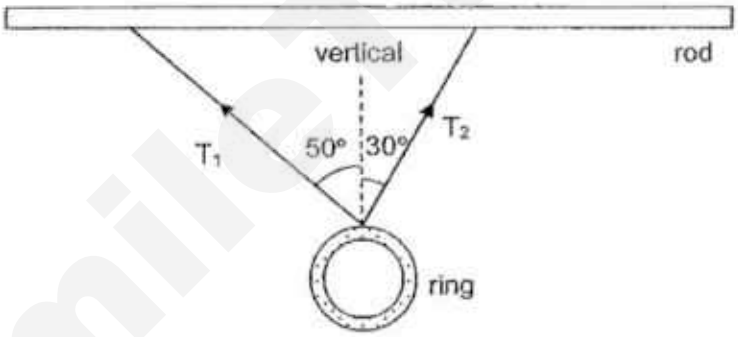
_____

_____

_____

_____

2. A ring is supported by two strings that hang from a rod as shown below.



The ring has a weight of 3.0 N

a. State the direction and the size of the resultant force of the two tensions T_1 and T_2.

[2]

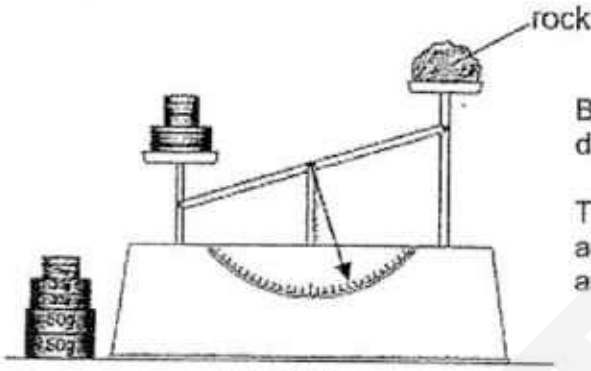
angle between resultant force and T_2 = _____ °

size of the resultant force = _____ N

b. On the plain paper provided, draw a labelled scaled diagram to determine the size of the two tensions T_1 and T_2 in the strings.

[4]

3. A space research organisation plans to send astronauts to Mars to examine rocks on its surface. The organisation will produce a report containing information about conditions on Mars. The gravitational field strength on the surface of Mars is 3.7 Nkg^{-1}.
While still on the surface of Mars, the astronauts will measure the mass of each rock collected. Fig. 3.1 and Fig. 3.2 show two instruments that the astronauts will use.



Balance X and a set of brass discs.

The mass of each disc is accurately determined on Earth and the value is marked on it.

Fig. 3.1

Balance **Y** which is accurately calibrated on Earth and the mass values are marked on the vertical scale.

Fig. 3.2

a. A rock of mass 0.50 kg is dropped on Mars and it falls to the surface. State the acceleration of the falling rock. Assume that there is no air resistance on Mars.

[1]

b. When the two instruments are used on Mars, they will give different readings for the mass of the same rock.

i. Explain the difference in readings by the two instruments.

[2]

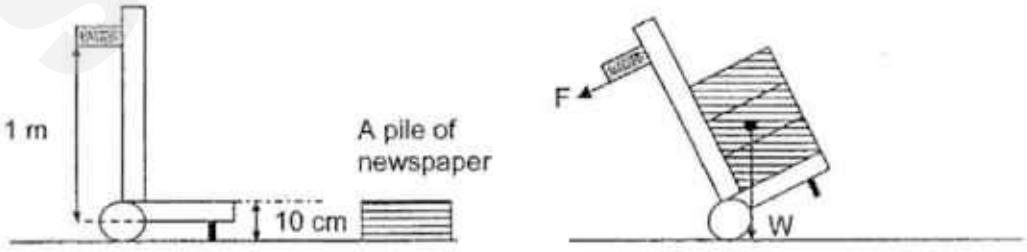
ii. Which instrument, balance X or Y, will give the correct reading of the mass of the rock? Name this instrument.

[1]

c. The astronauts will also determine the density of each rock. Explain if the density of the rock found on Mars differs from its density when brought back to Earth.

[2]

4. A newspaper collector uses a trolley to move his newspaper with ease.



a. Each pile of newspaper has a mass of 5 kg. Calculate the amount of work needed to vertically lift 3 piles of newspaper onto the trolley a pile at the same time.

[2]

b. Will it be more efficient to lift the piles of newspaper together as shown in Fig 4.1 instead of lifting 1 pile at a time as shown in Fig 4.2? Explain your answer.

[2]

Fig 4.1 Fig 4.2

c. The trolley is then tilted before being moved. The radius of the wheel of the trolley is 5 cm and W is the weight of the papers and trolley.
Calculate F, the minimum amount of force, needed to ready the papers for movement as shown above. The mass of trolley is given as 1 kg.

[2]

d. Should the trolley be tilted more or less to move the paper more efficiently? Explain your answer.

[3]

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5. Fig. 5.1 shows a cross-section of a piece of glass which has a refractive index of 1.60. A ray of light is incident normally at the top surface as shown.

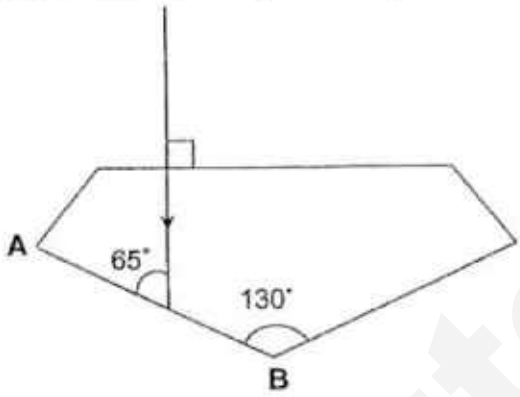


Fig. 5.1

a. Find the angle of refraction of the ray at the boundary AB.

[2]

b. A piece of diamond of refractive index 2.40 is cut to have the same shape as the glass in Fig. 5.1. Explain briefly why the diamond seems to 'glow' whereas the glass piece does not when light falls on it.

[2]

6. Microwaves are waves in the electromagnetic spectrum.

   a. State the name of the waves in the part of the electromagnetic spectrum that have wavelengths longer than microwaves.

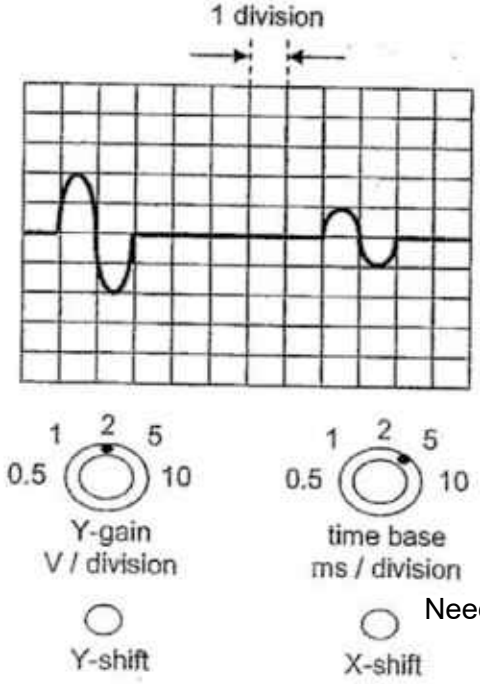
   [1]

   b. Explain why the frequency of these waves is lower than the frequency of microwaves.

   [1]

7. A boy, holding a microphone, is standing a distance d from a wall.

The microphone is connected to a cathode ray oscilloscope (C.R.O.) with four controls. When the boy claps once, the sound is received by the microphone and the audio signal is displayed on the C.R.O. as shown below.



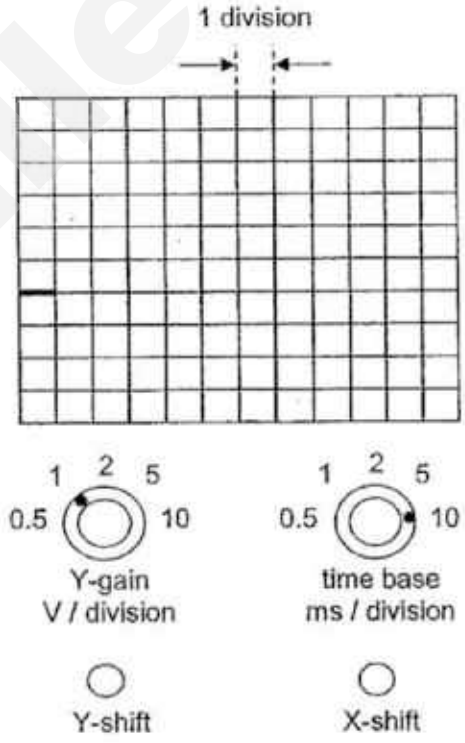
a. Determine the frequency of the sound due to the clap.

