

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

PHYSICS

Paper 2 AS Structured Questions

9702/21

May/June 2015

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 an HB pencil for any diagrams or graphs.

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

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

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.

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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
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.

- 1 (a) Use the definition of power to show that the SI base units of power are $\text{kg m}^2 \text{s}^{-3}$.

[2]

- (b) Use an expression for electrical power to determine the SI base units of potential difference.

units[2]

- 2 (a) Define *speed* and *velocity* and use these definitions to explain why one of these quantities is a scalar and the other is a vector.

speed:

velocity:

.....

.....

[2]

- (b) A ball is released from rest and falls vertically. The ball hits the ground and rebounds vertically, as shown in Fig. 2.1.

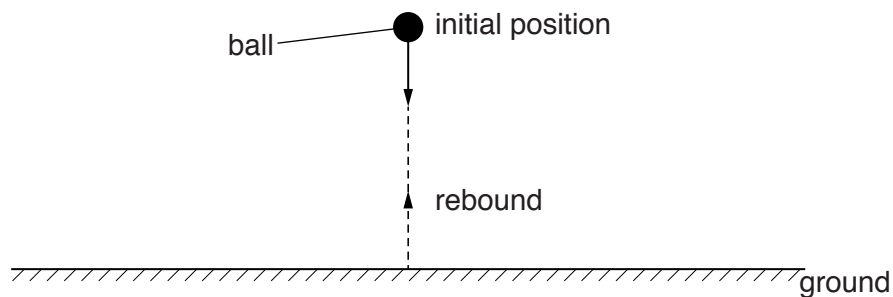


Fig. 2.1

The variation with time t of the velocity v of the ball is shown in Fig. 2.2.

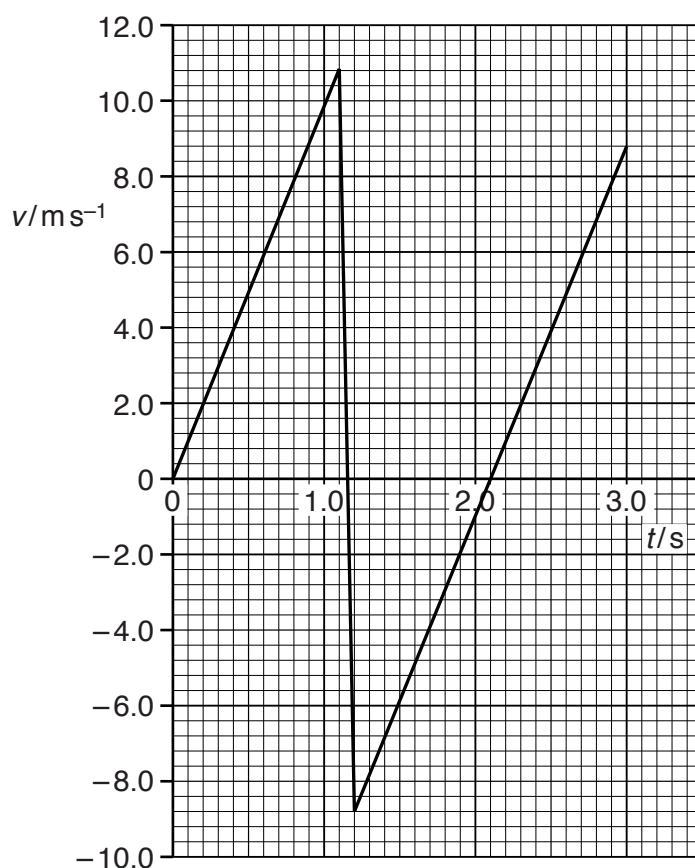


Fig. 2.2

Air resistance is negligible.

- (i) Without calculation, use Fig. 2.2 to describe the variation with time t of the velocity of the ball from $t = 0$ to $t = 2.1$ s.

.....

.....

.....

.....

.....

.....[3]

- (ii) Calculate the acceleration of the ball after it rebounds from the ground. Show your working.

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

(iii) Calculate, for the ball, from $t = 0$ to $t = 2.1$ s,

1. the distance moved,

distance = ... m [3]

2. the displacement from the initial position.

displacement = ... m [2]

(iv) On Fig. 2.3, sketch the variation with t of the speed of the ball.

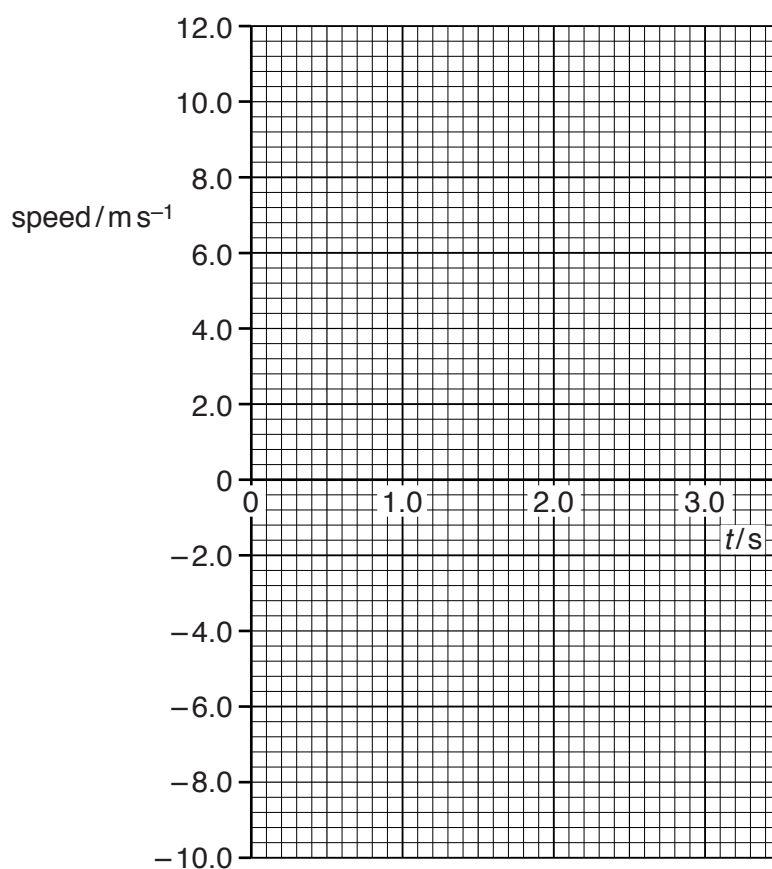


Fig. 2.3

[2]

- 3 Two balls X and Y are supported by long strings, as shown in Fig. 3.1.

