

--

--	--	--	--	--

--	--	--	--

9702/21

October/November 2010

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **15** printed pages and **1** blank page.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For
Examiner's
Use

- 1 (a) Two of the SI base quantities are mass and time. State three other SI base quantities.

1.

2.

3.

[3]

- (b) A sphere of radius r is moving at speed v through air of density ρ . The resistive force F acting on the sphere is given by the expression

$$F = Br^2\rho v^k$$

where B and k are constants without units.

- (i) State the SI base units of F , ρ and v .

F

ρ

v

[3]

- (ii) Use base units to determine the value of k .

$k =$ [2]

BLANK PAGE

Please turn over for Question 2.

- 2 A ball is thrown horizontally from the top of a building, as shown in Fig. 2.1.

For
Examiner's
Use

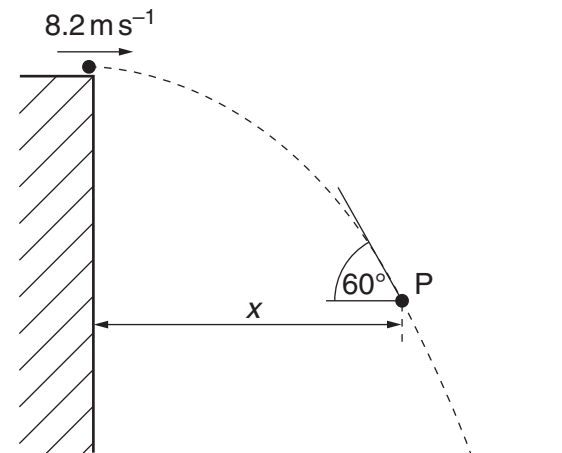


Fig. 2.1

The ball is thrown with a horizontal speed of 8.2 m s^{-1} . The side of the building is vertical. At point P on the path of the ball, the ball is distance x from the building and is moving at an angle of 60° to the horizontal. Air resistance is negligible.

- (a) For the ball at point P,

- (i) show that the vertical component of its velocity is 14.2 m s^{-1} ,

[2]

- (ii) determine the vertical distance through which the ball has fallen,

distance = ... m [2]

- (iii) determine the horizontal distance x .

$x = \dots\dots\dots$ m [2]

- (b) The path of the ball in (a), with an initial horizontal speed of 8.2 m s^{-1} , is shown again in Fig. 2.2.

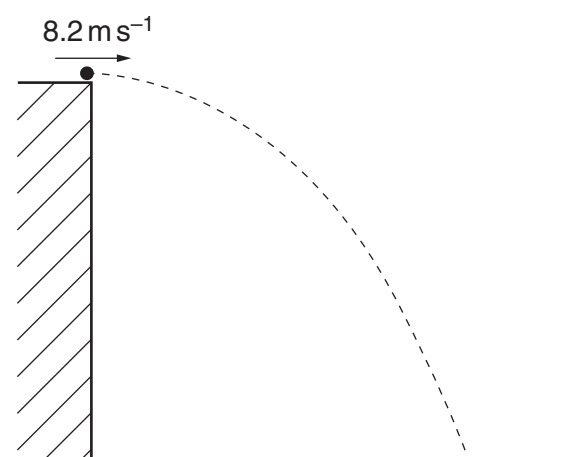


Fig. 2.2

On Fig. 2.2, sketch the new path of the ball for the ball having an initial horizontal speed

- (i) greater than 8.2 m s^{-1} and with negligible air resistance (label this path G), [2]
- (ii) equal to 8.2 m s^{-1} but with air resistance (label this path A). [2]

- 3 (a) State the relation between force and momentum.

..... [1]

For
Examiner's
Use

- (b) A rigid bar of mass 450 g is held horizontally by two supports A and B, as shown in Fig. 3.1.

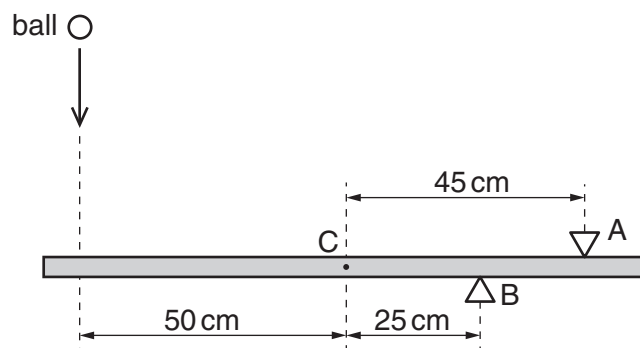


Fig. 3.1

The support A is 45 cm from the centre of gravity C of the bar and support B is 25 cm from C.

A ball of mass 140 g falls vertically onto the bar such that it hits the bar at a distance of 50 cm from C, as shown in Fig. 3.1.

The variation with time t of the velocity v of the ball before, during and after hitting the bar is shown in Fig. 3.2.

