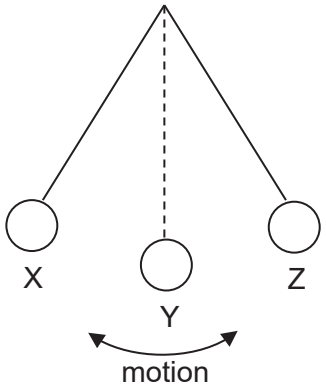
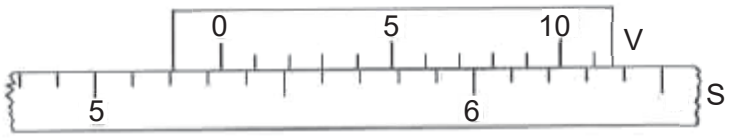
1 The diagram shows a simple pendulum. It swings between X and Z.



What sequence should be timed to measure the period of the pendulum?

A X → Y
B X → Z
C X → Z → Y
D X → Z → X

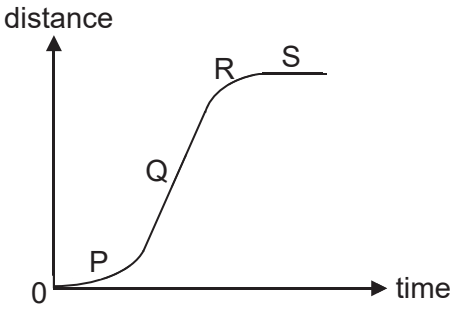
2 The diagram shows a vernier V placed against a scale S.



What is the vernier reading?

A 5.23cm
B 5.33cm
C 5.36cm
D 5.63cm

3 The graph shows how the distance travelled by a motorcycle changes with time.

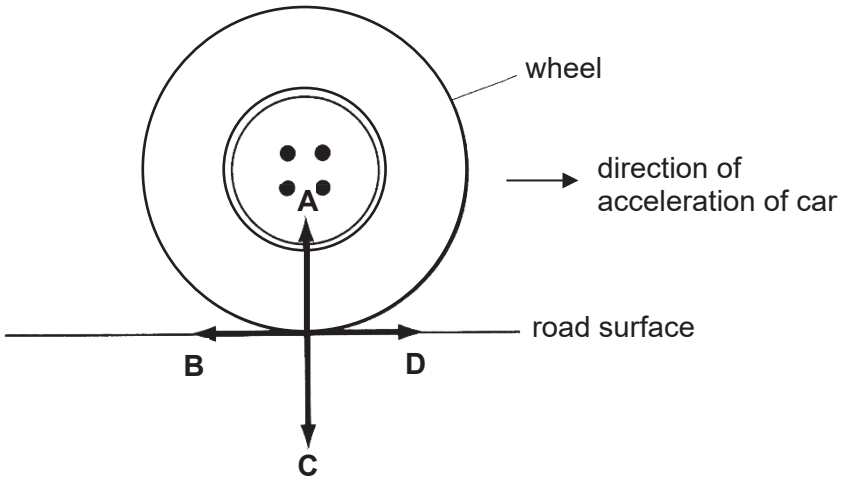


Which statement is correct?

A at P, the motorcycle is decelerating
B at Q, the motorcycle has constant acceleration
C at R, the motorcycle is slowing down
D at S, the motorcycle has constant speed

4 The wheel of a moving car is driven by the engine. The car is accelerating in the direction shown.

In which direction does the frictional force between the wheel and the road surface act?



5 An object with a mass of 15kg on the Earth is taken to Mars.

The gravitational field strength on the Earth is 10N/kg and on the Mars is 3.7N/kg.

What are the mass and weight of the object on the Mars?

	mass / kg	weight / N
A	15	56
B	15	150
C	41	15
D	41	150

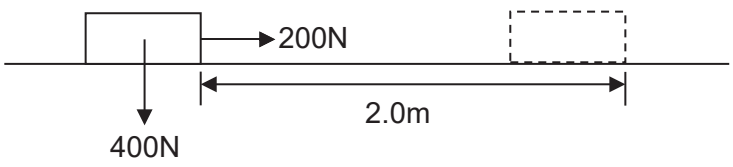
6 A chair weighing 50N stands on four legs, each having an area of contact of $0.0020m^2$.

What is the pressure of the chair on the floor?

A 6250Pa
B 10 000Pa
C 12 500Pa
D 25 000Pa

7 When a 200N force is applied to a box weighing 400N, the box moves 2.0m horizontally in 20s.

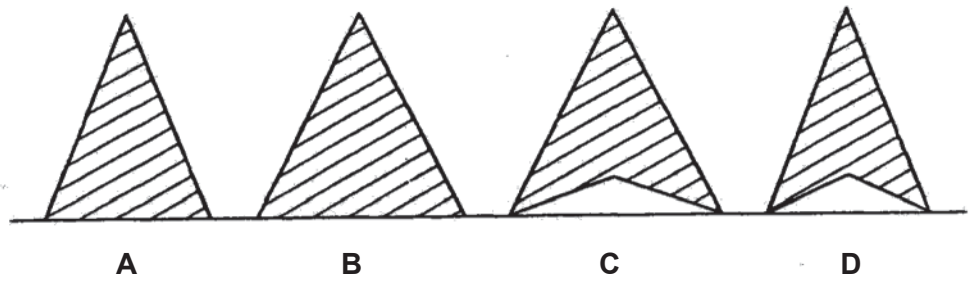
What is the average power?



A 20W
B 400W
C 60W
D 1200W

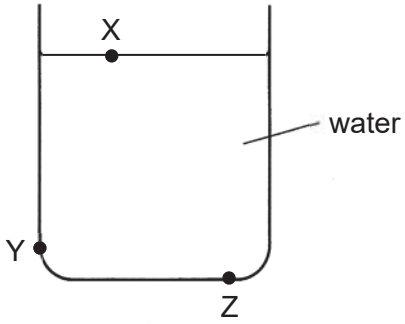
8 The diagrams show cross-sections of four solid objects.