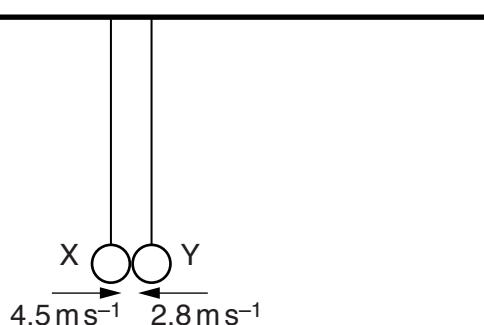


Fig. 3.1

The balls are each pulled back and pushed towards each other. When the balls collide at the position shown in Fig. 3.1, the strings are vertical. The balls rebound in opposite directions.

Fig. 3.2 shows data for X and Y during this collision.

ball	mass	velocity just before collision/ m s^{-1}	velocity just after collision/ m s^{-1}
X	50 g	+4.5	−1.8
Y	M	−2.8	+1.4

Fig. 3.2

The positive direction is horizontal and to the right.

- (a) Use the conservation of linear momentum to determine the mass M of Y.

$$M = \dots\dots\dots \text{ g [3]}$$

- (b) State and explain whether the collision is elastic.

.....

.....

.....[1]

- (c) Use Newton's second and third laws to explain why the magnitude of the change in momentum of each ball is the same.

.....

.....

.....

.....

.....[3]

- 4 A spring is kept horizontal by attaching it to points A and B, as shown in Fig. 4.1.

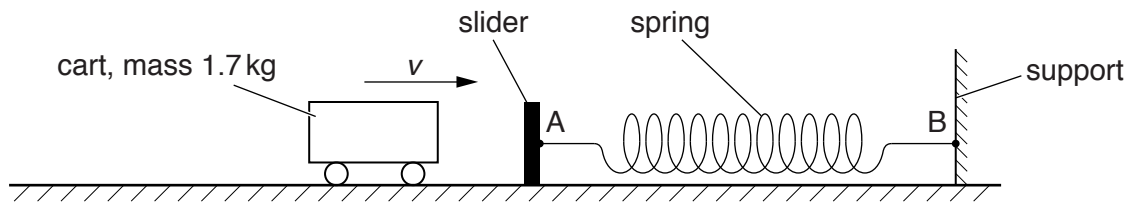


Fig. 4.1

Point A is on a movable slider and point B is on a fixed support. A cart of mass 1.7 kg has horizontal velocity v towards the slider. The cart collides with the slider. The spring is compressed as the cart comes to rest. The variation of compression x of the spring with force F exerted on the spring is shown in Fig. 4.2.

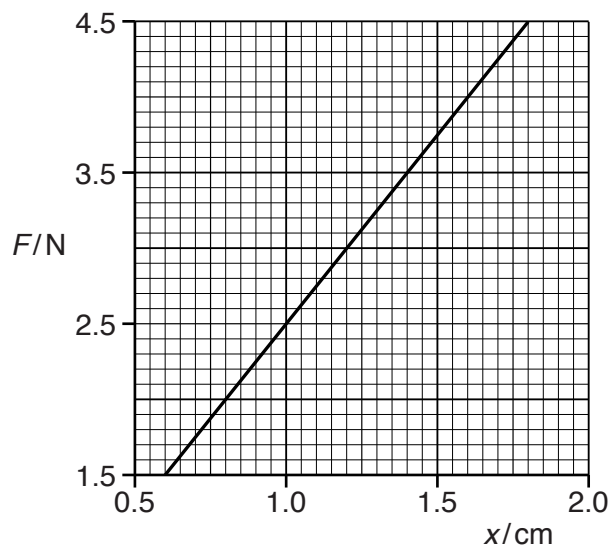


Fig. 4.2

Fig. 4.2 shows the compression of the spring for $F = 1.5\text{ N}$ to $F = 4.5\text{ N}$. The cart comes to rest when F is 4.5 N.

(a) Use Fig. 4.2 to

- (i) show that the compression of the spring obeys Hooke's law,

.....

 [2]

- (ii) determine the spring constant of the spring,

spring constant = ... Nm^{-1} [2]

- (iii) determine the elastic potential energy E_p stored in the spring due to the cart being brought to rest.

E_p = ... J [3]

- (b) Calculate the speed v of the cart as it makes contact with the slider. Assume that all the kinetic energy of the cart is converted to the elastic potential energy of the spring.

speed = ... ms^{-1} [2]

- 5 The variation with potential difference (p.d.) V of current I for a semiconductor diode is shown in Fig. 5.1.

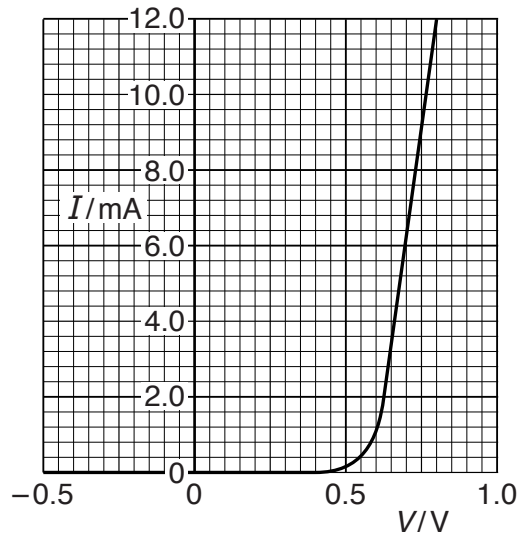


Fig. 5.1

- (a) Use Fig. 5.1 to describe the variation of the resistance of the diode between $V = -0.5\text{ V}$ and $V = 0.8\text{ V}$.

.....

[2]

- (b) On Fig. 5.2, sketch the variation with p.d. V of current I for a filament lamp. Numerical values are not required.