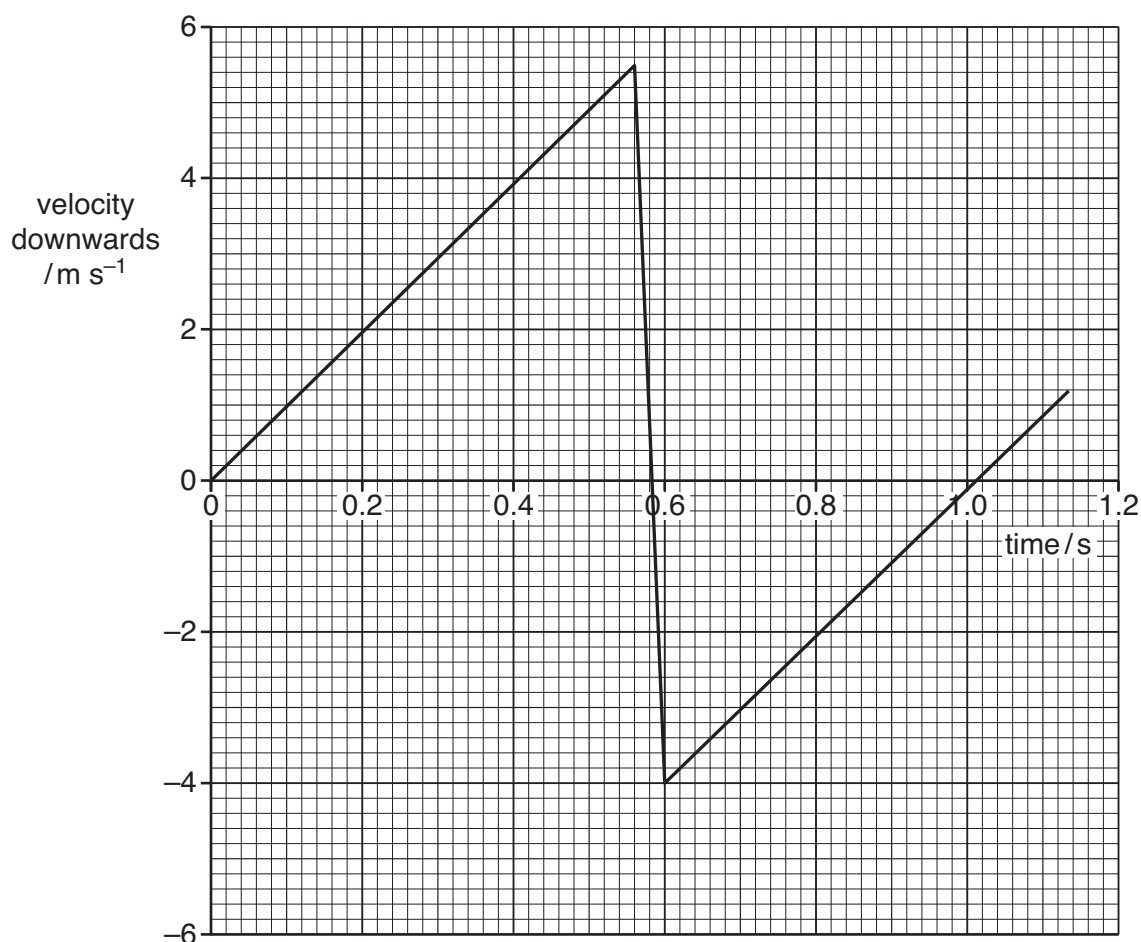


Fig. 3.2

For the time that the ball is in contact with the bar, use Fig. 3.2

- (i) to determine the change in momentum of the ball,

For
Examiner's
Use

change = ... kg ms^{-1} [2]

- (ii) to show that the force exerted by the ball on the bar is 33 N.

[1]

- (c) For the time that the ball is in contact with the bar, use data from Fig. 3.1 and (b)(ii) to calculate the force exerted on the bar by

- (i) the support A,

force = ... N [3]

- (ii) the support B.

force = ... N [2]

- 4 (a) A uniform wire has length L and constant area of cross-section A . The material of the wire has Young modulus E and resistivity ρ . A tension F in the wire causes its length to increase by ΔL .

For this wire, state expressions, in terms of L , A , F , ΔL and ρ for

- (i) the stress σ ,

..... [1]

- (ii) the strain ϵ ,

..... [1]

- (iii) the Young modulus E ,

..... [1]

- (iv) the resistance R .

..... [1]

- (b) One end of a metal wire of length 2.6 m and constant area of cross-section $3.8 \times 10^{-7} \text{ m}^2$ is attached to a fixed point, as shown in Fig. 4.1.

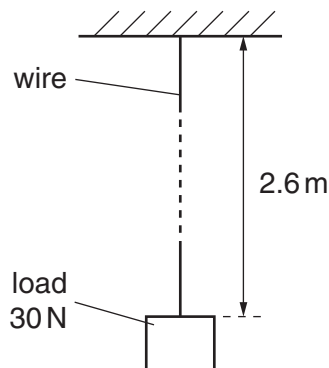


Fig. 4.1

The Young modulus of the material of the wire is $7.0 \times 10^{10} \text{ Pa}$ and its resistivity is $2.6 \times 10^{-8} \Omega \text{ m}$.

A load of 30 N is attached to the lower end of the wire. Assume that the area of cross-section of the wire does not change.

For this load of 30 N,

For
Examiner's
Use

- (i) show that the extension of the wire is 2.9 mm,

[1]

- (ii) calculate the change in resistance of the wire.

change = ... Ω [2]

- (c) The resistance of the wire changes with the applied load.
Comment on the suggestion that this change of resistance could be used to measure the magnitude of the load on the wire.

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

- 5 (a) State what is meant by the *diffraction* of a wave.

For
Examiner's
Use

.....

.....

..... [2]

- (b) Plane wavefronts are incident on a slit, as shown in Fig. 5.1.

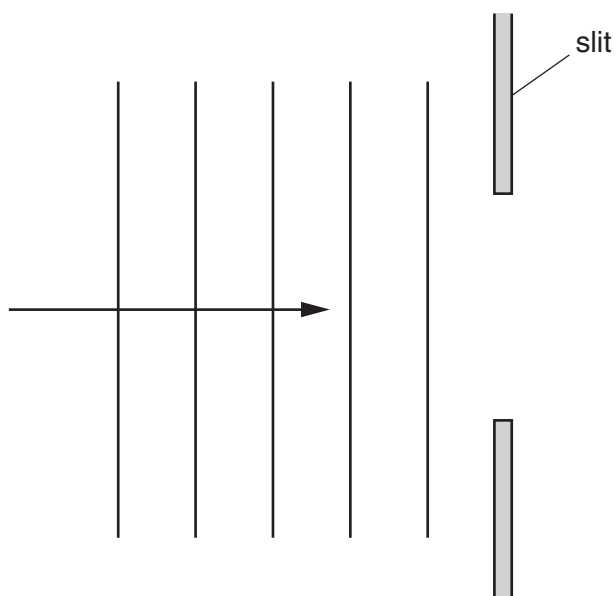


Fig. 5.1

Complete Fig. 5.1 to show four wavefronts that have emerged from the slit.

[2]

- (c) Monochromatic light is incident normally on a diffraction grating having 650 lines per millimetre, as shown in Fig. 5.2.

