

CANDIDATE
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PHYSICS

9702/21

Paper 2 AS Level Structured Questions

May/June 2016

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) Make estimates of

(i) the mass, in kg, of a wooden metre rule,

mass = ... kg [1]

(ii) the volume, in cm^3 , of a cricket ball or a tennis ball.

volume = ... cm^3 [1]

(b) A metal wire of length L has a circular cross-section of diameter d , as shown in Fig. 1.1.

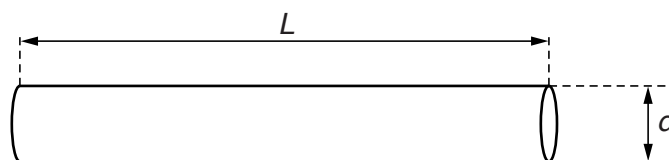


Fig. 1.1

The volume V of the wire is given by the expression

$$V = \frac{\pi d^2 L}{4}.$$

The diameter, length and mass M are measured to determine the density of the metal of the wire. The measured values are:

$$d = 0.38 \pm 0.01 \text{ mm},$$

$$L = 25.0 \pm 0.1 \text{ cm},$$

$$M = 0.225 \pm 0.001 \text{ g}.$$

Calculate the density of the metal, with its absolute uncertainty. Give your answer to an appropriate number of significant figures.

density = ... kg m^{-3} [5]

[Total: 7]

- 2 A ball is thrown from a point P with an initial velocity u of 12 m s^{-1} at 50° to the horizontal, as illustrated in Fig. 2.1.

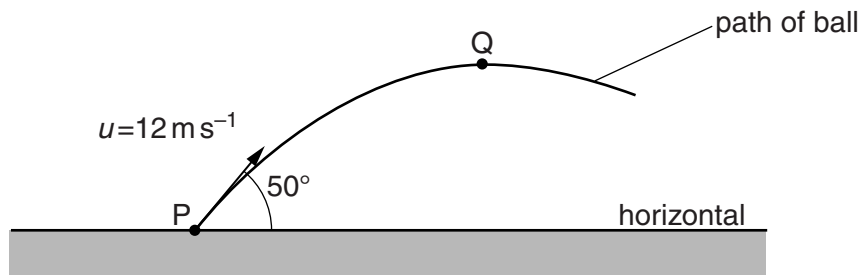


Fig. 2.1

The ball reaches maximum height at Q.

Air resistance is negligible.

(a) Calculate

- (i) the horizontal component of u ,

horizontal component = ... m s^{-1} [1]

- (ii) the vertical component of u .

vertical component = ... m s^{-1} [1]

- (b) Show that the maximum height reached by the ball is 4.3 m.

[2]

- (c) Determine the magnitude of the displacement PQ.

displacement = ... m [4]

[Total: 8]

[Turn over]

- 3 A ball of mass 150 g is at rest on a horizontal floor, as shown in Fig. 3.1.

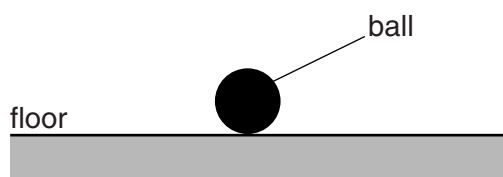


Fig. 3.1

- (a) (i) Calculate the magnitude of the normal contact force from the floor acting on the ball.

force = ... N [1]

- (ii) Explain your working in (i).

.....

 [1]

- (b) The ball is now lifted above the floor and dropped so that it falls vertically, as illustrated in Fig. 3.2.

