For Examiner's Use

Section A

Answer **all** questions in this section.

.

1 **Fig. 1.1** shows a cross-sectional view of a hollow spherical capsule made from a certain material.

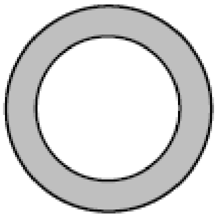

Fig. 1.1

Fig. 1.2 and **Fig. 1.3** show vernier calipers readings of the external and internal diameters of the hollow sphere capsule respectively.

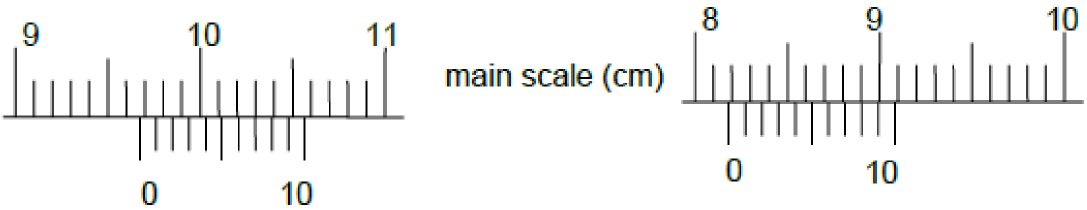

Fig. 1.2 **Fig. 1.3**

(a) State the external and internal diameters of the cross-section of the hollow spherical capsule.

External diameter = ...

Internal diameter = ... [2]

(b) Define *density*.

....

.... [1]

(c) The hollow spherical capsule has a mass of 700 g, and the mass of air in it is negligible. Given that the density of water is 1.0 g cm^{-3}, explain whether the hollow spherical capsule will float or sink when placed in water. Show your working clearly in the space below.

....

.... [3]

2 **Fig. 2.1** shows a can of compressed air that is being used to blow dust off a computer keyboard.

Fig. 2.1

(a) The pressure of the air inside the can is greater than the pressure of the atmosphere.

Explain, in terms of molecules, why the pressure of the air inside the can decreases as it is used.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [3]

(b) A student uses an inverted measuring cylinder in a water trough to measure the volume that the air in the can occupies at atmospheric pressure. **Fig. 2.2** shows the measuring cylinder gradually being filled with air from the can.

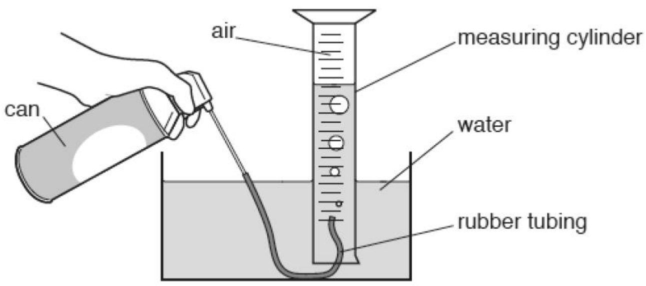

Fig. 2.2

Initially, the inverted measuring cylinder is full of water.

The student presses the top of the can and air passes through the rubber tubing into the inverted measuring cylinder. The air gradually replaces the water in the cylinder until no more air can leave the can.

The final temperature of the air is equal to its initial temperature. The volume of the air inside the can is 1.8×10^{-4} m^3. The student observes that, at an atmospheric pressure of 1.0×10^5 Pa, the total volume of the air in the measuring cylinder, the can and the tubing is now 9.4×10^{-4} m^3.

Determine the original pressure of the air in the can.

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Pressure = ………………………… [2]

3 **(a)** **(i)** Define the *focal length* of a converging lens.

……………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) **Fig. 3.1** shows an object **O** placed on a line that passes through the centre of a converging lens. The lens is perpendicular to the line but is not shown.

