Paper 1: [40 marks]
Answer all the questions in the OTAS Answer Sheet provided.

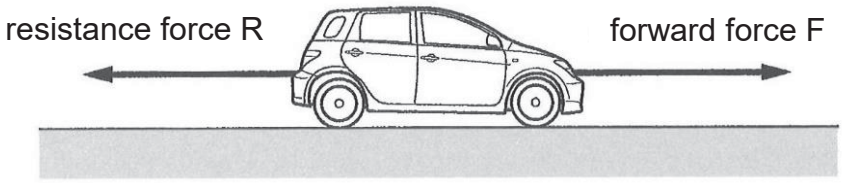
1 The diameter of the Earth is about 10 Mm while the diameter of an atom is about 0.5 nm.
Which row gives the correct values in standard form and SI unit?

	diameter of Earth / m	diameter of atom / m
A	10×10^{6}	0.5×10^{-9}
B	10×10^{9}	0.5×10^{-6}
C	1×10^{7}	5×10^{-8}
D	1×10^{7}	5×10^{-10}

2 Which cannot be used to calculate the total distance travelled by a car?

A area under a speed-time graph
B difference in distance between the start point and end point in a distance-time graph
C change in speed ÷ time taken
D average speed multiplied by total time taken

3 A car is moving forward. Two forces act on the car as shown.



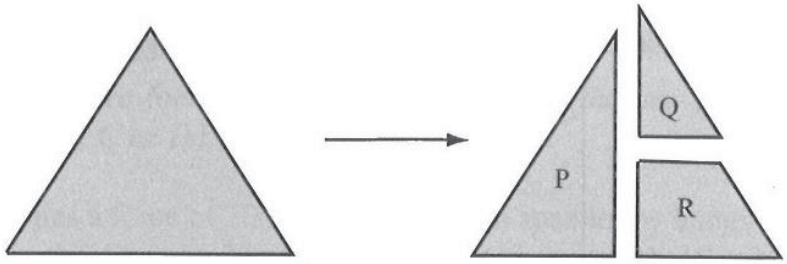
When the car is moving with uniform velocity, which statement is correct?

A The forward force F is greater than the resistance force R.
B The resultant of the forward force F and resistance force R is zero.
C There is lesser resistance force R acting on the car.
D The car will continue to move with uniform velocity when the resistance force R is removed.

4 Each tyre of a four-wheeled toy car exerts a pressure of 6.2 N / cm^2 on the ground. The area of each tyre in contact with the ground is 5 cm^2.
What is the total force exerted by the toy car on the ground?

A 1.24 N
B 4.96 N
C 31 N
D 124 N

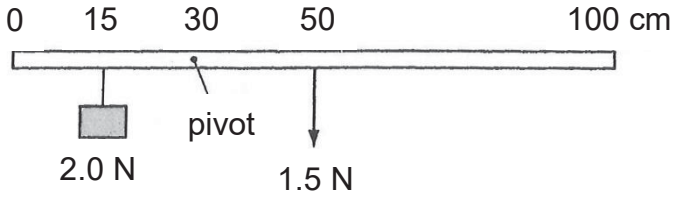
5 A solid triangle made of copper is cut into three pieces, P, Q and R.



Which piece has the greatest density?

A all pieces have the same density
B pieces P and R only
C piece P only
D piece Q only

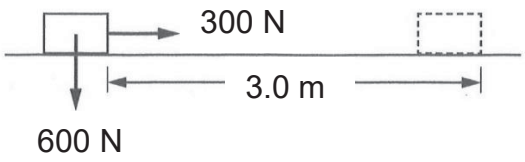
6 A uniform metre rule, which weighs 1.5 N, is pivoted on a horizontal nail through a hole at the 30 cm mark. A 2.0 N weight is hung at the 15 cm mark.



What is the resultant moment about the pivot?

	resultant moment / Nm	direction
A	0.30	anti-clockwise
B	0.60	clockwise
C	0.75	clockwise
D	0	-

7 When a 300 N force is applied to a box weighing 600 N, the box moves 3.0 m horizontally in 12 s.



What is the average power used when the box is moved?

A 75 W
B 150 W
C 900 W
D 1800 W

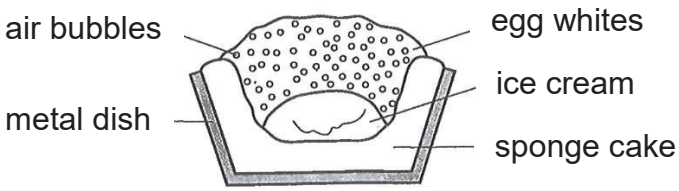
8 Which appliance converts electrical energy to mainly thermal energy?

