2020 MSHS Sec 4 Science Physics Prelim Answers

Paper 1

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
B	B	D	D	A	B	A	C	C	D
Q11	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
C	A	D	A	C	B	A	D	C	B

Paper 2

Section A

Answer **all** questions. Write your answer in the spaces provided.

1 Fig.1.1 shows the speed - time graphs of two falling balls. One of them is a rubber ball and the other is a plastic ball with a small parachute attached to it.

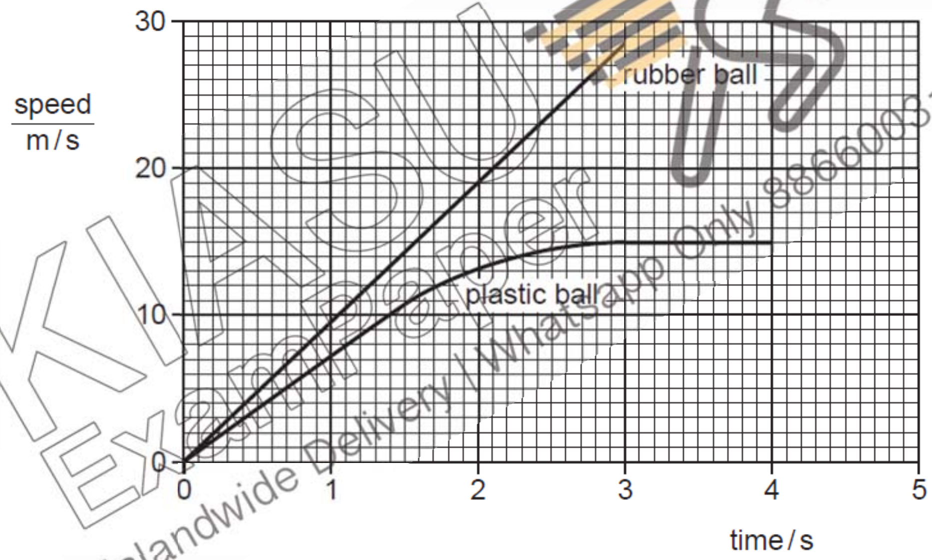


Fig. 1.1

(a) Describe the motion of the plastic ball during the first 3.0 s.

From 0 to 1.5 s, the plastic ball is moving with **constant acceleration**.[1/2]

After 1.5 s, the ball is moving with **decreasing acceleration**.[1/2]

(b) Calculate

(i) the acceleration of the falling rubber ball during the first 3.0 s,

$$a = \frac{v-u}{t}$$

$$= \frac{28.5-0}{3} \quad [1] \ \textit{with formula}$$

$$= 9.5 \text{ m/s}^2 \quad [1]$$

(ii) the distance fallen by the rubber ball during the first 3.0 s.

distance= area under v-t graph

$= \frac{1}{2} \times 3 \times 28.5$ [1] *with formula*

$= 42.8\ m$ [1]

(c) The weight of the plastic ball with the small parachute is 0.80 N. State the value of the air resistance acting on it 3.0 s after release. Explain your answer.

air resistance = **0.80 N** [1]
Plastic ball is moving with **constant speed** with **no acceleration**. There is **no resultant force** acting on the plastic ball.[1] Therefore, the **air resistance is equal to weight of plastic ball**.