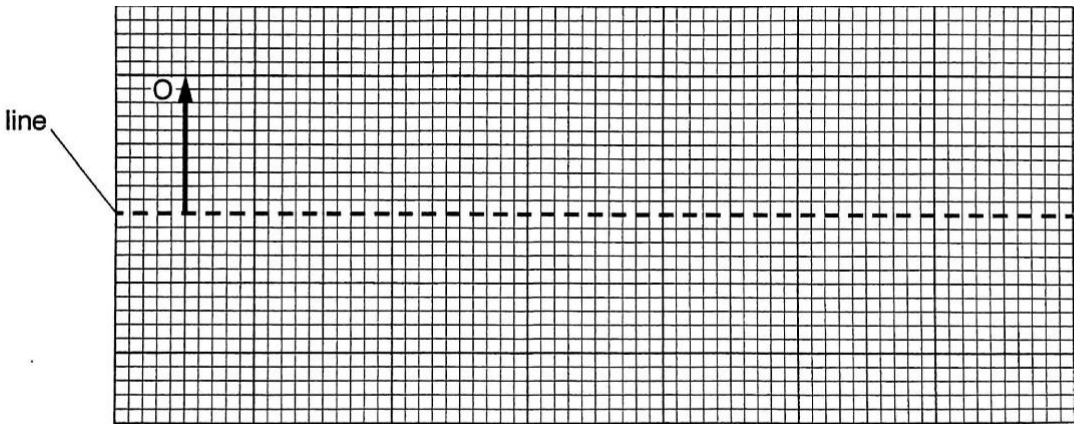

Fig. 3.1

A diminished, real image of the object is produced by the lens.

On **Fig. 3.1**,

1. draw and label the lens in a suitable postion, and mark with the letter F **one** focal point of the lens,

2. draw **three** rays of light from the top of the object to the image. [3]

(b) **Fig. 3.2** shows a ray of red light as it strikes the curved surface of a converging lens at **A**.

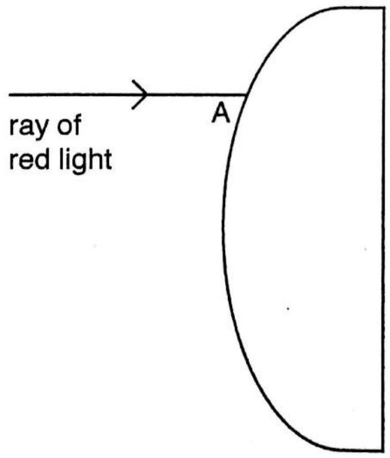

Fig. 3.2

(i) On **Fig. 3.2**,

- draw the normal at **A**,
- mark the angle of incidence at **A** with the letter *i*,
- draw the ray in the lens and in the air on the other side of the lens. [2]

(ii) The refractive index of glass for red light is 1.52 and for blue light is 1.55.

Suggest and explain what effect this difference in refractive indices has on focal length.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………. [2]

4 **Fig. 4** shows an athlete in the midst of a push-up as part of his strength training. The athlete weighs 850 N. His centre of gravity is at a distance 1.10 m from his feet and 0.50 m from his hands.

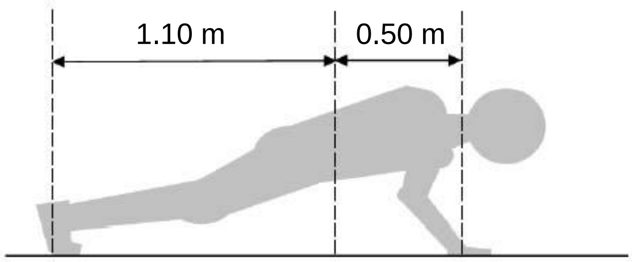

Fig. 4

(a) Define *centre of gravity*.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

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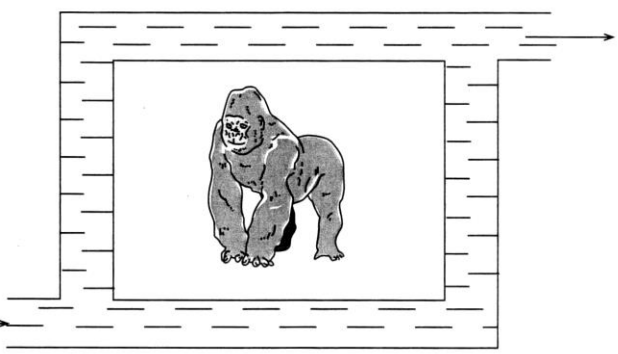
(b) Determine the magnitude of the force acting on the athlete's hands when he is in the position shown in **Fig. 4**.

Magnitude of force = …………………………. [2]

5 In order to determine the rate at which a monkey loses thermal energy, it is placed in a chamber through which water is circulated as shown.