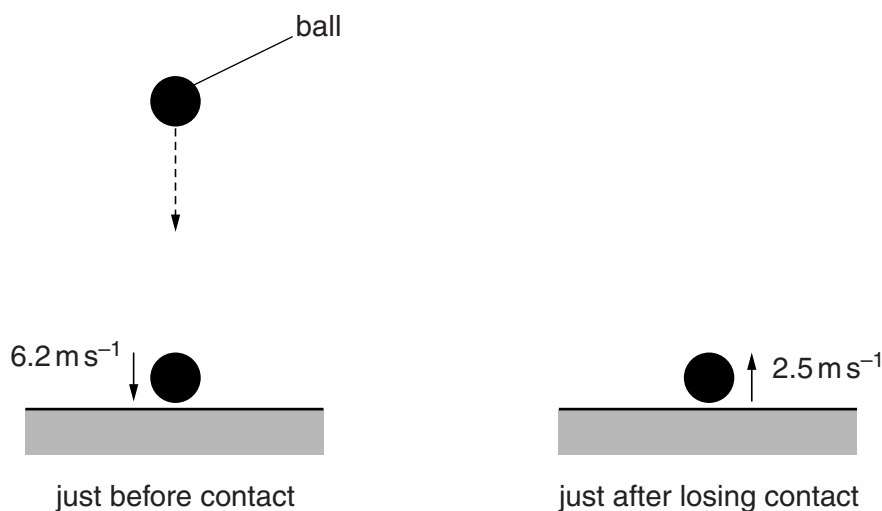


Fig. 3.2

Just before contact with the floor, the ball has velocity 6.2 m s^{-1} downwards. The ball bounces from the floor and its velocity just after losing contact with the floor is 2.5 m s^{-1} upwards. The ball is in contact with the floor for 0.12 s.

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

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

- (ii) Calculate the average resultant force on the ball when it is in contact with the floor.

magnitude of force = ... N

direction of force
[3]

- (iii) State and explain whether linear momentum is conserved during the collision of the ball with the floor.

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

[Total: 8]

- 4 (a) State what is meant by *elastic potential energy*.

.....
[1]

- (b) A spring is extended by applying a force. The variation with extension x of the force F is shown in Fig. 4.1 for the range of values of x from 20 cm to 40 cm.

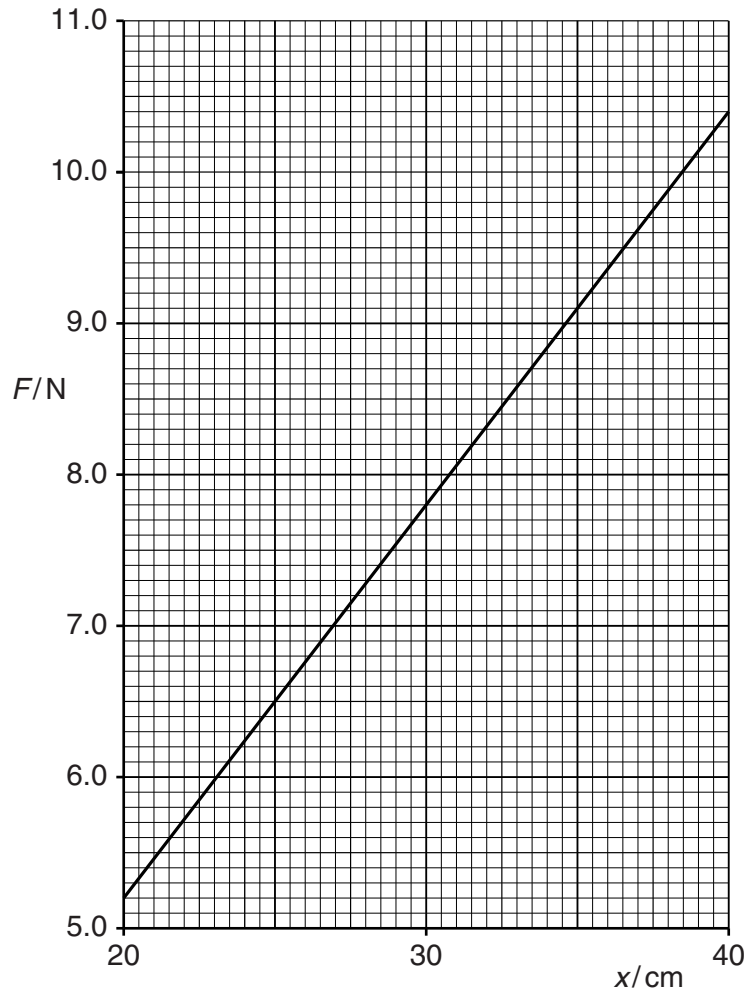


Fig. 4.1

- (i) Use data from Fig. 4.1 to show that the spring obeys Hooke's law for this range of extensions.

.....

[2]

(ii) Use Fig. 4.1 to calculate

1. the spring constant,

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

2. the work done extending the spring from $x = 20 \text{ cm}$ to $x = 40 \text{ cm}$.

work done = ... J [3]

(c) A force is applied to the spring in (b) to give an extension of 50 cm.

