

CANDIDATE
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PHYSICS

9702/21

Paper 2 AS Level Structured Questions

May/June 2017

1 hour 15 minutes

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 **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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
	$(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
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 unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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.	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
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	$W = \frac{1}{2} QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
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) Determine the SI base units of stress.
Show your working.

base units[2]

- (b) A beam PQ is clamped so that the beam is horizontal. A mass M of 500 g is hung from end Q and the beam bends slightly, as illustrated in Fig. 1.1.

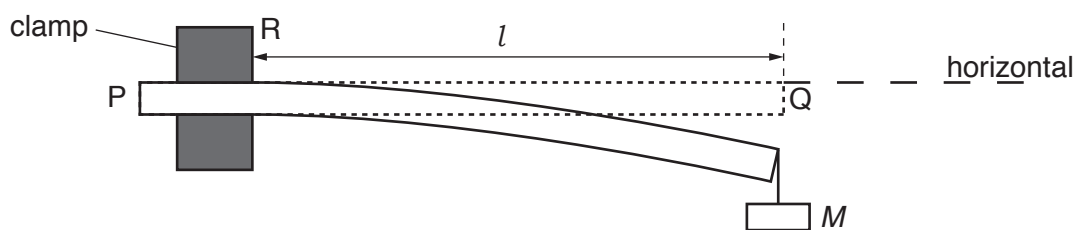


Fig. 1.1

The length l of the beam from the edge of the clamp R to end Q is 60.0 cm. The width b of the beam is 30.0 mm and the thickness d of the beam is 5.00 mm. The material of the beam has Young modulus E .

The mass M is made to oscillate vertically. The time period T of the oscillations is 0.58 s.

The period T is given by the expression

$$T = 2\pi \sqrt{\frac{4Ml^3}{Ebd^3}}.$$

- (i) Determine E in GPa.

$E = \dots\dots\dots$ GPa [3]

(ii) The quantities used to determine E should be measured with accuracy and with precision.

1. Explain the difference between accuracy and precision.

accuracy:

.....

precision:

.....

[2]

2. In a particular experiment, the quantities l and T are measured with the same percentage uncertainty. State and explain which of these two quantities contributes more to the uncertainty in the value of E .

.....

.....

.....[1]

[Total: 8]

2 (a) State the two conditions for a system to be in equilibrium.

1.

.....

2.

.....

[2]

(b) A paraglider P of mass 95 kg is pulled by a wire attached to a boat, as shown in Fig. 2.1.

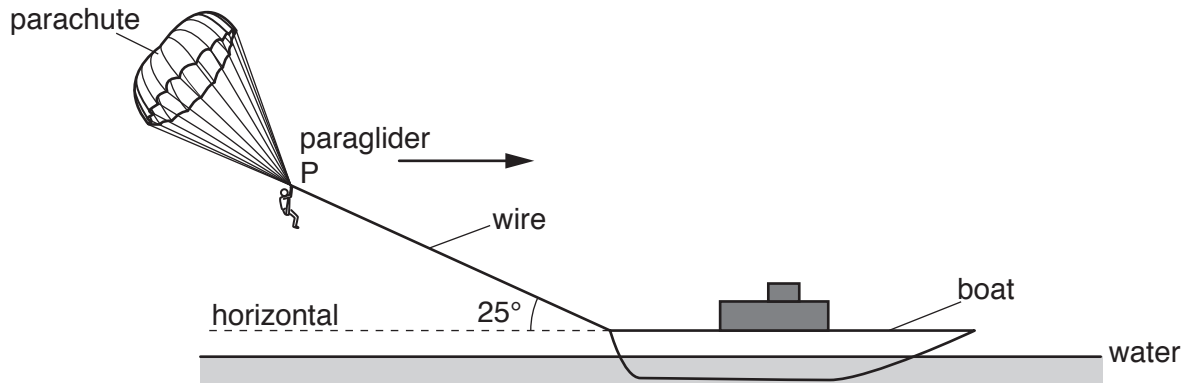


Fig. 2.1

The wire makes an angle of 25° with the horizontal water surface. P moves in a straight line parallel to the surface of the water.

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

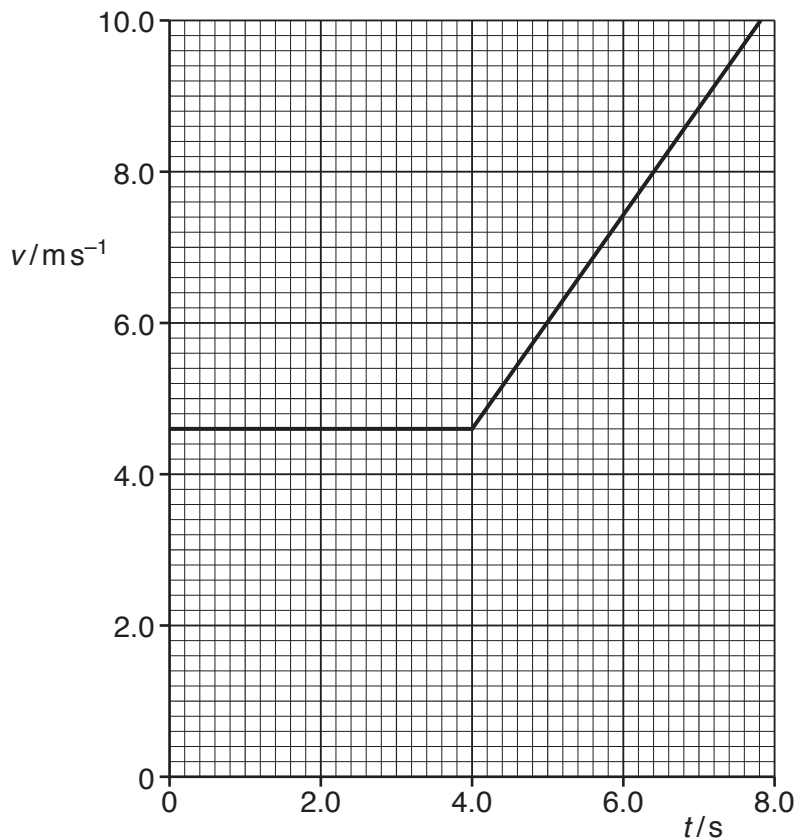


Fig. 2.2

- (i) Show that the acceleration of P is 1.4 ms^{-2} at time $t = 5.0 \text{ s}$.