The steady outlet temperature was recorded as 32 ˚C when the rate of flow of water was 3.0 kg h^{-1} and the inlet temperature was 25 ˚C.

When another monkey was added to the same chamber, the rate of flow of water had to increase to 7.0 kg h^{-1}, in order to achieve the same inlet and outlet temperatures.

Assume that each monkey lost thermal energy at constant rate, and the rate of loss of thermal energy from the chamber by other means remains constant.

(a) Define *temperature*.

……………………………………………………………………………………….…. [1]

(b) The main process of heat transfer from the monkey is thermal radiation. Describe **two** factors, in general, that could increase the rate of thermal radiation from an object.

1. ……………………………………………………………………………………...

……………………………………………………………………………………….….

2. ……………………………………………………………………………………...

……………………………………………………………………………………….…. [2]

(c) Calculate the rate of loss of thermal energy of the second monkey .
(Specific heat capacity of water = 4 200 J kg^{-1} K^{-1})

Rate of loss of thermal energy of the second monkey = ………………………… [4]

6 The displacement-distance graph of a wave in a string at an instant in time is shown in **Fig. 6**.

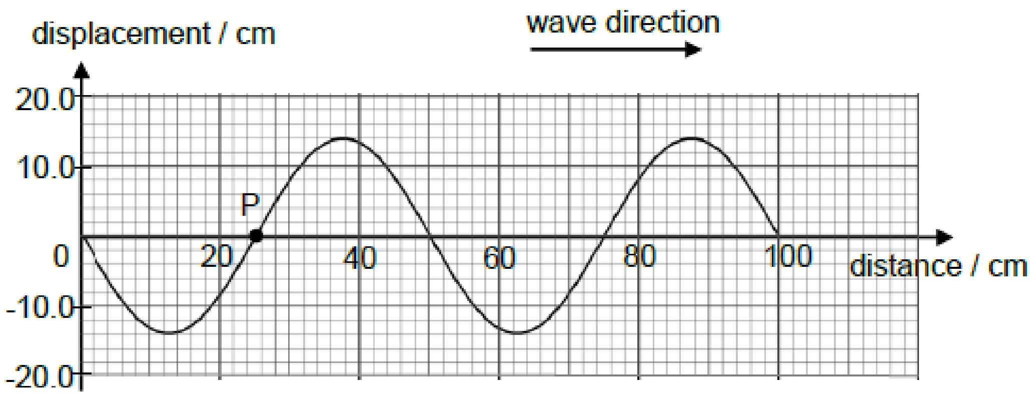


Fig. 6

The wave has a frequency of 2.0 Hz.

(a) Calculate the distance travelled by the wave in 0.060 s.

Distance = ………………………… [2]

(b) On **Fig. 6**, draw an arrow on particle P to show the direction of its motion in the next instant of time. [1]

7 **Table 7** shows the typical wavelengths of electromagnetic waves.

Electromagnetic wave	**Typical wavelength**
radio wave	3.0 m
microwave	0.030 m
X	100 μm
Y	600 nm
Z	10 nm
X-rays	0.10 nm
gamma ray	0.0010 nm

Table 7

(a) State the name of electromagnetic wave **Y**.

.... [1]

(b) State one use for electromagnetic wave **Z**.

.... [1]

(c) Calculate the frequency of electromagnetic wave **X**.

Frequency = ... [1]

(d) State one difference between sound waves and electromagnetic waves.

.... [1]

8 An electron travels horizontally towards a vertical uniform electric field formed by a pair of parallel metal plates as shown in **Fig. 8**.

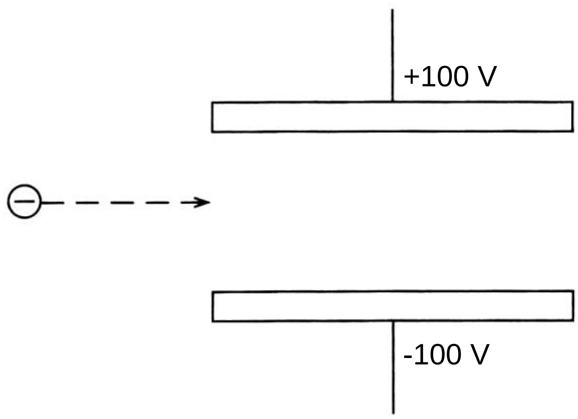


Fig. 8

For Examiner's Use

(a) Define *electric field*.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(b) On **Fig. 8**,