State how you would check that the spring has not exceeded its elastic limit.

.....
 [1]

[Total: 9]

- 5 The variation with time t of the displacement y of a wave X, as it passes a point P, is shown in Fig. 5.1.

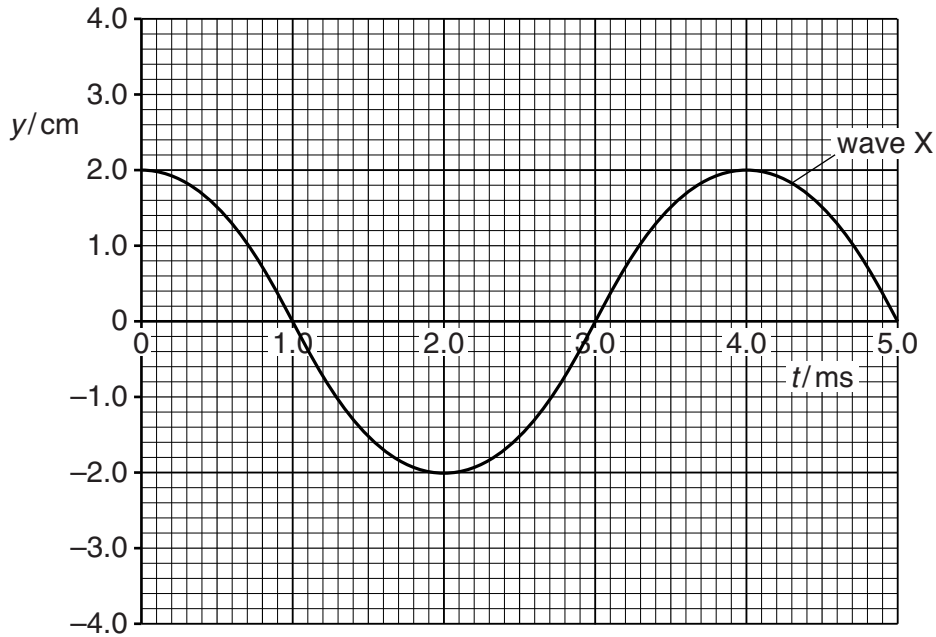


Fig. 5.1

The intensity of wave X is I .

- (a) Use Fig. 5.1 to determine the frequency of wave X.

frequency = ... Hz [2]

- (b) A second wave Z with the same frequency as wave X also passes point P. Wave Z has intensity $2I$. The phase difference between the two waves is 90° .

On Fig. 5.1, sketch the variation with time t of the displacement y of wave Z.

Show your working.

[3]

- (c) A double-slit interference experiment is used to determine the wavelength of light emitted from a laser, as shown in Fig. 5.2.

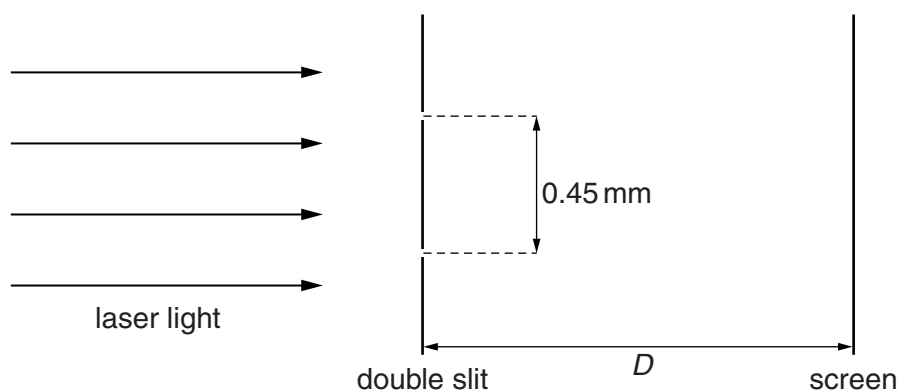


Fig. 5.2 (not to scale)

The separation of the slits is 0.45 mm. The fringes are viewed on a screen at a distance D from the double slit.

The fringe width x is measured for different distances D . The variation with D of x is shown in Fig. 5.3.