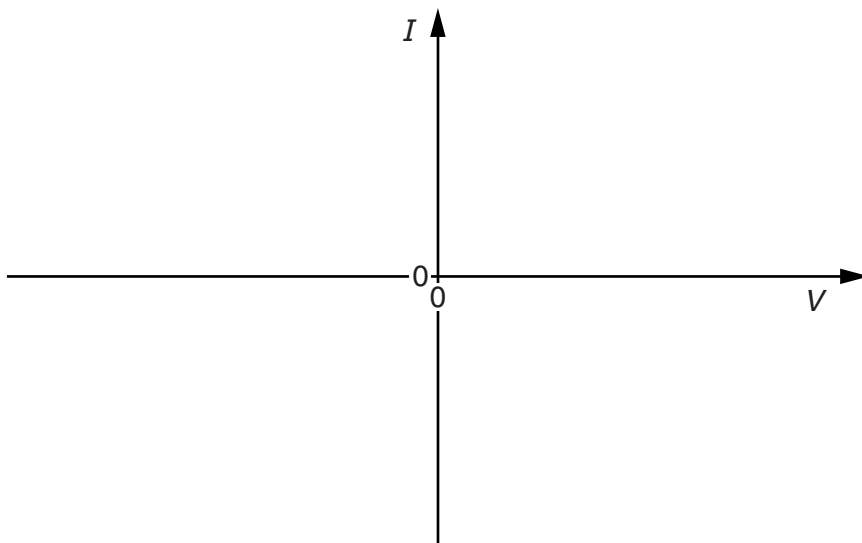


Fig. 5.2

[2]

- (c) Fig. 5.3 shows a power supply of electromotive force (e.m.f.) 12V and internal resistance 0.50Ω connected to a filament lamp and switch.

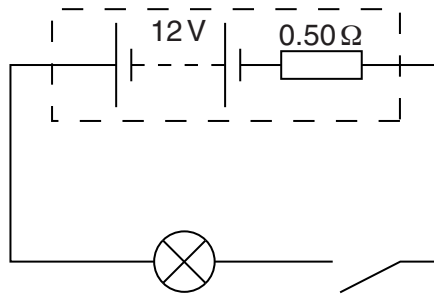


Fig. 5.3

The filament lamp has a power of 36W when the p.d. across it is 12V.

- (i) Calculate the resistance of the lamp when the p.d. across it is 12V.

resistance = ... Ω [1]

- (ii) The switch is closed and the current in the lamp is 2.8 A. Calculate the resistance of the lamp.

resistance = ... Ω [3]

- (d) Explain how the two values of resistance calculated in (c) provide evidence for the shape of the sketch you have drawn in (b).

.....
[1]

- 6 (a) State what is meant by *diffraction* and by *interference*.

diffraction:

.....

interference:

.....

[3]

- (b) Light from a source S_1 is incident on a diffraction grating, as illustrated in Fig. 6.1.

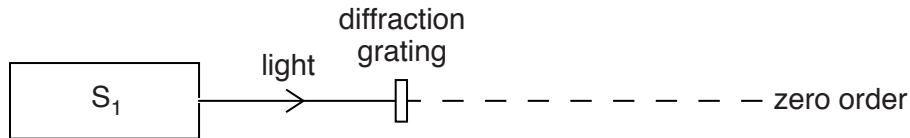


Fig. 6.1 (not to scale)

The light has a single frequency of 7.06×10^{14} Hz. The diffraction grating has 650 lines per millimetre.

Calculate the number of orders of diffracted light produced by the grating. Do not include the zero order.

Show your working.

number = ... [3]

- (c) A second source S_2 is used in place of S_1 . The light from S_2 has a single frequency lower than that of the light from S_1 .

State and explain whether more orders are seen with the light from S_2 .

.....

.....[1]

- 7 (a) Explain what is meant by an *electric field*.

.....
[1]

- (b) A uniform electric field is produced between two vertical metal plates AB and CD, as shown in Fig. 7.1.

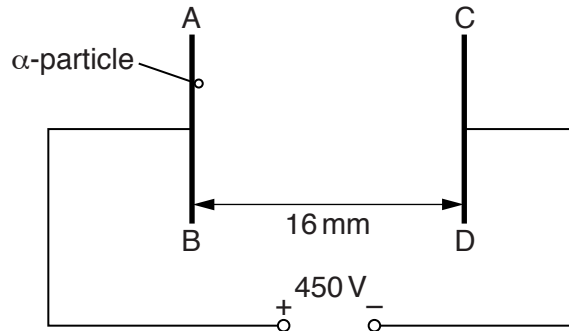


Fig. 7.1

The potential difference between the plates is 450V and the separation of the plates is 16 mm.

An α -particle is accelerated from plate AB to plate CD.

- (i) On Fig. 7.1, draw lines to represent the electric field between the plates. [2]
 (ii) Calculate the electric field strength between the plates.

electric field strength = ... V m^{-1} [2]

- (iii) Calculate the work done by the electric field on the α -particle as it moves from AB to CD.

work done = ... J [3]

Question 7 continues on page 16.

- (iv) A β -particle moves from AB to CD. Calculate the ratio

$\frac{\text{work done by the electric field on the } \alpha\text{-particle}}{\text{work done by the electric field on the } \beta\text{-particle}}$.

Show your working.

ratio = ... [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.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

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.

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

PHYSICS

9702/22

Paper 2 AS Structured Questions

May/June 2015

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 an HB pencil for any diagrams or graphs.

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

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

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.

This document consists of **14** printed pages and **2** 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
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.

- 1 (a) Use the definition of work done to show that the SI base units of energy are $\text{kg m}^2 \text{s}^{-2}$.

[2]

- (b) Define potential difference.

.....

..... [1]

- (c) Determine the SI base units of resistance. Show your working.

units [3]

- 2 A stone is thrown vertically upwards. The variation with time t of the displacement s of the stone is shown in Fig. 2.1.