[2]

b. If the speed of sound in air is 330 ms^{-1}, determine the distance, d, between the boy and the wall.

[2]

c. Another student then adjusts the display controls of the C.R.O. Part of the signal is given as shown below.



In the display above, complete the signal with the new settings.

[2]

Section C

Answer **all** the questions in this section in the spaces provided.
Question 10 is in the form either/or
and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

8. Fig. 8.1 shows a 1.2 kg trolley being pulled along a rough horizontal bench by means of tension, T, in the thread fastened to the trolley. The other end of the thread is attached to a mass-hanger of mass 200 g.

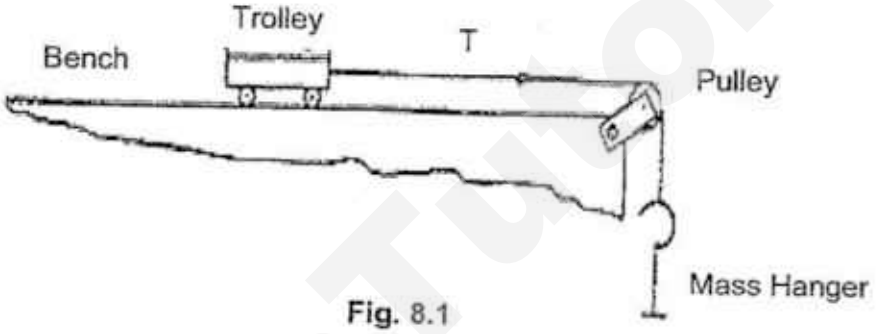


Fig. 8.1

a. Draw the free body diagram illustrating all the forces acting on the trolley.

[2]

b. The frictional force between the wheels of the trolley and the surface of the bench is 0.5 N. Calculate the acceleration of the trolley.

[3]

c. From your answer in (a) and (b), describe in detail, the motion of the trolley.

[2]

d. Suggest a way in which the friction between the wheels and the bench can be reduced.

[1]

e. If the trolley is loaded with sand, compare the change in speed of the loaded and unloaded trolley.

[2]

9. Ultrasound is a type of high frequency sound used in medical diagnosis. Important information about the internal structures of the body can be obtained by using a detector to analyse the reflections from the internal structures.

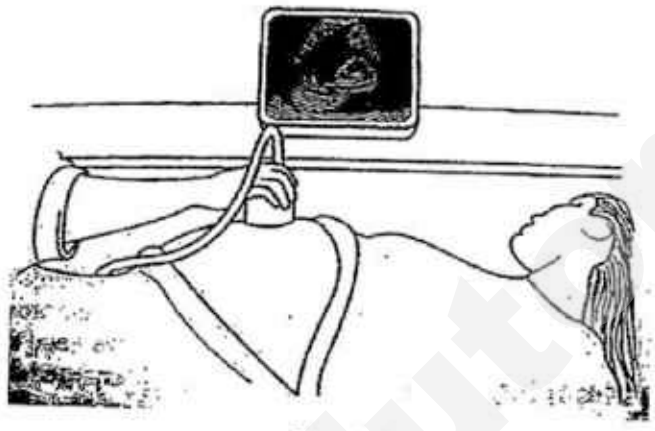


Fig. 9.1

Fig. 9.1 shows an ultrasonic scanner used to monitor the development of the baby of a pregnant woman. As an ultrasonic wave travel through the body tissues, energy is lost (attenuated) and the amplitude and intensity of the ultrasonic wave reduces.

Attenuation is measured in decibels per centimetre ($dBcm^{-1}$) of tissue and is represented by the attenuation coefficient of the specific tissue type. The higher the attenuation coefficient, the more attenuated the ultrasonic wave is affected by the specified tissue.

Attenuation is an important concept as it limits the depth of the image that can be obtained via ultrasound.

The table below shows the attenuation coefficients and speeds of ultrasonic waves, transmitted at 1 MHz, through different body tissues.

body tissue	attenuation coefficient / $dBcm^{-1}$	speed / ms^{-1}
water	0.002	1484
fat	0.63	1450
liver	0.5 - 0.94	1570
bone	5.0	4080

Sources: http://usra.ca/tissue.php & https://wiki.engr.illinois.edu

a. Describe how ultrasonic waves are transmitted from the scanner, through the body tissues, to the baby of the pregnant woman.

[2]

b. Describe one difference between an ultrasound and electromagnetic waves.

[1]

c. By studying the values in table, estimate the attenuation coefficient of human blood for an ultrasonic wave transmitted at 1 MHz.

[1]

d. Describe **two** properties of sound waves that contribute to the attenuation of ultrasonic waves in body tissues.

[2]

e. Explain why ultrasound is often **not** used in the medical diagnosis of bones in the body.

[2]

f. Calculate the wavelength of ultrasonic waves in the fat of the body of the pregnant woman.

[2]

Either

10a. State what is meant by the moment of a force and state how it can be calculated. [2]

10b. Fig. 10.1 shows a non-uniform rod PQ of length 35 cm attached to two strings A and B of equal length. The tension in string A is 5 N and that in string B is 2 N.

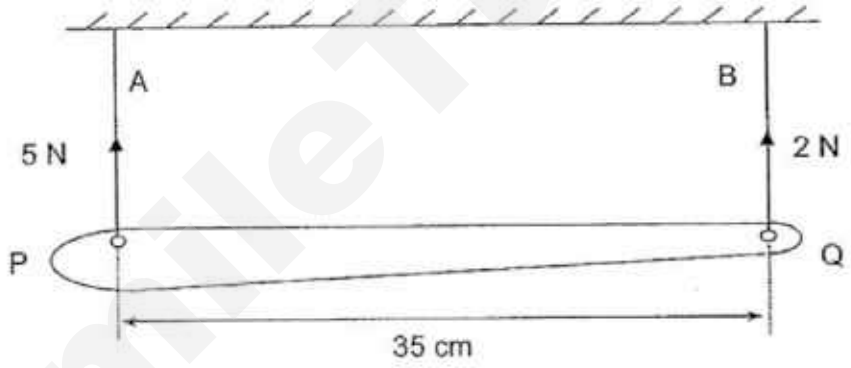


Fig. 10.1

Determine the following:

i. the weight of PQ, [1]

ii. the position of the centre of gravity of PQ from the end P. [2]

10c. Fig. 10.2 shows a sheet of metal suspended from a hole in one corner at A. The weight of the metal is 0.10 N and the centre of gravity is at G. The metal sheet swings freely and comes to rest.

i. In the space next to the given figure, sketch a diagram of the sheet in its final rest position. Mark points A and G on your diagram.

[1]

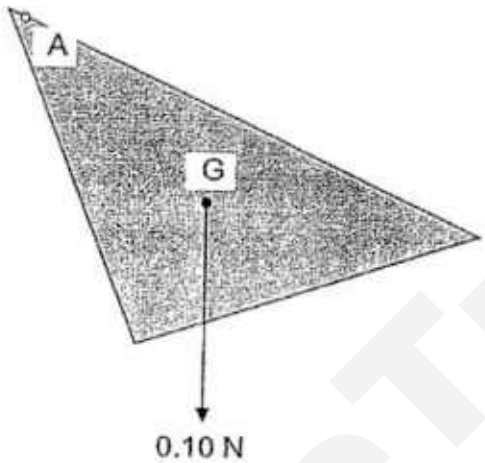


Fig. 10.2

ii. Explain why the sheet remains at rest in this position.

[2]

10d. The metal sheet is placed on a table. State two reasons why it is more stable when it is placed flat on the table than when it is placed on the table in a vertical position.

[2]

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Or

10a. In an experiment to find the focal length of a convex lens, the following readings were obtained.

distance of object from lens, u/cm	40.0	31.5	27.0	23.0	17.5	15.5	12.0
distance of image from lens, v/cm	10.0	12.5	15.0	17.5	22.5	25.0	30.0

i. Using a scale of 1.0 cm to 2.5 cm for both axes, plot a graph of u/cm against v/cm on the graph paper provided.

[3]

ii. Use the graph to find the value of u and v when they are equal by drawing the line u= v.

[1]

value of u = _____ cm

value of v = _____ cm

iii. Using the relationship,

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

determine the focal length of the lens.

[2]

10b. In what way(s) are the images formed by a camera and a slide projector similar and in what way(s) are they different?

[2]

_____

_____

_____

Section A

Answer **all** the questions in this paper.
The total mark for this section is 30.

1. The dimension of a rectangular block of wood is measure as 130 mm, 4.0 mm and 3.21 mm. What are the measuring instruments used to obtain such readings?

   (i) metre rule
   (ii) vernier calipers
   (iii) micrometer screw gauge

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

2. Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant.