Which object is the least stable?



9 A student has a large tank of water in which he wants to set up a convection current.

Which arrangement would **not** allow him to do this?



A cooling at X
B heating at X
C heating at Y
D heating at Z

10 A solid is heated.

Which statement is incorrect?

A The average distance between the molecules increases.
B The average speed of the molecules increases.
C The molecules expand.
D The molecules gain energy.

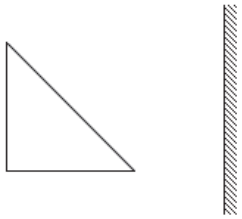
11 It takes 0.20s to generate one complete wave in a ripple tank.

The wavelength of each wave produced is 4.0cm.

What is the speed of the wave?

A 0.80cm/s
B 1.3cm/s
C 5.0cm/s
D 20cm/s

12 The diagram shows an object placed in front of a plane mirror.



Which diagram shows the correct mirror image of the object as seen in the plane mirror?

A **B** **C** **D**

13 A projector has a converging lens that projects an image from the visualiser onto a screen.

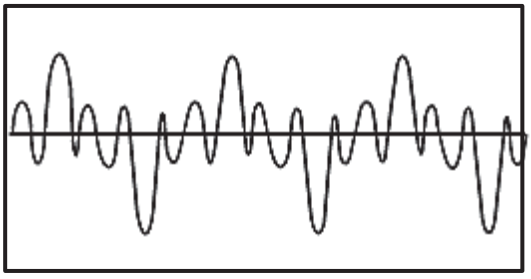
What type of image is produced?

A real, inverted, magnified
B real, upright, same size
C virtual, inverted, same size
D virtual, upright, magnified

14 Which of the following sets of electromagnetic waves have higher frequencies than visible light?

A Radio waves, infrared radiation, ultraviolet radiation
B Radio waves, microwaves, infrared radiation
C X-rays, gamma rays, ultraviolet radiation
D X-rays, microwaves, infrared radiation

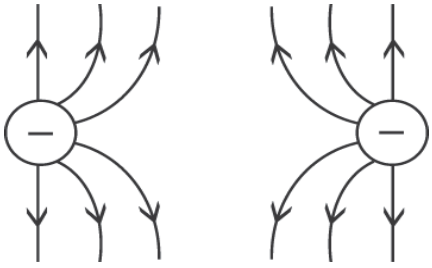
15 The diagram shows a cathode-ray oscilloscope trace for a note emitted by a guitar.



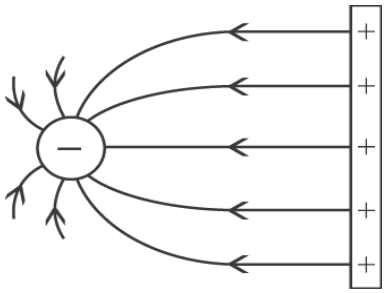
If the same note is played again, but softer, how will the trace change?

A The peaks will be closer together.
B The peaks will be further apart.
C The peaks will be higher.
D The peaks will be lower.

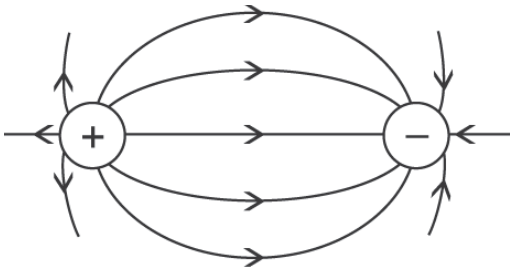
16 Which diagram shows the incorrect electric field lines between 2 charged objects?



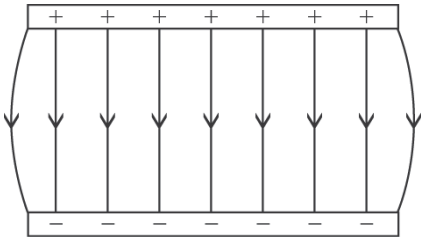
A



C



B



D

17 A 0.40m length of resistance wire with a cross-sectional area of 0.20mm^2 has a resistance of 2.0Ω.

Which wire of the same material will also have a resistance of 2.0Ω?

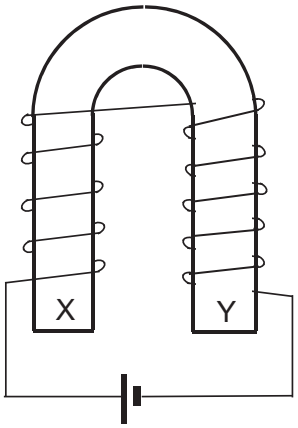
wire	length / m	area / mm^2
A	0.20	0.20
B	0.20	0.40
C	0.80	0.10
D	0.80	0.40

18 An electric oven is connected to the mains supply using insulated copper wires.
The wires become very warm.

What can be done to reduce the amount of heat produced in the insulated copper wires?

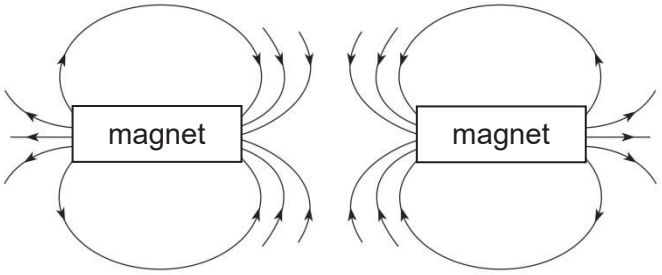
A use thicker copper wires
B use thicker insulation
C use thinner copper wires
D use thinner insulation

19 What are the poles of the electromagnet at X and Y?



	X	Y
A	North	North
B	North	South
C	South	North
D	South	South

20 The diagram shows the magnetic field pattern between two bar magnets.



Which two bar magnets produce this pattern?