For
Examiner's
Use

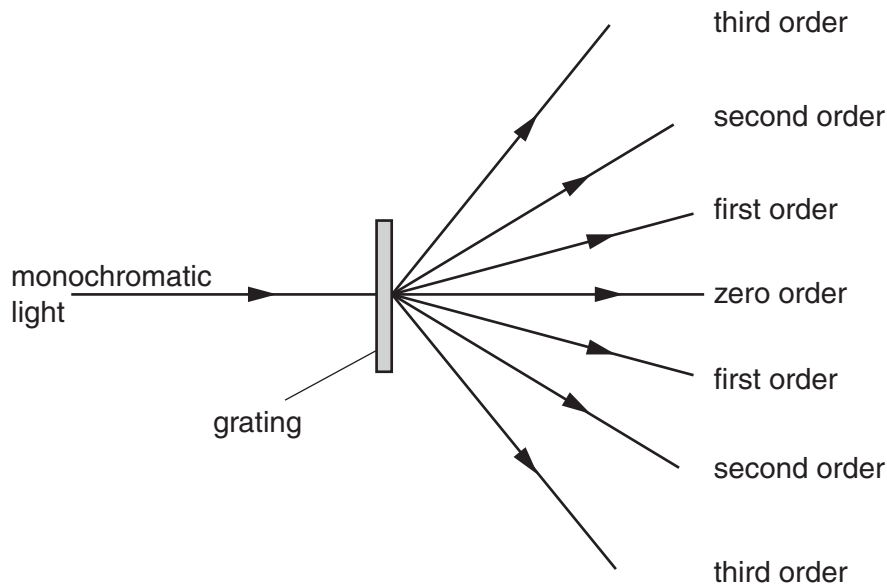


Fig. 5.2

An image (the zero order) is observed for light that has an angle of diffraction equal to zero.

For incident light of wavelength 590 nm, determine the number of orders of diffracted light that can be observed on each side of the zero order.

number = ... [3]

- (d) The images in Fig. 5.2 are viewed, starting with the zero order and then with increasing order number.
State how the appearance of the images changes as the order number increases.

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

6 (a) A lamp is rated as 12V, 36W.

(i) Calculate the resistance of the lamp at its working temperature.

For
Examiner's
Use

resistance = ... Ω [2]

(ii) On the axes of Fig. 6.1, sketch a graph to show the current-voltage (I – V) characteristic of the lamp. Mark an appropriate scale for current on the y -axis.

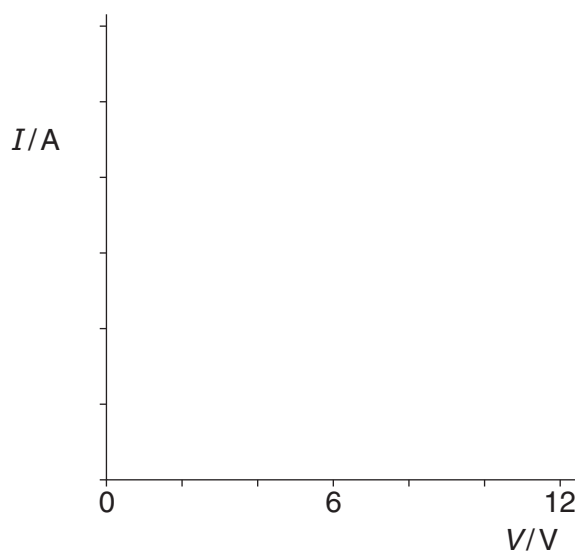


Fig. 6.1

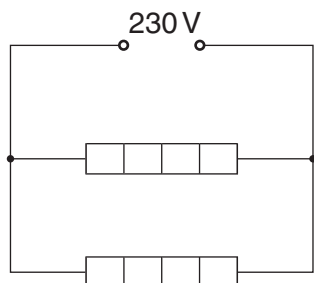
[3]

- (b) Some heaters are each labelled 230V, 1.0kW. The heaters have constant resistance.

Determine the total power dissipation for the heaters connected as shown in each of the diagrams shown below.

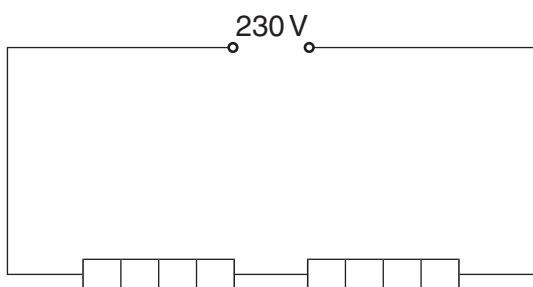
For
Examiner's
Use

(i)



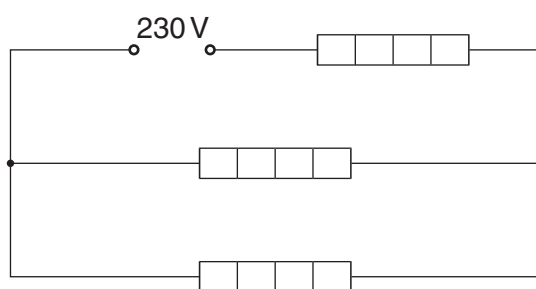
power = ... kW [1]

(ii)



power = ... kW [1]

(iii)



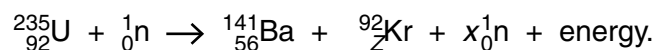
power = ... kW [2]

- 7 (a) Uranium (U) has at least fourteen isotopes.
Explain what is meant by *isotopes*.

For
Examiner's
Use

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

- (b) One possible nuclear reaction involving uranium is



- (i) State three quantities that are conserved in a nuclear reaction.

1.
.....
2.
.....
3.
..... [3]

- (ii) For this reaction, determine the value of

1. Z ,

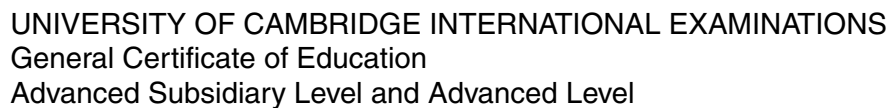
$Z =$ [1]

2. x .

$x =$ [1]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9702/22

October/November 2010

1 hour

No Additional Materials are required.

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **17** printed pages and **3** blank pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For
Examiner's
Use

- 1 (a) (i) Distinguish between vector quantities and scalar quantities.

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

- (ii) State whether each of the following is a vector quantity or a scalar quantity.

1. temperature

.....[1]

2. acceleration of free fall

.....[1]

3. electrical resistance

.....[1]

- (b) A block of wood of weight 25 N is held stationary on a slope by means of a string, as shown in Fig. 1.1.