   Which of the following is the unit for G?

   A. $kg^3\,m^3\,s^2$
   B. $kg\,s^2 / m^3$
   C. $m^3 / kg\,s^2$
   D. $kg^3\,m^3 / s^2$

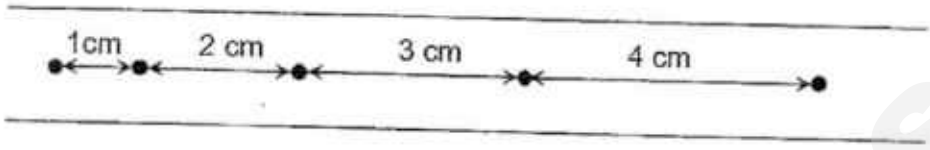
3. A cyclist, riding at a speed of 5 m/s, brakes with uniform deceleration and stops in 3 m. How long does the cyclist take to stop?

   A. 0.6 s
   B. 1.2 s
   C. 1.33 s
   D. 3.0 s

4. A stone is thrown vertically upwards from the top of a building with a speed of 10 m/s. The stone reaches the ground below after 3 s. What is the height of the building?

   A. 5 m
   B. 10 m
   C. 15 m
   D. 20 m

7. A ticker tape timer vibrates at 50 Hz. The tape in the figure shows the distance moved by a trolley.



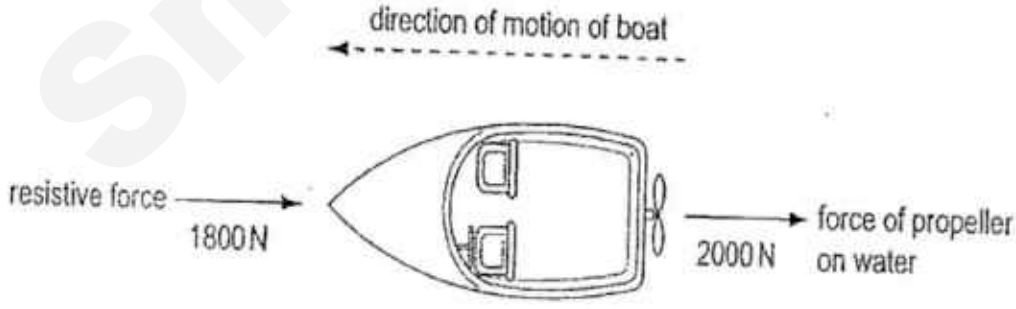
What is the average speed of the trolley for the interval shown?

A. 0.50 cm s^{-1}
B. 12 cm s^{-1}
C. 20 cm s^{-1}
D. 125 cm s^{-1}

8. A child of mass 20 kg slides down a rope which hangs vertically from a tree. If her acceleration is 2.0 m s^{-2}, what is the frictional force between the child and the rope? (Take the gravitational force on a mass of 1 kg to be 10 N.)

A. 40 N
B. 100 N
C. 160 N
D. 200 N

9. The propeller on a boat pushes water backwards with a force of 2000 N. The boat moves through the water against a total resistive force of 1800 N.

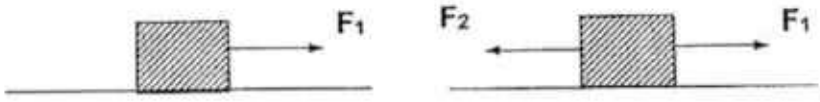


Using Newton's Third Law of Motion, what would be the forward force on the propeller due to the water?

A. 200 N
B. 1800 N
C. 2000 N
D. 3800 N

250

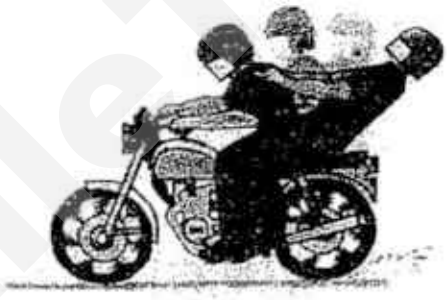
10. An object is moving under the influence of F_1 on a smooth surface. A while later, an opposing force F_2 of the same magnitude acts on it.



What will happen to the object?

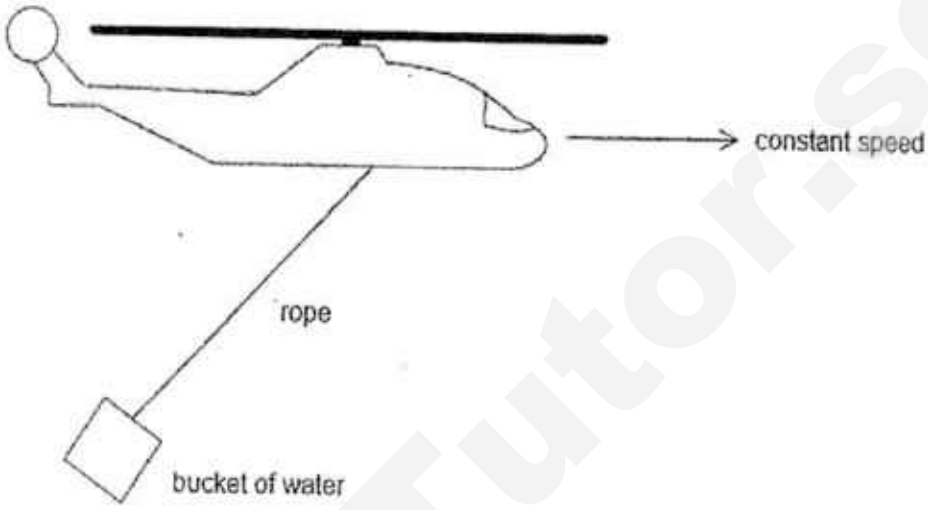
A. The object will slow down.
B. The object will move in the opposite direction.
C. The object will come to rest immediately after the opposing force acts on it.
D. The object will continue to move but with a constant velocity.

11. The diagram shows a pillion rider moving backwards when the motorcycle accelerates. Which option correctly explains the backward movement of the pillion rider?



A. the pillion rider having an inertia
B. the forces on the riders being zero
C. the moment of the pillion rider
D. the conservation of total energy of the riders

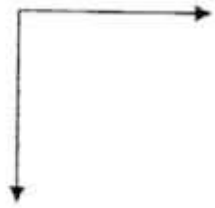
12. A fire-fighting helicopter is flying at constant speed along a horizontal straight-line carrying a bucket of water as shown in the diagram below. The rope to the bucket makes a fixed angle with the vertical.



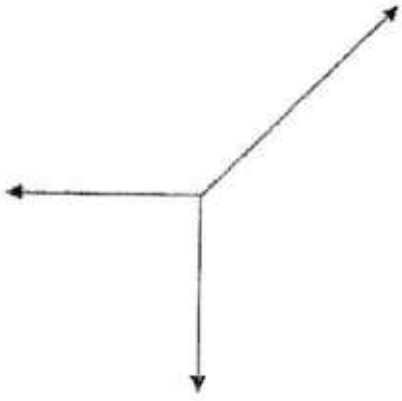
Which of the following diagrams is the correct free body diagram of the forces acting on the bucket?

A.

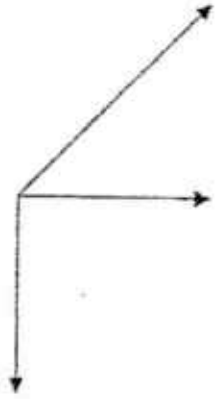
B.



C.

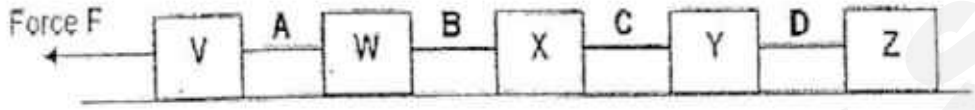


D.



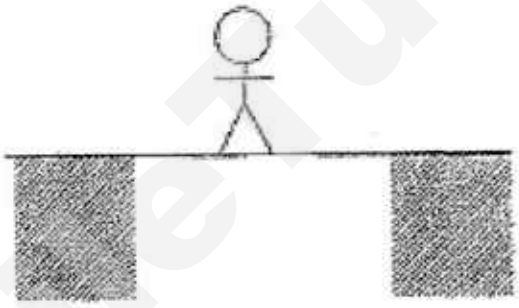
251

13. Five blocks of equal masses V, W, X, Y and Z are connected by four identical strings as shown in the diagram. They are pulled by a steadily increasing force F.