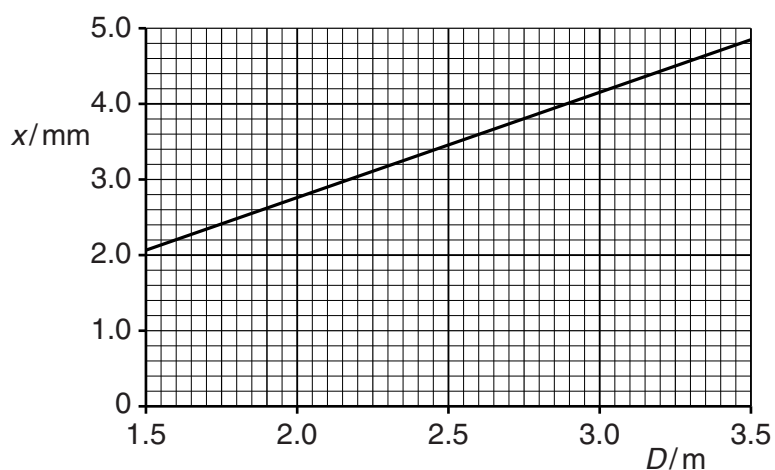


Fig. 5.3

- (i) Use the gradient of the line in Fig. 5.3 to determine the wavelength, in nm, of the laser light.

wavelength = ... nm [4]

- (ii) The separation of the slits is increased. State and explain the effects, if any, on the graph of Fig. 5.3.

.....

.....

.....[2]

[Total: 11]

- 6 (a) Define the *coulomb*.

.....[1]

- (b) A resistor X is connected to a cell as shown in Fig. 6.1.

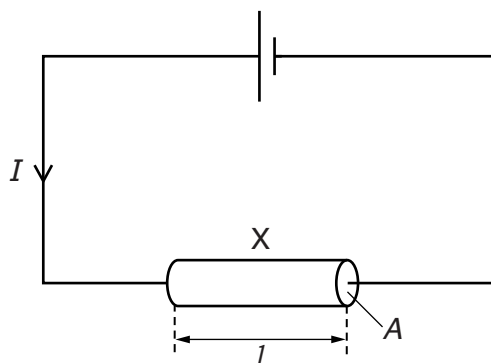


Fig. 6.1

The resistor is a wire of cross-sectional area A and length l . The current in the wire is I .

Show that the average drift speed v of the charge carriers in X is given by the equation

$$v = \frac{I}{nAe}$$

where e is the charge on a charge carrier and n is the number of charge carriers per unit volume in X.

[3]

- (c) A 12V battery with negligible internal resistance is connected to two resistors Y and Z, as shown in Fig. 6.2.

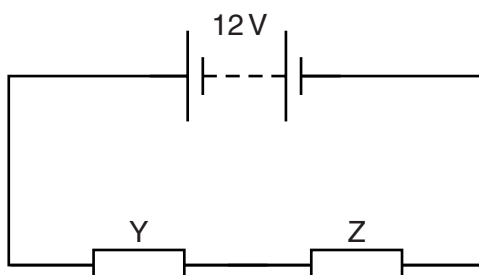


Fig. 6.2

The resistors are made from wires of the same material. The wire of Y has a diameter d and length l . The wire of Z has a diameter $2d$ and length $2l$.

(i) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in Y}}{\text{average drift speed of the charge carriers in Z}} .$$

ratio = ... [3]

(ii) Show that

$$\frac{\text{resistance of Y}}{\text{resistance of Z}} = 2.$$

[2]

(iii) Determine the potential difference across Y.

potential difference = ... V [2]

(iv) Determine the ratio

$$\frac{\text{power dissipated in Y}}{\text{power dissipated in Z}} .$$

ratio = ... [1]

[Total: 12]

7 (a) Give one example of

a hadron:

a lepton:

[1]

(b) Describe, in terms of the simple quark model,

(i) a proton,

.....[1]

(ii) a neutron.

.....[1]

(c) Beta particles may be emitted during the decay of an unstable nucleus of an atom. The emission of a beta particle is due to the decay of a neutron.

(i) Complete the following word equation for the particles produced in this reaction.

neutron $\rightarrow$ + ... + ... [1]

(ii) State the change in quark composition of the particles during this reaction.

.....[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) Define *acceleration*.

.....
[1]

- (b) A man travels on a toboggan down a slope covered with snow from point A to point B and then to point C. The path is illustrated in Fig. 1.1.