A radio
B washing machine
C hair dryer
D television

9 Which statement about solids, liquids and gases is correct?

A In a solid, particles move slowly at random directions.
B In a liquid, particles slide against each other.
C In a gas, particles are slightly further apart compared to solid.
D In a solid, particles are spaced very far apart.

10 A chef makes the pudding “baked Alaska”.



The pudding is placed in a very hot oven until the top of the egg whites turns brown. It is then removed from the oven.
Why does the ice cream stay cold?

A The metal dish is a good conductor of heat and conducts the heat away from the ice cream.
B The metal dish is a poor conductor of heat and prevents the heat from reaching the ice cream.
C Air is a poor conductor of heat and prevents the heat from reaching the ice cream.
D Air is a good conductor of heat and conducts the heat away from the ice cream.

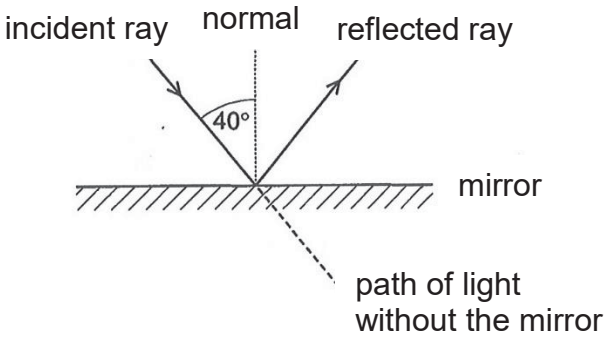
11 Which surface will allow a body to lose thermal energy by radiation more efficiently?

	colour	texture
A	white	smooth
B	white	rough
C	black	smooth
D	black	rough

12 An object is placed in front of a thin converging lens at a distance more than twice the focal length of the lens.
Which is the correct description of the image formed?

A real, inverted and diminished
B real, inverted and same size as the object
C real, inverted and magnified
D upright, virtual and magnified

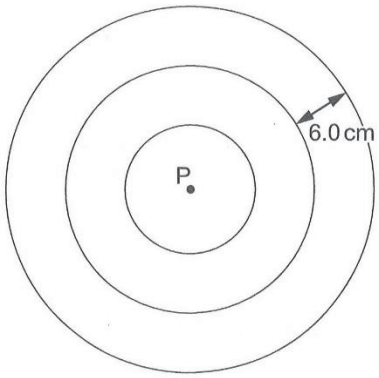
13 A mirror is placed in the path of a ray of light.



Through which angle does the direction of the ray of light change?

A 40° **B** 80°
C 100° **D** 140°

14 In a ripple tank, a dipper moves up and down at point P.



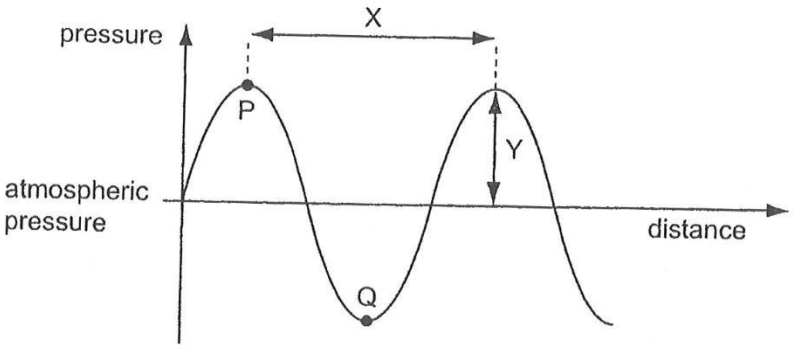
In 5.0 s, three wave crests are produced on the water surface as shown above. The distance between consecutive wave crests is 6.0 cm.
What is the frequency and period of the wave?

	frequency / Hz	period / s
A	0.6	1.67
B	0.6	3.6
C	1.67	0.6
D	1.67	10

15 Ultraviolet radiation is one type of electromagnetic radiation.
Which row is correct for ultraviolet radiation?

	type of wave	speed of wave in vacuum / ms^{-1}
A	transverse	330
B	transverse	3×10^8
C	longitudinal	330
D	longitudinal	3×10^8

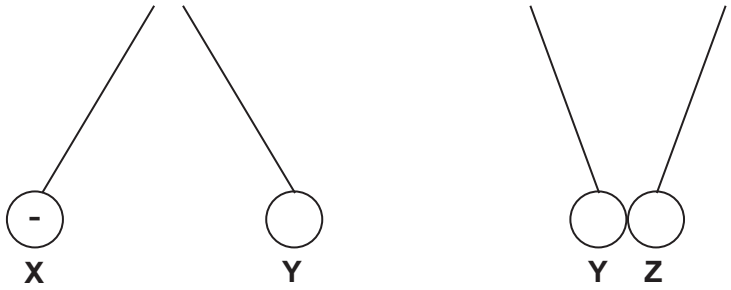
16 The graph below shows, at one instant, the pressure variation along a sound wave.