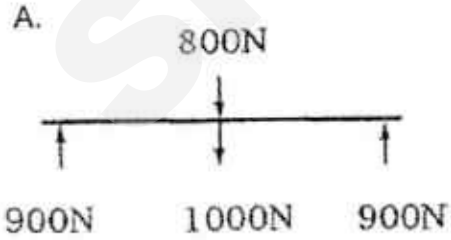
Which of the strings A, B, C or D is most likely to break first?

14. The diagram below shows a man of weight 800 N standing in the middle of a uniform, rigid, horizontal plank. The plank weighs 1000 N.

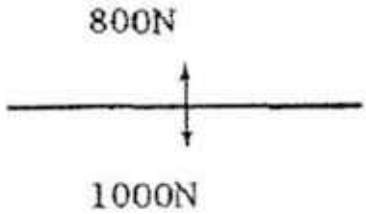


Which of the following diagrams show the forces on the plank?

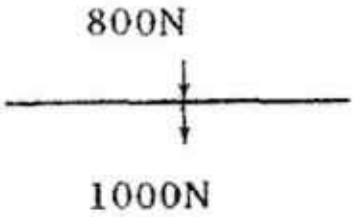
A.



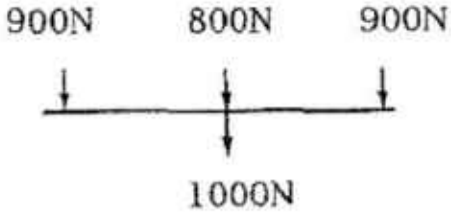
B.



C.



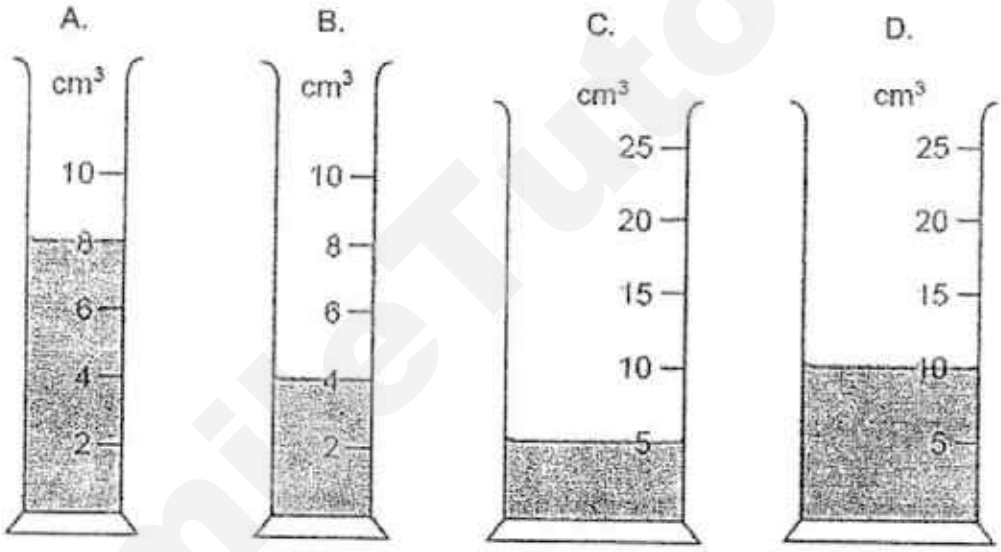
D.



15. Which of the following statement about a bag of rice on the Earth is correct?

A. The weight of a bag of rice is measured in kilograms.
B. The weight of a bag of rice is one of the forces acting on it.
C. The mass of a bag of rice is inversely related to its inertia.
D. The mass of a bag of rice at the North Pole is different from its mass at the Equator.

16. The same mass of four different liquids is placed in some measuring cylinders.



Which measuring cylinder contains the liquid with the greatest density?

17. The density of a silver bar, of volume 10 cm^3, is 10.0 g cm^{-3}. What will be the density of the silver bar when a hole of volume 1.0 cm^3 is drilled into the bar?

A. 9.0 g cm^{-3}
B. 10.0 g cm^{-3}
C. 10.5 g cm^{-3}
D. 11.0 g cm^{-3}

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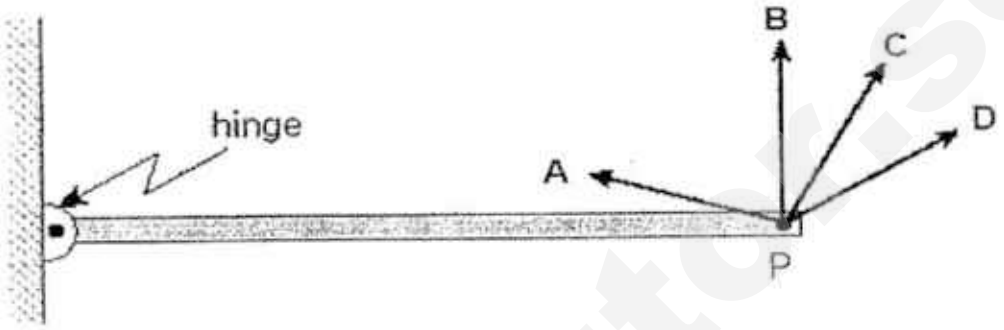
18. The diagram below shows a force applied in several different directions at the point P on a hinged beam. In which direction will the force produce the largest moment about the hinge?



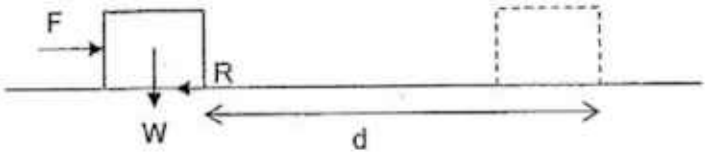
19. The diagram illustrates three uniform objects of the same external diameter.

(1) hollow sphere mass 100 g | *(2) solid sphere mass 100 g* | *(3) hollow sphere mass 200 g*

Which objects have the centre of gravity at a similar point?

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

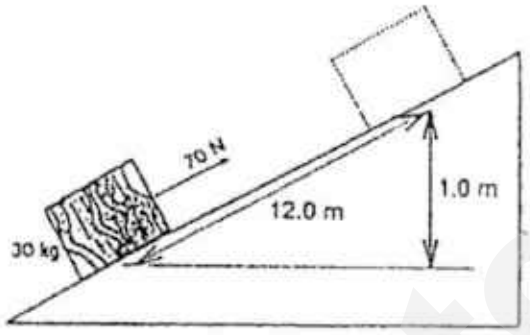
20. The figure below shows a box being pushed using a constant force of F through a distance d. The box has a weight of W and there is a total resistive force R acting against the box.



What is the useful work done on the box?

A. Fd – Rd – Wd
B. Fd + Rd + Wd
C. Fd – Rd
D. Fd – Wd

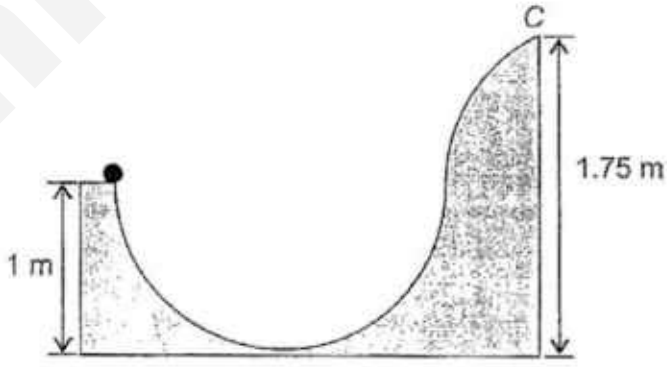
21. A wooden block of mass 30 kg is pulled up a rough inclined plane at a constant speed by a force of 70 N. When the distance moved along the plane is 12.0 m, the increase in height is 1.0 m.



What is the work done against friction for every 1.0 m increase in height?

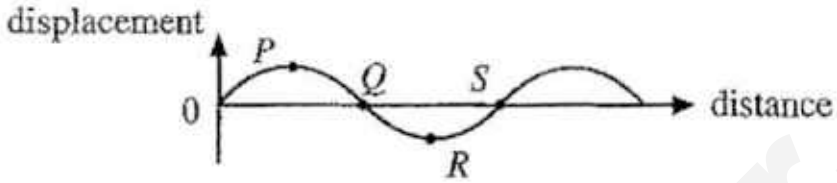
A. 300 J
B. 360 J
C. 540 J
D. 840 J

22. Assuming that there is no energy loss, calculate the minimum value of initial speed required for the ball to reach point C as shown in the figure.



A. 2.06 m s–1
B. 3.87 m s^{-1}
C. 4.50 m s^{-1}
D. 5.21 m s^{-1}

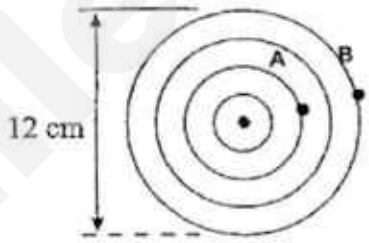
23. The diagram below shows the displacement-distance graph of a transverse wave traveling to the right at a certain instant.



