

**1** Make estimates of the following quantities.

**(a)** the thickness of a sheet of paper

thickness = ..... mm [1]

**(b)** the time for sound to travel 100 m in air

time = ..... s [1]

**(c)** the weight of  $1000\text{ cm}^3$  of water

weight = ..... N [1]

**2** Briefly describe the structures of crystalline solids, polymers and amorphous materials.

crystalline solids .....

.....

.....

polymers .....

.....

.....

amorphous materials .....

.....

.....

[5]

**3** A loudspeaker produces a sound wave of constant frequency.

Outline how a cathode-ray oscilloscope (c.r.o.) may be used to determine this frequency.

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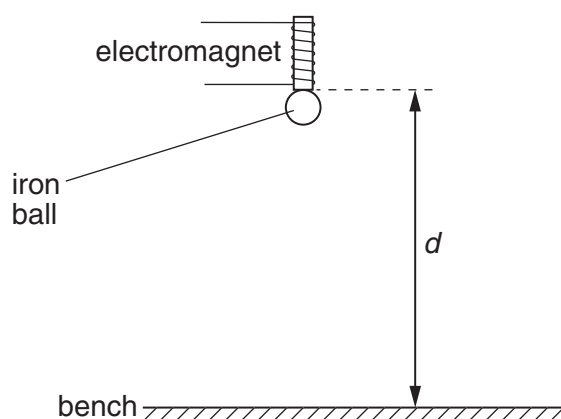
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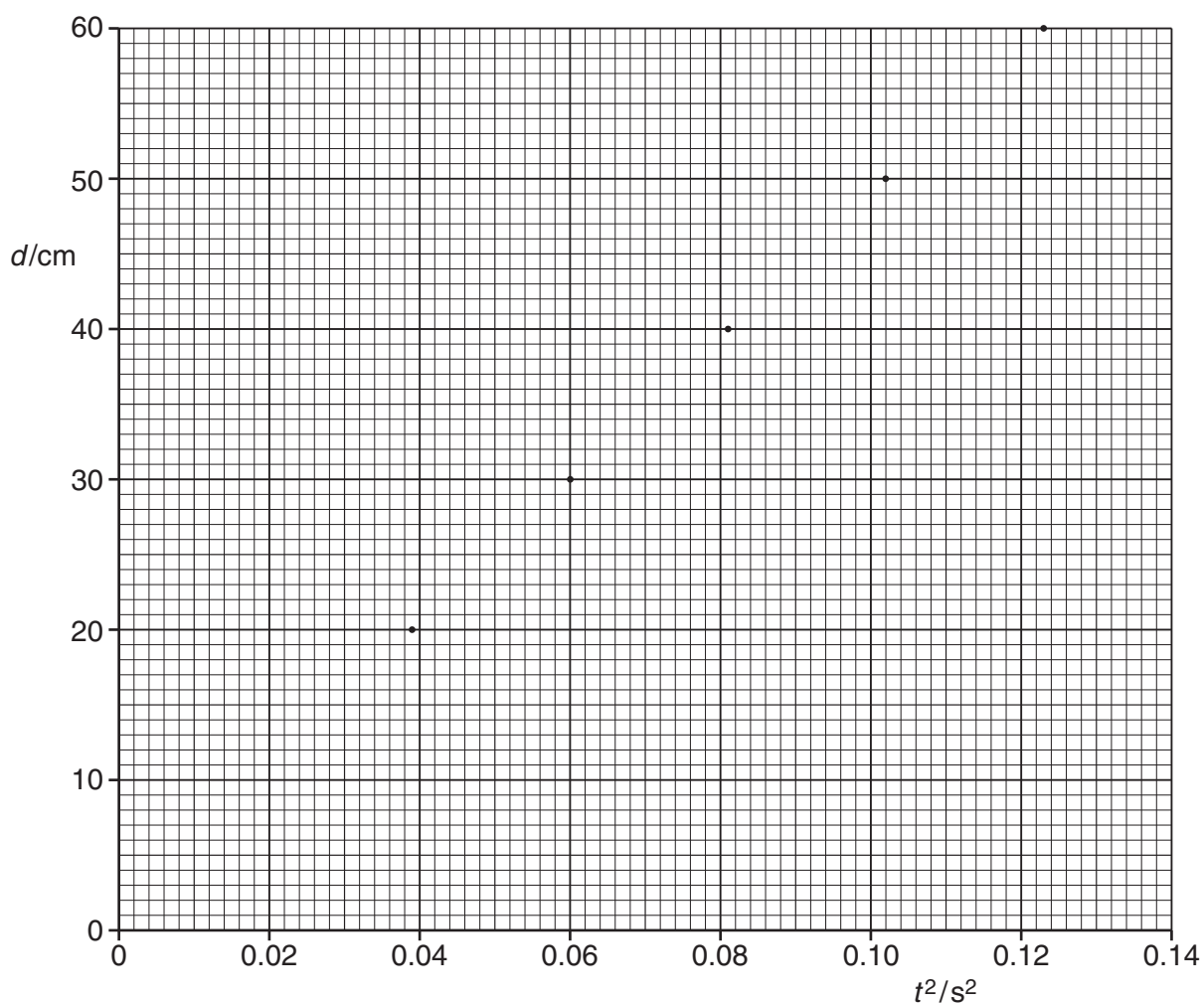
- 4 A student takes measurements to determine a value for the acceleration of free fall. Some of the apparatus used is illustrated in Fig. 4.1.