(i) draw the electric field pattern between the plates, [2]

(ii) complete the path of travel of the electron through the plates. [1]

9 A solenoid is placed in between two magnetic bars that are freely suspended from the ceiling, as shown in **Fig. 9**.

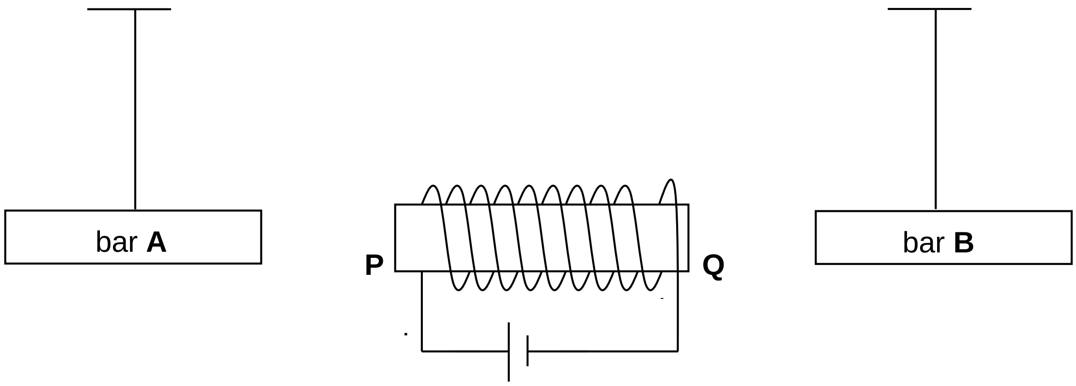


Fig. 9

(a) Determine the polarity of the solenoid at point **P** and **Q** when a current is flowing through it.

P: ……………………………………………………………………………………

Q:…………………………………………………………………………………… [1]

(b) When the current is flowing through the solenoid, bar **A** is repelled from the solenoid while bar **B** is attracted towards it.

For each bar, state whether is it *magnetised*, *unmagnetised* or *undetermined*, and explain your answer.

Bar **A**: ………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Bar **B**: ………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [4]

For Examiner's Use

10 A student sets up the circuit shown in **Fig. 10**.

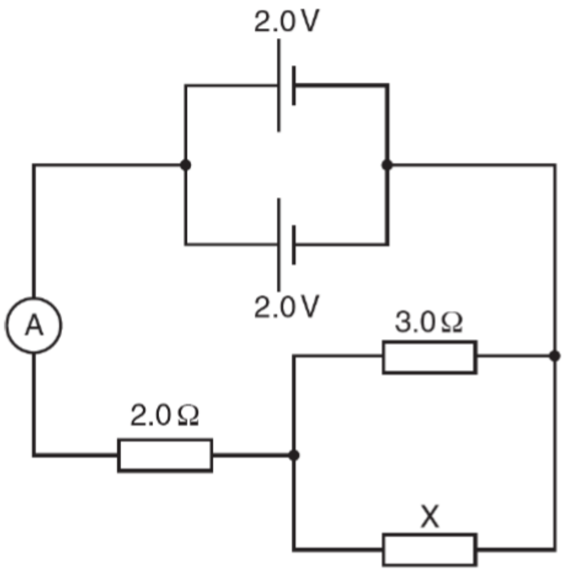


Fig. 10

(a) State one advantage of using two cells in parallel rather than using a single 2.0 V cell.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(b) Resistor **X** and the 3.0 Ω resistor have a combined resistance that is equal to 0.73 Ω.

Calculate

(i) the resistance of **X**,

Resistance = …………………………. [2]

(ii) the current passing through resistor **X**.

Current = …………………………. [2]

For Examiner's Use

Section B

Answer **all** questions from this section.
Answer only one of the two alternative questions in **Question 13**.

11 **Fig. 11** shows an electric motor used to raise a lift which is carrying a passenger of mass 70 kg. The specifications of the lift system is shown in the table below.

mass of empty lift	610 kg
voltage supply to motor	400 V
power of electrical motor	7 100 W
upward acceleration profile	0.61 m s^{-2} for 2.6 s

The journey from Level 1 at the ground floor to Level 5 takes 14 s.