Which of the following statements is correct?

A. Particle P is moving downwards.
B. Particle Q is momentarily at rest.
C. Particle R is moving to the right.
D. Particle S is moving downwards.

24. Circular water waves are produced by a dot vibrator. The wave pattern at a certain instant is as shown in the diagram below.



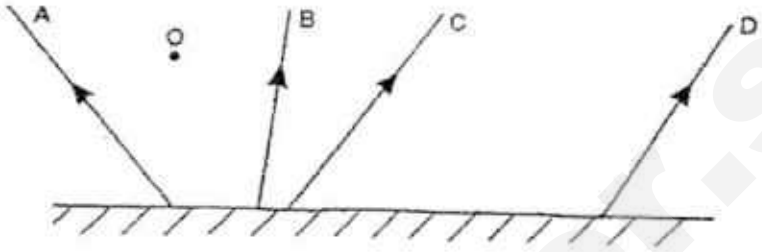
If the speed of the water waves is 0.6 m s^{-1}, what is the time taken for the wave to travel from A to B?

A. 0.050 s
B. 0.67 s
C. 5.0 s
D. 6.7 s

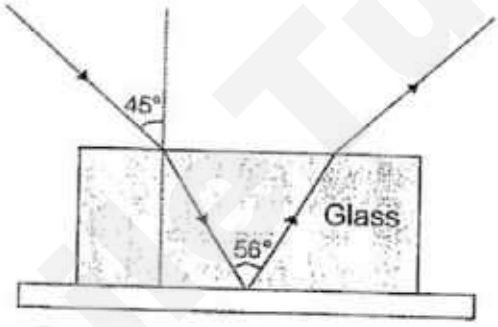
25. Which of the following devices does **NOT** make use of electromagnetic waves in its operation?

A. camera
B. loudspeaker
C. television remote control
D. sun-tanning machine

26. The diagram below shows the plan view of an object O in front of a plane mirror. Which one of the reflected rays of light appears to come from the image of O?



27. A piece of glass was placed on top of a polished mirror surface as shown in the figure below. What is the critical angle of glass?



A. 28.1°
B. 41.6°
C. 45.0°
D. 58.5°

28. A pupil did an experiment on a thin converging lens. The distance between the illuminated object to the centre of the lens is recorded as the object distance. He measured and recorded the image height as shown in the table. All the images obtained are real and inverted.

Object height / cm	3.0	3.0
Object distance / cm	9.0	11.0
Image height /cm	3.7	2.5

Which length is most probably the focal length of the lens?

A. 5.0 cm
B. 9.0 cm
C. 10.0 cm
D. 11.0 cm

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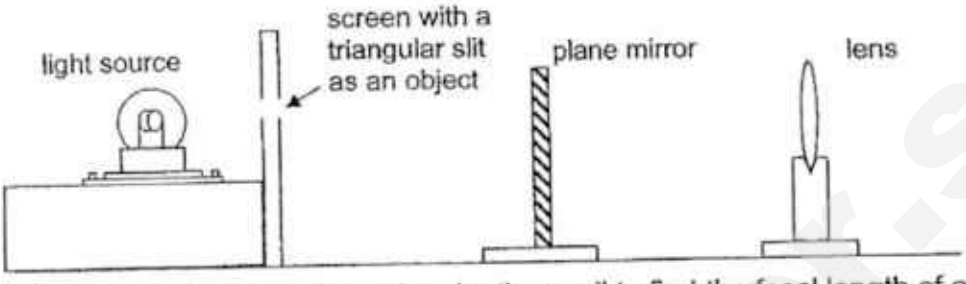
29. The diagram below shows some apparatus setup in a Physics Lab.



The following is a list of steps taken by the pupil to find the focal length of a convex lens.

(1) Move the object to and fro until a sharp image is formed side by side with it on the screen.
(2) Place a plane mirror behind the lens.
(3) Measure the distance between the lens and the screen.
(4) Measure the distance between the light source and the plane mirror.

Which is the correct order of steps for the pupil to take in order to find the focal length of a convex lens?

A. (1), (2), (3)
B. (2), (1), (3)
C. (2), (1), (4)
D. (4), (1), (3)

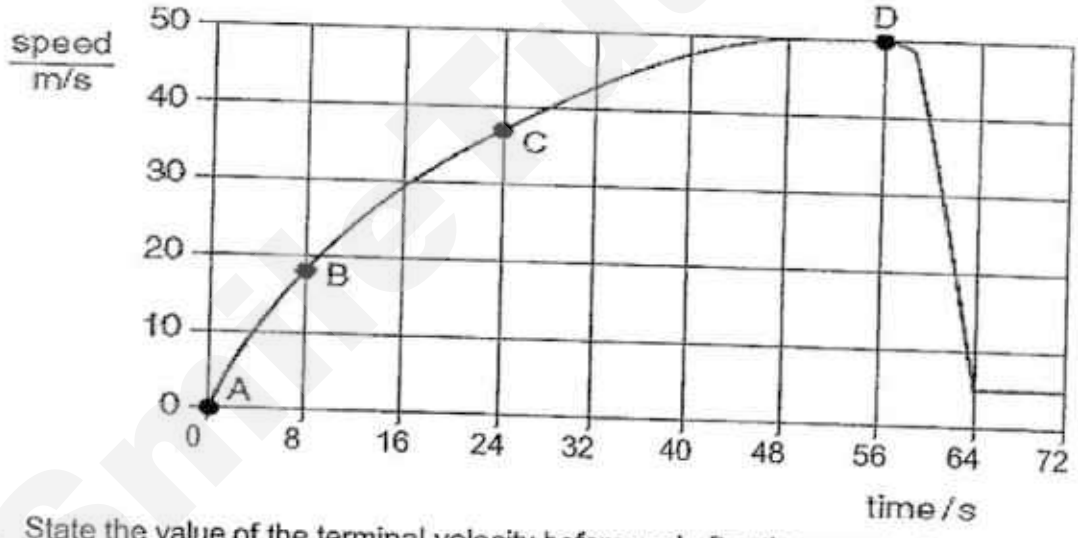
30. Which option correctly describes what happens when sound waves pass through liquid?

A. a convection current is produced throughout the liquid
B. molecules vibrate faster about fixed points
C. molecules vibrate perpendicularly to the direction of travel of the waves
D. molecules vibrate parallel to the direction of travel of the waves

Section B

Answer all the questions in this section.
The total mark for this section is 40.

1. During the National Day Parade, parachutists from the Red Lions free-fall vertically downwards from a height of 10 000 ft (3 048 m). The figure below shows a parachutist during his descend after his parachute has opened. The graph shows how the speed of the parachutist varies with time for a section of the flight in the air.



a. State the value of the terminal velocity before and after the parachute opens.

i. before parachute opens, terminal velocity = ... [1]

ii. after parachute opens, terminal velocity = ... [1]

before parachute opens, terminal velocity = 50 m/s	A[1]
after parachute opens, terminal velocity = 5 m/s	A[1]

b. Describe the motion of the parachutist between A and D.

[2]

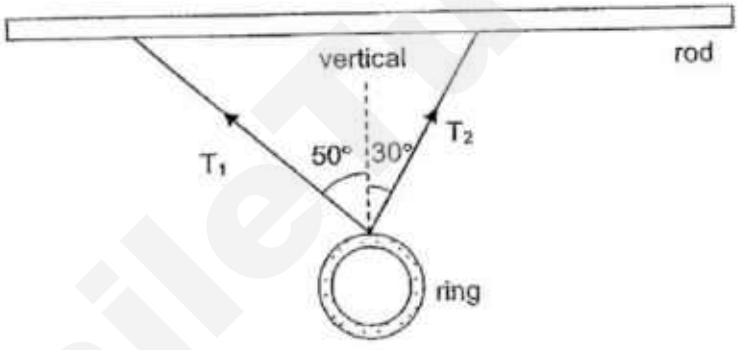
The speed is ***increasing*** at a ***decreasing*** rate.	A[1] for each ***bold*** word

c. Explain how the velocity changes from the point the parachutist begin his descend till just before the parachute is opened.

[3]

Initially, the amount of air resistance experienced by the parachutist is zero. Thus the resultant force experienced by him is due to his weight.	A[1]
Thus will create him to experience a large value of acceleration since F = ma	A[1/2]
As the amount of air resistance increases over time, the resultant force experienced by him gradually decreased.	A[1]
Thus the acceleration experienced by the parachutist is reduced over time.	A[1/2]

2. A ring is supported by two strings that hang from a rod as shown below.



The ring has a weight of 3.0 N

a. State the direction and the size of the resultant force of the two tensions T_1 and T_2.