**Fig. 4.1**

The student measures the vertical distance  $d$  between the base of the electromagnet and the bench. The time  $t$  for an iron ball to fall from the electromagnet to the bench is also measured.

Corresponding values of  $t^2$  and  $d$  are shown in Fig. 4.2.



**Fig. 4.2**

(a) On Fig. 4.2, draw the line of best fit for the points. [1]

(b) State and explain why there is a non-zero intercept on the graph of Fig. 4.2.

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

(c) Determine the student's value for

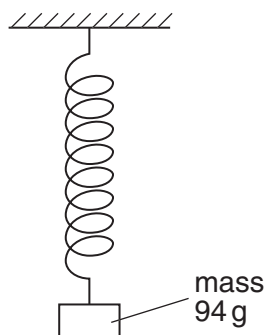
(i) the diameter of the ball,

diameter = ..... cm [1]

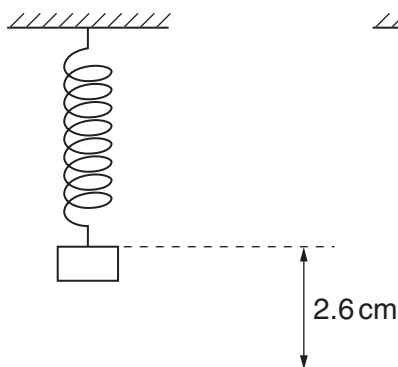
(ii) the acceleration of free fall.

acceleration = .....  $\text{ms}^{-2}$  [3]

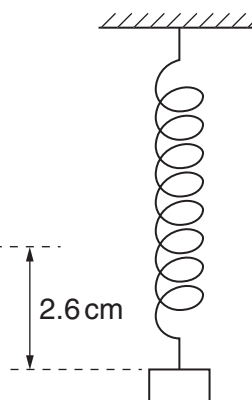
- 5 A spring hangs vertically from a fixed point and a mass of 94 g is suspended from the spring, stretching the spring as shown in Fig. 5.1.



**Fig. 5.1**



**Fig. 5.2**



**Fig. 5.3**

The mass is raised vertically so that the length of the spring is its unextended length. This is illustrated in Fig. 5.2.

The mass is then released. The mass moves through a vertical distance of 2.6 cm before temporarily coming to rest. This position is illustrated in Fig. 5.3.