2 At a sports event, a television camera is supported above the playing area by two wires A and B, as shown in Fig. 2.1.

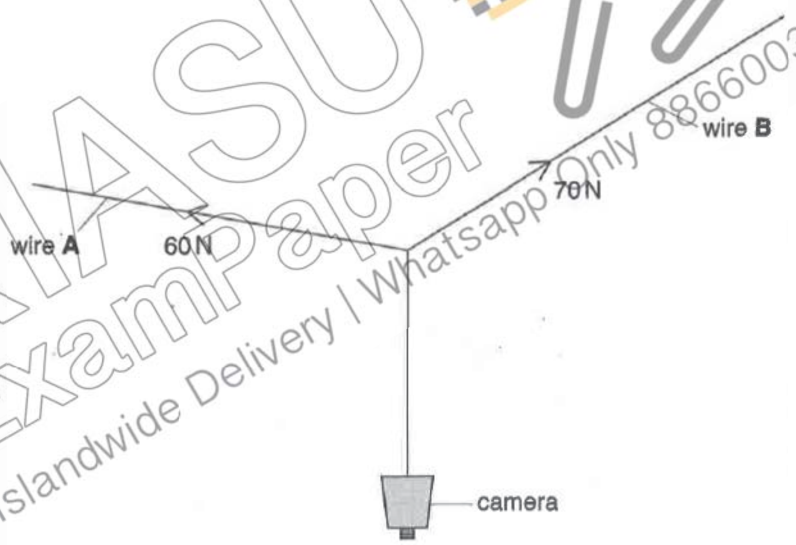
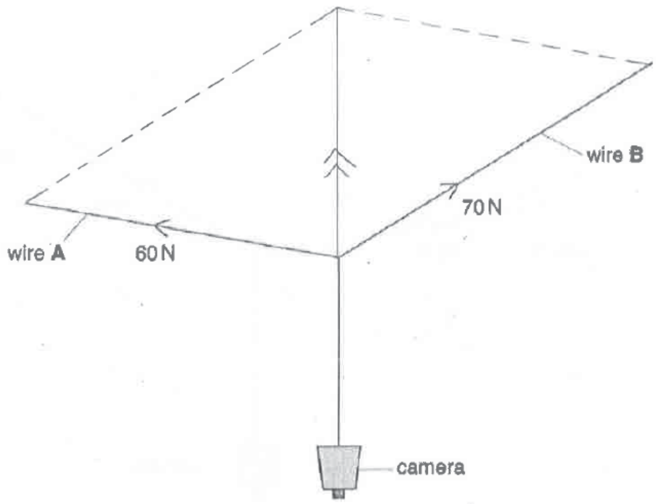


Fig. 2.1

There is a force of 60 N in wire A and a force of 70 N in wire B.
Fig. 2.1 is drawn to scale.

On Fig. 2.1, draw a vector diagram, using a scale of 1.0 cm representing 10 N, to determine the weight of the camera.



Correct parallelogram drawn with dotted lines [1]
Correct upward resultant force with double arrows [1]

Resultant force due to wire A and B
= (4.7 cm / 1 cm) x 10 N
= 47 N

Weight = 47 N (44 N to 50 N) [1]

3 A falling metal hammer is used to drive a hollow steel post into the ground, as shown in Fig. 3.1. The hammer is lifted by an electric motor and then falls freely to hit the baseplate.

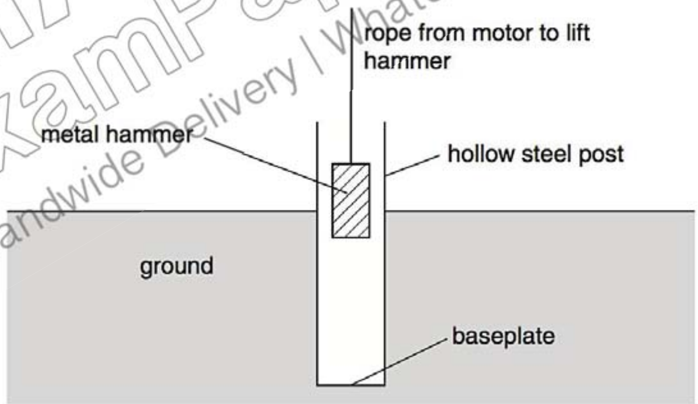


Fig. 3.1

(a) The metal hammer has a mass of 1500 kg and it hits the baseplate with a speed of 8.0 m/s.

(i) Calculate the kinetic energy of the hammer as it hits the baseplate.