[2]

angle between resultant force and T_2 = _____ °

size of the resultant force = _____ N

angle between resultant force and T_2 = 30 °	A[1]
size of the resultant force = 3 N	A[1]

b. In the plain paper provided, draw a labelled scaled diagram to determine the size of the two tensions T_1 and T_2 in the strings.

[4]

3. A space research organisation plans to send astronauts to Mars to examine rocks on its surface. The organisation will produce a report containing information about conditions on Mars. The gravitational field strength on the surface of Mars is 3.7 N kg^{-1}.

While still on the surface of Mars, the astronauts will measure the mass of each rock collected. Fig. 3.1 and Fig. 3.2 show two instruments that the astronauts will use:

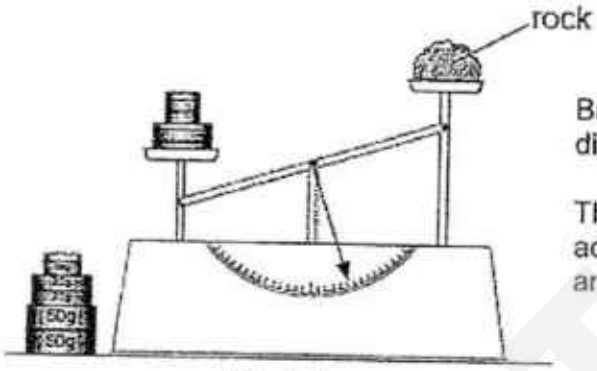


Fig. 3.1

Balance X and a set of brass discs;

The mass of each disc is accurately determined on Earth and the value is marked on it.

Fig. 3.2

Balance **Y** which is accurately calibrated on Earth and the mass values are marked on the vertical scale.

a. A rock of mass 0.50 kg is dropped on Mars and it falls to the surface. State the acceleration of the falling rock. Assume that there is no air resistance on Mars.

[1]

acceleration = 3.7 ms^{-2}	A[1]

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b. When the two instruments are used on Mars, they will give different readings for the mass of the same rock.

i. Explain the difference in readings by the two instruments.

[2]

Mass remains the same when it is being measured on Mars.	A[1]
Weight is dependent on the gravitational field strength and will be different when measured on Mars.	A[1]

ii. Which instrument, balance X or Y, will give the correct reading of the mass of the rock? Name this instrument.

[1]

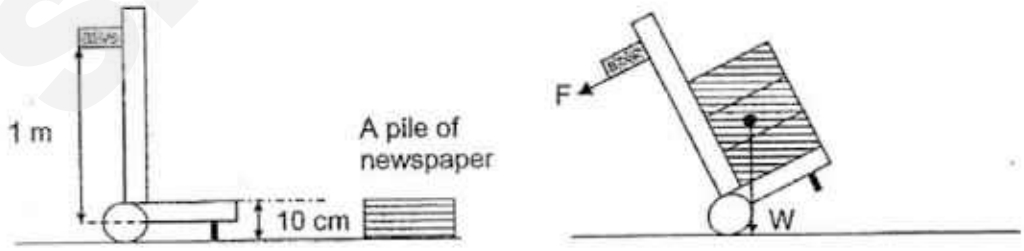
Balance X	A[1/2]
Beam Balance	A[1/2]

c. The astronauts will also determine the density of each rock. Explain if the density of the rock found on Mars differs from its density when brought back to Earth.

[2]

Density will remain the same.	A[1]
It is dependent on the ***mass*** and the ***volume*** if the rock and not the weight.	A[1]

4. A newspaper collector uses a trolley to move his newspaper with ease.

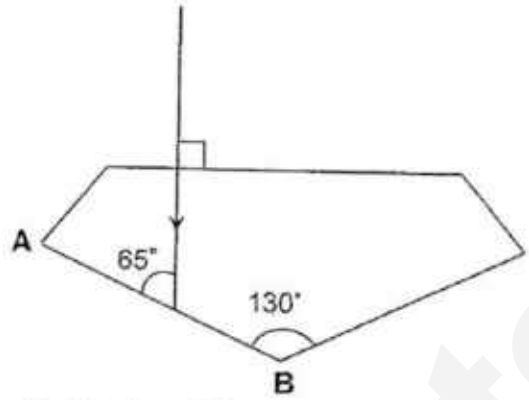


a. Each pile of newspaper has a mass of 5 kg. Calculate the amount of work needed to vertically lift 3 piles of newspaper onto the trolley a pile at the same time.

[2]

Work done = F x d	
Work done = 3 x (50 x 0.1)	A[1]
Work done = 15 J	A[1]

5. The figure below shows a cross-section of a piece of glass which has a refractive index of 1.60. A ray of light is incident normally at the top surface as shown.



a. Find the angle of refraction of the ray at the boundary AB

[2]

$n_i \sin i = n_r \sin r$	
$1.6 \times \sin 25 = 1.00 \times \sin r$	A[1]
$\sin r = 0.6762$	
$r = 42.5°$	A[1]

b. A piece of diamond of refractive index 2.40 is cut to have the same shape as the glass in the figure. Explain briefly why the diamond seems to 'glow' whereas the glass piece does not when light falls on it.

[2]

When the refractive index is higher, the critical angle will be reduced as shown in the calculation.	A[1/2]
$\sin c = 1 \div n$ $\sin c = 1 \div 2.4$ $c = 24.6°$	A[1/2]
With a smaller critical angle, it is more likely for the light rays to undergo total internal reflection and be refracted back into air at the top surface of the diamond.	A[1]

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6. Microwaves are waves in the electromagnetic spectrum.

a. State the name of the waves in the part of the electromagnetic spectrum that have wavelengths longer than microwaves.

[1]

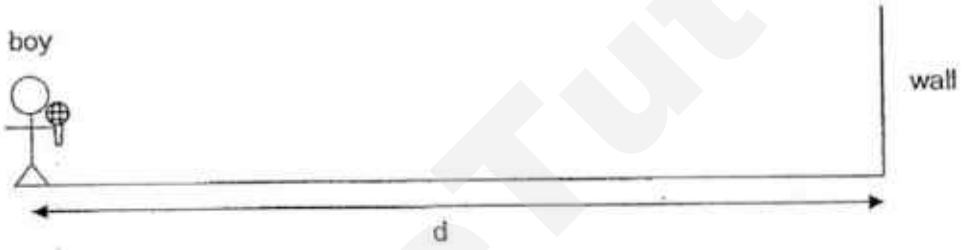
Radiowaves	A[1]

b. Explain why the frequency of these waves is lower than the frequency of microwaves.

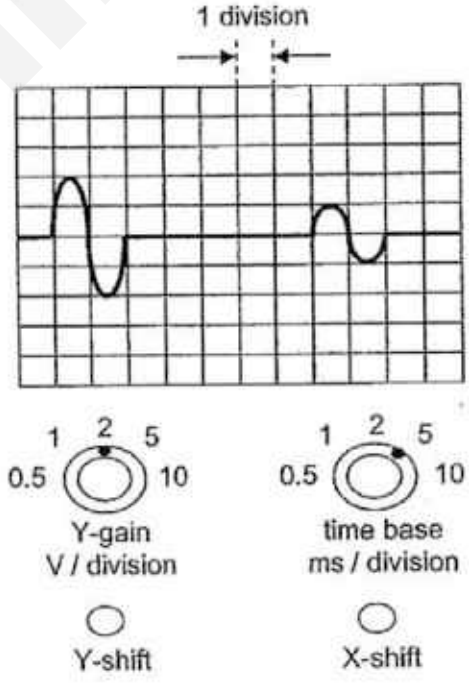
[1]

As all the waves in the electromagnetic spectrum travel at the same speed in vacuum,	A[1/2]
The frequency is lower when the wavelength is larger according to the relationship $v = f\lambda$	A[1/2]

7. A boy, holding a microphone, is standing a distance d from a wall.



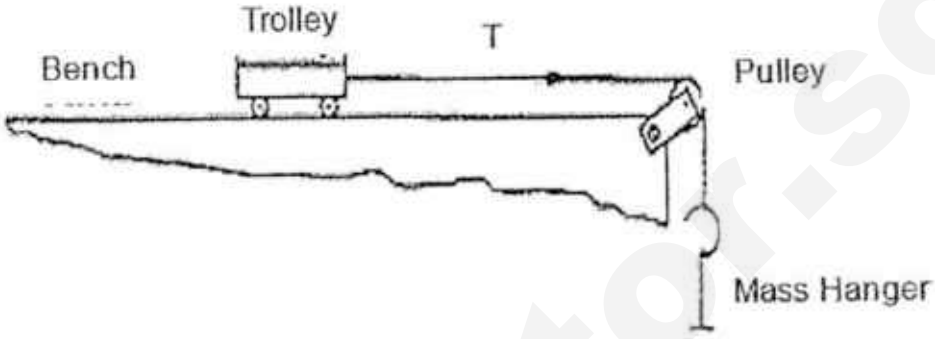
The microphone is connected to a cathode ray oscilloscope (C.R.O.) with four controls. When the boy claps once, the sound is received by the microphone and the audio signal is displayed on the C.R.O. as shown below.