- (a) State which diagram, Fig. 5.1, Fig. 5.2 or Fig. 5.3, illustrates the position of the mass such that

- (i) the mass has maximum gravitational potential energy,

..... [1]

- (ii) the spring has maximum strain energy.

..... [1]

- (b) Briefly describe the variation of the kinetic energy of the mass as the mass falls from its highest position (Fig. 5.2) to its lowest position (Fig. 5.3).

.....

..... [1]

- (c) The strain energy  $E$  stored in the spring is given by the expression

$$E = \frac{1}{2}kx^2$$

where  $k$  is the spring constant and  $x$  is the extension of the spring.

the mass moving between the positions shown in Fig. 5.2 and Fig. 5.3,

- (i) calculate the change in the gravitational potential energy of the mass,

change = ..... J [2]

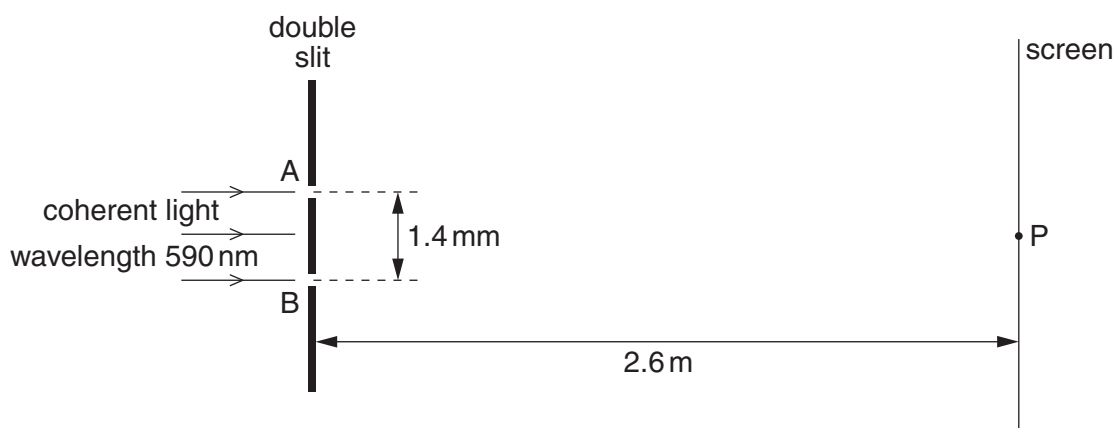
- (ii) determine the extension of the spring at which the strain energy is half its maximum value.

extension = ..... cm [3]

- 6 (a) State the principle of superposition.

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

- (b) Coherent light of wavelength 590 nm is incident normally on a double slit, as shown in Fig. 6.1.



**Fig. 6.1** (not to scale)

The separation of the slits A and B is 1.4 mm.  
Interference fringes are observed on a screen placed parallel to the plane of the double slit.  
The distance between the screen and the double slit is 2.6 m.

At point P on the screen, the path difference is zero for light arriving at P from the slits A and B.

- (i) Determine the separation of bright fringes on the screen near to point P.

separation = ..... mm [3]

- (ii) The variation with time of the displacement  $x$  of the light wave arriving at point P on the screen from slit A and from slit B is shown in Fig. 6.2a and Fig. 6.2b respectively.