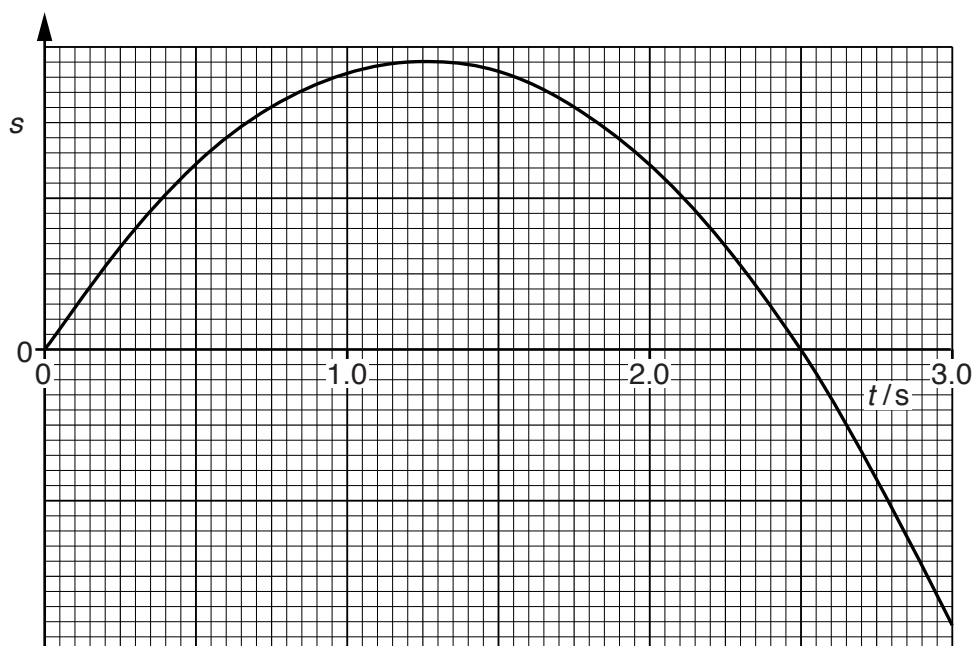


Fig. 2.1

- (a) Use Fig. 2.1 to describe, without calculation, the speed of the stone from $t = 0$ to $t = 3.0$ s.

.....

 [2]

- (b) Assume air resistance is negligible and therefore the stone has constant acceleration.

Calculate, for the stone,

- (i) the speed at 3.0 s,

speed = ... ms^{-1} [3]

(ii) the distance travelled from $t = 0$ to $t = 3.0$ s,

distance = ... m [3]

(iii) the displacement from $t = 0$ to $t = 3.0$ s.

displacement = ... m

direction [2]

(c) On Fig. 2.2, draw the variation with time t of the velocity v of the stone from $t = 0$ to $t = 3.0$ s.

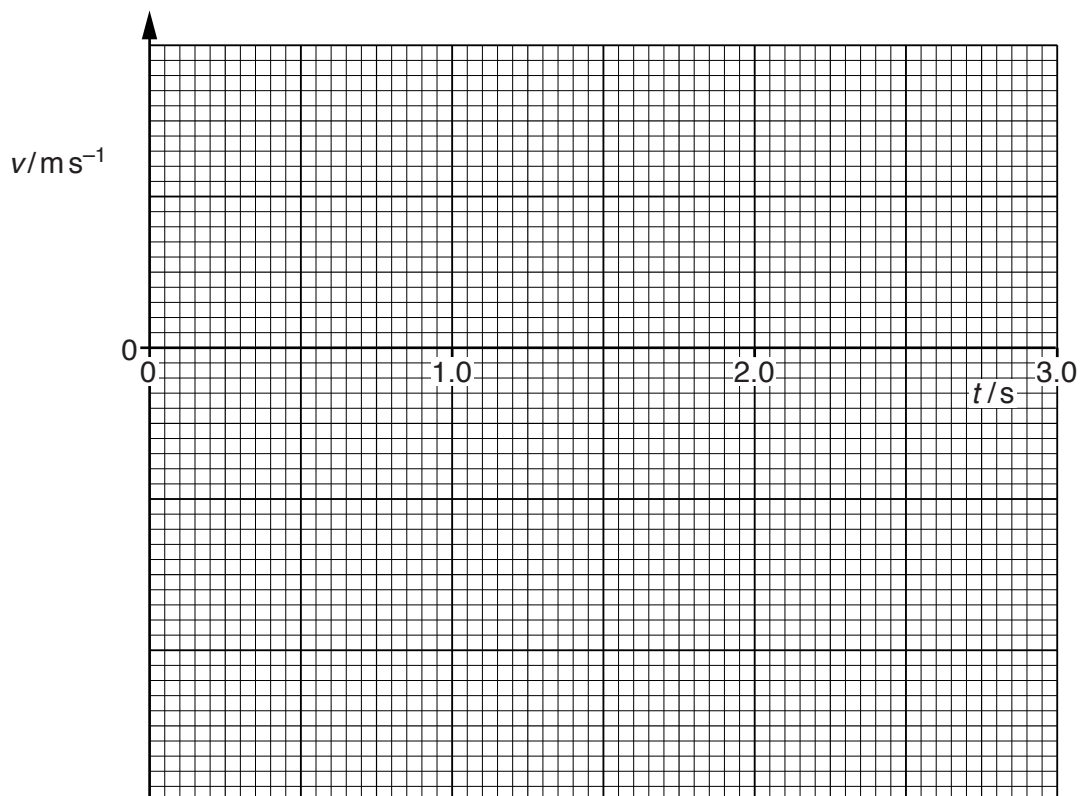


Fig. 2.2

- 3 A rod PQ is attached at P to a vertical wall, as shown in Fig. 3.1.