[2]

- (ii) Calculate the total distance moved by P from time $t = 0$ to $t = 7.0 \text{ s}$.

distance = ...m [2]

- (iii) Calculate the change in kinetic energy of P from time $t = 0$ to $t = 7.0 \text{ s}$.

change in kinetic energy = ...J [2]

- (iv) The tension in the wire at time $t = 5.0 \text{ s}$ is 280 N .

Calculate, for the horizontal motion,

1. the vertical lift force F supporting P,

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

2. the force R due to air resistance acting on P in the horizontal direction.

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

[Total: 14]

- 3 (a) A cylinder is made from a material of density 2.7 g cm^{-3} . The cylinder has diameter 2.4 cm and length 5.0 cm .

Show that the cylinder has weight 0.60 N .

[3]

- (b) The cylinder in (a) is hung from the end A of a non-uniform bar AB, as shown in Fig. 3.1.

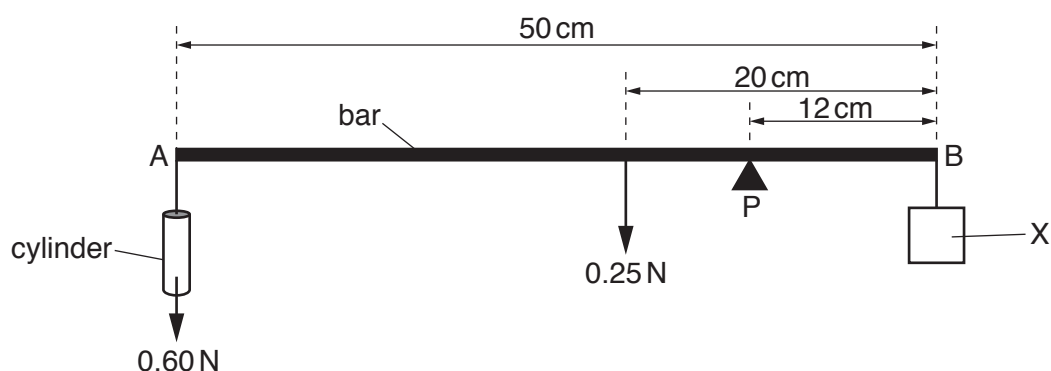


Fig. 3.1

The bar has length 50 cm and has weight 0.25 N . The centre of gravity of the bar is 20 cm from B. The bar is pivoted at P. The pivot is 12 cm from B.

An object X is hung from end B. The weight of X is adjusted until the bar is horizontal and in equilibrium.

- (i) Explain what is meant by *centre of gravity*.

.....
[1]

- (ii) Calculate the weight of X.

weight of X = ... N [3]

- (c) The cylinder is now immersed in water, as illustrated in Fig. 3.2.



Fig. 3.2

An upthrust acts on the cylinder and the bar is not in equilibrium.

- (i) Explain the origin of the upthrust.

.....

[2]

- (ii) Explain why the weight of X must be reduced in order to obtain equilibrium for AB.

.....

[1]

[Total: 10]

- 4 (a) State the conditions required for the formation of stationary waves.

.....

.....

.....[2]

- (b) One end of a string is attached to a vibrator. The string is stretched by passing the other end over a pulley and attaching a load, as illustrated in Fig. 4.1.

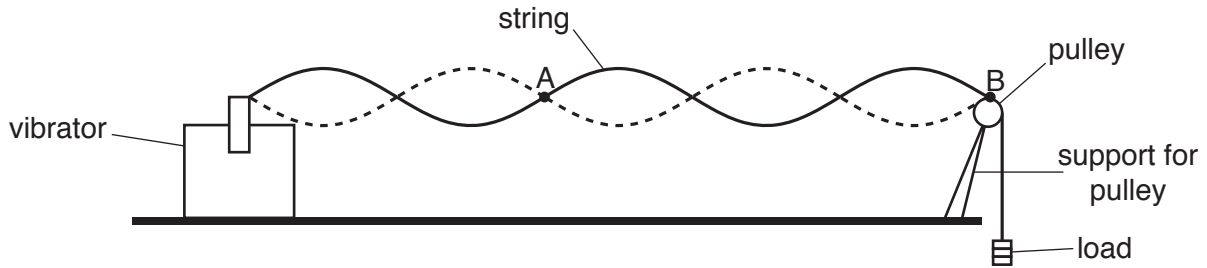


Fig. 4.1

The frequency of vibration of the vibrator is adjusted to 250 Hz and a transverse wave travels along the string with a speed of 12 m s^{-1} . The wave is reflected at the pulley and a stationary wave forms on the string.

Fig. 4.2 shows the string between points A and B at time $t = t_1$.

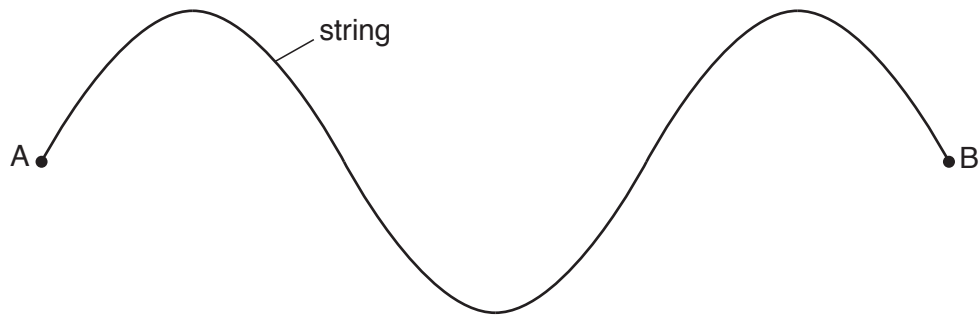


Fig. 4.2

At time $t = t_1$ the string has maximum displacement.

- (i) Calculate the distance AB.

distance = ...m [2]

(ii) On Fig. 4.2, sketch the position of the string between A and B at times

1. $t = t_1 + 2.0 \text{ ms}$ (label this line P),
2. $t = t_1 + 5.0 \text{ ms}$ (label this line Q).