Section C

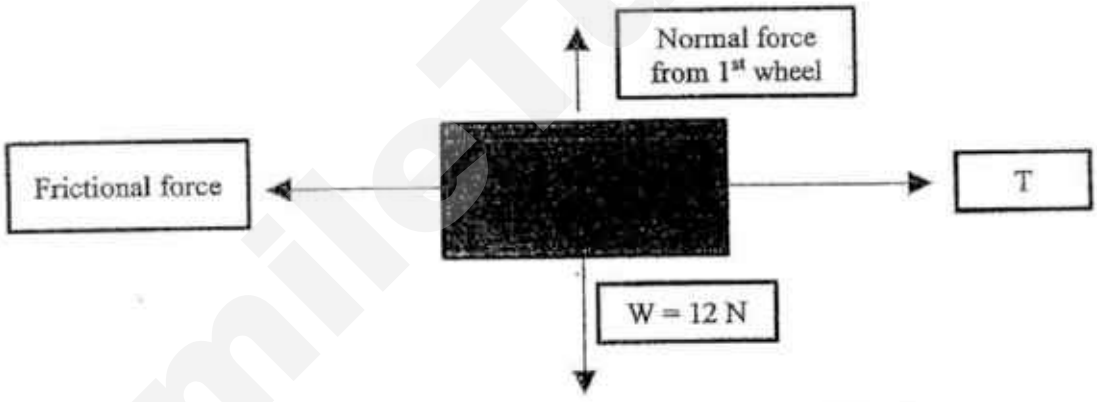
Answer **all** the questions in this section in the spaces provided.
Question 10 is in the form either/or
and only **one** of the alternatives should be attempted.
The total mark for this section is 30.

8. The figure shows a 1.2 kg trolley being pulled along a rough horizontal bench by means of tension T in the thread fastened to the trolley. The other end of the thread is attached to a mass-hanger of mass 200 g.



a. Draw in the space below, the free body diagram illustrating all the forces acting on the trolley.

[2]



A[1/2] for each correct force drawn
-½ m if no label of force
-½ m if no value for weight

b. The frictional force between the wheels of the trolley and the surface of the bench is 0.5 N. Calculate the acceleration of the trolley.

[3]

F – frictional force = ma	
0.2 x 10 – 0.5 = 1.2 x a	A[1]
a = 1.25 m/s^2	A[1]

c. From your answer in (a) and (b), describe in detail, the motion of the trolley.

[2]

Since there is a resultant force acting on the trolley, the system is not balanced.	A[1/2]
In accordance to Newton's 2nd law, the trolley will experience an acceleration.	A[1/2]
The speed of the trolley will increase at 1.25 m/s for each second.	A[1]

d. Suggest a way in which the friction between the wheels and the bench can be reduced.

[1]

Use lubricants or oil	Any 1 of thee suggested answers.
Use material of lower friction for the wheel and the ground	
Use roller, ball bearings or wheels – not accepted	

e. The trolley is loaded with sand. Compare the change in speed of the loaded and unloaded trolley.

[2]

The mass of the trolley is now increased.	A[1/2]
With the same resultant force experienced by the trolley, the value of the acceleration will be reduced for the loaded trolley	A[1/2]
This is in accordance to the relationship, F = ma	A[1/2]
Thus the velocity of the loaded trolley will be lower than that of the unloaded trolley.	A[1/2]

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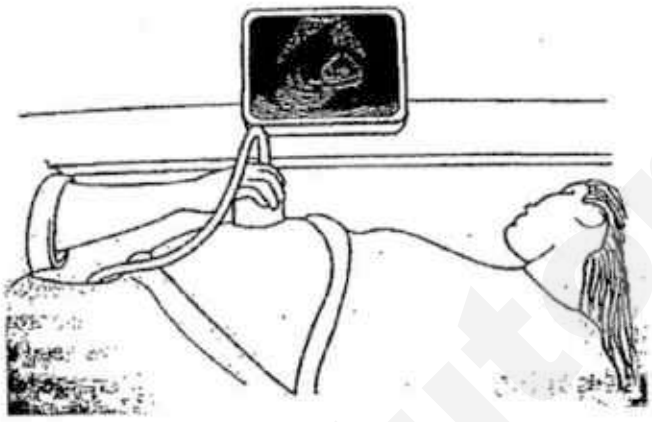
9. Ultrasound is a type of high frequency sound used in medical diagnosis. Important information about the internal structures of the body can be obtained by using a detector to analyse the reflections from the internal structures.



The figure above shows an ultrasonic scanner used to monitor the development of the baby of a pregnant woman. As an ultrasonic wave travel through the body tissues, energy is lost (attenuated) and the amplitude and intensity of the ultrasonic wave reduces.

Attenuation is measured in decibels per centimetre (dBcm-1) of tissue and is represented by the attenuation coefficient of the specific tissue type. The higher the attenuation coefficient, the more attenuated the ultrasonic wave is by the specified tissue.

Attenuation is an important concept as it limits the depth of the image that can be obtained via ultrasound.

The table below shows the attenuation coefficients and speeds of ultrasonic waves, transmitted at 1 MHz, through different body tissues.

body tissue	attenuation coefficient / $dBcm^{-1}$	speed / ms^{-1}
water	0.002	1484
fat	0.63	1450
liver	0.5 - 0.94	1570
bone	5.0	4080

Sources: http://usra.ca/tissue.php & https://wiki.engr.illinois.edu

a. Describe how ultrasonic waves are transmitted from the scanner, through the body tissues, to the baby of the pregnant woman.

[2]

Waves are caused by vibration of the particles.	A[1/2]
Ultrasonic waves are longitudinal waves.	A[1/2]
As the ultrasonic waves travel through tissues, they will caused the tissue particles to vibrate parallel to the direction of the wave motion.	A[1]

b. Describe one difference between an ultrasound and electromagnetic waves.

[1]

Ultrasonic waves are longitudinal while electromagnetic waves are transverse.	A[1]

c. By studying the values in table, estimate the attenuation coefficient of human blood for an ultrasonic wave transmitted at 1 MHz

[1]

Since blood is thicker than water, the attenuation coefficient is between 0.002 and 0.63 $dBcm^{-1}$.	A[1]

d. Describe **two** properties of sound waves that contribute to the attenuation of ultrasonic waves in body tissues.

[2]

Ultrasonic waves can be reflected by the body tissues into the original medium upon incidence.	A[1]
Ultrasonic waves can undergo absorption as they travel through soft tissue. The particles vibrate and cause friction and a loss of sound energy occurs and heat is produced	A[1]

e. Explain why ultrasound is often not used in the medical diagnosis of bones in the body.

[2]

Ultrasonic waves may not be strong enough to penetrate the bones to give detailed images for diagnosis purposes.	A[1]
The reflected waves may be too weak to be detected.	A[1]

f. Calculate the wavelength of ultrasonic waves in the fat of the body of the pregnant woman.

[2]

$v = f\lambda$	
$1450 = (1/1\ 000\ 000) \times \lambda$	A[1]
$\lambda = 1.45 \times 10^{9}$ m	A[1]

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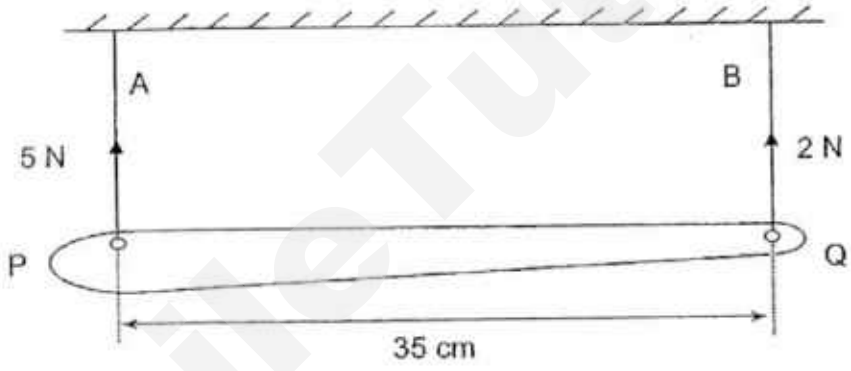
10. Either

a. State what is meant by the moment of a force and state how it can be calculated. [2]

Moment of a force refers to the product of the ***force*** and the ***perpendicular distance*** measured from ***the pivot to the line of application of the force.***	A[1]
M = F x d	A[1]

b. The figure shows a non-uniform rod PQ of length 35 cm attached to two strings A and B of equal length. The tension in string A is 5 N and that in string B is 2 N.