A S N S N

B S N N S

C N S S N

D N S N S

Section A (45 marks)

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

1 Fig. 1.1 shows a stone supported by two strings. The tensions in the two strings are 3.0N and 4.0N.

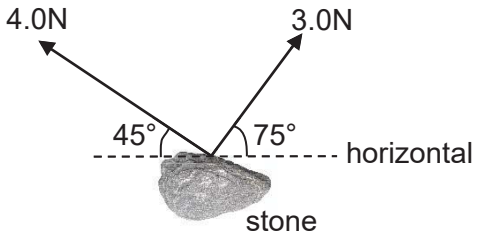


Fig. 1.1 (not to scale)

(a) In the space below, draw a labelled diagram to show the resultant of the two tensions. [2]

Determine the size and direction of the resultant force.

scale: ..... [1]

resultant force = ……N [1]

direction of resultant force = ... [1]

(b) State the weight of the stone.

weight = ...N [1]

2 A boy pulls a crate along a table with a force *P*, as shown in Fig. 2.1. When the crate is moving, there is a frictional force of 1.0N acting as shown. Fig. 2.2 shows how the acceleration, *a* of the crate varies with *P*.

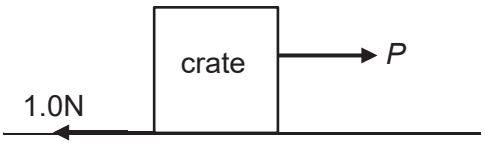


Fig. 2.1

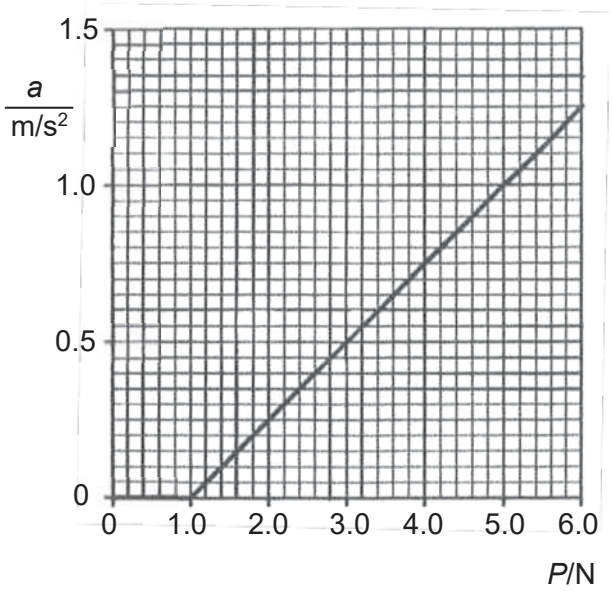


Fig. 2.2

(a) Explain why *P* must be greater than 1.0N for the crate to accelerate.

……

…… [1]

(b) By using *P* = 6.0N in Fig. 2.2, calculate the mass of the crate, *m*.

m = …… kg [2]

(c) The force *P* is reduced to 1.0N.

State and explain what happens to the crate.

……

……

…… [2]

3 The 'torture tool' shown in Fig. 3.1 was used in medieval times as an instrument of torture by lowering the victim, strapped to the seat, into the cold water of the sea. The total mass of the torture tool is 120kg. The torture tool can be balanced, when no victim is present, by a flat stone of mass 100kg placed at a distance of 2.0m from the pivot.

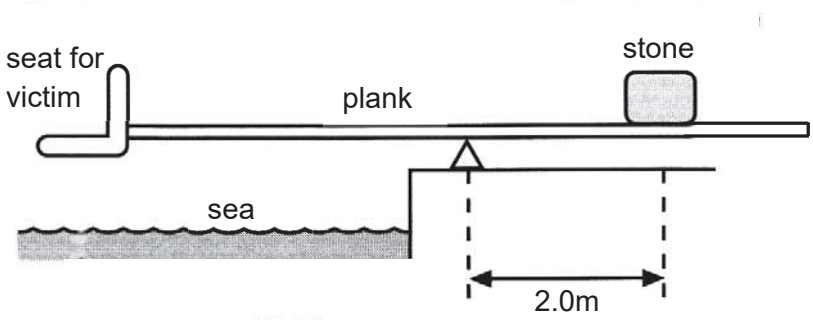


Fig. 3.1

(a) Explain what is meant by *centre of gravity*.

.....

..... [1]

(b) **(i)** On Fig. 3.1, draw and label a possible position of the weight of the torture tool to keep it balanced. [1]

(ii) Hence, calculate the distance of the centre of gravity of the torture tool to the pivot.
(gravitational field strength, g = 10N/kg)

distance = ...m [2]

(c) A victim is strapped onto the seat. The torture tool starts to rotate anticlockwise about the pivot.

Suggest and explain one method that the operator can do to keep the torture tool horizontal again.

.....

.....

.....

.....

..... [2]

4 Fig. 4.1 shows the design of the rail of a roller-coaster with a mass of 2000kg.

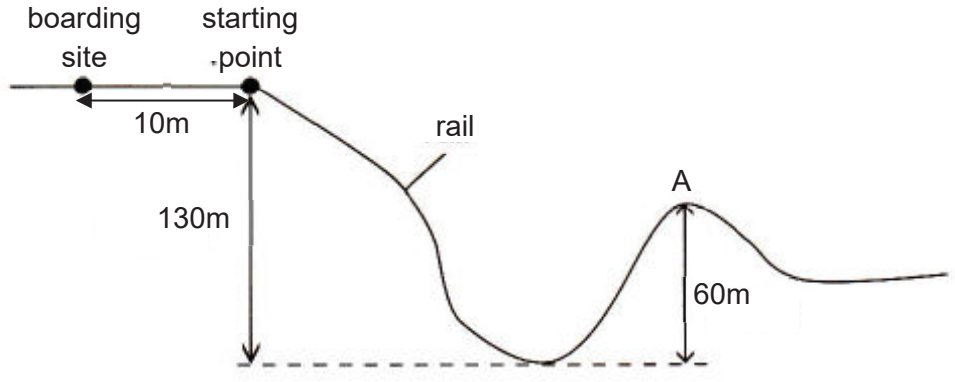


Fig. 4.1

(a) The roller-coaster starts to accelerate from rest at a constant rate after the passengers are on board at the boarding site. The distance between the boarding site and the starting point is 10m. The roller-coaster passes through the starting point at a speed of 1.5m/s.