[3]

[Total: 7]

- 5 (a) Describe the Doppler effect.

.....

.....

.....[1]

- (b) A car travels with a constant velocity along a straight road. The car horn with a frequency of 400 Hz is sounded continuously. A stationary observer on the roadside hears the sound from the horn at a frequency of 360 Hz.
The speed of sound is 340 m s^{-1} .

Determine the magnitude v , and the direction, of the velocity of the car relative to the observer.

$v = \dots\dots\dots \text{m s}^{-1}$

direction $\dots\dots\dots$

[3]

[Total: 4]

- 6 (a) Define the *ohm*.

.....
[1]

- (b) A cell X of electromotive force (e.m.f.) 1.5 V and negligible internal resistance is connected in series to three resistors A, B and C, as shown in Fig. 6.1.

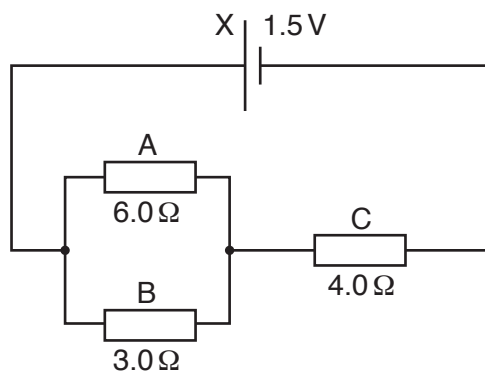


Fig. 6.1

Resistors A and B have resistances 6.0Ω and 3.0Ω respectively and are connected in parallel. Resistor C has resistance 4.0Ω and is connected in series with the parallel combination.

Calculate

- (i) the current in the circuit,

current = ...A [3]

- (ii) the current in resistor B,

current = ...A [1]

(iii) the ratio

$$\frac{\text{power dissipated in resistor B}}{\text{power dissipated in resistor C}}$$

ratio = ...[2]

(c) The resistors A, B and C in (b) are wires of the same material and have the same length.

(i) Explain how the resistors may be made with different resistance values.

.....[1]

(ii) Calculate the ratio

$$\frac{\text{average drift speed of the charge carriers in resistor B}}{\text{average drift speed of the charge carriers in resistor C}}$$

ratio = ...[2]

(d) A cell of e.m.f. 1.5 V and negligible internal resistance is connected in parallel with cell X in Fig. 6.1 with their positive terminals together.

State the change, if any, to the current in

(i) cell X,

.....[1]

(ii) resistor C.

.....[1]

[Total: 12]

7 (a) Use the quark model to show that

(i) the charge on a proton is $+e$,

.....[1]

(ii) the charge on a neutron is zero.

.....[1]

(b) A nucleus of $^{90}_{38}\text{Sr}$ decays by the emission of a β^- particle. A nucleus of $^{64}_{29}\text{Cu}$ decays by the emission of a β^+ particle.

(i) In Fig. 7.1, state the nucleon number and proton number for the nucleus produced in each of these decay processes.

	nucleus formed by β^- decay	nucleus formed by β^+ decay
nucleon number		
proton number		

Fig. 7.1

[1]

(ii) State the name of the force responsible for β decay.

.....[1]

(iii) State the names of the leptons produced in each of the decay processes.

β^- decay:

β^+ decay:

[1]

[Total: 5]

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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) State two SI base units other than kilogram, metre and second.

1.

2.

[1]

- (b) Determine the SI base units of resistivity.

base units [3]

- (c) (i) A wire of cross-sectional area 1.5 mm^2 and length 2.5 m has a resistance of 0.030Ω . Calculate the resistivity of the material of the wire in $\text{n}\Omega\text{m}$.

resistivity = ... $\text{n}\Omega\text{m}$ [3]

- (ii) 1. State what is meant by *precision*.

.....
.....

2. Explain why the precision in the value of the resistivity is improved by using a micrometer screw gauge rather than a metre rule to measure the diameter of the wire.

.....
.....
.....

[2]

[Total: 9]

2 (a) Define *velocity*.

.....
[1]

(b) A ball of mass 0.45 kg leaves the edge of a table with a horizontal velocity v , as shown in Fig. 2.1.

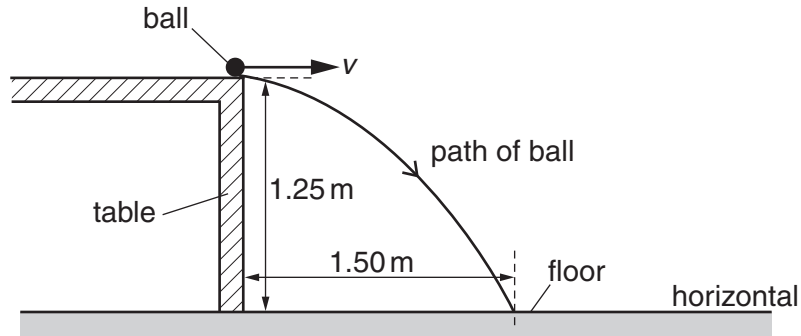


Fig. 2.1

The height of the table is 1.25 m. The ball travels a distance of 1.50 m horizontally before hitting the floor.

Air resistance is negligible.

Calculate, for the ball,

(i) the horizontal velocity v as it leaves the table,

$v = \dots\dots\dots \text{ms}^{-1}$ [3]

(ii) the velocity just as it hits the floor,

magnitude of velocity = ...ms⁻¹

angle to the horizontal = ...°
[4]

(iii) the kinetic energy just as it hits the floor,

kinetic energy = ...J [2]

(iv) the loss in gravitational potential energy as it falls from the table to the floor.

loss in potential energy = ...J [2]

(c) Explain why the kinetic energy of the ball in **(b)(iii)** does not equal the loss of gravitational potential energy in **(b)(iv)**.

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

[Total: 13]

- 3 The Young modulus of the material of a wire can be determined using the apparatus shown in Fig. 3.1.