The acceleration profile describes how the lift accelerates and this affects the comfort of the lift passengers. The lift accelerates upwards with the acceleration profile before reaching its constant travelling speed, known as the contract speed. The gravitational field strength g is 10 N kg^{-1}.

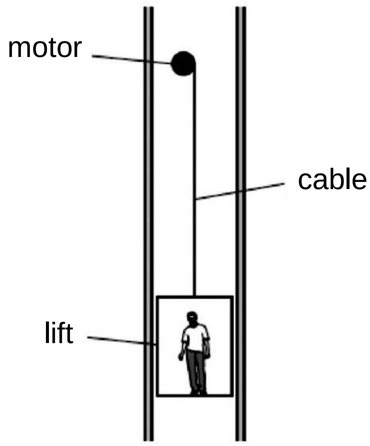


Fig. 11

(a) Calculate the electrical current drawn by the lift during normal operation.

Current = ………………………… [2]

(b) Ignoring air resistance, calculate

(i) the tension in the lift cable when the lift with its passenger are accelerating upwards,

Tension = ………………………… [2]

For Examiner's Use

(ii) the normal contact force acting on the passenger as he is accelerating upwards with the lift.

Normal contact force = ………………………… [2]

(c) Calculate the maximum speed attained by the lift with its passenger as it travels from Level 1 to Level 5.

Maximum speed = ………………………… [2]

(d) The height gained by the lift with its passenger as it journeyed from Level 1 to Level 5 was 13 m. Consider the gain in kinetic energy and gravitational potential energy, calculate the efficiency of the lift system.

[3]

Efficiency= …………………………

12 **Fig. 12.1** shows a children's ride. A carriage with children is pulled up the slope by a motor. The carriage stops at **A** and then runs down through **B**, **C** and **D** without further input of energy. The height of the ride is 30.0 m at **A** and 10.0 m at **C**.

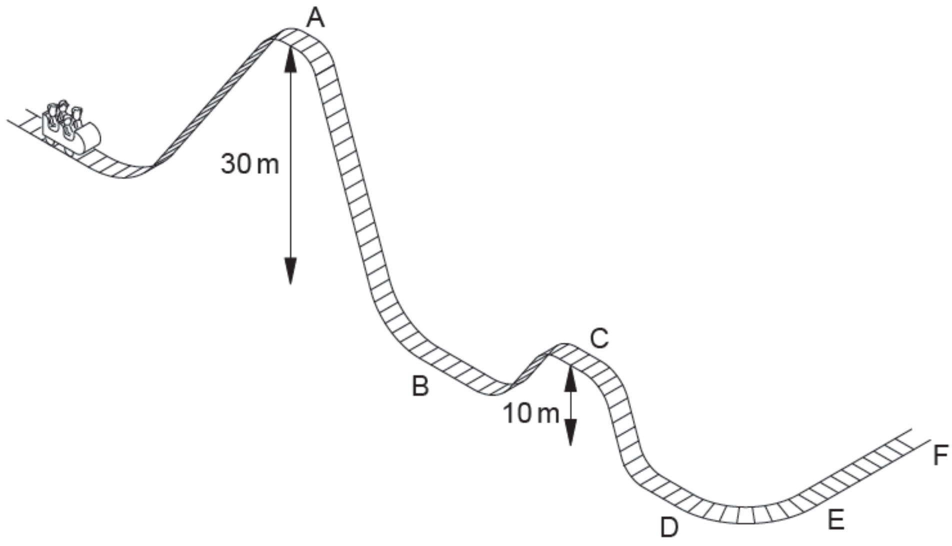


Fig. 12.1

The mass of the children and the carriage is 490 kg.
Take the gravitational field strength to be 10 N kg^{-1}.

(a) **(i)** State the *law of conservation of energy*.

…………………………………………………………………………………….

…………………………………………………………………………………….

…………………………………………………………………………………….

……………………………………………………………………………………. [1]

(ii) Calculate the gain in gravitational potential energy of the carriage and children when it is pulled up to **A**.

Gravitational potential energy = …………………………. [2]

(iii) The speed of the carriage at **C** is 10 m s^{-1}.

Calculate the work done by the carriage against friction in travelling from **A** to **C**.