Which point on the graph represents a compression and which distance represents a wavelength of the sound wave?

	compression	wavelength
A	P	Y
B	P	X
C	Q	Y
D	Q	X

17 Three balls, X, Y and Z are suspended by insulating threads. Ball X is negatively charged.



What are the charges on **Y** and **Z**?

	Y	**Z**
A	positive	neutral
B	positive	negative
C	negative	neutral
D	negative	negative

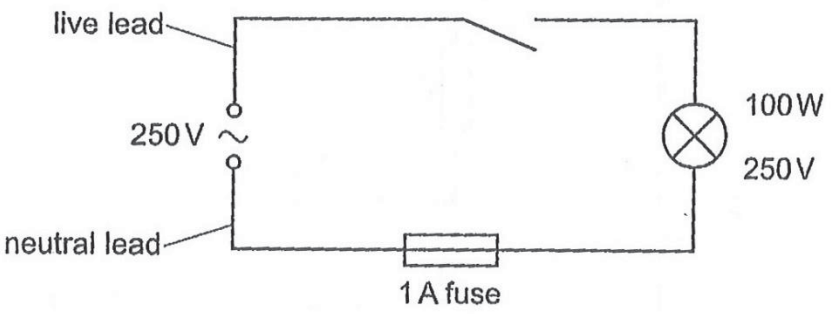
18 A resistor with resistance R is made from a length L of resistance wire with a cross-sectional area A.
A second resistor, made from the same material, has a length of 4L and a cross sectional area of A/2.
What is the resistance of the second resistor?

A 2 **B** 8
C 2R **D** 8R

19 Three 5 Ω resistors can be connected together in series and parallel in different ways.
Which effective resistance could **not** be obtained from different combinations of these resistors?

A 1.5 Ω **B** 1.67 Ω
C 7.5 Ω **D** 15 Ω

20 A student suggests setting up the circuit as shown below.



Why is this circuit unsafe?

A The fuse rating is too small.
B The fuse is connected to the wrong lead.
C The lamp's power is too small.
D The switch is connected to the wrong lead.

Section A

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

1 When a car driver sees an emergency ahead while driving on a level road, he applies the brakes. Fig.1.1 shows the speed-time graph of the car. The combined mass of the car and the driver is 620 kg.

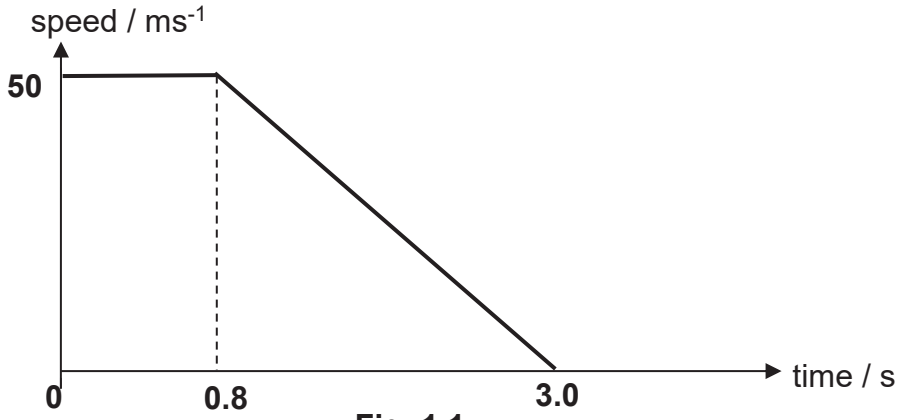


Fig. 1.1

(a) From the graph, what is the reaction time of the driver? Explain your answer.

……

……

…….. [2]

(b) Calculate the total distance travelled by the car.

total distance = …….. m [2]

(c) Calculate the deceleration of the car during braking.

deceleration = …….. m/s^2 [2]

2 Fig. 2.1 shows a stone being supported by two strings that hang from a rod. The tensions in the two strings are 1.3 N and 2.0 N.

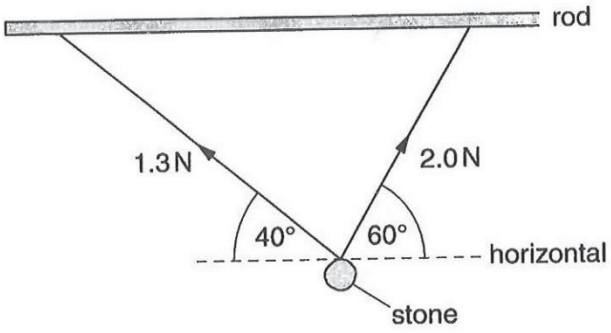


Fig. 2.1

(a) In the space below, draw a vector diagram to determine the resultant of the two tensions.

scale: ……. represents …… [1]

resultant force = …….. N [3]

(b) What is the weight of the stone?

weight of stone = …….. N [1]

3 Fig. 3.1 shows a large metal washer of mass 6.5 g.
The washer is 0.15 cm thick. The internal and external diameters are marked as shown.
[Take the value of π to be 3.142.]