(i) On Fig. 4.2, sketch the speed-time graph to show the motion of the roller-coaster between the boarding site and the starting point. Label all necessary value(s) on the axes. [1]

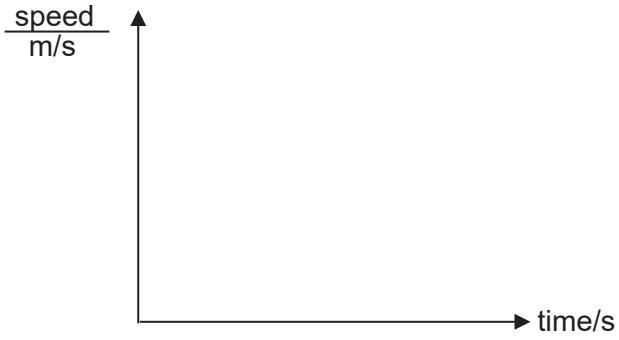


Fig. 4.2

(ii) Using Fig. 4.2, show that the time taken for the roller-coaster to accelerate to a speed of 1.5m/s is 13s. [2]

(iii) Hence, calculate the acceleration of the roller-coaster in the first 13s.

acceleration = ...m/s^2 [2]

(b) The distance along the rail from the starting point to point A is 180m and the average friction acting on the roller-coaster is 350N.

(i) Calculate the work done against friction when the roller-coaster travels from the starting point to point A.

work done against friction = ...J [2]

(ii) Hence, calculate the kinetic energy of the roller-coaster at point A.

kinetic energy = ...J [3]

5 Fig. 5.1 shows a transparent block in air.

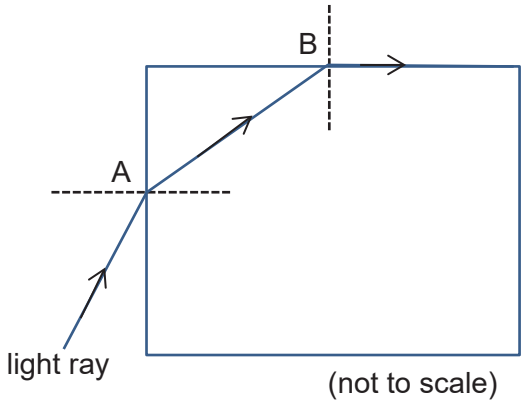


Fig. 5.1

A light ray enters the block at A and is refracted towards B. At B, the light is refracted along the surface of the block. The refractive index of the block is 1.55.

(a) On Fig. 5.1, label

(i) at A, the angle of incidence i and the angle of refraction r, [1]

(ii) at B, the critical angle c. [1]

(b) Calculate the critical angle c.

c = ... ° [2]

(c) The block is replaced by another block which has a higher refractive index.

State one change, if any, to the light ray at the top surface.

..... [1]

6 Ultrasound is used to find the distance from the ship to the seabed as shown in Fig. 6.1.

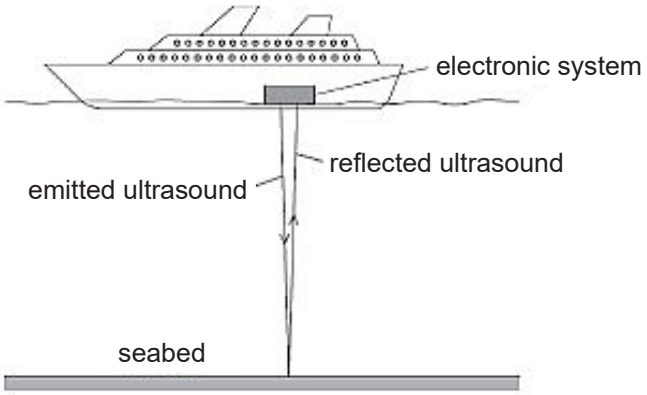


Fig. 6.1

Ultrasound waves are similar to sound waves but have a frequency that is too high to be heard by humans.

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

……..…….. [1]

(b) State the highest frequency of sound that can be heard by humans.

……..…….. [1]

(c) The speed of ultrasound in water is 1500m/s. The time taken for the ultrasound to be emitted and reflected back to the electronic system is 0.80s.

Calculate the distance between the ship and the seabed.

distance = …….. m [2]

7 An electric fence is used to keep the cow in one part of a field as shown in Fig. 7.1.

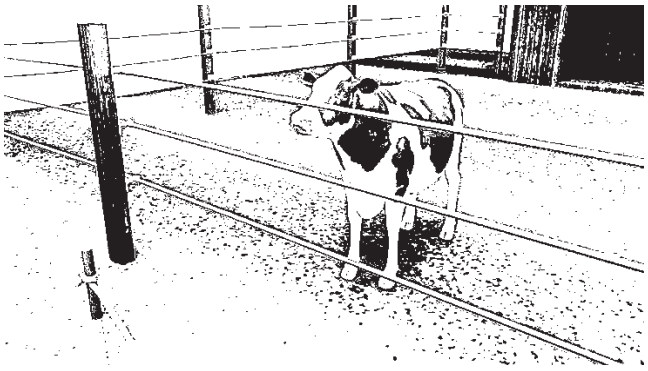


Fig. 7.1

The wire of the fence gives out short high-voltage pulses that each last for 0.10s.