KE = ½ mv^2 [1/2]
= ½ × 1500 kg × $(8.0 \text{ m/s})^2$ [1]
= 48 000 J [1/2]

(ii) Calculate the height above the baseplate from which the hammer is dropped. Assume air resistance is negligible. Take g = 10 N/kg.

Loss in GPE = Gain in KE [1/2]
mgh = 48 000 J

1500 kg × 10 N/kg × h = 48 000 J [1/2]

h = 3.2 m [1]

(b) State and explain one change to the equipment in Fig. 3.1 that would cause the baseplate to move further into the ground each time the hammer falls.

increase the mass of hammer will cause an increase in GPE
increase height of hammer will cause an increase in GPE
decrease surface area of base plate in contact with ground will caused an increase in pressure by baseplate
(any reasonable change) 1 mark for change, 1 mark for each explanation.

4 **(a)** A large amount of thermal energy loss from a house takes place through the walls. This thermal energy loss can be reduced by filling the space between the walls with polystyrene foam as shown in Fig. 4.1.

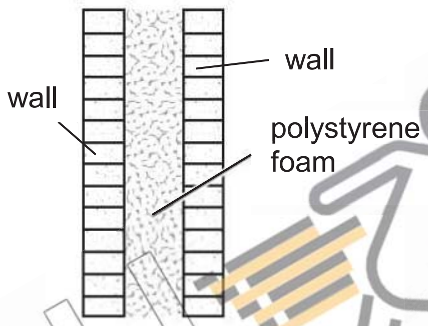


Fig. 4.1

Explain how this reduces thermal energy loss.

There is a layer of **trapped air** in the polystyrene foam and **air is a poor conductor of heat**./ polystyrene is a poor conductor of heat or insulator of heat [1]
This reduces **the rate of the thermal energy loss from the house to the surrounding** by **conduction**.[1]

(b) Fig. 4.2 shows the inside of a conventional oven.

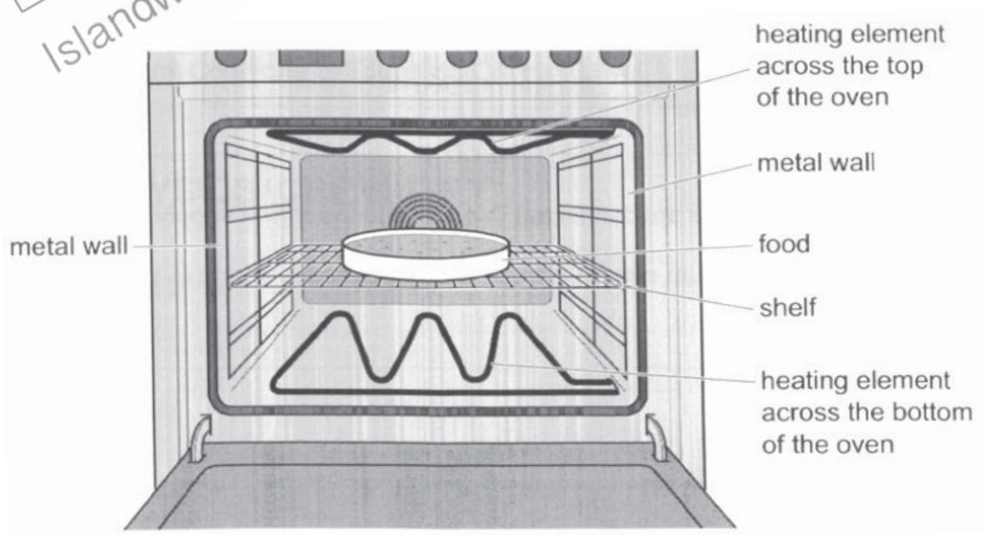


Fig. 4.2

(i) Explain how thermal energy is transferred from the heating element to the food by convection.