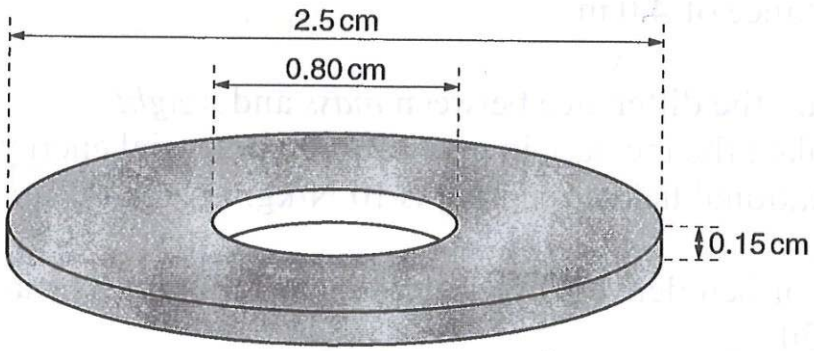


Fig. 3.1

(a) Calculate the volume of metal in the washer.

volume of metal = _____ cm^3 [2]

(b) Calculate the density of the metal.

density of metal = _____ g / cm^3 [2]

(c) What is the density of the metal in kg / m^3?

density of metal = _____ kg / m^3 [1]

4 A uniform rod of length 1.6 m is supported by two strings R and S. The rod has a weight of 180 N which acts at the centre of the rod. String S is at one end of the rod while string R is 0.40 m from the other end as shown Fig. 4.1.

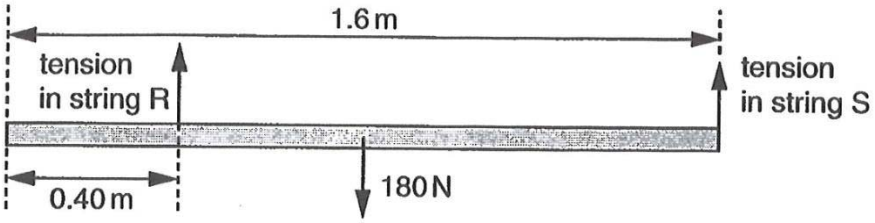


Fig. 4.1

(a) By taking moments about string S,

(i) what is the moment due to the tension in string S? Explain your answer.

.....

.....

..... [2]

(ii) calculate the tension in string R.

tension in string R = ... N [2]

(b) By taking moments about string R, calculate the tension in string S.

tension in string R = ... N [2]

(c) From the calculations in **(a)(ii)** and **(b)**, what is the relationship between the tensions in strings R and S with the weight of the rod?

.....

..... [1]

5 A pure substance has a boiling point of 70 °C. The substance is heated from 30 °C until the temperature is 90 °C.

(a) On Fig. 5.1, sketch a graph to show how the temperature of the substance changes with time as it is heated from 30 °C to 90 °C. [2]