When the cow touches the wire of the fence, a current of 0.015A passes through its body into the ground. This current is not enough to harm the cow but gives it an electric shock.

(a) Calculate the charge that passes through the cow when it gets an electric shock.

charge = ... [3]

(b) The potential difference between the wire of the fence and the ground is 3000V.

Calculate the energy contained in the high-voltage pulse.

energy = ... J [2]

8 A rigid wire is held between the poles of a magnet as shown in Fig 8.1.

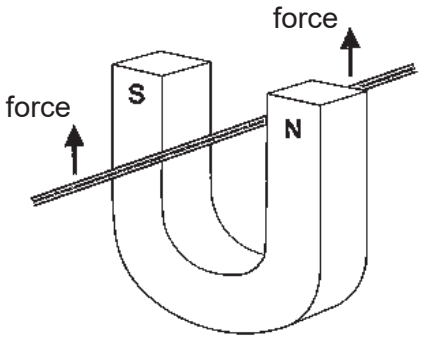


Fig. 8.1

There is a force on the wire in an upward direction when the current flows in the wire.

(a) On Fig. 8.1, draw an arrow to show the direction of the current in the wire. [1]

(b) State two ways to increase the magnitude of the force on this wire.

1 .....

2 ..... [2]

(c) State one change that can be made to cause a downward force on the wire.

..... [1]

Section B (20 marks)

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

9 **(a)** Thermal flasks are used to store hot liquids and keep them warm for a period of time. There are two types of thermal flasks. One makes use of foam as the insulating material and the other one, vacuum as shown in Fig. 9.1 and Fig. 9.2 respectively.

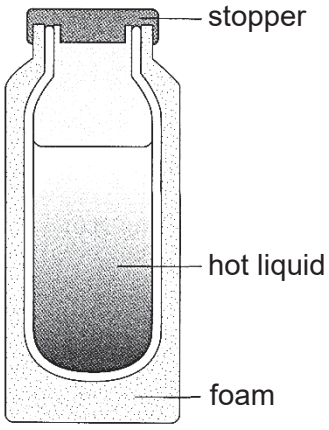


Fig. 9.1

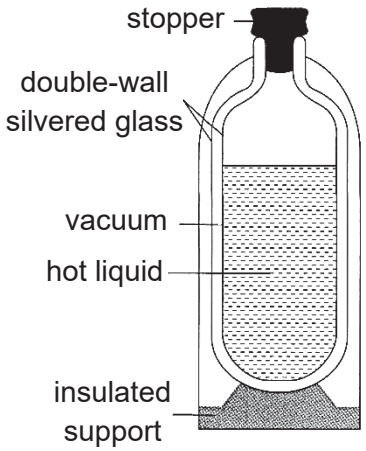


Fig. 9.2

The foam traps small pockets of air between them.

(i) Explain why the foam in Fig. 9.1 reduces loss of thermal energy by conduction.

……..

…… [1]

(ii) Explain why the vacuum between the double glass walls in Fig. 9.2 provides a better heat insulation than foam.

……..

……..

…… [2]

(iii) Explain why the silvered glass in Fig. 9.2 helps to keep the liquid hot for a longer period of time.

……..

……..

…… [2]

(b) A staff in a restaurant puts water at room temperature T_1 into the freezer of a refrigerator to make ice cubes. The cooling curve of the water is shown in Fig. 9.3.

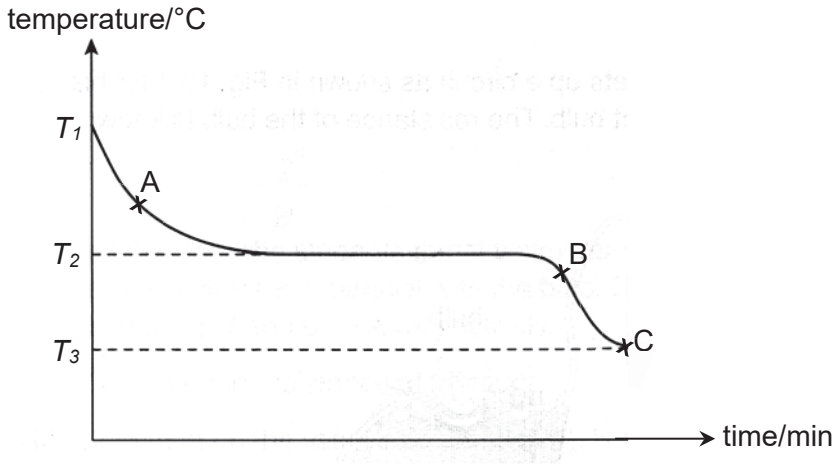


Fig. 9.3

(i) State the physical meaning of temperature T_2.

…… [1]

(ii) Describe the arrangement of the molecules of the substance at point A.

……..

…… [1]

(iii) Describe the changes, if any, that occur to the motion of the molecules of the substance as it cools from B to C.

……..

…… [1]

(c) Explain, in terms of the kinetic theory, why a cooling effect occurs when water evaporates from the surface of the skin.

.....

.....

.....

..... [2]

10 A thermistor is a resistor that changes its resistance with temperature. Component T is a thermistor connected in series with a resistor U of resistance 500Ω and a 9.0V battery as shown in Fig. 10.1.

Fig. 10.1

Fig. 10.2 shows the variation with temperature of the resistance of T.