Heating element at the bottom heats up air around it, **air expands**, being **less dense and rises**.[1] **Cooler, denser surrounding air sinks**. The difference in densities sets up **convection current**.[1]

<u>Transfer of thermal energy by other processes:</u>
Heat is conducted from warm air to food by conduction
Thermal energy from top and bottom heating elements is transferred to food by infrared radiation
Shelf also conducts heat to food by conduction.

(ii) State and explain how the design of the oven can be changed to reduce heat loss by radiation from the inside of the oven.

Make the **inner walls of oven shiny** [1] as **shiny surfaces are poor emitters / radiators of infrared radiation** [1] so heat loss is reduced by radiation.

(iii) State the type of electromagnetic wave that is used to cook the food in the conventional oven.

Infrared radiation [1]

5 Some ice is placed in a beaker and is heated until the beaker contains boiling water only. Fig. 5.1 shows the temperature - time graph.

Fig. 5.1

(a) Identify the process taking place during WX.

Melting [1]

(b) Describe the changes, if any, that occur to the arrangement and to the motion of the molecules during WX.

arrangement of molecules: from **closely packed and in orderly /regular manner** to **slightly further apart but in random arrangement** /not in orderly manner [1]

Motion of molecules: change from **vibrating about fixed position** to **move and slide past each other**. [1]

(c) State what happens to the internal kinetic energy and internal potential energy of the molecules during YZ.

Internal KE: does not increase / remains constant [1/2]
Internal PE: increases [1/2]

6 Fig. 6.1 shows the magnified view of the path that a light ray takes when it strikes the lens.

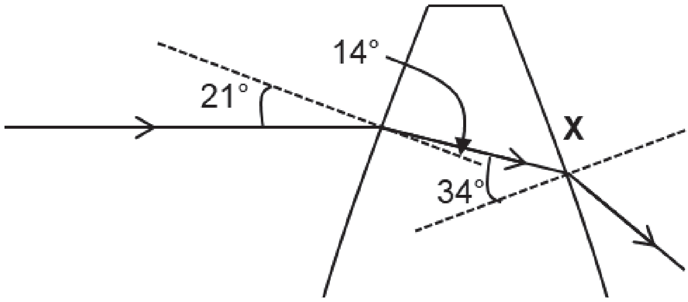


Fig. 6.1

(a) Calculate the refractive index of the lens.

$$n = \frac{\sin i}{\sin r} \qquad [1]$$

$$= \frac{\sin 21^o}{\sin 14^o} \qquad [1]$$

$$= 1.5 \qquad [1]$$

(b) Calculate the critical angle of the lens.

$$n = \frac{1}{\sin c}$$

$$1.5 = \frac{1}{\sin c} \qquad [1]\textit{with formula}$$

$$c = 42^o \qquad [1]$$

(c) Explain why the light ray does not undergo total internal reflection when it strikes the surface of the lens at point **X**.

The **angle of incidence** at X (34°) is **less than the critical angle** of the lens (42°). [1]