For
Examiner's
Use

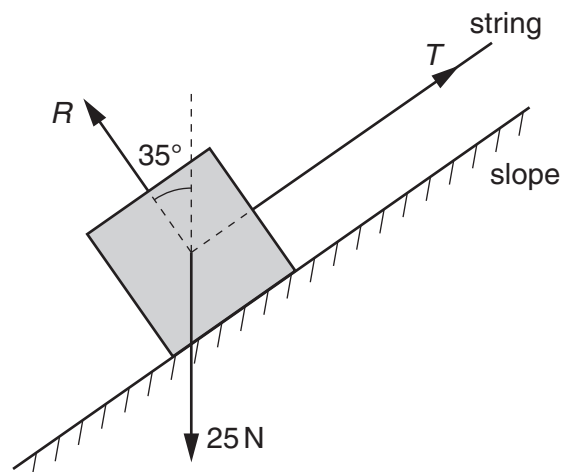


Fig. 1.1

The tension in the string is T and the slope pushes on the block with a force R that is normal to the slope.

Either by scale drawing on Fig. 1.1 or by calculation, determine the tension T in the string.

$T = \dots\dots\dots$ N [3]

- 2 A ball is thrown from a point P, which is at ground level, as illustrated in Fig. 2.1.

For
Examiner's
Use

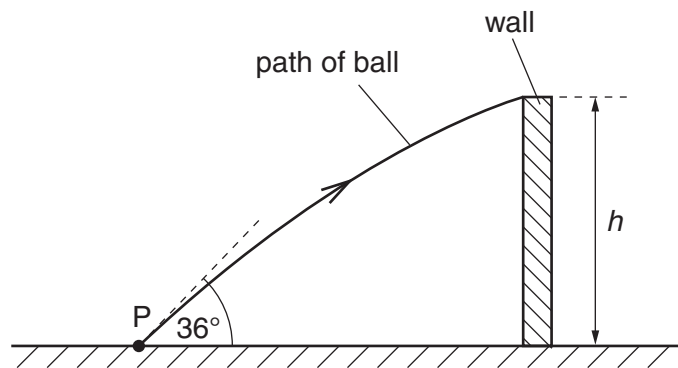


Fig. 2.1

The initial velocity of the ball is 12.4 m s^{-1} at an angle of 36° to the horizontal. The ball just passes over a wall of height h . The ball reaches the wall 0.17 s after it has been thrown.

- (a) Assuming air resistance to be negligible, calculate
- (i) the horizontal distance of point P from the wall,

distance = ... m [2]

(ii) the height h of the wall.

$h = \dots\dots\dots$ m [3]

- (b) A second ball is thrown from point P with the same velocity as the ball in (a). For this ball, air resistance is not negligible. This ball hits the wall and rebounds.

On Fig. 2.1, sketch the path of this ball between point P and the point where it first hits the ground. [2]

- 3 (a) State what is meant by the *centre of gravity* of a body.

.....

.....

.....[2]

- (b) A uniform rectangular sheet of card of weight W is suspended from a wooden rod. The card is held to one side, as shown in Fig. 3.1.

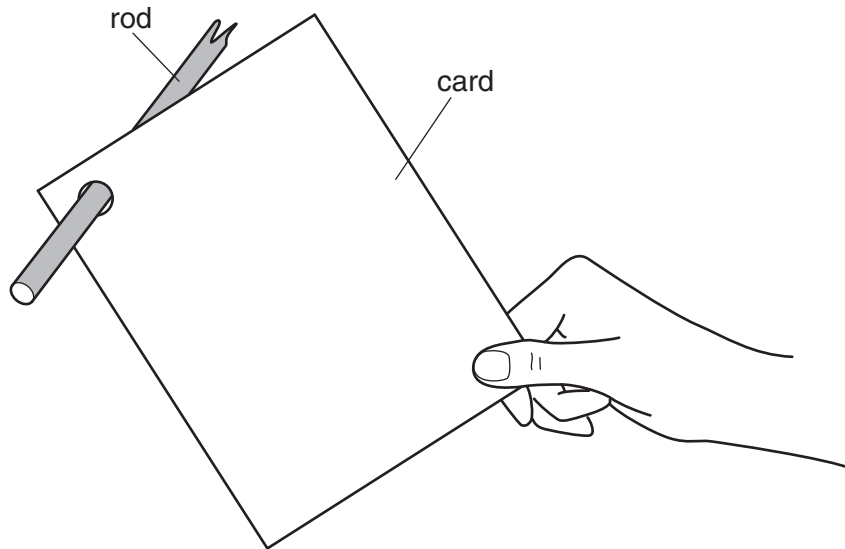


Fig. 3.1

On Fig. 3.1,

- (i) mark, and label with the letter C , the position of the centre of gravity of the card, [1]
- (ii) mark with an arrow labelled W the weight of the card. [1]

(c) The card in (b) is released. The card swings on the rod and eventually comes to rest.

- (i) List the two forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1.

.....

2.

.....

[3]

- (ii) By reference to the completed diagram of Fig. 3.1, state the position in which the card comes to rest.

Explain why the card comes to rest in this position.

.....

.....

..... [2]

- 4 (a) A metal wire has spring constant k . Forces are applied to the ends of the wire to extend it within the limit of Hooke's law.
Show that, for an extension x , the strain energy E stored in the wire is given by

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

For
Examiner's
Use

[4]

- (b) The wire in (a) is now extended beyond its elastic limit. The forces causing the extension are then removed.

The variation with extension x of the tension F in the wire is shown in Fig. 4.1.

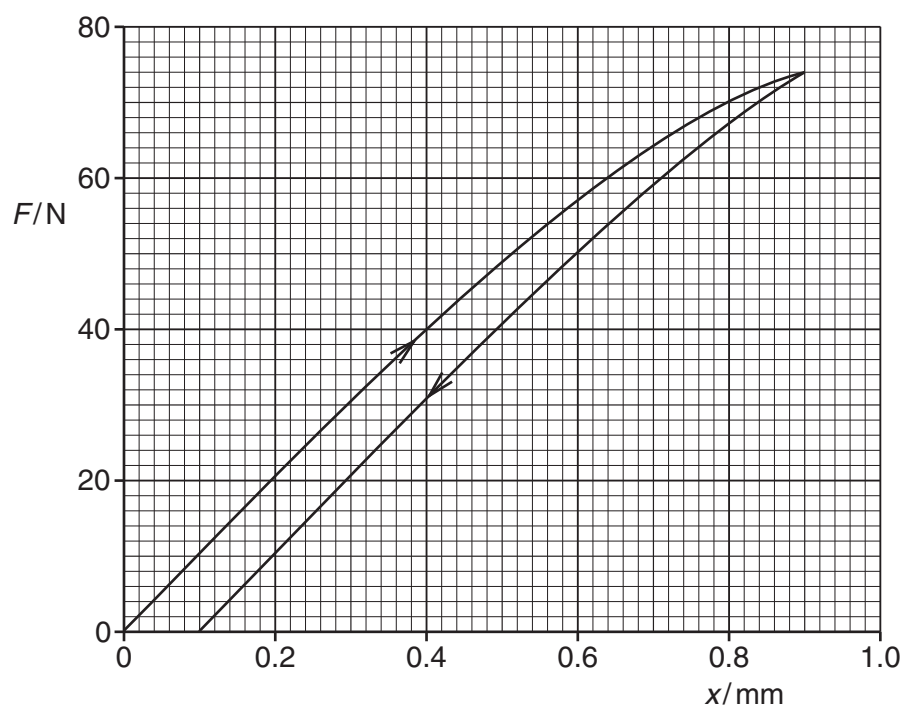


Fig. 4.1

Energy E_S is expended to cause a permanent extension of the wire.