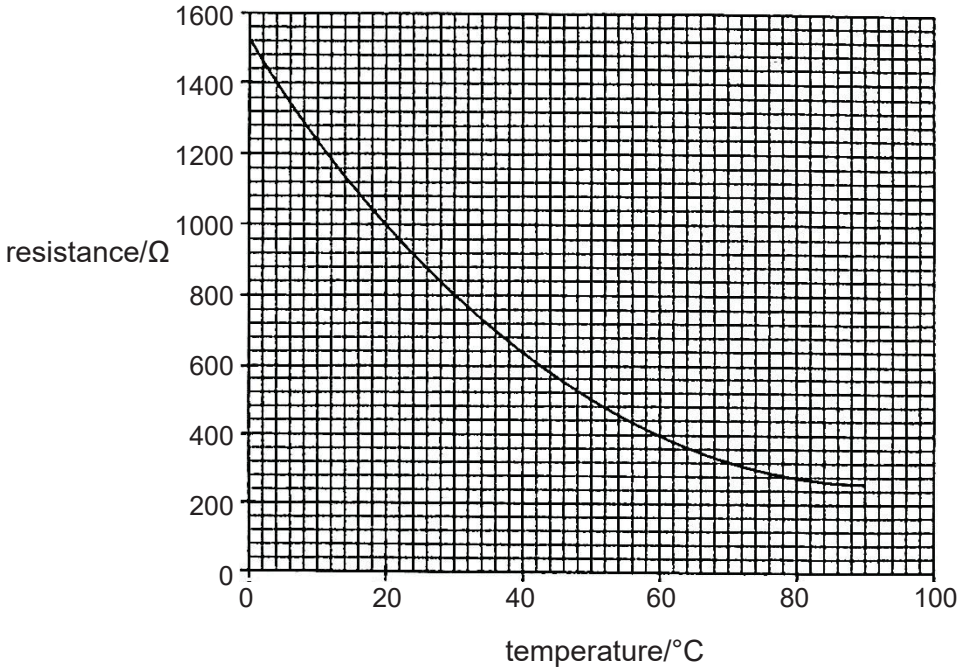


Fig. 10.2

(a) When the temperature is 60°C,

(i) use Fig.10.2 to determine the resistance of T,

resistance = …….. Ω [1]

(ii) calculate the current in the circuit,

current = …….. A [2]

(iii) calculate the potential difference across resistor U.

potential difference = …… V [1]

(b) The temperature drops from 60°C to 30°C.

State and explain what happens to

(i) the current in the circuit,

……..

…… [2]

(ii) the potential difference across resistor U,

……..

…… [1]

(iii) the potential difference across thermistor T.

……..

…… [1]

(c) When the circuit in Fig. 10.1 is in use, a fuse is connected to the circuit.

State the function of a fuse and describe how it works.

.....

.....

.....

..... [2]

11 An air-conditioner with a remote controller is shown in Fig. 11.1.

Fig. 11.1

The air-conditioner is installed at the top of the wall near the ceiling and is operated using the remote controller.

(a) Describe and explain why the air-conditioner is installed at the top of the wall.

……..

……..

……..

…… [2]

(b) State the component of the electromagnetic spectrum used by the remote controller to operate the air-conditioner.

…… [1]

(c) The air-conditioner was switched on for 8 hours and used 4.0kWh of electrical energy.

(i) If the cost per kWh is $0.30, calculate the cost of using the air-conditioner.

cost = $ ……. [1]

(ii) Calculate the power consumption of the air-conditioner.

power = ……..W [2]

(d) The air-conditioner is connected to the main supply by a circuit breaker, as shown in Fig. 11.2.

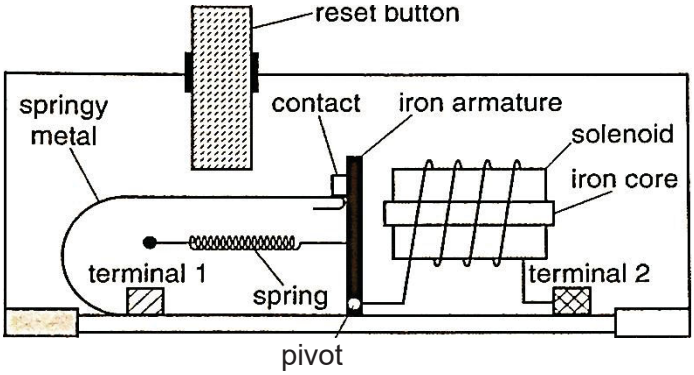


Fig. 11.2

When a fault develops, the circuit breaker switches off the current. The circuit breaker with the current switched off is shown in Fig. 11.3.

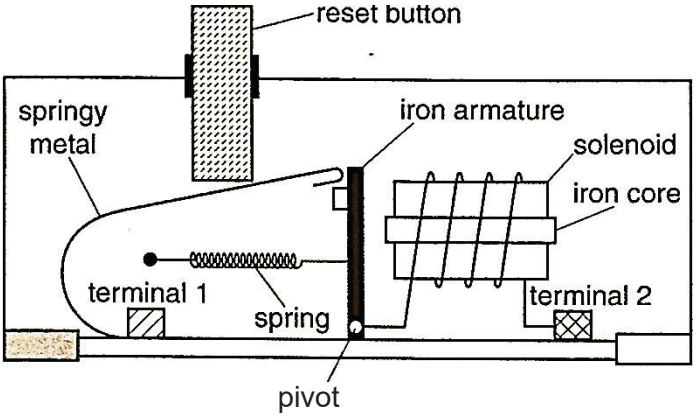


Fig. 11.3

(i) State the type of fault that could cause the circuit breaker to operate.

…… [1]

(ii) Describe how the circuit breaker switches off the current.