7 An object is placed 18 cm in front of a thin converging lens, as shown in Fig. 7.1.

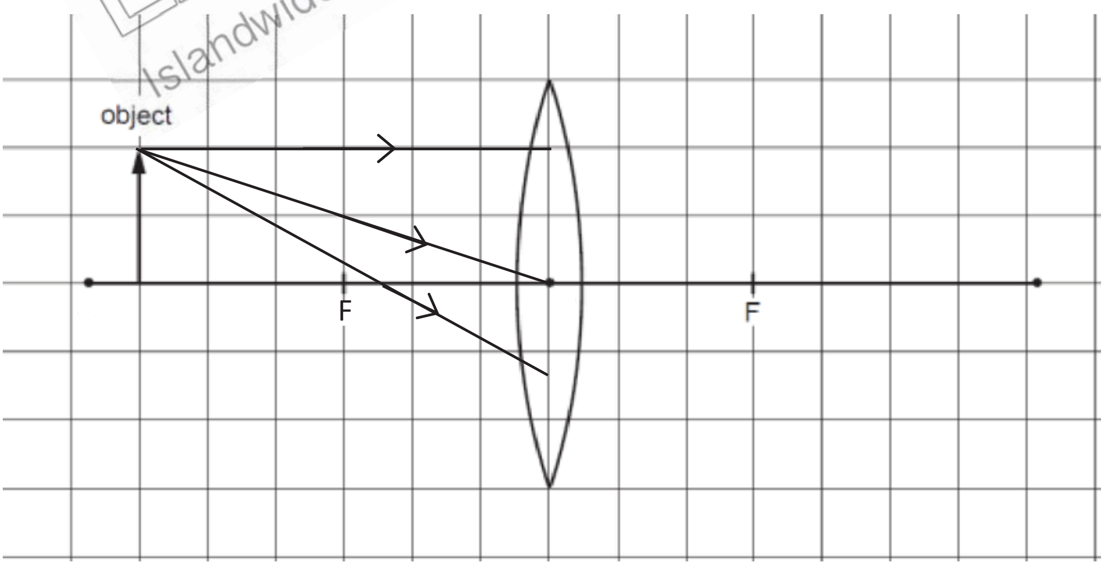


Fig. 7.1

F is the principal focus of the lens.
Three rays have been drawn from the top of the object to the lens.

(a) On Fig. 7.1, complete the three rays from the top of the object to locate the image. [3]

Each correct ray with arrow [1] x 3

(b) The object is now moved so that it is 5.0 cm from the lens.
Describe two characteristics of the new image formed.

Upright, magnified, virtual image (any 2)

8 Two small uncharged metal spheres **A** and **B** are suspended side by side using insulating thread, as shown in Fig. 8.1.

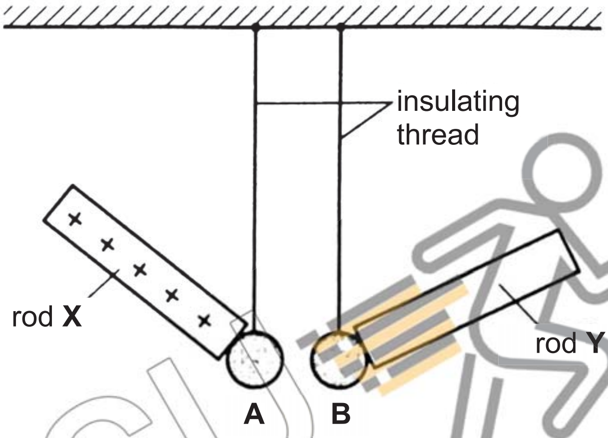


Fig. 8.1

Rods **X** and **Y** are both charged conductors that are held using insulators.

Rod **X** is positively charged and touches sphere **A**. Rod **Y** touches sphere **B**.

The rods are removed and sphere A becomes positively charged. The spheres move towards each other as shown in Fig. 8.2.

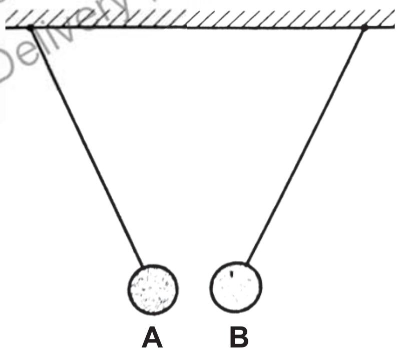


Fig. 8.2

State and explain what can be deduced about rod Y.