Determine the following:



i. the weight of PQ, [1]

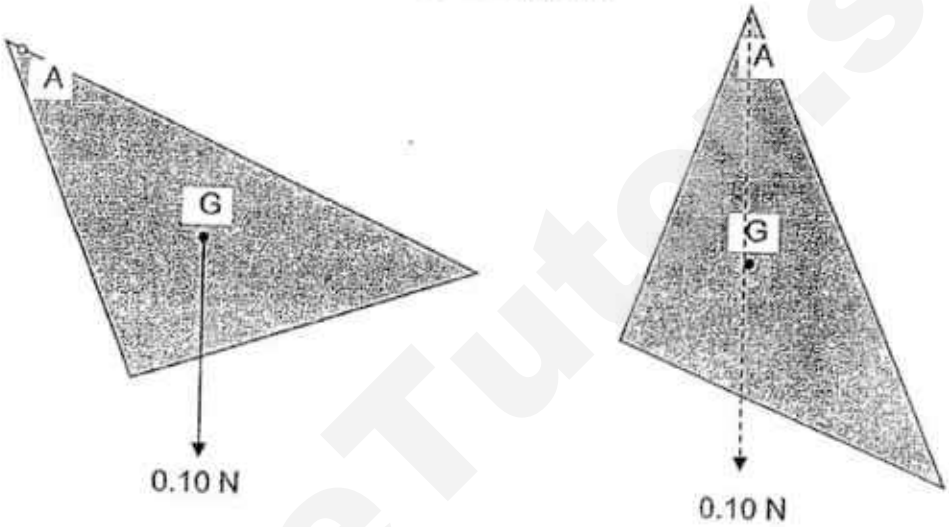
Upward force = Downward force	
W = 5 + 2	
W = 7 N	A[1]

ii. the position of the centre of gravity of PQ from the end P. [2]

CW moments = anti-CW moments	
7 x dist = 2 x 35	A[1]
Dist = 10 cm away from P	A[1]

c. The figure below shows a sheet of metal suspended from a hole in one corner at A. The weight of the metal is 0.10 N and the centre of gravity is at G. The metal sheet swings freely and comes to rest.

i. In the space next to given figure, sketch a diagram of the sheet in its final rest position. Mark points A and G on your diagram.



ii. Explain why the sheet remains at rest in this position.

[2]

At the rest position, the weight will act through the pivot.	A[1]
There is no perpendicular distance between the pivot and the force, thus no moment is created.	A[1]

d. The metal sheet is placed on a table. State **two** reasons why it is more stable when it is placed flat on the table than when it is placed on the table in a vertical position.

[2]

The CG will be lower.	A[1]
The base area will be wider.	A[1]

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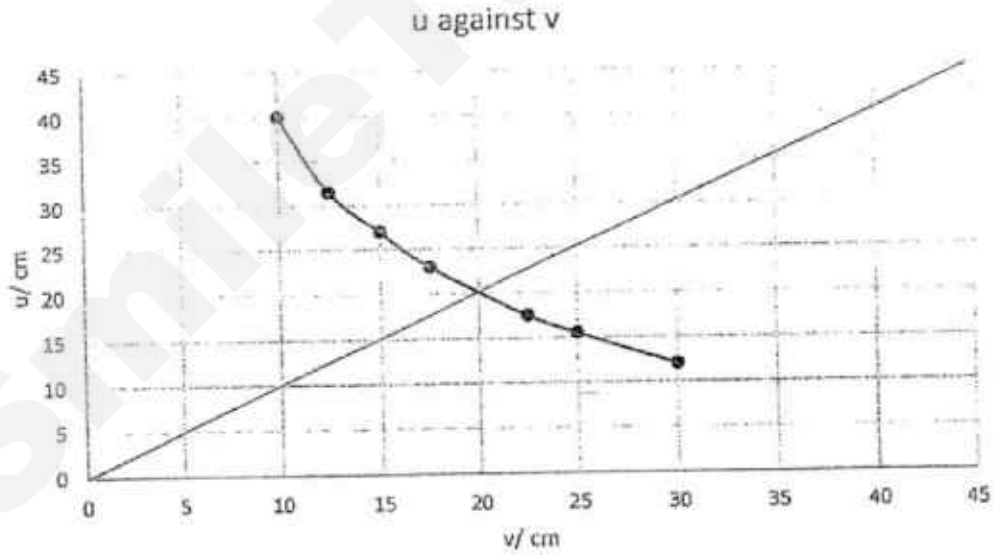
Or

a. In an experiment to find the focal length of a convex lens, the following readings were obtained.

Distance of object from lens, u/cm	40.0	31.5	27.0	23.0	17.5	15.5	12.0
Distance of image from lens, v/cm	10.0	12.5	15.0	17.5	22.5	25.0	30.0

i. Using a scale of 1.0 cm to 2.5 cm for both axes, plot a graph of u/cm against v/cm on the graph paper provided.

[3]



All points correctly plotted	A[1]
Smooth curve drawn	A[1]
Both axes labelled correctly	A[1]

ii. Use the graph to find the value of u and v when they are equal by drawing the line u= v.

[1]

value of u = _____ cm

value of v = _____ cm

value of u = 20 cm	A[1/2]
value of v = 20 cm	A[1/2]

iii. Using the relationship,

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

hence determine the focal length of the lens

[2]

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$	
$\frac{1}{f} = \frac{1}{20} + \frac{1}{20}$	A[1]
f = 10 cm	A[1]

b. In what way(s) are the images formed by a camera and a slide projector similar and in what way(s) are they different?

[2]

Similar – Real and Inverted	A[1/2] each
Difference – Size of image	A[1]

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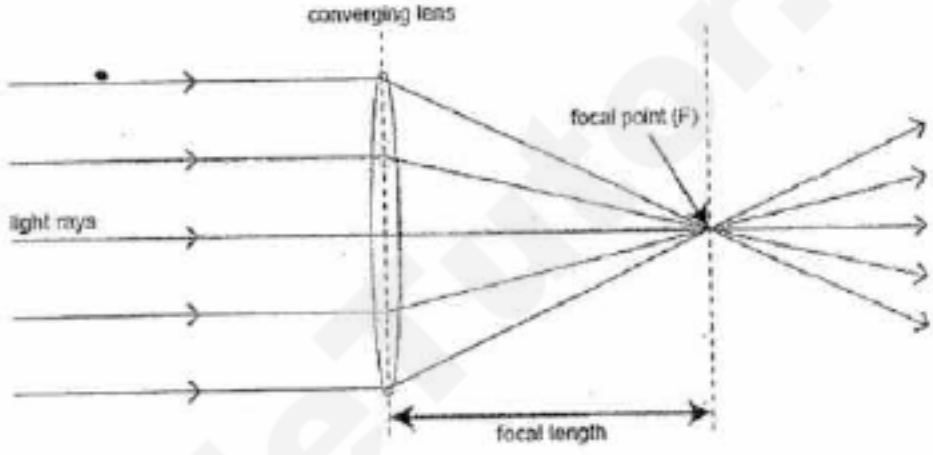
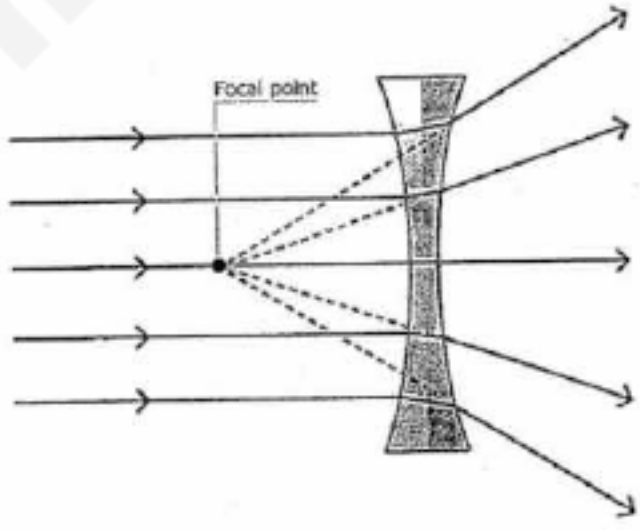
c. It is possible for parallel incident rays to either converge to a point or appear to be diverging from a point by action of a piece of lens.

i. Draw ray diagram to illustrate the action on parallel incident rays by a converging lens. [1]



ii. Draw ray diagram to illustrate the action on parallel incident rays by a diverging lens. [1]



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