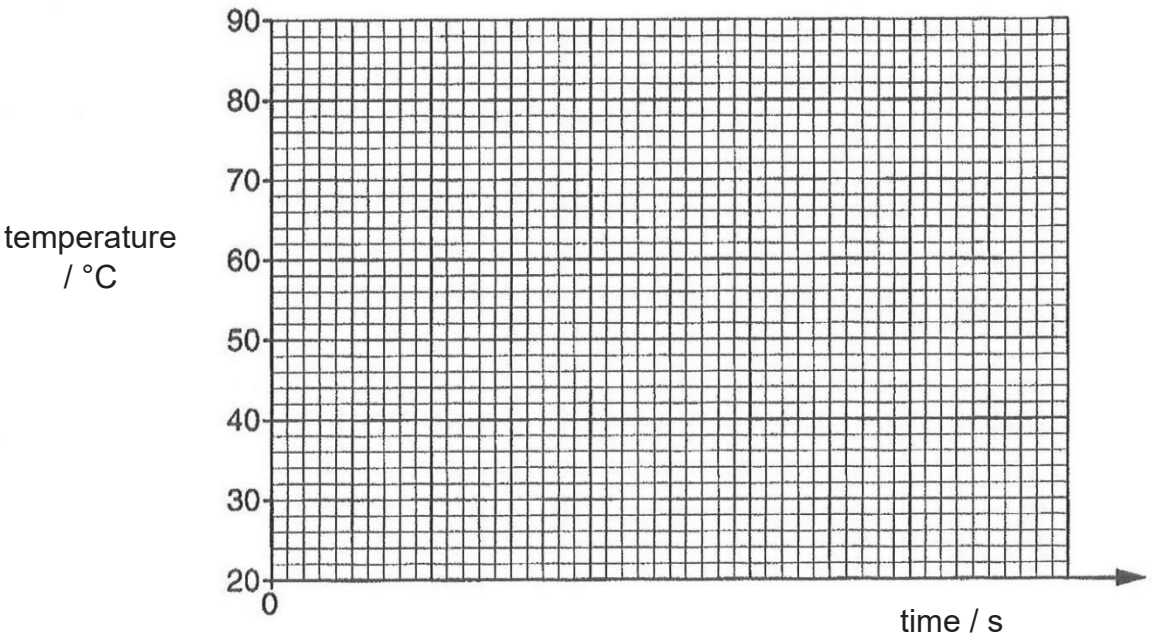


Fig. 5.1

(b) State the condensation point of the substance.

…….. [1]

(c) Describe the **changes** that occur to the arrangement and motion of the molecules when the substance boils at 70 °C.

(i) changes in arrangement:

……

……

…….. [2]

(ii) changes in motion:

……

……

…….. [2]

6 Fig. 6.1 shows circular wavefronts produced at the centre of a circular ripple tank.

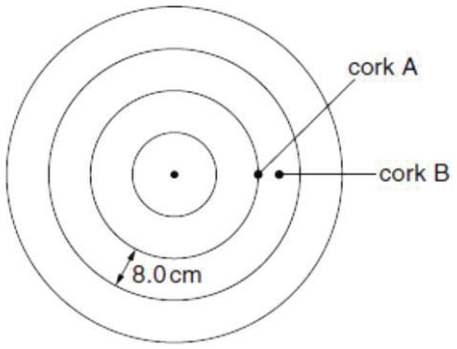


Fig. 6.1

Two corks, A and B, float on the water in the ripple tank. They move up and down on the surface of the water as the wave passes. The wavelength of the wave is 8.0 cm.

Fig. 6.2 shows how the displacement of A varies with time.

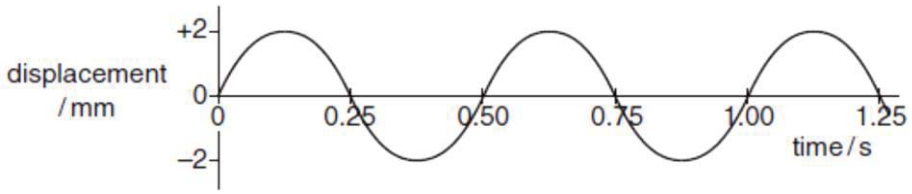


Fig. 6.2

(a) Define what is meant by wavefront.

……

…… [1]

(b) Using the graph above,

(i) determine the frequency of the wave.

frequency = …….. Hz [1]

(ii) calculate the speed of the wave.

speed = …….. cm / s [2]

(c) The horizontal distance between corks A and B is half the wavelength of the wave.

On Fig. 6.2, add another graph to show how the displacement of B varies with time. [1]

7 Fig. 7.1 shows rays of light travelling from a light source O, in water.

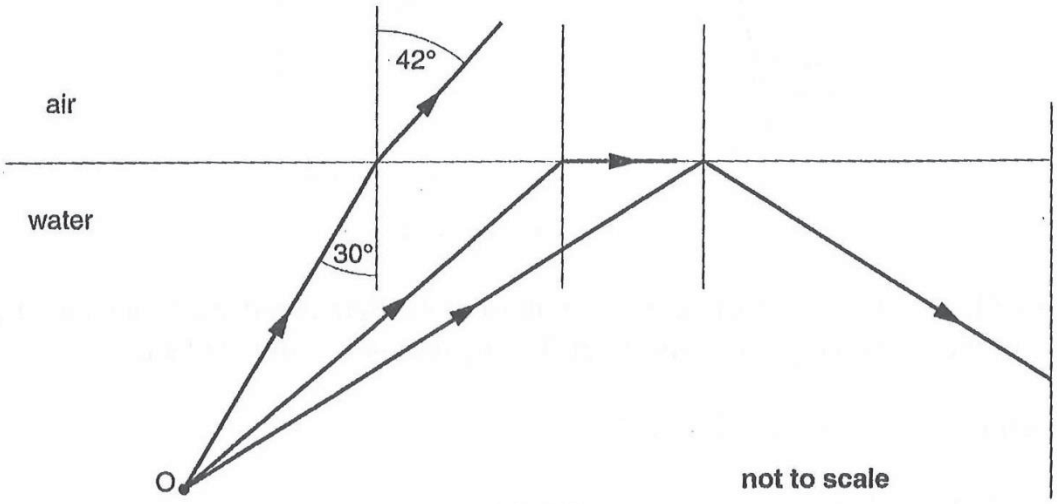


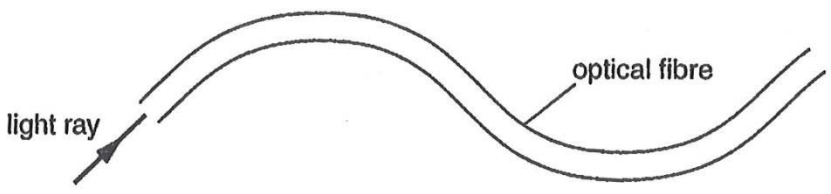
Fig. 7.1

(a) On Fig. 7.1, mark the critical angle and label it as C. [1]