Rod Y is negatively charged.[1] It is because both spheres attract each other as **unlike charges attract** so **sphere B must be negatively charged**.[1]

9 Fig. 9.1 shows a circuit which consists of three resistors connected to a battery of e.m.f. 12 V.

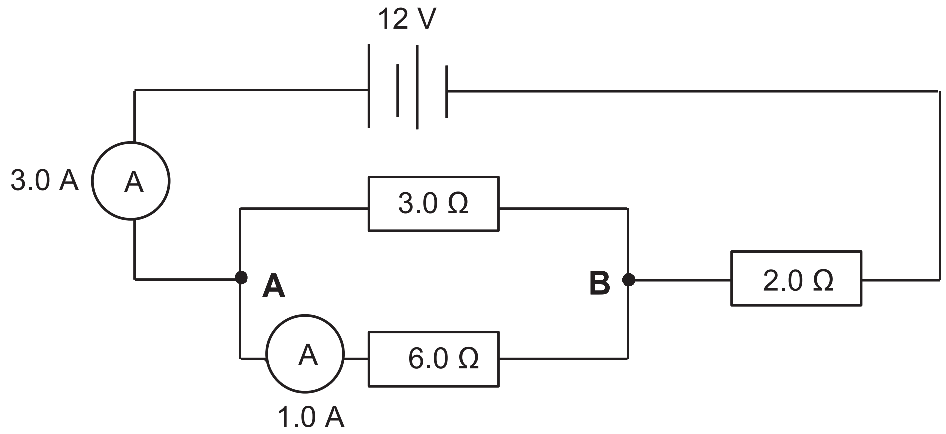


Fig. 9.1

(a) Calculate

(i) the current flowing through the 3.0 Ω resistor,

current = 3.0 A – 1.0 A

= 2.0 A [1]

(ii) the potential difference across the 3.0 Ω resistor.

V = IR

= 2.0 A × 3.0 Ω [1] with formula

= 6.0 V [1]

(b) **(i)** Calculate the potential difference across the 2.0 Ω resistor.

V = IR

= 3.0 A × 2.0 Ω [1/2]

= 6.0 V [1/2]

OR

V = 12 V – 6.0 V [1/2]

= 6.0 V [1/2]

(ii) Hence, calculate the energy transferred in 40 s in the 2.0 Ω resistor.

E = VQ

E = VIt

= 6.0 V × 3.0 A x 40 s [1/2]

= 720 J [1/2]

Section B

Answer any **two** questions in this section.

Write your answer in the spaces provided.

10 A mechanical digger is used to remove soil from the ground, as shown in Fig. 10.1.

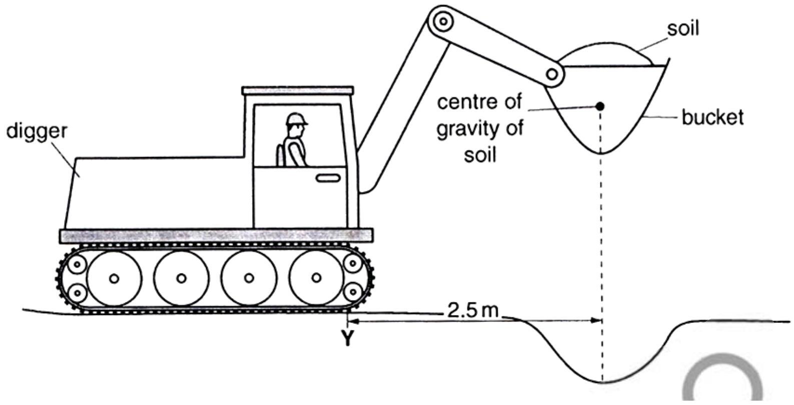


Fig. 10.1

The bucket of the digger contains 1.4 m^3 of soil. The density of the soil is 2500 kg/m^3.

(a) Calculate, for the soil in the bucket,

(i) its mass,

mass = volume × density

= 1.4 m^3 × 2500 kg/m^3 [1/2]

= 3 500 kg [1/2]

(ii) its weight (g = 10 N/kg).

W = mg [1/2]

= 3 500 kg × 10 N/kg [1/2] ecf

= 35 000 N [1]

(b) Fig. 10.1 shows the centre of gravity of the soil is a horizontal distance 2.5 m from the front edge Y of the tracks in contact with the ground.