- (i) On Fig. 4.1, shade the area that represents the energy E_S .

[1]

- (ii) Use Fig. 4.1 to calculate the energy E_S .

For
Examiner's
Use

$$E_S = \dots\dots\dots \text{mJ} [3]$$

- (iii) Suggest the change in the structure of the wire that is caused by the energy E_S .

.....

..... [1]

- 5 A student is studying a water wave in which all the wavefronts are parallel to one another. The variation with time t of the displacement x of a particular particle in the wave is shown in Fig. 5.1.

For
Examiner's
Use

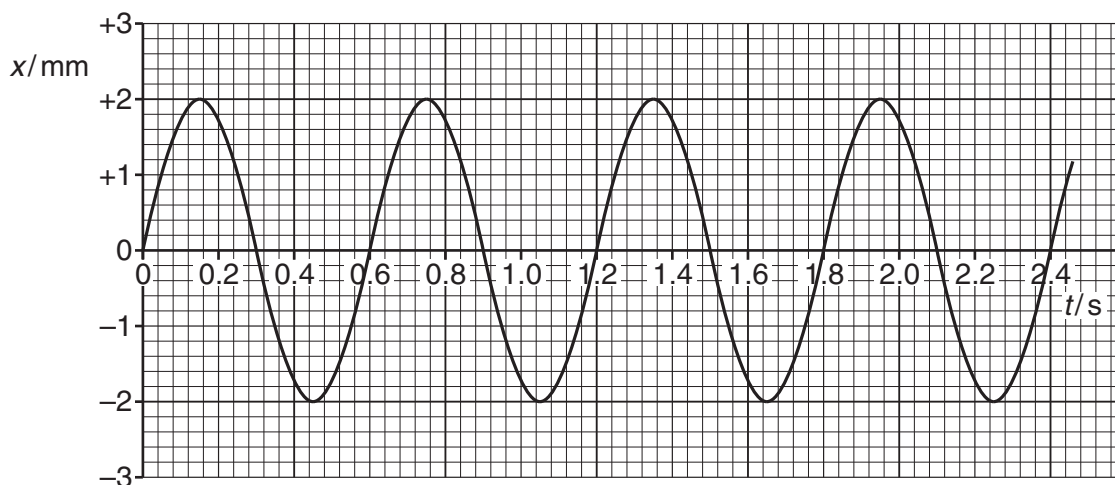


Fig. 5.1

The distance d of the oscillating particles from the source of the waves is measured. At a particular time, the variation of the displacement x with this distance d is shown in Fig. 5.2.

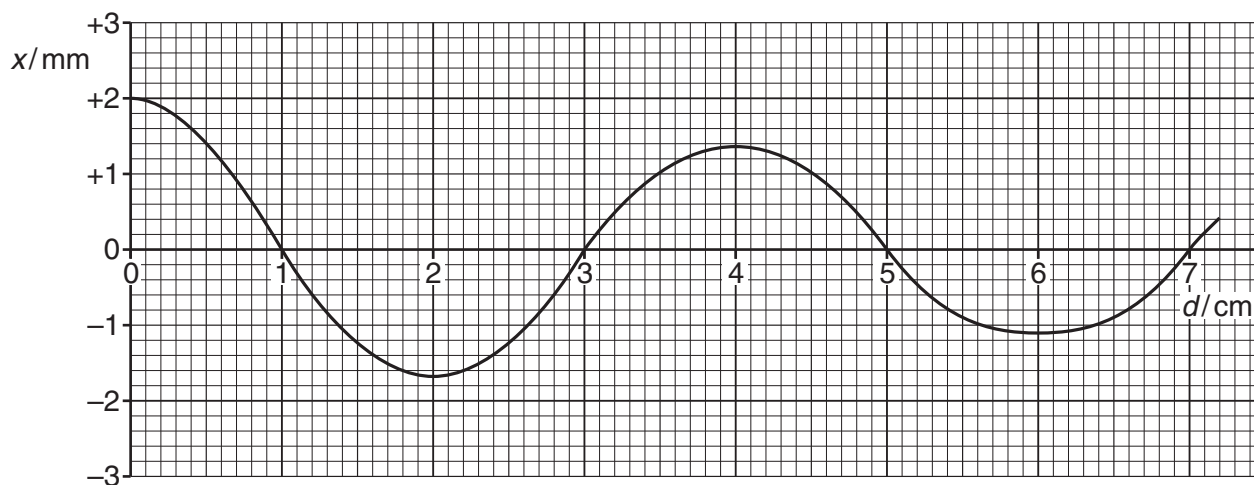


Fig. 5.2

(a) Define, for a wave, what is meant by

(i) *displacement*,

.....
 [1]

(ii) *wavelength*.

.....
 [1]

(b) Use Figs. 5.1 and 5.2 to determine, for the water wave,

(i) the period T of vibration,

$T = \dots\dots\dots$ s [1]

(ii) the wavelength λ ,

$\lambda = \dots\dots\dots$ cm [1]

(iii) the speed v .

$v = \dots\dots\dots$ cm s⁻¹ [2]

(c) (i) Use Figs. 5.1 and 5.2 to state and explain whether the wave is losing power as it moves away from the source.

.....

 [2]

(ii) Determine the ratio

$$\frac{\text{intensity of wave at source}}{\text{intensity of wave 6.0 cm from source}} .$$

ratio = ... [3]

- 6 The variation with temperature of the resistance R_T of a thermistor is shown in Fig. 6.1.