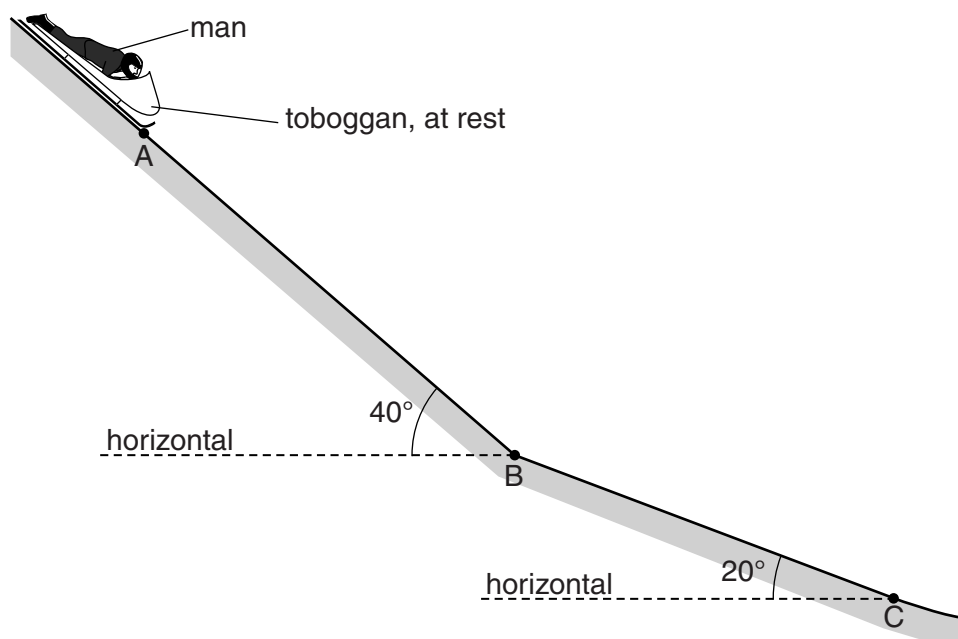


Fig. 1.1 (not to scale)

The slope AB makes an angle of 40° with the horizontal and the slope BC makes an angle of 20° with the horizontal. Friction is not negligible.

The man and toboggan have a combined mass of 95 kg.

The man starts from rest at A and has constant acceleration between A and B. The man takes 19 s to reach B. His speed is 36 m s^{-1} at B.

- (i) Calculate the acceleration from A to B.

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

- (ii) Show that the distance moved from A to B is 340 m.

[1]

(iii) For the man and toboggan moving from A to B, calculate

1. the change in kinetic energy,

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

2. the change in potential energy.

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

(iv) Use your answers in (iii) to determine the average frictional force that acts on the toboggan between A and B.

frictional force = ... N [2]

(v) A parachute opens on the toboggan as it passes point B. There is a constant deceleration of 3.0 m s^{-2} from B to C.

Calculate the frictional force that produces this deceleration between B and C.

frictional force = ... N [2]

[Total: 12]

- 2 (a) Fig. 2.1 shows a liquid in a cylindrical container.

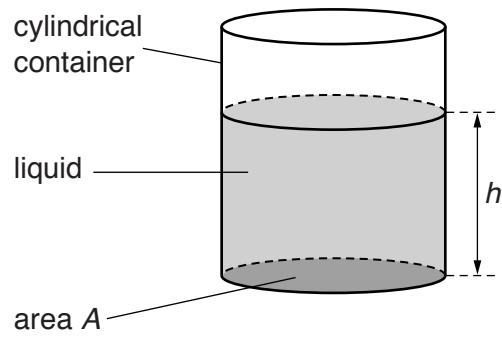


Fig. 2.1

The cross-sectional area of the container is A . The height of the column of liquid is h and the density of the liquid is ρ .

Show that the pressure p due to the liquid on the base of the cylinder is given by

$$p = \rho gh.$$

[3]

- (b) The variation with height h of the total pressure P on the base of the cylinder in (a) is shown in Fig. 2.2.