(i) Calculate the moment about Y of the weight of the soil

Moment = F × d [1/2]

= 35 000 N × 2.5 m [1/2] ecf

= 87 500 Nm [1]

(ii) The digger does not tip over. Use your knowledge of moments to explain why the digger does not tip.

The digger does not tip over as the **clockwise moment due to the weight of soil about Y** [1] is **equal to (balances)** the **anticlockwise moment due to the weight of digger** [1] about Y.

Fig. 10.2 shows a figurine of a martial artist adopting a basic stance.

Fig. 10.2

(i) State the advantage(s) of this stance.

The **centre of gravity is lowered** and **larger base area** to increase stability.[1]

(ii) Fig. 10.3 shows the figurine being tilted by a force applied to the side.

Fig. 10.3

Explain why the figurine will not topple over when the force is removed.

The **line of action of the weight of the figurine** through the centre of gravity **lies within/inside the base area** of the figurine.[1]
Anticlockwise moment of the weight about the point of contact (pivot) causes the figurines to **return to its original position**.[1]

11 **(a)** The displacement-distance and displacement-time graphs of a wave are shown in Fig. 11.1 and Fig. 11.2 respectively.

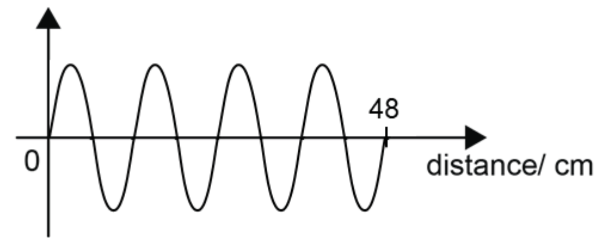


Fig. 11.1

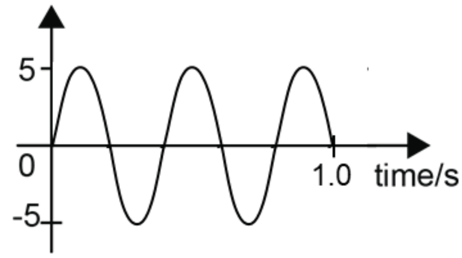


Fig. 11.2

Determine the

(i) period of the wave,

period = ... [1]

$T = 1.0/2.5 = 0.40$ s [1]

(ii) wavelength of the wave,

wavelength = ... [1]

$\lambda = 48 / 4 = 12$ cm [1]

(iii) speed of the wave.

speed = ... [2]

$v = f \times \lambda$

$= \lambda / T$

$= 12$ cm / 0.40 s [1]

$= 30$ cm/s or 0.30 m/s [1]

(b) Sabrina goes to the concert hall where she sits at the back of the hall to listen to musical instruments performance.

(i) Explain how sound waves from the instruments travel through air to enable Sabrina hear the sound through her ears.

The vibrations from the instruments **displace surrounding air particles** from their equilibrium positions and **cause the air particles to move to and fro.** These vibrating particles **collide** with the **neighboring air particles and transfer energy to them**.[1] This produces **longitudinal waves** with a **series of compressions and rarefactions** [1] which reaches Sabrina's ears.

(ii) Fig 11.3 shows a digital displacement-time display of sound waves of a particular note Sabrina hears.

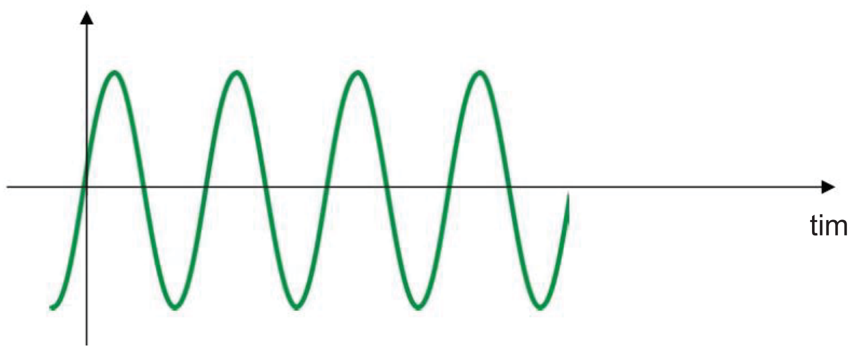


Fig. 11.3

On Fig 12.3, draw another sound wave which is softer but lower in pitch. [2]

lower amplitude [1] , lower frequency (larger period) [1]