For
Examiner's
Use

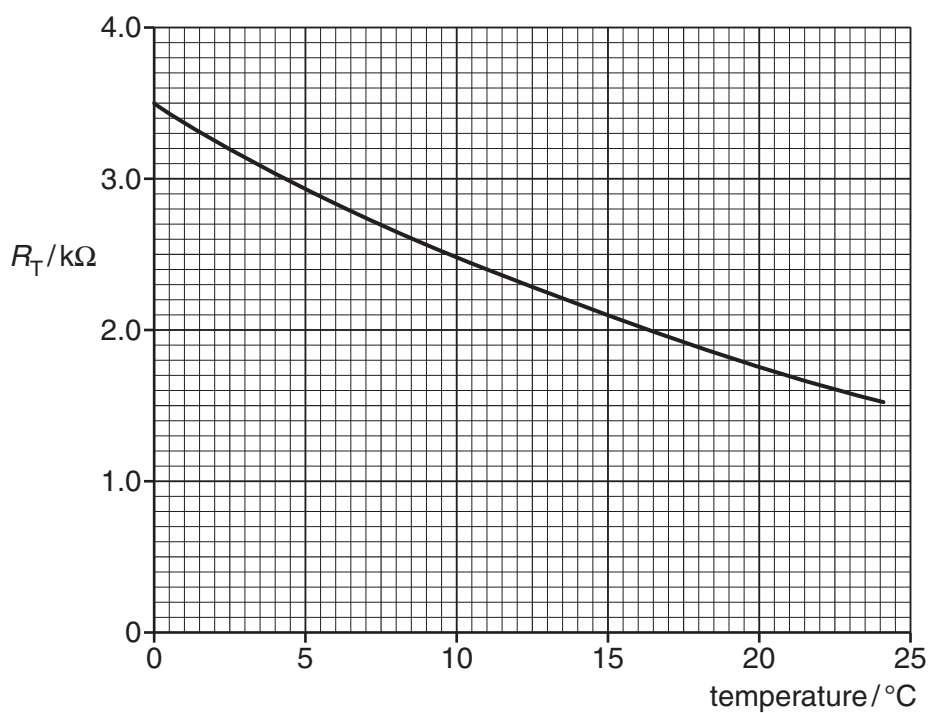


Fig. 6.1

The thermistor is connected into the circuit of Fig. 6.2.

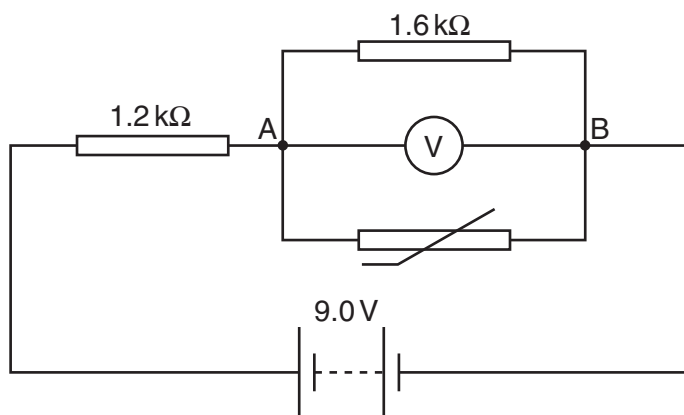


Fig. 6.2

The battery has e.m.f. 9.0V and negligible internal resistance. The voltmeter has infinite resistance.

For
Examiner's
Use

(a) For the thermistor at 22.5 °C, calculate

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the reading on the voltmeter.

voltmeter reading = ... V [2]

(b) The temperature of the thermistor is changed. The voltmeter now reads 4.0V.
Determine

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

- (ii) the temperature of the thermistor.

temperature = ... °C [2]

- (c) A student suggests that the voltmeter, reading up to 10V, could be calibrated to measure temperature.

Suggest two disadvantages of using the circuit of Fig. 6.2 with this voltmeter for the measurement of temperature in the range 0 °C to 25 °C.

1.
.....
2.
.....

[2]

- 7 The results of the α -particle scattering experiment provided evidence for the existence and small size of the nucleus.

(a) State the result that provided evidence for

- (i) the small size of the nucleus, compared with the atom,

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

- (ii) the nucleus being charged and containing the majority of the mass of the atom.

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

- (b) The α -particles in this experiment originated from the decay of a radioactive nuclide. Suggest two reasons why β -particles from a radioactive source would be inappropriate for this type of scattering experiment.

1.
.....
2.
.....
[2]

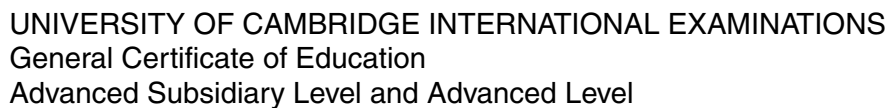
BLANK PAGE

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9702/23

October/November 2010

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

This document consists of **16** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2} QV$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

For
Examiner's
Use

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 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.

*For
Examiner's
Use*

.....

.....

.....

.....

..... [4]

- 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.

For
Examiner's
Use

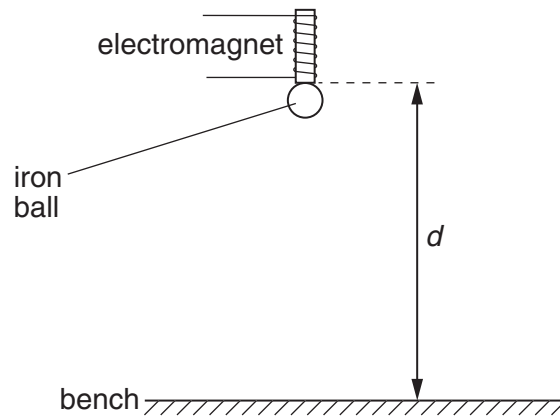


Fig. 4.1

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.