(b) Using the information from Fig. 7.1, calculate the refractive index of water.

refractive index = …….. [2]

(c) Optical fibres are used in telecommunication using light rays as shown below.



Explain why the light does **not** escape from the sides of the optical fibre.

……..

……..

…… [2]

8 Fig. 8.1 shows a table which gives information about two household appliances.

appliance	mains supply voltage / V	current through appliance / A	power / W	time used per day / h	energy used per day / kWh
television	240	1.20	288	2.50	0.720
water heater	240	12.6		0.50	

Fig. 8.1

(a) Fill in the missing values in the empty spaces in Fig. 8.1. [2]
You may use the space below for your calculations.

(b) Calculate the cost of using the television for 30 days if a unit of electrical energy costs 18 cents.

cost of electrical energy = $ ……. [1]

(c) The water heater is connected to the mains supply.
Explain why using a 3 A fuse would not be suitable.

……

……

…… [2]

Section B

Answer any **two** questions in the spaces provided.

9 Fig. 9.1 shows a student standing midway between a bell tower and a steep mountainside.

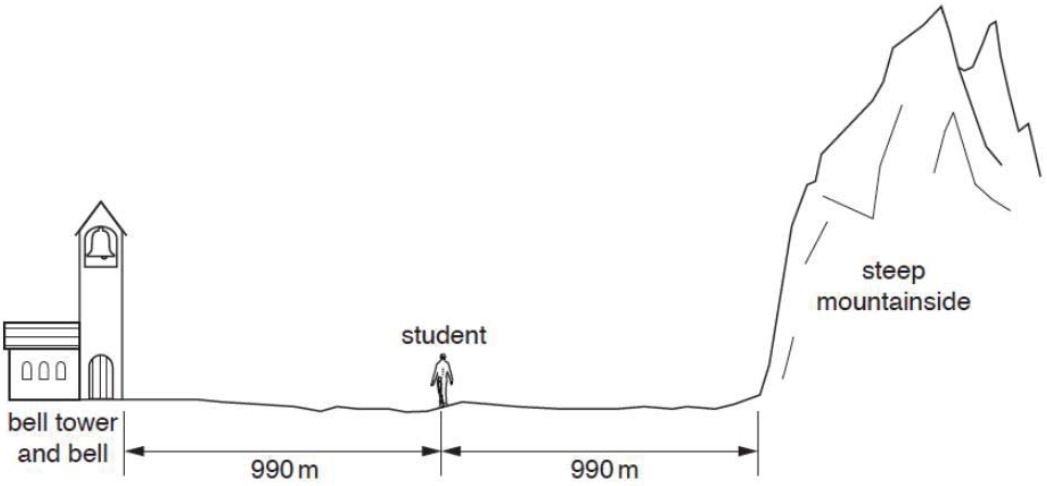


Fig. 9.1

(a) The bell rings once but the student hears two rings separated by a short time interval.
Explain why the student hears two rings.

……

……

…… [2]

(b) Given that sound travels at 330 m / s in air, calculate the time interval between the two rings.

time interval = …….. [3]

(c) Fig. 9.2 shows the displacement–time graph of the waveform of the note from the bell.