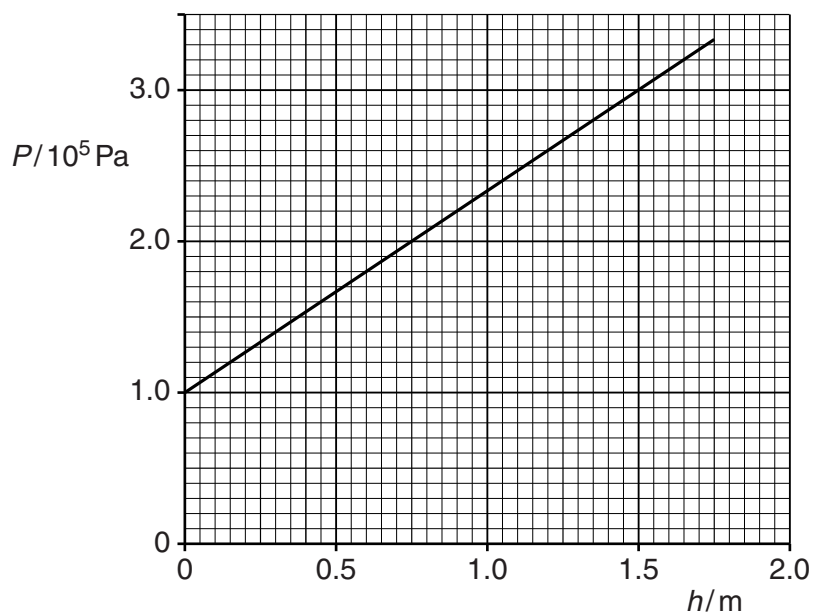


Fig. 2.2

- (i) Explain why the line of the graph in Fig. 2.2 does not pass through the origin (0,0).

.....
[1]

- (ii) Use data from Fig. 2.2 to calculate the density of the liquid in the cylinder.

density = ... kg m^{-3} [2]

[Total: 6]

- 3 (a) Define the *Young modulus*.

.....
[1]

- (b) The Young modulus of steel is 1.9×10^{11} Pa. The Young modulus of copper is 1.2×10^{11} Pa.

A steel wire and a copper wire each have the same cross-sectional area and length. The two wires are each extended by equal forces.

- (i) Use the definition of the Young modulus to determine the ratio

$$\frac{\text{extension of the copper wire}}{\text{extension of the steel wire}} .$$

ratio = ...[3]

- (ii) The two wires are each extended by a force. Both wires obey Hooke's law.

On Fig. 3.1, sketch a graph for each wire to show the variation with extension of the force.

Label the line for steel with the letter **S** and the line for copper with the letter **C**.



Fig. 3.1

[1]

[Total: 5]

- 4 (a) By reference to the direction of the propagation of energy, state what is meant by a *longitudinal* wave and by a *transverse* wave.

longitudinal:

.....

.....

transverse:

.....

.....

[2]

- (b) The intensity of a sound wave passing through air is given by

$$I = Kv\rho f^2 A^2$$

where I is the intensity (power per unit area),
 K is a constant without units,
 v is the speed of sound,
 ρ is the density of air,
 f is the frequency of the wave
and A is the amplitude of the wave.

Show that both sides of the equation have the same SI base units.

[3]

- (c) (i) Describe the *Doppler effect*.

.....
[1]

- (ii) A distant star is moving away from a stationary observer.

State the effect of the motion on the light observed from the star.

.....

[1]

- (d) A car travels at a constant speed towards a stationary observer. The horn of the car sounds at a frequency of 510 Hz and the observer hears a frequency of 550 Hz. The speed of sound in air is 340 m s^{-1} .

Calculate the speed of the car.

speed = ... m s^{-1} [3]

[Total: 10]

- 5 (a) Light of a single wavelength is incident on a diffraction grating. Explain the part played by *diffraction* and *interference* in the production of the first order maximum by the diffraction grating.

diffraction:

.....

interference:

.....

.....

.....

[3]

- (b) The diffraction grating illustrated in Fig. 5.1 is used with light of wavelength 486 nm.