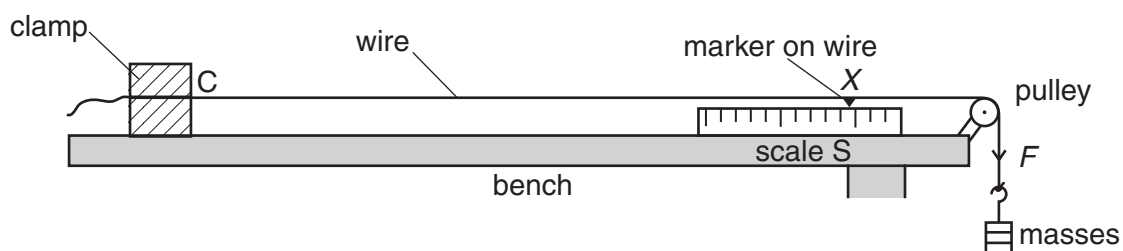


Fig. 3.1

One end of the wire is clamped at C and a marker is attached to the wire above a scale S. A force to extend the wire is applied by attaching masses to the other end of the wire.

The reading X of the marker on the scale S is determined for different forces F applied to the end of the wire. The variation with X of F is shown in Fig. 3.2.

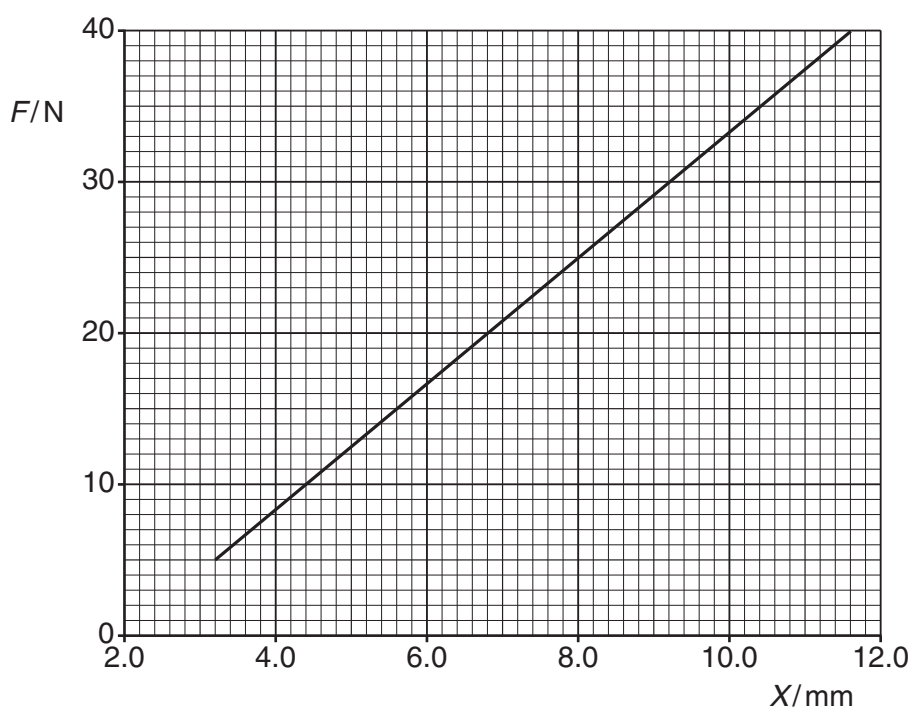


Fig. 3.2

- (a) The length of the wire from C to the marker for $F = 0$ is 3.50 m. The diameter of the wire is 0.38 mm.

Use the gradient of the line in Fig. 3.2 to determine the Young modulus E of the material of the wire in TPa.

$$E = \dots\dots\dots \text{TPa} [3]$$

- (b) The experiment is repeated with a thicker wire of the same material and length.

State how the range of the force F must be changed to obtain the same range of scale readings as in Fig. 3.2.

.....

[1]

[Total: 4]

- 4 (a) State Newton's first law of motion.

.....
[1]

- (b) An object A of mass 100 g is moving in a straight line with a velocity of 0.60 m s^{-1} to the right. An object B of mass 200 g is moving in the same straight line as object A with a velocity of 0.80 m s^{-1} to the left, as shown in Fig. 4.1.



Fig. 4.1

Objects A and B collide. Object A then moves with a velocity of 0.40 m s^{-1} to the left.

- (i) Calculate the magnitude of the velocity of B after the collision.

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

- (ii) The collision between A and B is inelastic.

Explain how the collision is inelastic and still obeys the law of conservation of energy.

.....

[1]

[Total: 4]

- 5 (a) Define the *frequency* of a sound wave.

.....
[1]

- (b) A sound wave travels through air. Describe the motion of the air particles relative to the direction of travel of the sound wave.

.....
[1]

- (c) The sound wave emitted from the horn of a stationary car is detected with a microphone and displayed on a cathode-ray oscilloscope (c.r.o.), as shown in Fig. 5.1.

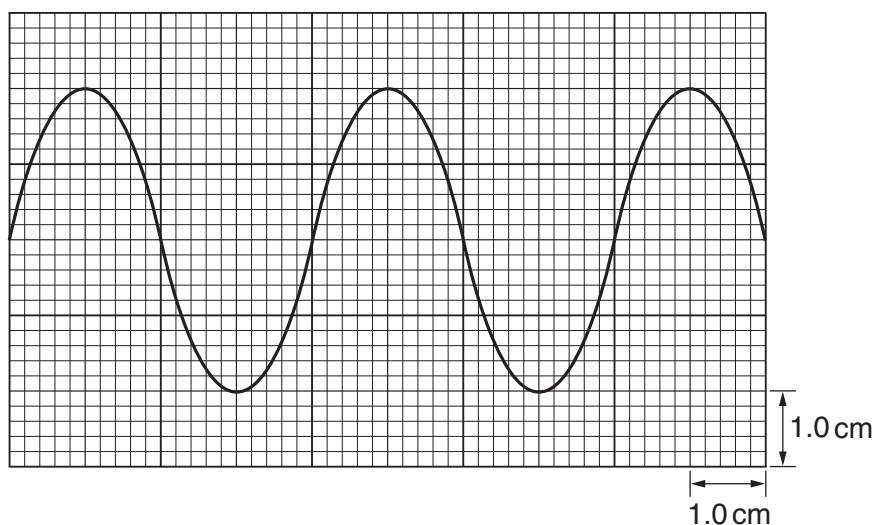


Fig. 5.1

The y-axis setting is 5.0 mV cm^{-1} .