Work done against friction = …………………………. [3]

(b) Between **D** and **E**, the carriage and children go around a horizontal circular section of the track as shown in **Fig. 12.2** at a constant speed.

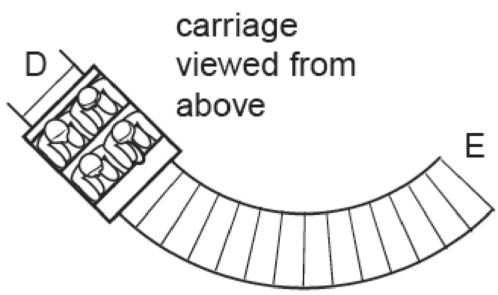


Fig. 12.2

(i) On **Fig. 12.2**, draw an arrow on the carriage to mark the direction of its velocity at the position shown. Label the arrow *v*. [1]

(ii) All the children move towards the right side of the carriage just as the carriage turns left. A student said that there is a force pushing the children to the right. State whether the student is *correct* or *incorrect*. Explain.

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………. [2]

13 EITHER

A spring hangs vertically from a fixed point. A copper plate is attached to the free end of the spring, as shown in **Fig. 13.1**.

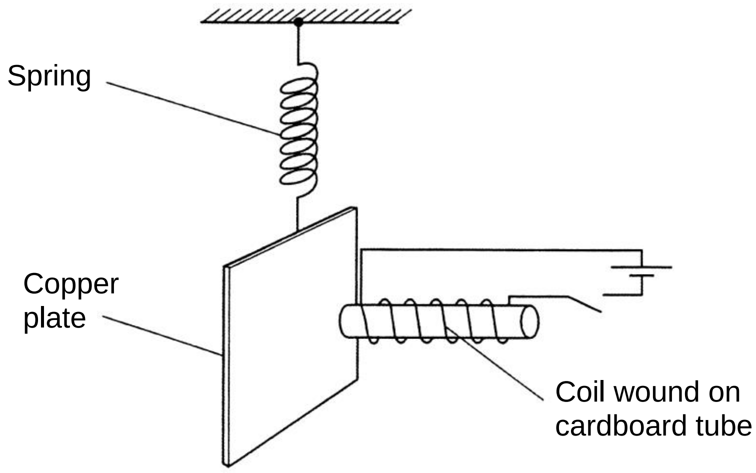


Fig. 13.1

One end of a coil of wire, wound on a cardboard tube, is placed near to the copper plate.

The copper plate is displaced vertically and then released. The variation with time t of the vertical displacement y of the plate is shown in **Fig. 13.2**.

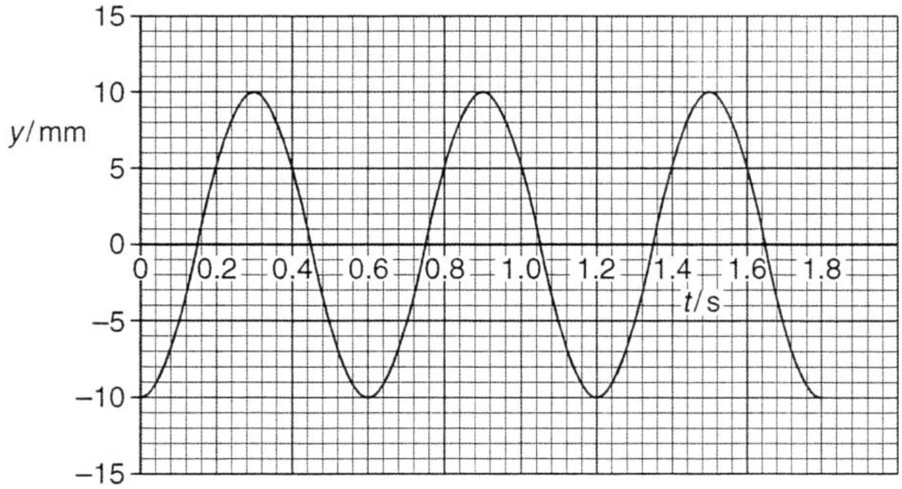


Fig. 13.2

(a) Calculate the frequency of the oscillation.

Frequency of oscillation = ………………………… [2]

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(b) Write down the amplitude of the oscillation.