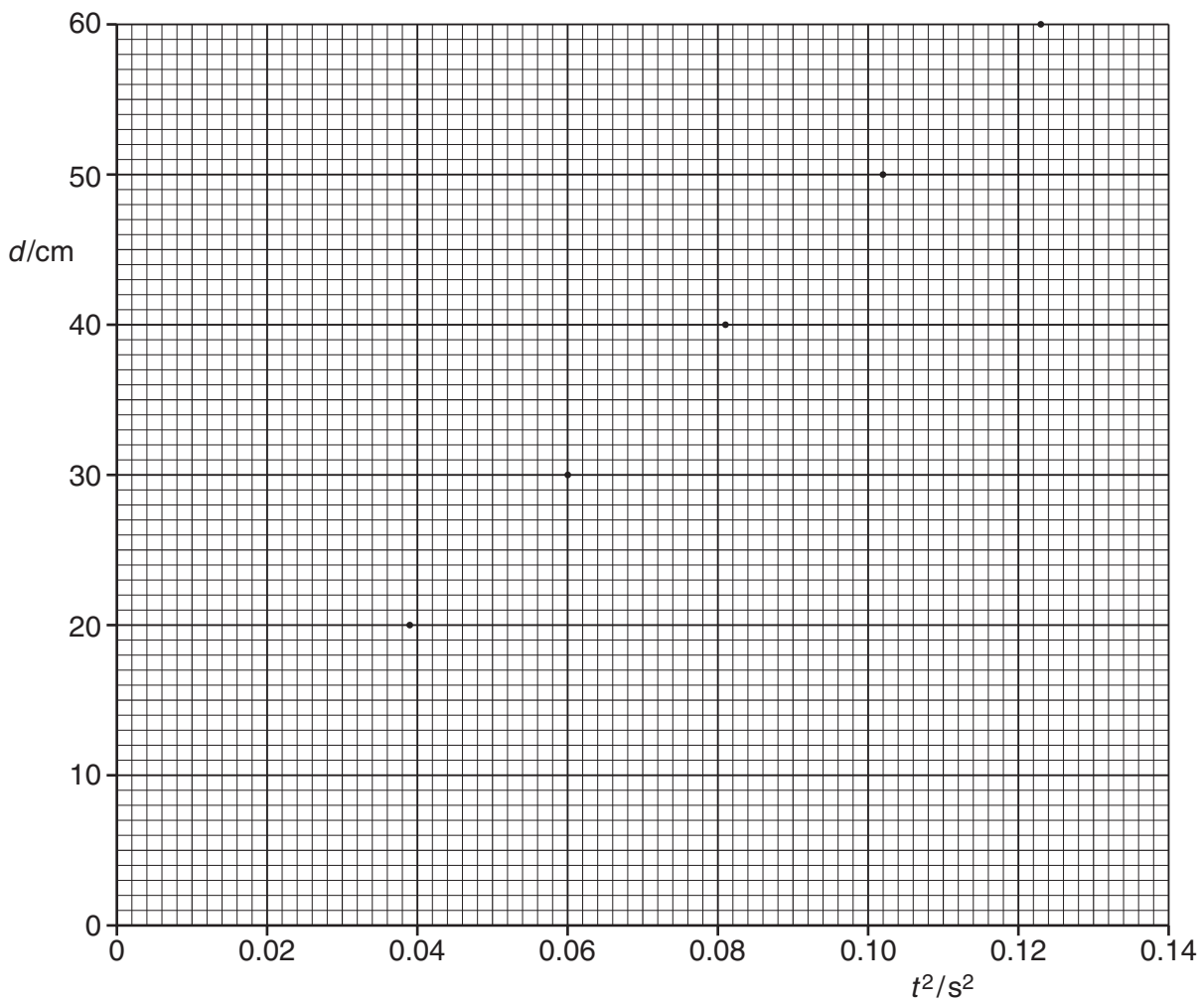


Fig. 4.2

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

[1]

For
Examiner's
Use

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

.....

 [2]

(c) Determine the student's value for

(i) the diameter of the ball,

diameter = ... cm [1]

(ii) the acceleration of free fall.

acceleration = ... 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.

For
Examiner's
Use

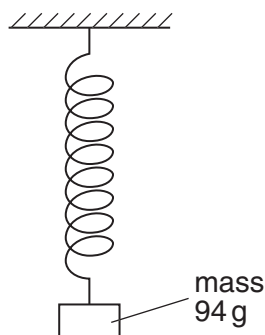


Fig. 5.1

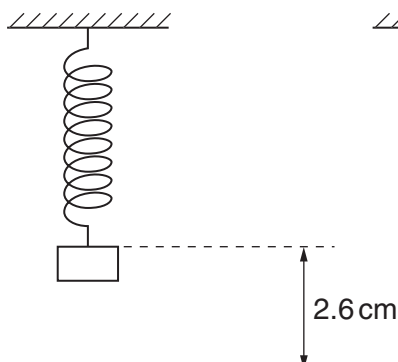


Fig. 5.2

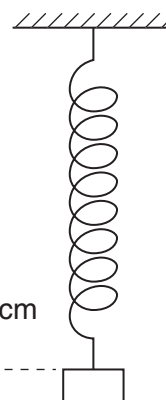


Fig. 5.3

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.

For 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]

For
Examiner's
Use

- 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.

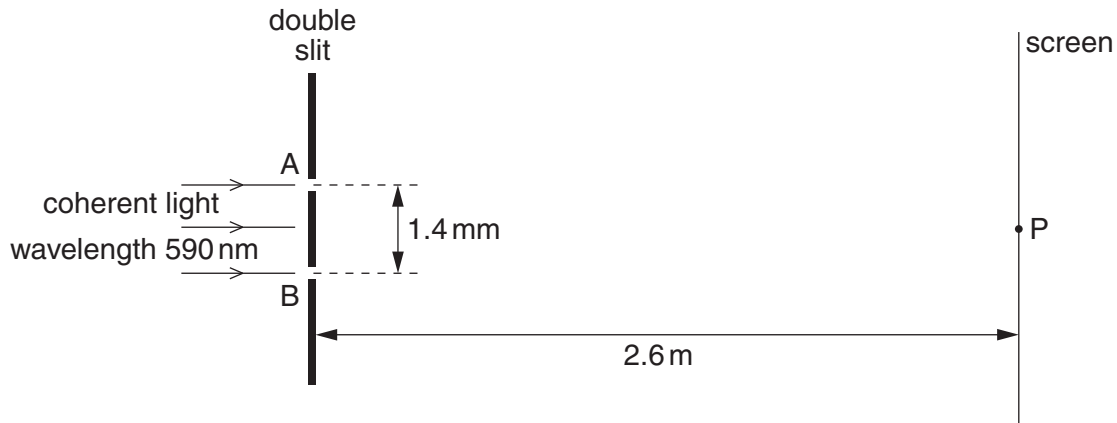


Fig. 6.1 (not to scale)

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.