The time-base setting is 0.50 ms cm^{-1} .

- (i) Use Fig. 5.1 to determine the frequency of the sound wave.

frequency = ... Hz [2]

- (ii) The horn of the car sounds continuously. Describe the changes to the trace seen on the c.r.o. as the car travels at constant speed

1. directly towards the stationary microphone,

.....

2. directly away from the stationary microphone.

.....

[3]

[Total: 7]

- 6 (a) Interference fringes may be observed using a light-emitting laser to illuminate a double slit. The double slit acts as two sources of light.

Explain

- (i) the part played by diffraction in the production of the fringes,

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

- (ii) the reason why a double slit is used rather than two separate sources of light.

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

- (b) A laser emitting light of a single wavelength is used to illuminate slits S_1 and S_2 , as shown in Fig. 6.1.

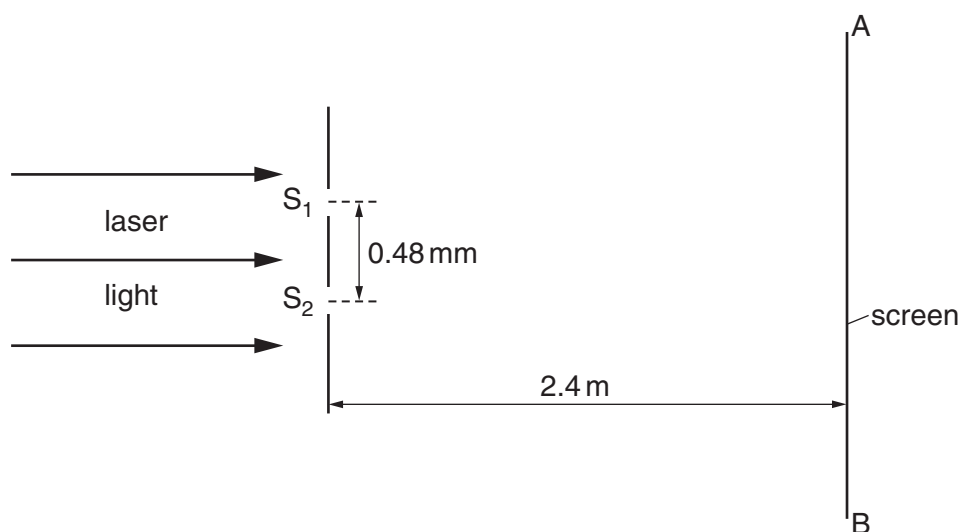


Fig. 6.1 (not to scale)

An interference pattern is observed on the screen AB. The separation of the slits is 0.48 mm . The slits are 2.4 m from AB. The distance on the screen across 16 fringes is 36 mm , as illustrated in Fig. 6.2.

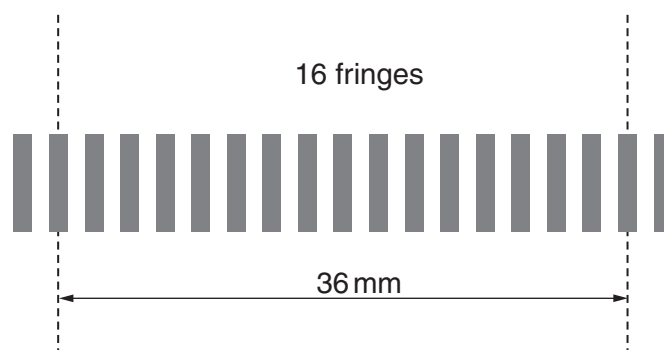


Fig. 6.2

Calculate the wavelength of the light emitted by the laser.

wavelength = ...m [3]

- (c) Two dippers D_1 and D_2 are used to produce identical waves on the surface of water, as illustrated in Fig. 6.3.

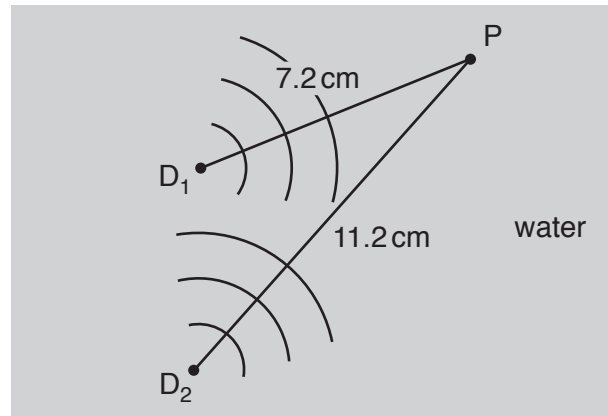


Fig. 6.3 (not to scale)

Point P is 7.2 cm from D_1 and 11.2 cm from D_2 .

The wavelength of the waves is 1.6 cm. The phase difference between the waves produced at D_1 and D_2 is zero.

- (i) State and explain what is observed at P.

.....

 [2]

- (ii) State and explain the effect on the answer to (c)(i) if the apparatus is changed so that, separately,

1. the phase difference between the waves at D_1 and at D_2 is 180° ,

.....

2. the intensity of the wave from D_1 is less than the intensity of that from D_2 .

.....

[2]

[Total: 10]

- 7 (a) Define *electromotive force* (e.m.f.) of a cell.

.....
[1]

- (b) A cell C of e.m.f. 1.50 V and internal resistance $0.200\ \Omega$ is connected in series with resistors X and Y, as shown in Fig. 7.1.

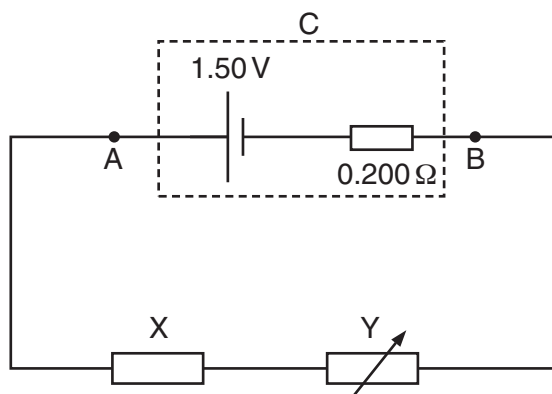


Fig. 7.1

The resistance of X is constant and the resistance of Y can be varied.