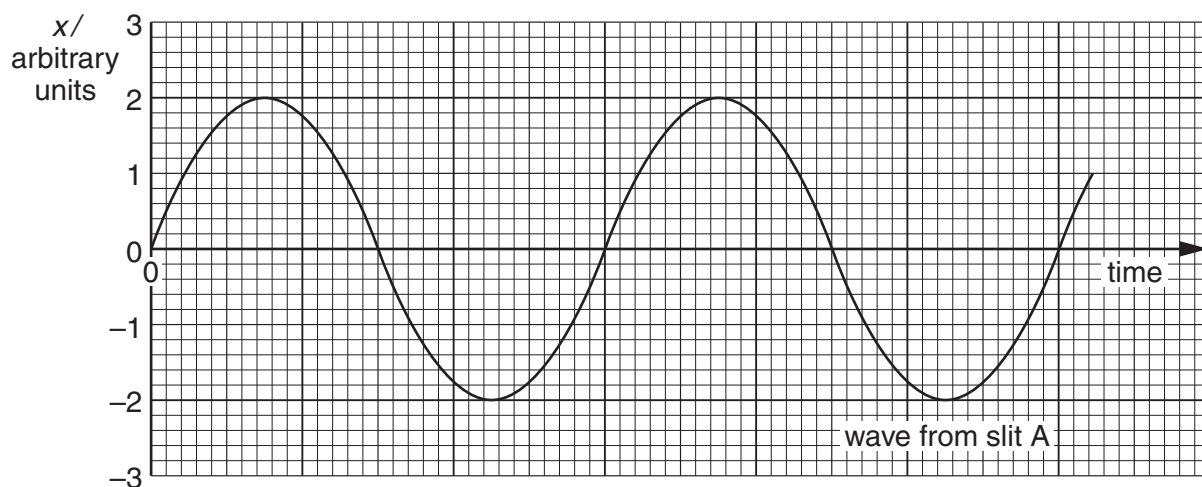


Fig. 6.2a

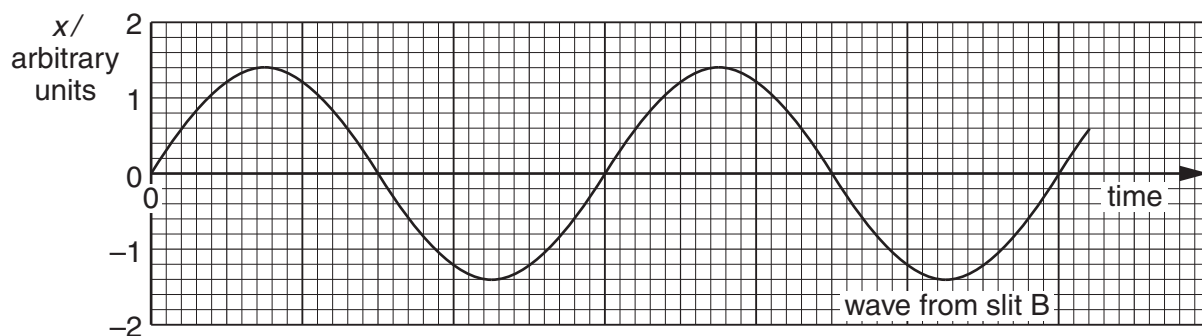


Fig. 6.2b

1. State the phase difference between waves forming the dark fringe on the screen that is next to point P.

phase difference = ..... ° [1]