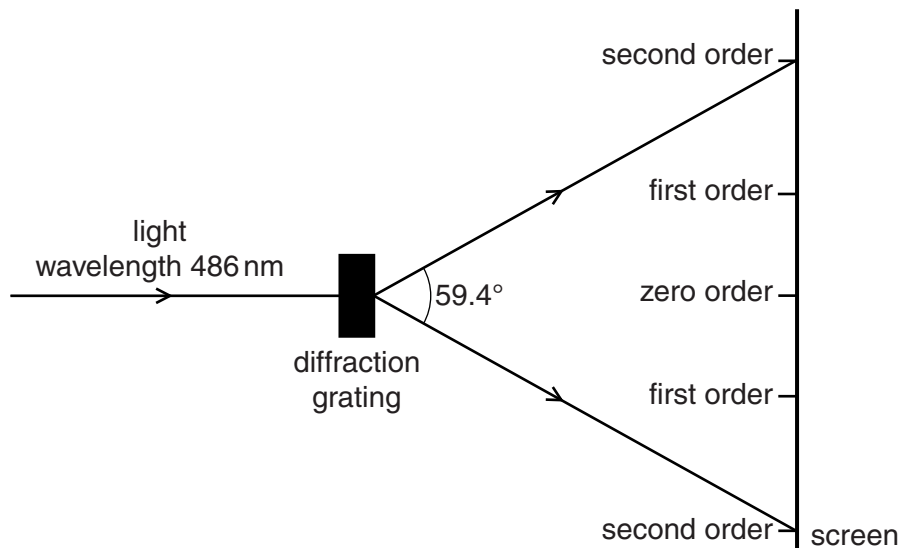


Fig. 5.1 (not to scale)

The orders of the maxima produced are shown on the screen in Fig. 5.1. The angle between the two second order maxima is 59.4° .

Calculate the number of lines per millimetre of the grating.

number of lines per millimetre = ... mm^{-1} [3]

[Total: 6]

- 6 Two parallel vertical metal plates are connected to a power supply, as shown in Fig. 6.1.

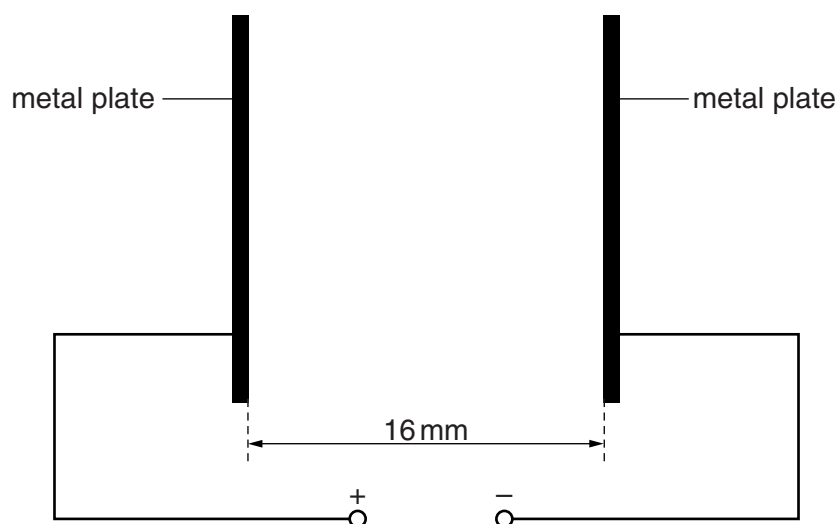


Fig. 6.1

The separation of the plates is 16 mm.

- (a) On Fig. 6.1, draw at least six field lines to represent the electric field between the plates. [1]
- (b) An α -particle travels in a vacuum between the two plates.

The electric field does work on the α -particle. The gain in kinetic energy of the α -particle is 15 keV.

Calculate the electric field strength between the plates.

electric field strength = ... V m^{-1} [4]

[Total: 5]

- 7 (a) Electric current is a flow of charge carriers. The charge on the carriers is quantised. Explain what is meant by *quantised*.

.....[1]

- (b) A battery of electromotive force (e.m.f.) 9.0 V and internal resistance $0.25\ \Omega$ is connected in series with two identical resistors X and a resistor Y, as shown in Fig. 7.1.

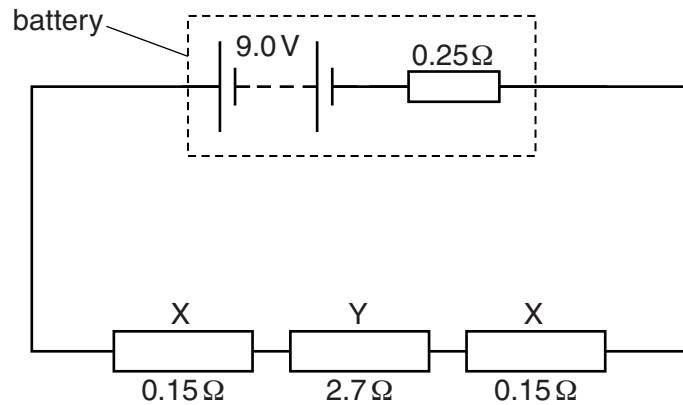


Fig. 7.1

The resistance of each resistor X is $0.15\ \Omega$ and the resistance of resistor Y is $2.7\ \Omega$.