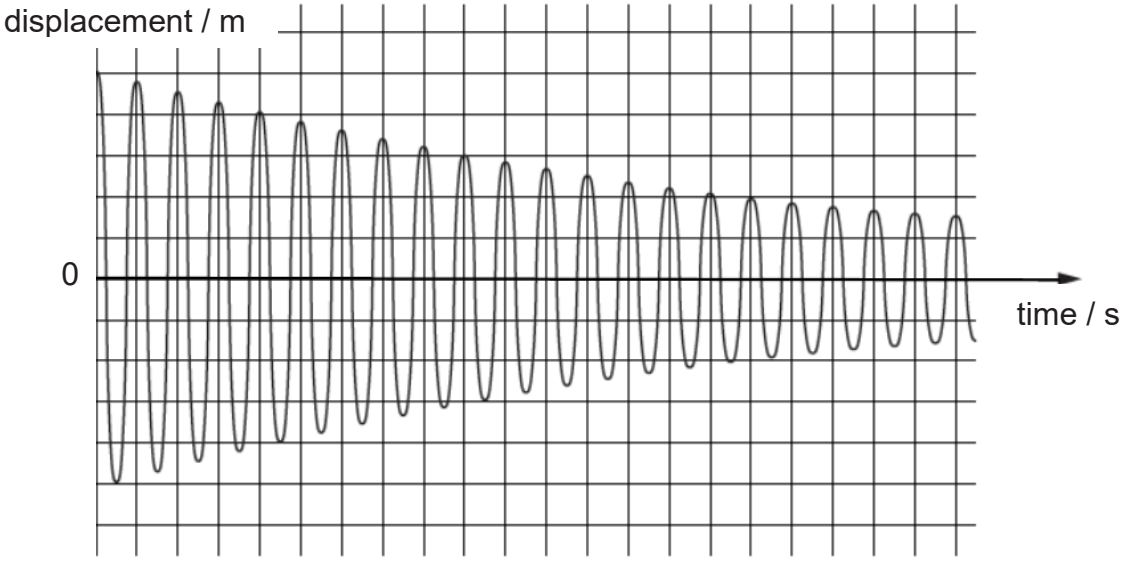


Fig. 9.2

(i) State and explain what is happening to the loudness of the note.

……

……

…… [2]

(ii) Given that the frequency of the note is 250 Hz, calculate the time taken for the amplitude to decrease to half its initial value.

time taken = …….. [3]

10 Fig. 10.1 shows an electrostatic precipitator that stops dust and ash from emerging through the chimney.

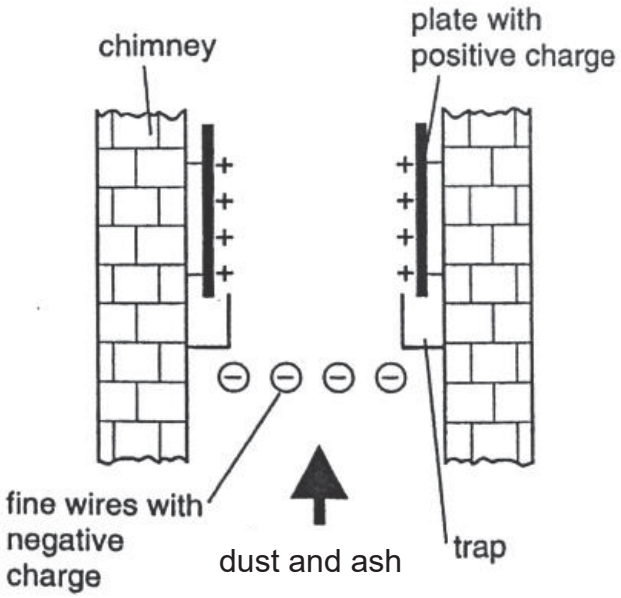


Fig. 10.1

(a)(i) Define ***electric field***.

……

…….. [1]

(ii) On Fig. 10.2, draw the electric field lines of a positively charged particle. [1]

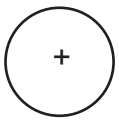


Fig. 10.2

(iii) Describe how the electrostatic precipitator removes hot ash and dust particles after it passes through the fine wires.

……...

……...

……...

…… [3]

(b) Fig. 10.3 shows a circuit connected with four resistors P, Q, R, S and a battery of electromotive force of 6 V.

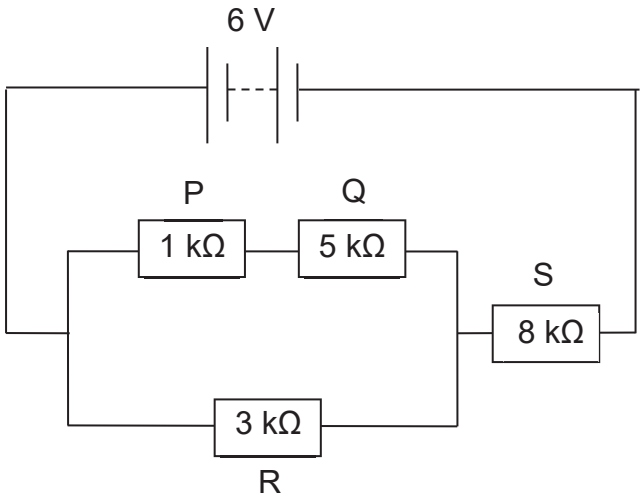


Fig. 10.3

(i) Show that the total resistance of the circuit is 10 kΩ. [1]

(ii) Calculate the current flowing through the battery.

current = …….. [2]

(iii) Calculate the current flowing through the 5 kΩ resistor.

current = …….. [2]

11 Fig. 11.1 shows a 'G-machine'. The G-machine is used in astronaut training. The G-machine moves the astronaut in a horizontal circle.