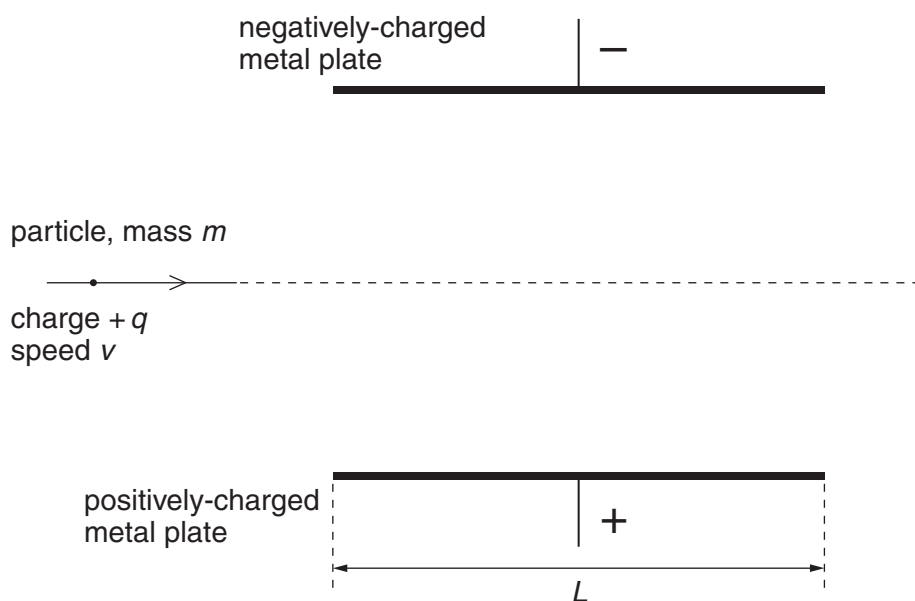
2. Determine the ratio

$$\frac{\text{intensity of light at a bright fringe}}{\text{intensity of light at a dark fringe}}$$

ratio = ..... [3]



- 7 Two oppositely-charged parallel metal plates are situated in a vacuum, as shown in Fig. 7.1.



**Fig. 7.1**

The plates have length  $L$ .

The uniform electric field between the plates has magnitude  $E$ . The electric field outside the plates is zero.

A positively-charged particle has mass  $m$  and charge  $+q$ . Before the particle reaches the region between the plates, it is travelling with speed  $v$  parallel to the plates. The particle passes between the plates and into the region beyond them.

- (a) (i) On Fig. 7.1, draw the path of the particle between the plates and beyond them. [2]

- (ii) the particle in the region between the plates, state expressions, in terms of  $E$ ,  $m$ ,  $q$ ,  $v$  and  $L$ , as appropriate, for

1. the force  $F$  on the particle,

..... [1]

2. the time  $t$  for the particle to cross the region between the plates.

..... [1]

**(b) (i)** State the law of conservation of linear momentum.

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

**(ii)** Use your answers in **(a)(ii)** to state an expression for the change in momentum of the particle.

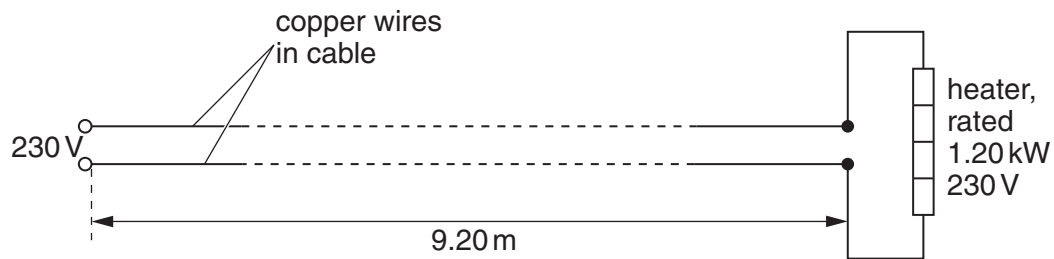
..... [1]

**(iii)** Suggest and explain whether the law of conservation of linear momentum applies to the particle moving between the plates.

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

- 8 An electric heater has a constant resistance and is rated as 1.20 kW, 230 V.

The heater is connected to a 230 V supply by means of a cable that is 9.20 m long, as illustrated in Fig. 8.1.



**Fig. 8.1**

The two copper wires that make up the cable each have a circular cross-section of diameter 0.900 mm. The resistivity of copper is  $1.70 \times 10^{-8} \Omega \text{ m}$ .

**(a)** Show that

- (i)** the resistance of the heater is  $44.1 \Omega$ ,

[2]

- (ii)** the total resistance of the cable is  $0.492 \Omega$ .

[2]

9 (a) Explain what is meant by *radioactive decay*.

.....

.....

..... [2]

(b) (i) State how the random nature of radioactive decay may be inferred from observations of the count rate.

.....

..... [1]

(ii) A radioactive source has a long half-life so that, over a period of several days, its rate of decay remains constant.  
State the effect, if any, of a rise in temperature on this decay rate.

..... [1]

(iii) Suggest why some radioactive sources are found to contain traces of helium gas.

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..... [2]