For
Examiner's
Use

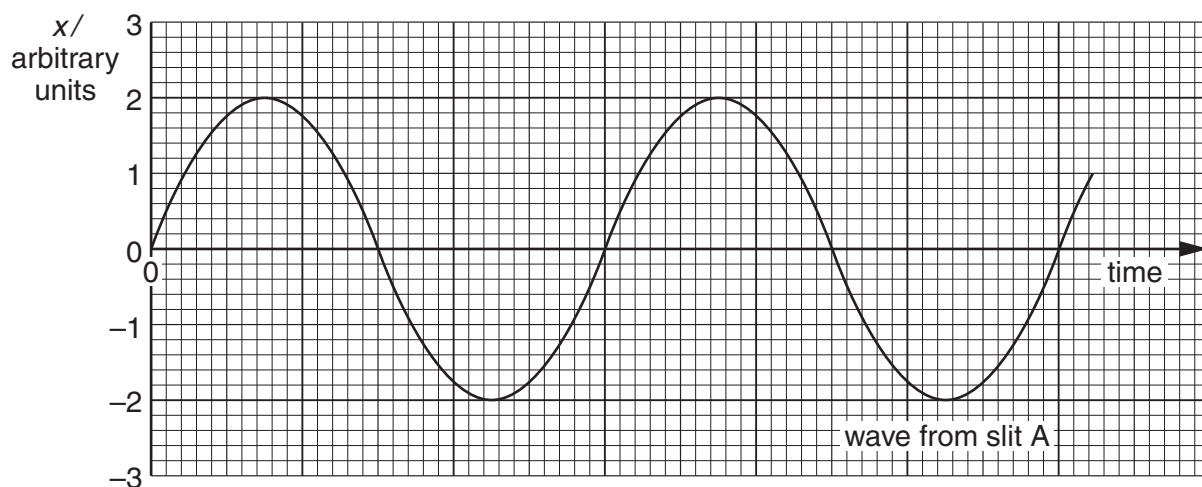


Fig. 6.2a

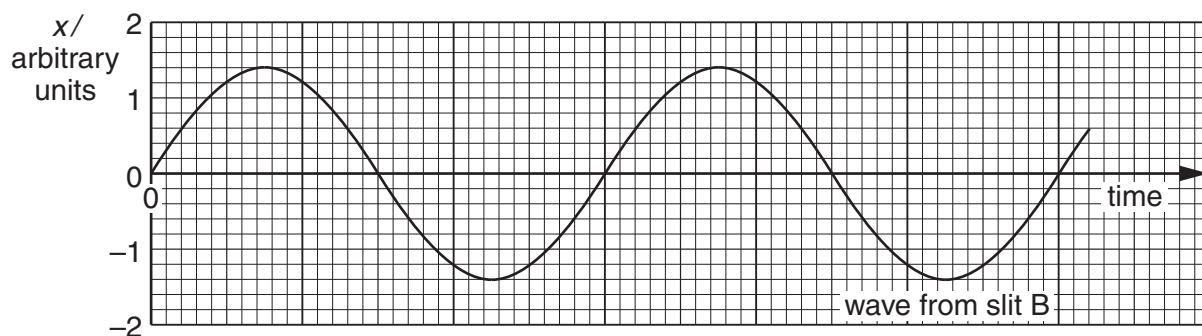


Fig. 6.2b

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.

For
Examiner's
Use

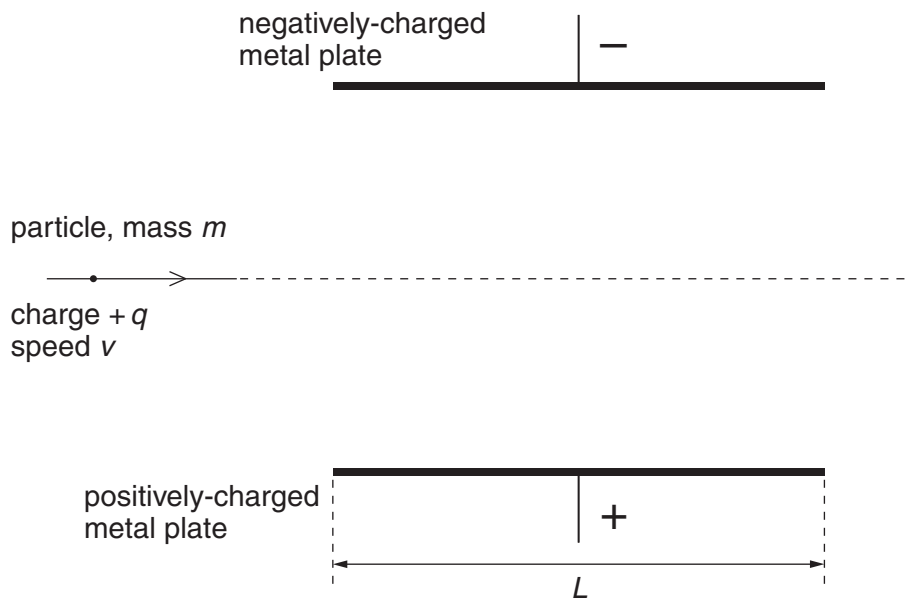


Fig. 7.1

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) For 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.

For
Examiner's
Use

.....
.....
..... [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.

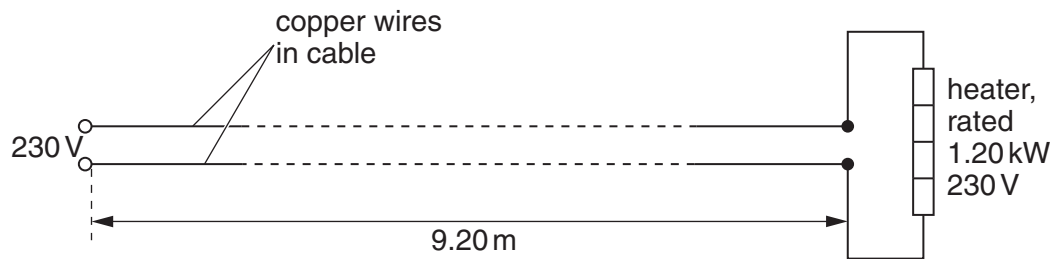


Fig. 8.1

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 44.1Ω ,

[2]

- (ii) the total resistance of the cable is 0.492Ω .

[2]

- (b) The current in the cable and heater is switched on. Determine, to three significant figures, the power dissipated in the heater.

For
Examiner's
Use

power = ... W [3]

- (c) Suggest two disadvantages of connecting the heater to the 230V supply using a cable consisting of two thinner copper wires.

1.

.....

2.

.....

[2]

Please turn over for Question 9.

- 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.

.....

.....

..... [2]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.