……

……

……

……

……

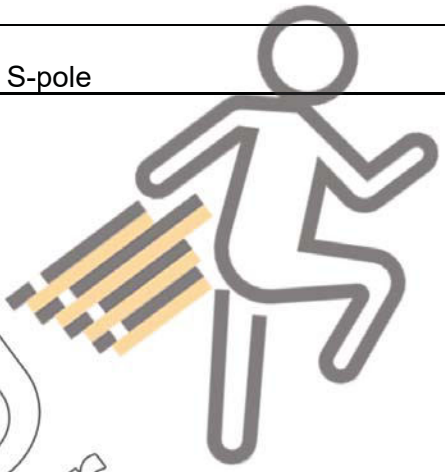
…… [3]

End of Paper

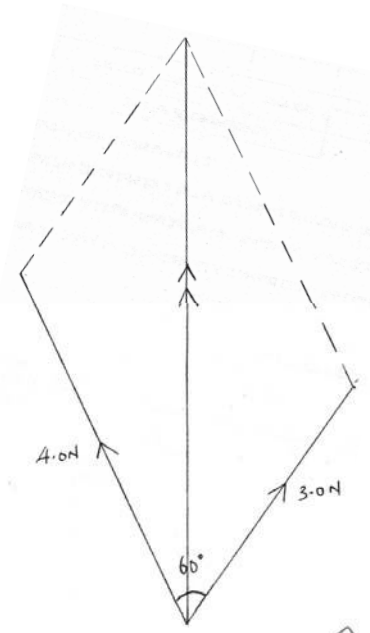
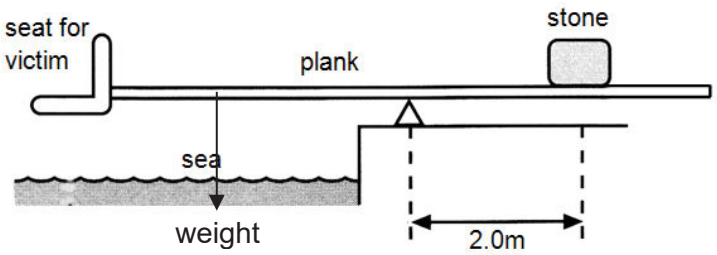
Explanations

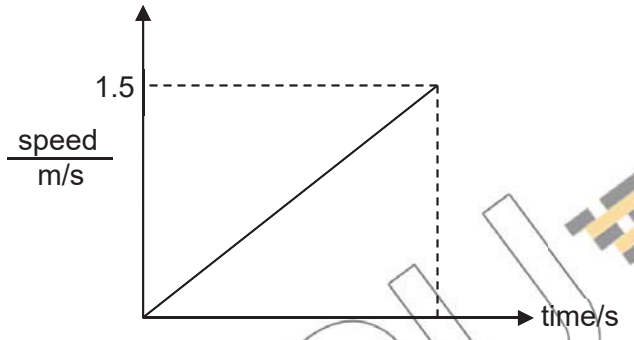
No.	Reasoning
1	D X → Z → X is one complete oscillation. Period is time for one complete oscillation.
2	B Main scale = 5.30cm, Vernier scale = 0.03cm Observed reading = 5.33cm
3	C at P, the motorcycle is ~~decelerating~~ accelerating at Q, the motorcycle has ~~constant acceleration~~ constant speed at R, the motorcycle is slowing down at S, the motorcycle ~~has constant speed~~ is at rest
4	D Wheel rotates clockwise. Thus friction acts against the motion.
5	A Mass remains unchanged on the Earth and on the Mars. W = mg = 15 × 3.7 = 56N
6	A P = F/A = 50 / (0.002 × 4) = 6250Pa
7	A Work done = F × d = 200 × 2 = 400J There is no work done by the 400N force as the distance travelled is perpendicular to the force. Power = work done / time = 400 / 20 = 20W
8	D Smallest base area & high centre of gravity
9	B Heating at X, hot water is less dense and remains at the top. No convection current.
10	C Molecules cannot expand!
11	D f = 1/T = 1/0.20 =5.0Hz $v = f\lambda = 5 \times 4 = 20cm/s$
12	B Characteristic of image formed by a plane mirror apply

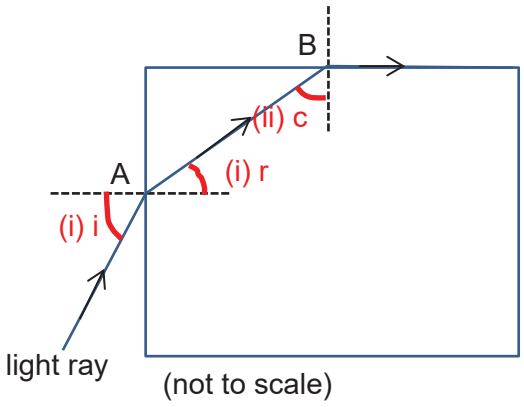
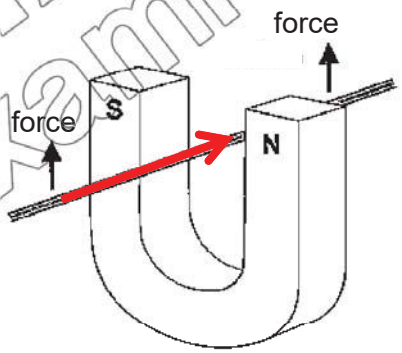
13	A Image formed is larger, it is real and inverted as it can be projected onto a screen.
14	C Gamma rays, x-rays and UV rays have higher frequencies and short wavelengths compared to visible light
15	D Softer sound produced lower amplitude
16	A Electric field flow from positive to negative
17	D Ratio of length and area is 2
18	A Thicker wire has lower resistance thus producing less heat
19	C Using right hand grip rule
20	C Like poles repels and magnetic field go into the S-pole