(iii) While listening to the music at the back of the hall, Sabrina realised that the frequency of the sound does not affect the speed at which it travels.

Explain why the speed of the sound is not affected.

Frequency of sound affects pitch. [1] **Different pitch notes still has the same speed**,[1] frequency does not affect speed.
OR
Speed depends on the medium [1] in which it travels. The **medium (air) does not change** [1] so speed does not change

12 Fig. 12.1 shows the electrical wiring in a table lamp.

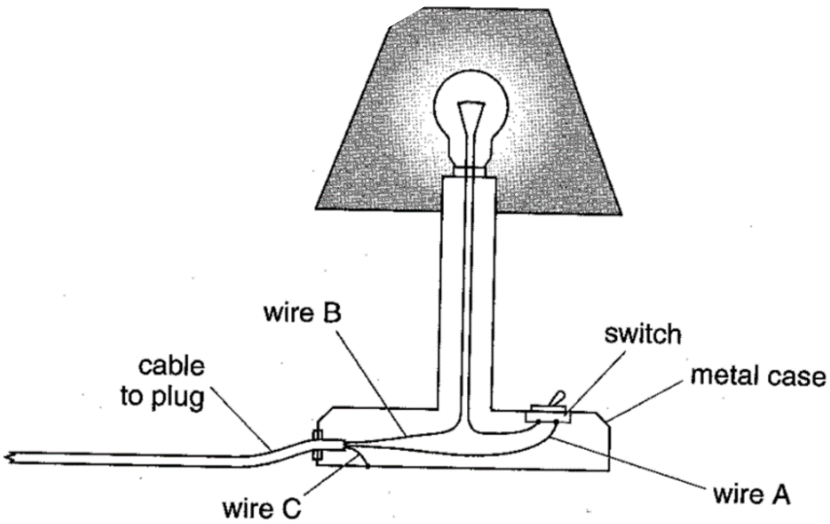


Fig. 12.1

(a) The lamp is marked “240 V, 90 W”. The lamp is switched on for 10 minutes.

(i) Calculate the current drawn by the lamp.

$P = VI$ [1/2]
$I = 90\ W / 240\ V$ [1]
$= 0.375\ A$ [1/2]

(ii) Calculate the amount of charge passing through the lamp.

$Q = It$ [1/2]
$= 0.375\ A \times (10 \times 60)\ s$ [1]
$= 225\ C$ [1/2]

(b) Explain why wire A rather than wire B is connected to the live terminal in the plug.

Switch is always connected to the **live wire** (**wire A**) [1]
Appliance is disconnected from the high voltage source [1] when the switch is turned off.

(c) State which wire carries no current when the table lamp is working normally.

Earth wire (Wire C) [1]

(d) Wire **A** becomes loose and touches the metal case. Explain why a person who touches the casing does not get electric shock.

The **excessive current** flows **to the earth from the metal case via the earth wire as earth wire has very low resistance compared to person**. [1]

OR
When wire A touches the metal case, the **fuse would have blown** due to the excessive current flowing through the live wire.

(e) A second lamp is double insulated. Explain whether an earth wire is required for the second lamp.

Earth wire is not required as the lamp is double insulated with a **non-conductor / an insulator outer casing**, [1] hence the **casing will not become live** and **current will not flow through the user who touches the casing**, causing electric shocks. [1]

END OF PAPER