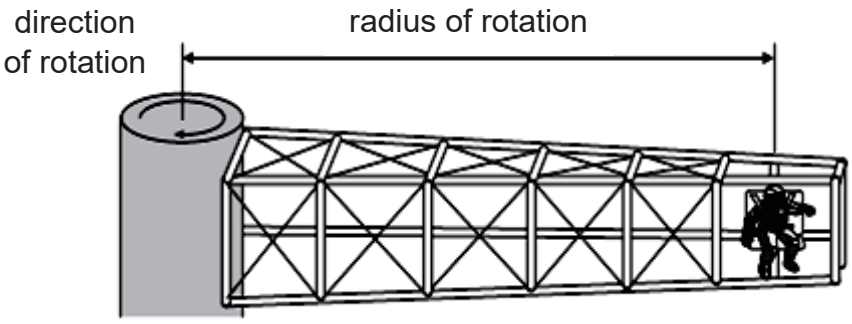


Fig. 11.1

(a) When the G-machine is rotating at a constant speed, the astronaut is accelerating.
Explain why the astronaut is accelerating when he is rotating at a constant speed.

……...

…… [1]

(b) The force causing the astronaut to move in a circle is measured.
Fig. 11.2 shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

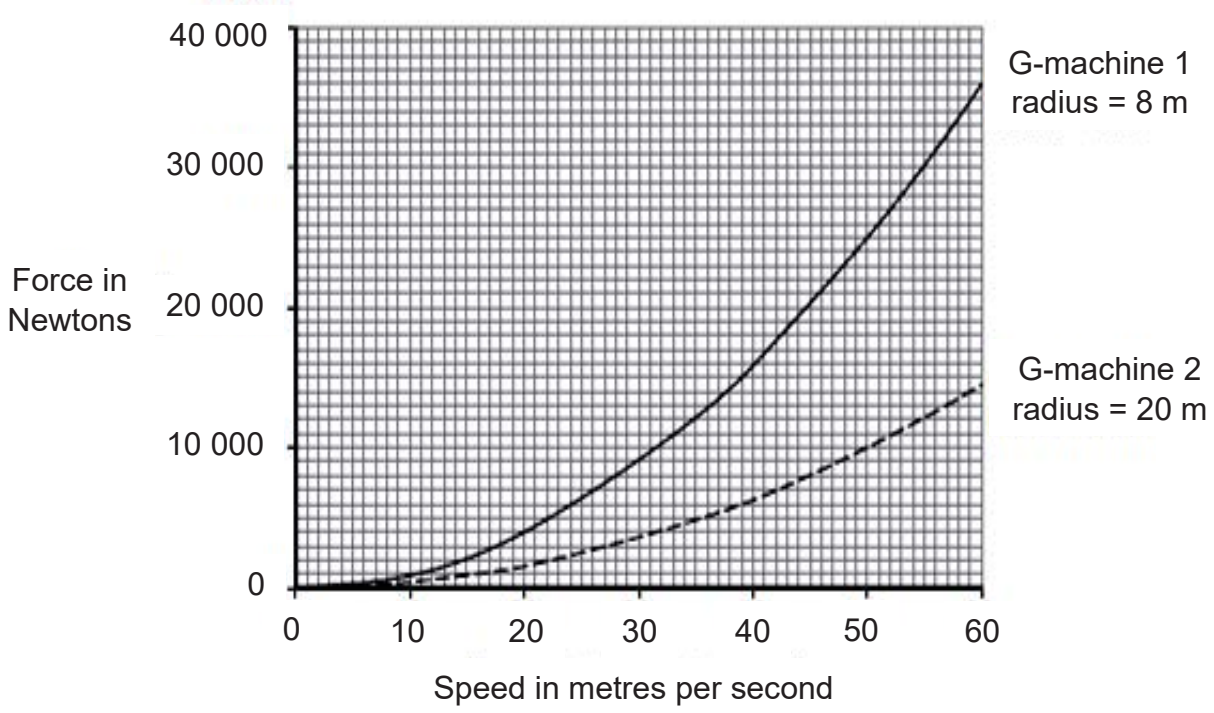


Fig. 11.2

The radius of rotation of the astronaut is different for each G-machine.
State two observations that can be derived from the graph in Fig. 11.2.

……

……

…….. [2]

(c)(i) The speed of rotation of G-machine 1 is increased from 20 m / s to 40 m /s. Determine the change in force acting on the astronaut.
(Show your workings clearly on the graph).

change in force = …….. [2]

(ii) Calculate the work done, on the astronaut, by G-machine 1 when it is moving at a speed of 60 m / s, for 1 complete round.

work done on astronaut = …….. [3]

(iii) Calculate the kinetic energy of the astronaut if he is moving at a speed of 60 m / s and the mass of the astronaut is 90 kg.

kinetic energy of astronaut = …….. [2]

End of Paper 2