Marking Scheme

No.	Solutions	Marks
1a	Scale 1cm : 0.5N OR 2cm : 1N OR 3cm : 1N  Correct resultant force with double arrowheads Forces labelled (with arrowhead) and correct angle Resultant force = 12.1cm × 0.5 = 6.05N (5.9N to 6.2N) Direction of resultant force = 25° from 4.0N OR 35° from 3.0N (±2°)	1 mark 1 mark 1 mark 1 mark 1 mark
1b	Weight of stone = 6.05N (same as 1a)	1 mark (Allow ECF)
2a	There will be a <u>resultant force</u> acting to the right on the crate.	1 mark
2b	When P = 6.0N, a = 1.25m/s^2 F_{net} = ma 6.0 - 1.0 = m × 1.25 m = 4.0kg	 1 mark (F_{net}) 1 mark (mass)
2c	The crate continues to move forward at a <u>constant speed</u>. / travel at zero acceleration. <u>P is equal and opposite to frictional force</u> and there is <u>no resultant force</u> acting on the crate.	1 mark 1 mark (either 1)
3a	A point where the whole weight of the object seems / appears to act.	1 mark
3bi	 	1 mark Weight is acting to the left of the pivot

3bii	Take moment about pivot, Anticlockwise moment = Clockwise moment 1200 × d = 1000 × 2 d = 1.67m	 1 mark 1 mark
3c	Shift the stone to the end of the plank to increase the perpendicular distance. OR Replace the stone with a larger mass / Add more stones to increase the force applied on the plank. The clockwise moment produced by the weight of the stone from the pivot increases.	1 mark 1 mark
4ai		1 mark (did not penalize for missing 1.5m/s)
4aii	Distance = Area under graph $10 = \frac{1}{2} \times t \times 1.5$ t = 13s (Shown)	1 mark 1 mark
4aiii	$a = \frac{v-u}{t} = \frac{1.5-0}{13}$ = 0.115 m/s^2	1 mark 1 mark
4bi	Work done against friction = f × d = 350 × 180 = 63000 J	1 mark 1 mark
4bii	Total energy at starting point = Total energy at A GPE + KE = GPE + KE + WD against friction $(2000\times10\times130) + (\frac{1}{2} \times 2000 \times 1.5^2) = (2000\times10\times60) + KE + 63000$ KE = 1340000J	LHS 1mark, RHS 1 mark 1 mark

5a		Part (i) 1 mark Part (ii) 1mark
5b	$c = sin^{-1}\left(\frac{1}{1.55}\right) = 40.177 = 40.2°$	1 mark working 1 mark answer
5c	Total internal reflection occurs. / the light ray will be internally reflected. / reflect back into the block	1 mark
6a	The number of complete waves/oscillation in one second.	1 mark
6b	20000Hz or 20kHz	1 mark
6c	$distance\ travelled\ by\ the\ wave = speed \times time$ $= 1500 \times 0.8 = 1200m$ $distance\ from\ ship\ to\ seabed = \frac{1200}{2} = 600m$	1 mark 1 mark
7a	$Q = It = 0.015 \times 0.1$ $= 0.0015C$	1 mark working 1 mark answer 1 mark unit
7b	$E = VQ = 3000 \times 0.0015 = 4.5$J	1 mark working 1 mark answer
8a		1 mark
8b	<u>Increase the current in the wire</u> by increasing the emf of the source <u>using a stronger magnet</u> to Increase the strength of the magnetic field	1 mark 1mark
8c	Reverse the direction of the current flow Swop the poles of the magnet to reverse the magnetic field	1 mark for any correct answer

9ai	The foam traps air and air is a poor conductor of thermal energy.	1 mark
9aii	There is no heat transfer by conduction and convection in vacuum. Conduction and convection requires a medium for energy transfer. However, there is no medium in a vacuum.	1 mark 1 mark
9aiii	Silvered surfaces are poor emitters / good reflector of thermal energy. The rate of heat lost from the hot liquid to the surrounding by radiation is smaller. / The thermal energy is reflected back into the liquid.	1 mark 1 mark
9bi	Freezing point of water OR melting point of ice	1 mark
9bii	Molecules are packed relatively close together in a random arrangement.	1 mark
9biii	The solid molecules vibrate about their fixed position slower.	1 mark
9c	During evaporation, the water molecules absorb heat from the skin. The more energetic water molecules leave the surface of the skin and the average kinetic energy of the remaining molecules decreases.	1 mark 1 mark
10ai	400Ω	1 mark
10aii	Total R = 400+500 = 900Ω $I = \frac{V}{R} = \frac{9.0}{900} = 0.010A$	1 mark 1 mark
10aiii	$V = IR = 0.010 \times 500 = 5.0V$	1 mark
10bi	The current in the circuit decreases, when temperature decreases, the resistance of thermistor T increases causing the effective resistance to increase and since $= \frac{V}{R}$, current decreases when R increases.	1 mark 1 mark
10bii	since $V = IR$,the current decreases and resistance of U remains the same, the p.d. across resistor U decreases.	1 mark
10biii	Since the p.d. across T and U is equal to the emf / 9.0V, the p.d. across T will increase when the p.d. across resistor U decreases.	1 mark
10c	A fuse prevents excessive current and hence damages to appliances. / protect appliances from overheating	1 mark

	The fuse is connected to the live wire and when current exceed its rating, the fuse becomes hot and melts. This cuts off the current flow from the live wire to the appliance.	1 mark
11a	Cooler air from the air-con being denser will sink, warmer air at the bottom being less dense will rise, convection current is setup to cool the room effectively.	1 mark 1 mark
11b	The data is transmitted using infrared radiation.	1 mark
11ci	$Cost = kWh \times cost\ per\ unit$ $= 4 \times 0.30 = \$1.20$	 1 mark
11cii	$power = \frac{E}{t} = \frac{4}{8} = 0.5kW$ $= 500W$	1 mark 1 mark
11di	Short circuit / when large current passes through	1 mark
11dii	When the current is large enough, the strength of the electromagnet increases until it is strong enough to attract the iron armature. This pulls the iron armature away from the spring and release the contact. This causes an open circuit and switch off the current.	 1 mark 1 mark 1 mark