- (i) The resistance of Y is varied from 0 to $8.00\ \Omega$.

State and explain the variation in the potential difference (p.d.) between points A and B (terminal p.d. across C). Numerical values are not required.

.....

[3]

- (ii) The resistance of Y is set at $6.00\ \Omega$. The current in the circuit is 0.180 A.

Calculate

1. the resistance of X,

resistance = ... Ω [2]

2. the p.d. between points A and B,

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

3. the efficiency of the cell.

efficiency = ... [2]

[Total: 10]

- 8 (a) Describe **two** differences between the decay of a nucleus that emits a β^- particle and the decay of a nucleus that emits a β^+ particle.

1.

.....

2.

.....

[2]

- (b) In a simple quark model there are three types of quark. State the composition of the proton and of the neutron in terms of these three quarks.

proton:

neutron:

[1]

[Total: 3]

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1 hour 15 minutes

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 unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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.	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
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	$W = \frac{1}{2} QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
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) Two forces, with magnitudes 5.0 N and 12 N, act from the same point on an object. Calculate the magnitude of the resultant force R for the forces acting

(i) in opposite directions,

$R = \dots\dots\dots$ N [1]

(ii) at right angles to each other.

$R = \dots\dots\dots$ N [1]

- (b) An object X rests on a smooth horizontal surface. Two horizontal forces act on X as shown in Fig. 1.1.

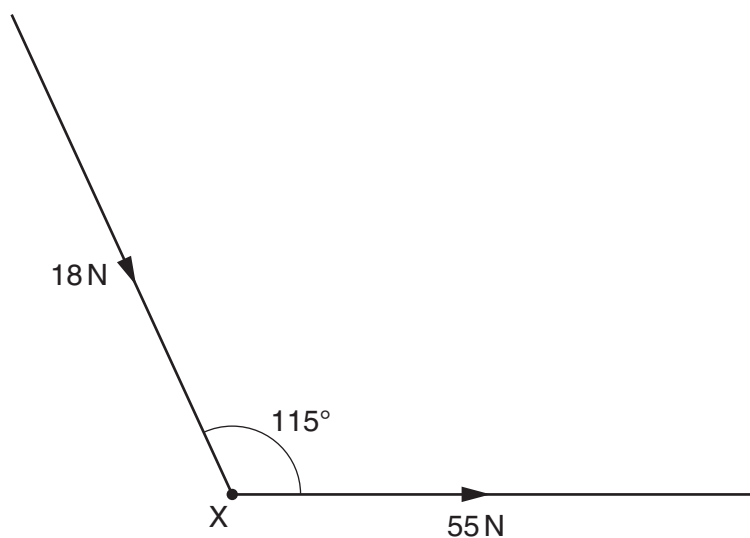


Fig. 1.1 (not to scale)

A force of 55 N is applied to the right. A force of 18 N is applied at an angle of 115° to the direction of the 55 N force.

- (i) Use the resolution of forces or a scale diagram to show that the magnitude of the resultant force acting on X is 65 N.

[2]

- (ii) Determine the angle between the resultant force and the 55 N force.

angle = ... ° [2]

- (c) A third force of 80 N is now applied to X in the opposite direction to the resultant force in (b).

The mass of X is 2.7 kg.

Calculate the magnitude of the acceleration of X.

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

[Total: 9]

- 2 (a) State Newton's second law of motion.

.....
[1]

- (b) A constant resultant force F acts on an object A. The variation with time t of the velocity v for the motion of A is shown in Fig. 2.1.

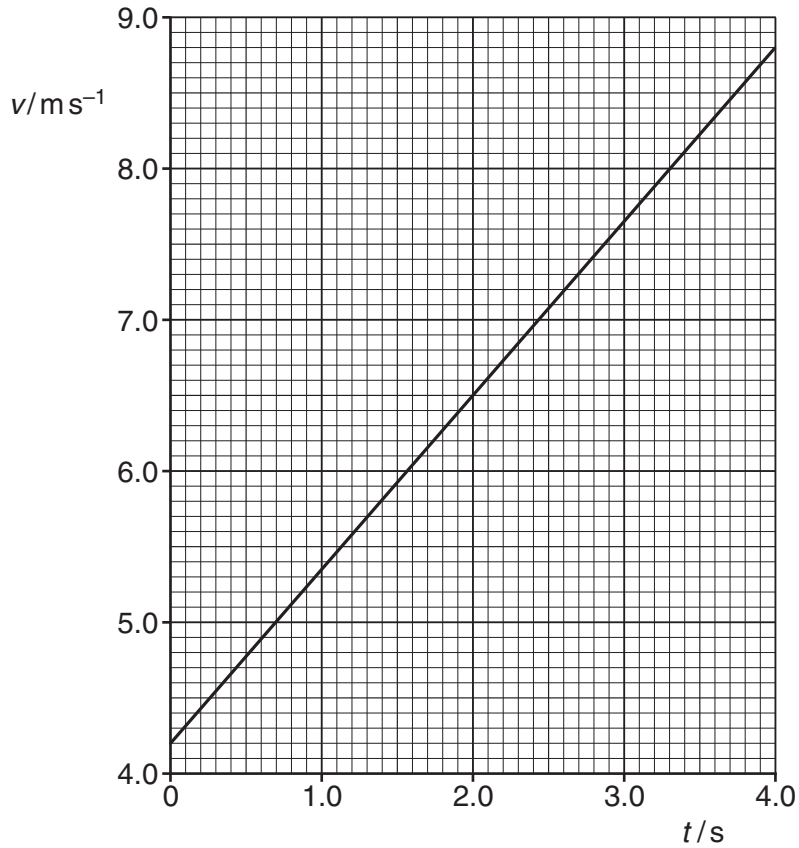


Fig. 2.1

The mass of A is 840 g.

Calculate, for the time $t = 0$ to $t = 4.0$ s,

- (i) the change in momentum of A,

change in momentum = ... kg ms⁻¹ [2]

- (ii) the force F .