.... [1]

(c) At time t = 1.8 s, the current in the coil in **Fig. 13.1** is switched on. The variation with time t of the subsequent oscillations of the plate is shown in **Fig. 13.3**.

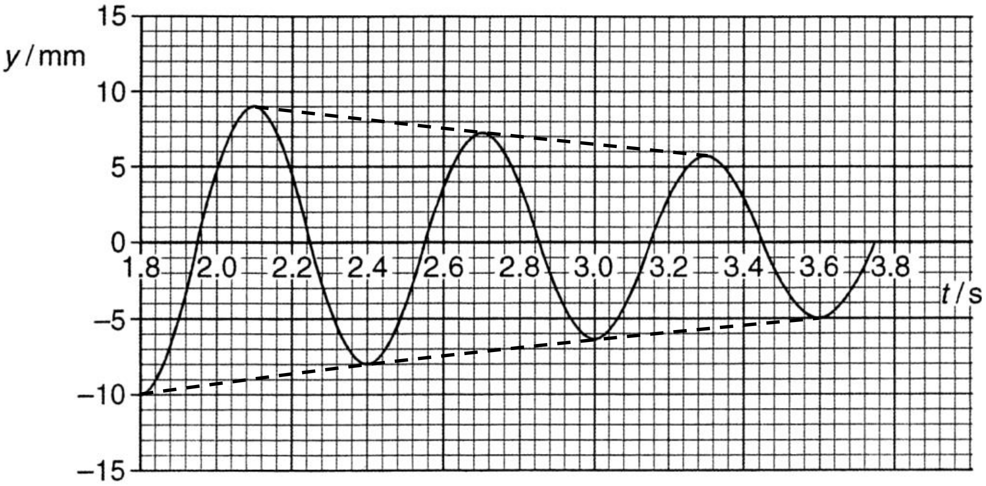

Fig. 13.3

(i) Explain why the amplitude of the oscillations is lower after the coil is switched on.

....

....

....

....

....

....

....

....

....

.... [5]

(ii) It is observed that the amplitude of the oscillations decreases with a decreasing rate. Explain.

....

....

....

.... [2]

For Examiner's Use

13 OR

Fig. 13.4 shows the electrical wiring in a table lamp.

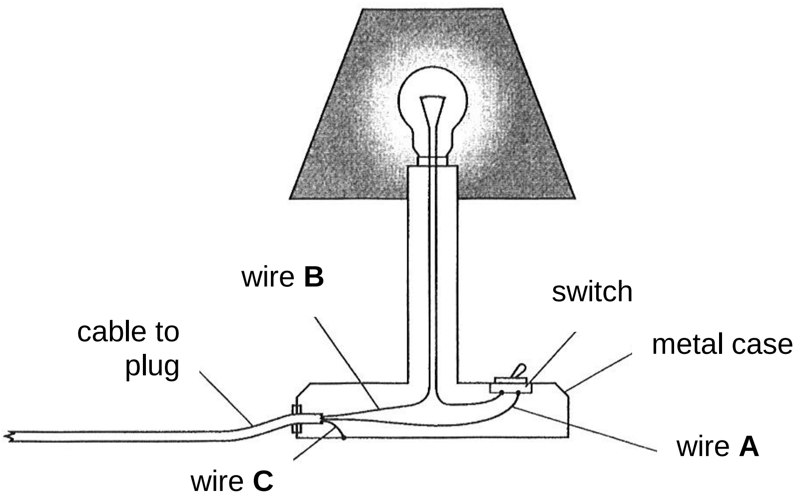

Fig. 13.4

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

....

....

.... [2]

(b) **(i)** The cable is connected to a plug which contains a fuse. Explain the purpose and action of the fuse.

....

....

....

....

.... [3]

(ii) Wire **A** becomes loose and touches the metal case.

Explain why a person who later touches the case feels no shock and is not harmed.

....

....

.... [1]

For Examiner's Use

(c) The lamp is marked “230 V, 100 W”.

(i) Calculate the resistance of the lamp when it is working normally.

Resistance = …………………………. [2]

(ii) A second lamp is marked “230 V, 60 W”.

Calculate the ratio of the resistance of the first lamp to the resistance of the second lamp when they are working normally.

Ratio = …………………………. [1]

(d) The second lamp is doubly insulated and there is no wire connected to the case. Explain why this lamp is safe to use.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

End of paper