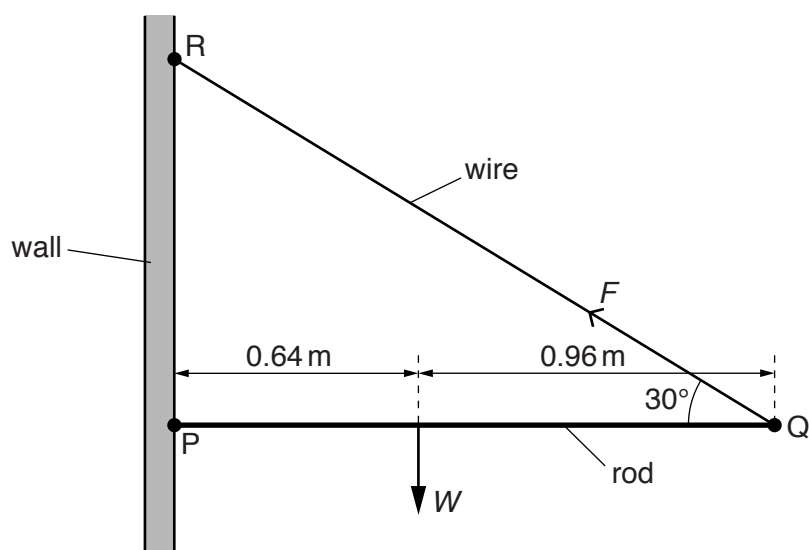


Fig. 3.1

The length of the rod is 1.60 m. The weight W of the rod acts 0.64 m from P. The rod is kept horizontal and in equilibrium by a wire attached to Q and to the wall at R. The wire provides a force F on the rod of 44 N at 30° to the horizontal.

- (a) Determine

- (i) the vertical component of F ,

vertical component = ... N [1]

- (ii) the horizontal component of F .

horizontal component = ... N [1]

- (b) By taking moments about P, determine the weight W of the rod.

$W =$ N [2]

- (c) Explain why the wall must exert a force on the rod at P.

.....

.....

..... [1]

- (d) On Fig. 3.1, draw an arrow to represent the force acting on the rod at P. Label your arrow with the letter S. [1]

- 4 (a) A gas molecule has a mass of $6.64 \times 10^{-27} \text{ kg}$ and a speed of 1250 ms^{-1} . The molecule collides normally with a flat surface and rebounds with the same speed, as shown in Fig. 4.1.

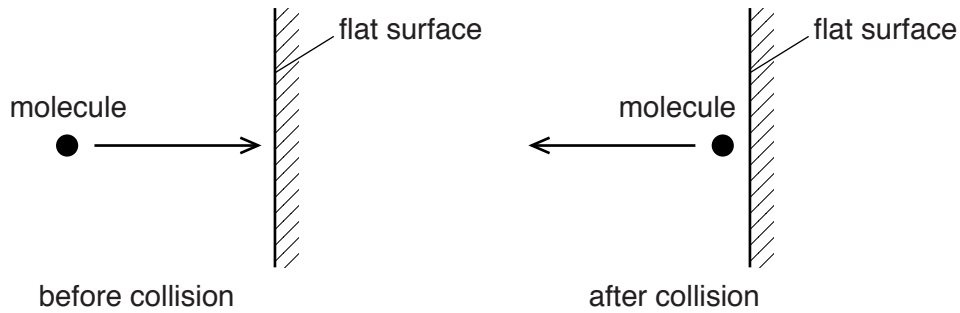


Fig. 4.1

Calculate the change in momentum of the molecule.

change in momentum = ... Ns [2]

- (b) (i) Use the kinetic model to explain the pressure exerted by gases.

.....

 [3]

- (ii) Explain the effect of an increase in density, at constant temperature, on the pressure of a gas.

.....
 [1]

- 5 (a) On Fig. 5.1, sketch the temperature characteristic of a thermistor.

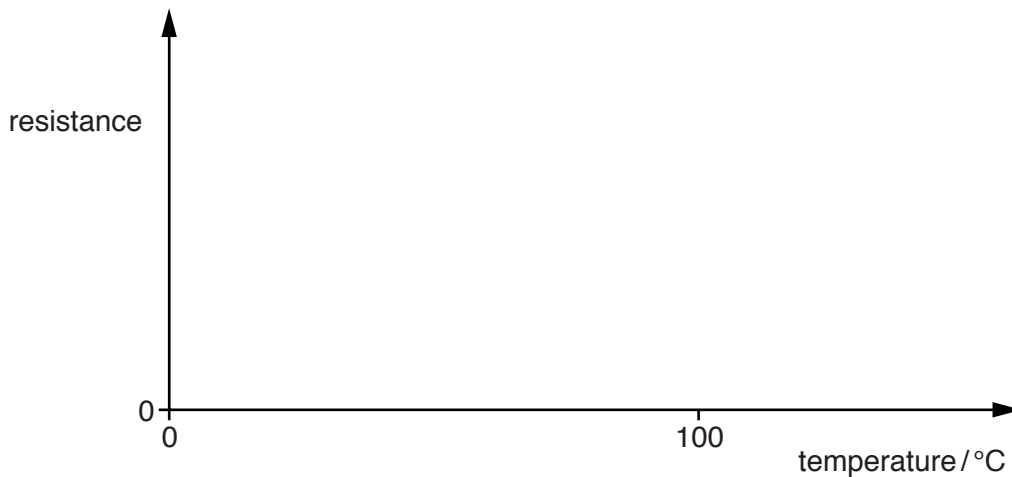


Fig. 5.1

[2]

- (b) A potential divider circuit is shown in Fig. 5.2.

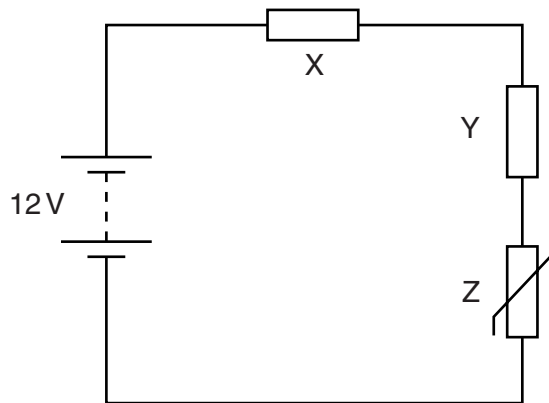


Fig. 5.2

The battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected in series with resistors X and Y and thermistor Z. The resistance of Y is $15\text{ k}\Omega$ and the resistance of Z at a particular temperature is $3.0\text{ k}\Omega$. The potential difference (p.d.) across Y is 8.0 V.

- (i) Explain why the power transformed in the battery equals the total power transformed in X, Y and Z.

..... [1]

- (ii) Calculate the current in the circuit.

current = ... A [2]

- (iii) Calculate the resistance of X.

resistance = ... Ω [3]

- (iv) The temperature of Z is increased.