$F =$ N [1]

- (c) The force F is removed at $t = 4.0$ s. Object A continues at constant velocity before colliding with an object B, as illustrated in Fig. 2.2.



Fig. 2.2

Object B is initially at rest. The mass of B is 730 g.
The objects A and B join together and have a velocity of 4.7 m s^{-1} .

- (i) By calculation, show that the changes in momentum of A and of B during the collision are equal and opposite.

[2]

- (ii) Explain how the answers obtained in (i) support Newton's third law.

.....

 [2]

- (iii) By reference to the speeds of A and B, explain whether the collision is elastic.

.....
 [1]

[Total: 9]

- 3 (a) Define *electric field strength*.

.....
[1]

- (b) An electron is accelerated from point A to point B by a uniform electric field, as illustrated in Fig. 3.1.

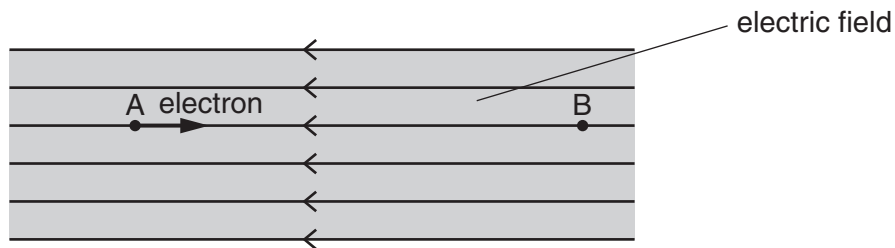


Fig. 3.1

The distance between A and B is 12 mm. The velocity of the electron at A is 2.5 km s^{-1} and at B is 18 Mm s^{-1} .

Calculate

- (i) the acceleration of the electron,

acceleration = ... m s^{-2} [2]

- (ii) the change in kinetic energy of the electron,

change in kinetic energy = ... J [3]

(iii) the electric field strength.

electric field strength = ... V m^{-1} [3]

(c) An α -particle moves from A to B in the electric field in (b).

Describe and explain how the change in the kinetic energy of the α -particle compares with that of the electron. Numerical values are not required.

.....

.....

.....

.....

.....[3]

[Total: 12]

- 4 A spring is supported so that it hangs vertically, as shown in Fig. 4.1.

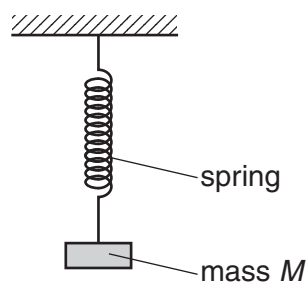


Fig. 4.1

Different masses are attached to the lower end of the spring. The extension x of the spring is measured for each mass M . The variation with x of M is shown in Fig. 4.2.

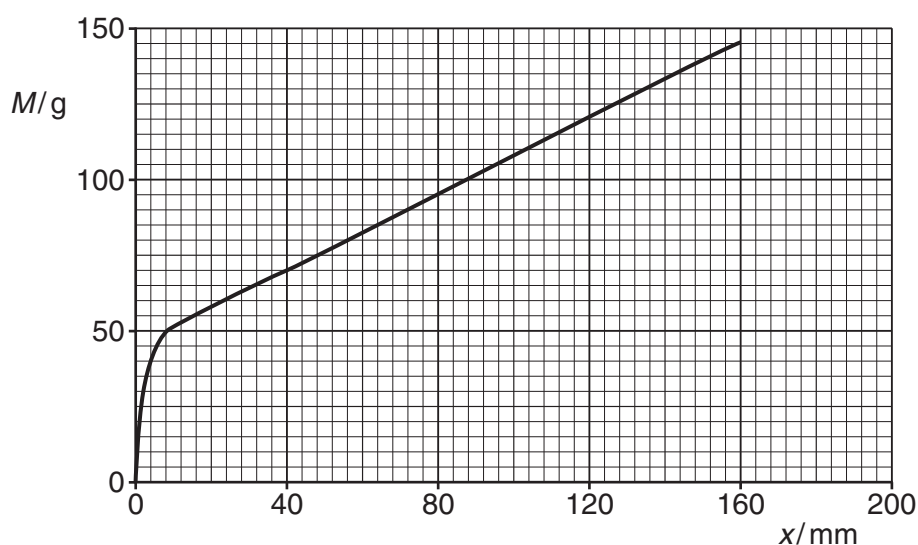


Fig. 4.2

- (a) State and explain whether the spring obeys Hooke's law.

.....
[1]

- (b) State the form of energy stored in the spring due to the addition of the masses.

.....[1]

- (c) Describe how to determine whether the extension of the spring is elastic.

.....
[1]

- (d) Calculate the work done on the spring as it is extended from $x = 40.0 \text{ mm}$ to $x = 160 \text{ mm}$.

work done = ...J [3]

[Total: 6]

5 (a) A diffraction grating is used to determine the wavelength of light.

(i) Describe the diffraction of light at a diffraction grating.

.....

[2]

(ii) By reference to interference, explain

1. the zero order maximum,

.....

2. the first order maximum.

.....

[3]

(b) A diffraction grating is used with different wavelengths of light. The angle θ of the second order maximum is measured for each wavelength. The variation with wavelength λ of $\sin \theta$ is shown in Fig. 5.1.