State and explain the effect on the potential difference across Z.

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

6 (a) State two differences between progressive waves and stationary waves.

1.
 2.
- [2]

(b) A source S of microwaves is placed in front of a metal reflector R, as shown in Fig. 6.1.

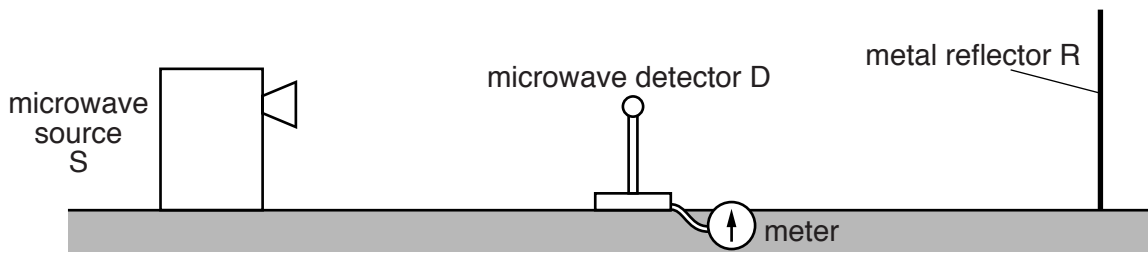


Fig. 6.1

A microwave detector D is placed between R and S.

Describe

(i) how stationary waves are formed between R and S,

-
-
-
- [3]

(ii) how D is used to show that stationary waves are formed between R and S,

-
-
- [2]

(iii) how the wavelength of the microwaves may be determined using the apparatus in Fig. 6.1.

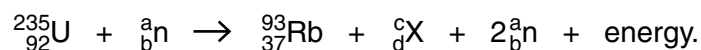
-
-
- [2]

- (c) The wavelength of the microwaves in (b) is 2.8 cm. Calculate the frequency, in GHz, of the microwaves.

frequency = ... GHz [3]

Please turn over for Question 7.

- 7 A uranium-235 nucleus absorbs a neutron and then splits into two nuclei. A possible nuclear reaction is given by



- (a) State the constituent particles of the uranium-235 nucleus.

..... [1]

- (b) Complete Fig. 7.1 for this reaction.

	value
a	
b	
c	
d	

[3]

Fig. 7.1

- (c) Suggest a possible form of energy released in this reaction.

..... [1]

- (d) Explain, using the law of mass-energy conservation, how energy is released in this reaction.

.....

 [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.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

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.

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

PHYSICS

9702/23

Paper 2 AS Structured Questions

May/June 2015

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 an HB pencil for any diagrams or graphs.

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

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

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.

This document consists of **14** printed pages and **2** 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
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.

- 1 (a) The distance between the Sun and the Earth is 1.5×10^{11} m. State this distance in Gm.

distance = ... Gm [1]

- (b) The distance from the centre of the Earth to a satellite above the equator is 42.3 Mm. The radius of the Earth is 6380 km.

A microwave signal is sent from a point on the Earth directly below the satellite.

Calculate the time taken for the microwave signal to travel to the satellite and back.

time = ... s [2]

- (c) The speed v of a sound wave through a gas of density ρ and pressure P is given by

$$v = \sqrt{\frac{CP}{\rho}}$$

where C is a constant.

Show that C has no unit.

[3]

- (d) Underline all the scalar quantities in the list below.

acceleration

energy

momentum

power

weight

[1]

- (e) A boat travels across a river in which the water is moving at a speed of 1.8 m s^{-1} . The velocity vectors for the boat and the river water are shown to scale in Fig. 1.1.

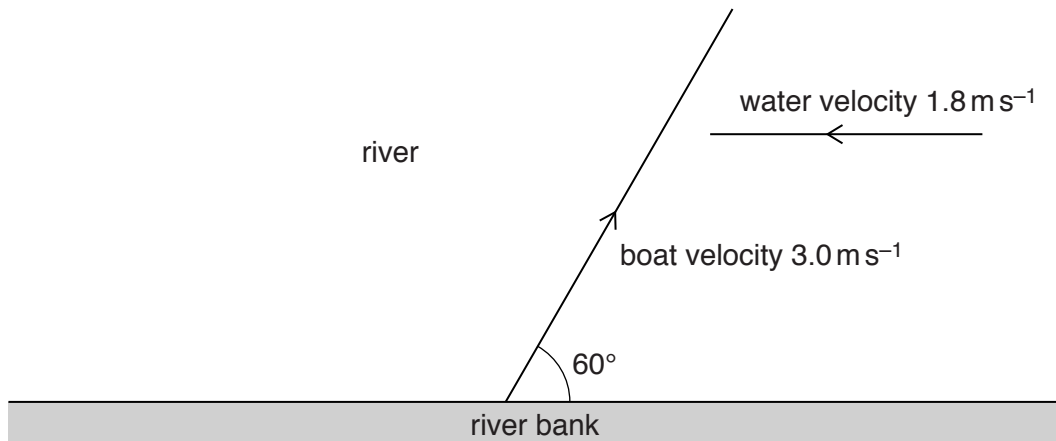


Fig. 1.1 (shown to scale)

In still water the speed of the boat is 3.0 m s^{-1} . The boat is directed at an angle of 60° to the river bank.

- (i) On Fig. 1.1, draw a vector triangle or a scale diagram to show the resultant velocity of the boat. [2]
- (ii) Determine the magnitude of the resultant velocity of the boat.

resultant velocity = ... m s^{-1} [2]

- 2 The variation with time t of the velocity v of a ball is shown in Fig. 2.1.

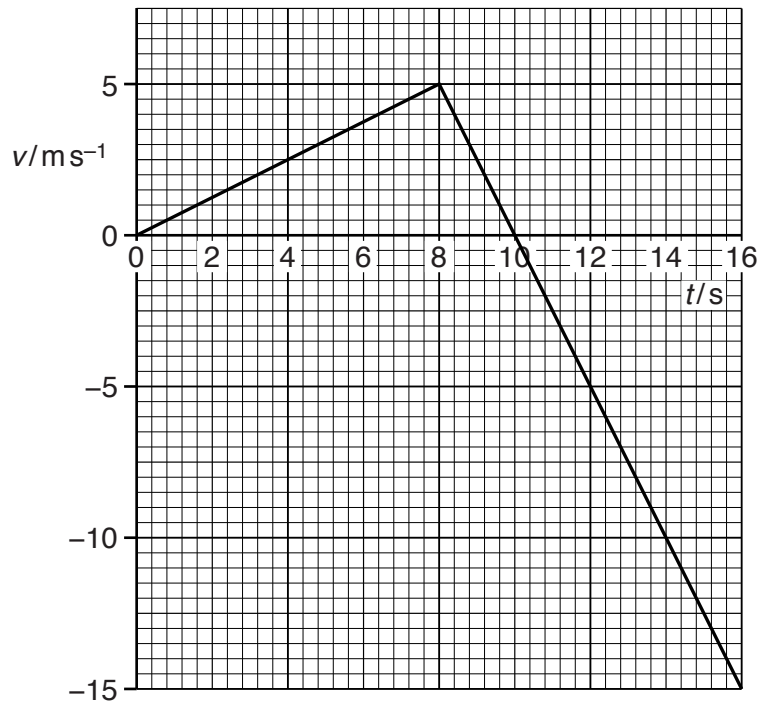


Fig. 2.1

The ball moves in a straight line from a point P at $t = 0$. The mass of the ball is 400 g.

- (a) Use Fig. 2.1 to describe, without calculation, the velocity of the ball from $t = 0$ to $t = 16$ s.

.....

.....

.....

.....

.....[2]

(b) Use Fig. 2.1 to calculate, for the ball,

(i) the displacement from P at $t = 10$ s,

displacement = ... m [2]

(ii) the acceleration at $t = 10$ s,

acceleration = ... ms^{-2} [2]

(iii) the maximum kinetic energy.

kinetic energy = ... J [2]

(c) Use your answers in **(b)(i)** and **(b)(ii)** to determine the time from $t = 0$ for the ball to return to P.

time = ... s [2]

- 3 (a) Define *power*.

.....
[1]

- (b) Fig. 3.1 shows a car travelling at a speed of 22 m s^{-1} on a horizontal road.

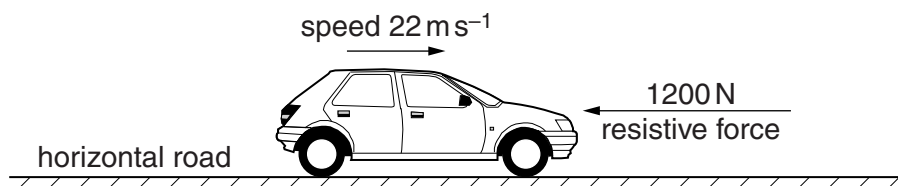


Fig. 3.1

The car has a mass of 1500 kg . A resistive force of 1200 N acts on the car.

Calculate

- (i) the force F required from the car to produce an acceleration of 0.82 m s^{-2} ,

$$F = \dots\dots\dots \text{ N [3]}$$

- (ii) the power required to produce this acceleration.

$$\text{power} = \dots\dots\dots \text{ W [2]}$$

- (c) The resistive force on the car is proportional to v^2 , where v is the speed of the car. Suggest why the car has a maximum speed.

.....
[1]

- 4 Fig. 4.1 shows the values obtained in an experiment to determine the Young modulus E of a metal in the form of a wire.

quantity	value	instrument
diameter d	0.48 mm	
length l	1.768 m	
load F	5.0 N to 30.0 N in 5.0 N steps	
extension e	0.25 mm to 1.50 mm	

Fig. 4.1

- (a) (i) Complete Fig. 4.1 with the name of an instrument that could be used to measure each of the quantities. [3]
- (ii) Explain why a series of values of F , each with corresponding extension e , are measured.
-
-[1]
- (b) Explain how a series of readings of the quantities given in Fig. 4.1 is used to determine the Young modulus of the metal. A numerical answer for E is not required.

.....

.....

.....

.....[2]

- 5 A uniform resistance wire AB has length 50 cm and diameter 0.36 mm. The resistivity of the metal of the wire is $5.1 \times 10^{-7} \Omega \text{ m}$.

(a) Show that the resistance of the wire AB is 2.5Ω .

[2]

- (b) The wire AB is connected in series with a power supply E and a resistor R as shown in Fig. 5.1.

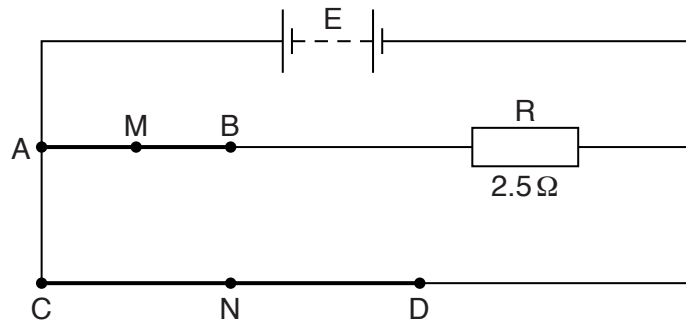


Fig. 5.1

The electromotive force (e.m.f.) of E is 6.0 V and its internal resistance is negligible. The resistance of R is 2.5Ω . A second uniform wire CD is connected across the terminals of E. The wire CD has length 100 cm, diameter 0.18 mm and is made of the same metal as wire AB.

Calculate

- (i) the current supplied by E,

current = ... A [4]

- (ii) the power transformed in wire AB,

power = ... W [2]

- (iii) the potential difference (p.d.) between the midpoint M of wire AB and the midpoint N of wire CD.

p.d. = ... V [2]

- 6 (a) Two overlapping waves of the same type travel in the same direction. The variation with distance x of the displacement y of each wave is shown in Fig. 6.1.