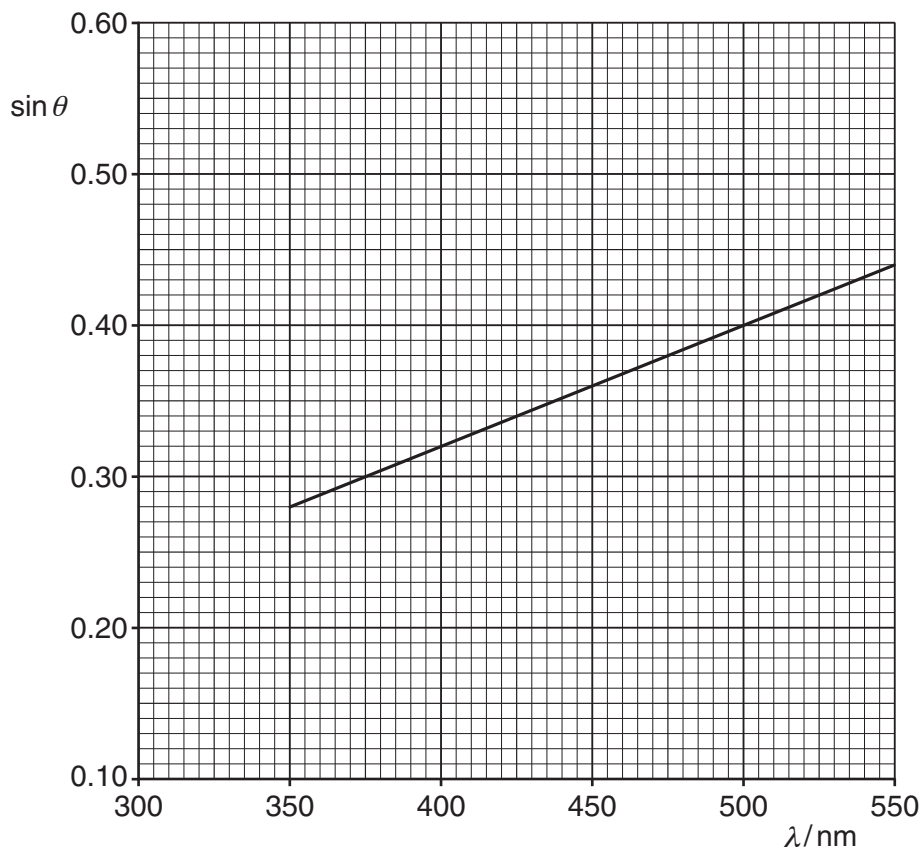


Fig. 5.1

- (i) Determine the gradient of the line shown in Fig. 5.1.

gradient = ...[2]

- (ii) Use the gradient determined in (i) to calculate the slit separation d of the diffraction grating.

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

- (iii) On Fig. 5.1, sketch a line to show the results that would be obtained for the first order maxima. [1]

[Total: 10]

6 (a) Describe the I – V characteristic of

(i) a metallic conductor at constant temperature,

.....
[1]

(ii) a semiconductor diode.

.....

[2]

(b) Two identical filament lamps are connected in series and then in parallel to a battery of electromotive force (e.m.f.) 12 V and negligible internal resistance, as shown in Fig. 6.1a and Fig. 6.1b.

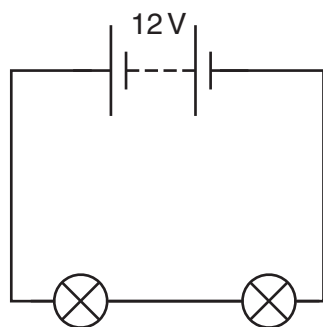


Fig. 6.1a

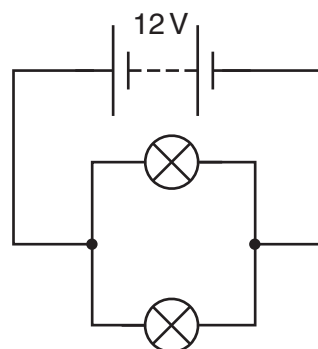


Fig. 6.1b

The I – V characteristic of each lamp is shown in Fig. 6.2.

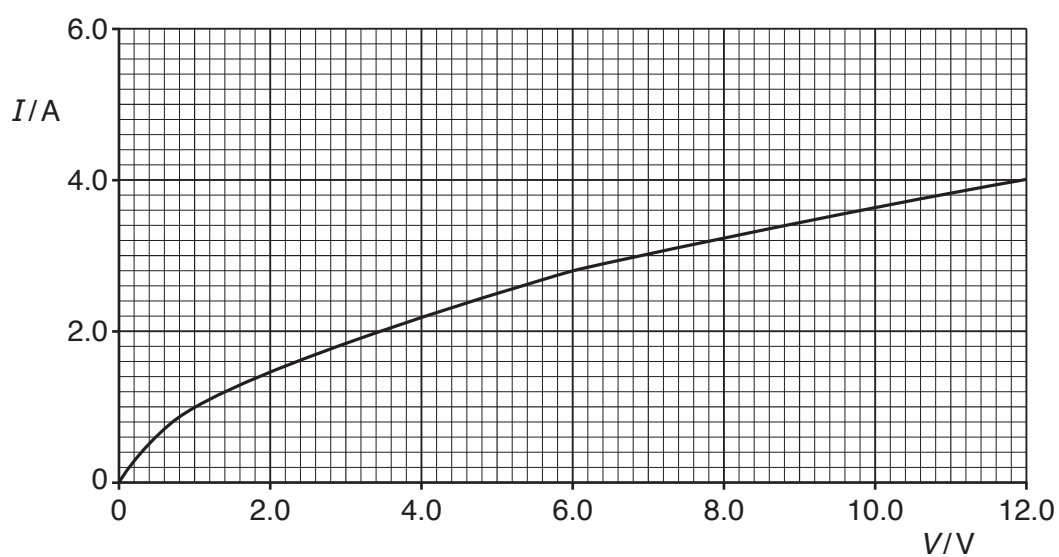


Fig. 6.2

(i) Use the information shown in Fig. 6.2 to determine the current through the battery in

1. the circuit of Fig. 6.1a,

current = ...A

2. the circuit of Fig. 6.1b.

current = ...A
[3]

(ii) Calculate the total resistance in

1. the circuit of Fig. 6.1a,

resistance = ... Ω

2. the circuit of Fig. 6.1b.

resistance = ... Ω
[3]

(iii) Calculate the ratio

$$\frac{\text{power dissipated in a lamp in the circuit of Fig. 6.1a}}{\text{power dissipated in a lamp in the circuit of Fig. 6.1b}}$$

ratio = ...[2]

[Total: 11]

[Turn over

- 7 (a) The following particles are used to describe the structure of an atom.

electron neutron proton quark

Underline the fundamental particles in the above list. [1]

- (b) The following equation represents the decay of a nucleus of ${}^{60}_{27}\text{Co}$ to form nucleus Q by β^- emission.



- (i) Complete Fig. 7.1.

	value
A	
B	

Fig. 7.1

[1]

- (ii) State the name of the particle x.

.....[1]

[Total: 3]

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