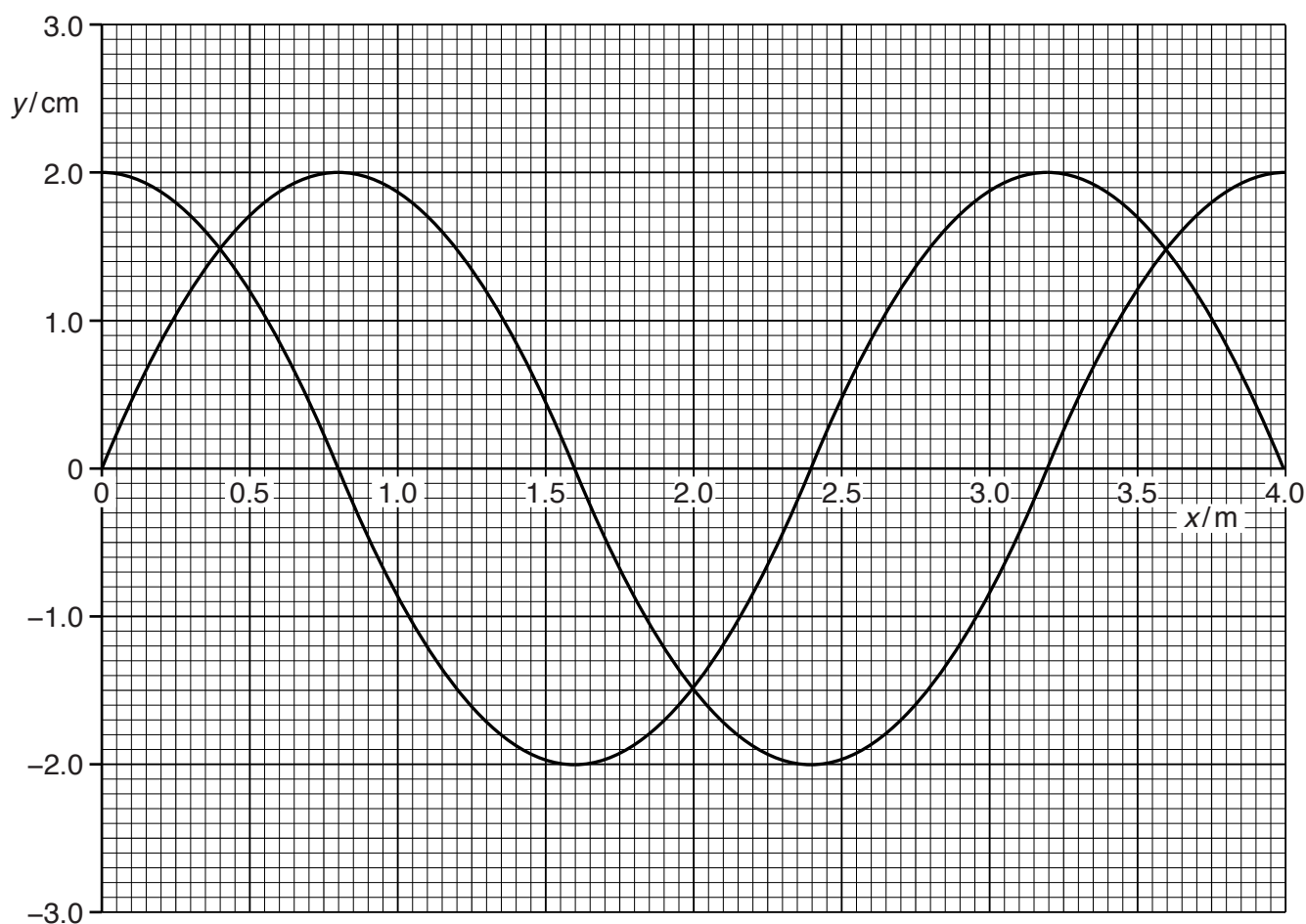


Fig. 6.1

The speed of the waves is 240 ms^{-1} . The waves are coherent and produce an interference pattern.

- (i) Explain the meaning of *coherence* and *interference*.

coherence:

.....

interference:

.....

[2]

- (ii) Use Fig. 6.1 to determine the frequency of the waves.

frequency = ... Hz [2]

- (iii) State the phase difference between the waves.

phase difference = ... ° [1]

- (iv) Use the principle of superposition to sketch, on Fig. 6.1, the resultant wave. [2]

- (b) An interference pattern is produced with the arrangement shown in Fig. 6.2.

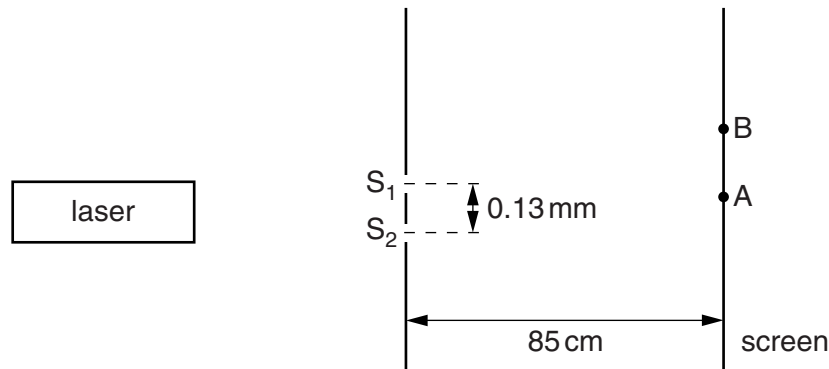


Fig. 6.2 (not to scale)

Laser light of wavelength λ of 546 nm is incident on the slits S_1 and S_2 . The slits are a distance 0.13 mm apart. The distance between the slits and the screen is 85 cm .

Two points on the screen are labelled A and B. The path difference between S_1A and S_2A is zero. The path difference between S_1B and S_2B is 2.5λ . Maxima and minima of intensity of light are produced on the screen.

- (i) Calculate the distance AB.

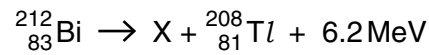
distance = ... m [3]

- (ii) The laser is replaced by a laser emitting blue light. State and explain the change in the distance between the maxima observed on the screen.

.....

 [1]

- 7 The equation represents the spontaneous radioactive decay of a nucleus of bismuth-212.



- (a) (i) Explain the meaning of *spontaneous* radioactive decay.

.....
[1]

- (ii) State the constituent particles of X.

.....[1]

- (b) (i) Use the conservation of mass-energy to explain the release of 6.2 MeV of energy in this reaction.

.....

[2]

- (ii) Calculate the energy, in joules, released in this reaction.

energy = ... J [1]

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.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

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.