- (i) Show that the current in the circuit is 2.8 A .

[3]

- (ii) Calculate the potential difference across the battery.

potential difference = ... V [2]

- (c) Each resistor X connected in the circuit in (b) is made from a wire with a cross-sectional area of 2.5 mm^2 . The number of free electrons per unit volume in the wire is $8.5 \times 10^{29} \text{ m}^{-3}$.

- (i) Calculate the average drift speed of the electrons in X.

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

- (ii) The two resistors X are replaced by two resistors Z made of the same material and length but with half the diameter.

Describe and explain the difference between the average drift speed in Z and that in X.

.....

[2]

[Total: 10]

- 8 (a) State the name of the class (group) to which each of the following belongs:

electron

neutron

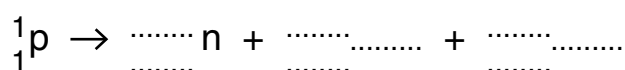
neutrino

proton

[2]

- (b) A proton may decay into a neutron together with two other particles.

- (i) Complete the following to give an equation that represents this proton decay.



[2]

- (ii) Write an equation for this decay in terms of quark composition.

[1]

- (iii) State the name of the force responsible for this decay.

.....[1]

[Total: 6]

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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) A list of quantities that are either scalars or vectors is shown in Fig. 1.1.

quantity	scalar	vector
distance	✓	
energy		
momentum		
power		
time		
weight		

Fig. 1.1

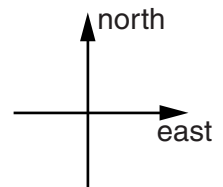
Complete Fig. 1.1 to indicate whether each quantity is a scalar or a vector.

One line has been completed as an example.

[2]

- (b) A girl runs 120m due north in 15s. She then runs 80m due east in 12s.

- (i) Sketch a vector diagram to show the path taken by the girl. Draw and label her resultant displacement R.



[1]

(ii) Calculate, for the girl,

1. the average speed,

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

2. the magnitude of the average velocity v and its angle with respect to the direction of the initial path.

magnitude of v = ... ms^{-1}

angle = ... $^{\circ}$
[3]

[Total: 7]

- 2 (a) Describe the effects, one in each case, of systematic errors and random errors when using a micrometer screw gauge to take readings for the diameter of a wire.

systematic errors:

.....

random errors:

.....

[2]

- (b) Distinguish between precision and accuracy when measuring the diameter of a wire.

precision:

.....

accuracy:

.....

[2]

[Total: 4]

- 3 (a) Explain what is meant by *gravitational potential energy* and by *kinetic energy*.

gravitational potential energy:

.....

kinetic energy:

.....

[2]

- (b) A motion sensor is used to measure the velocity of a ball falling vertically towards the ground, as illustrated in Fig. 3.1.

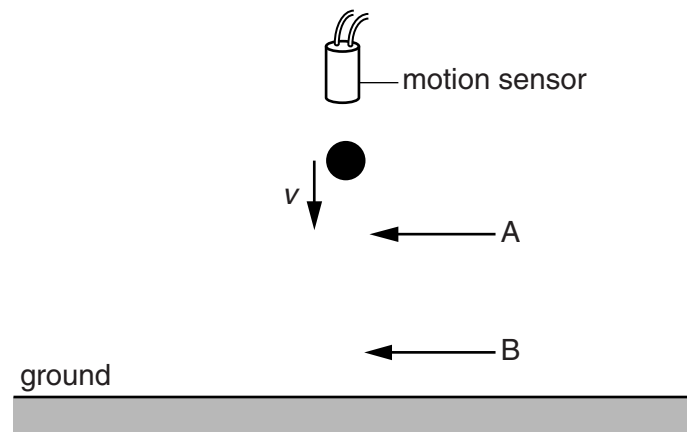


Fig. 3.1

The ball passes through points A and B as it falls. The ball has a mass of 1.5 kg.

The variation with time t of the velocity v of the ball as it falls from A to B is shown in Fig. 3.2.

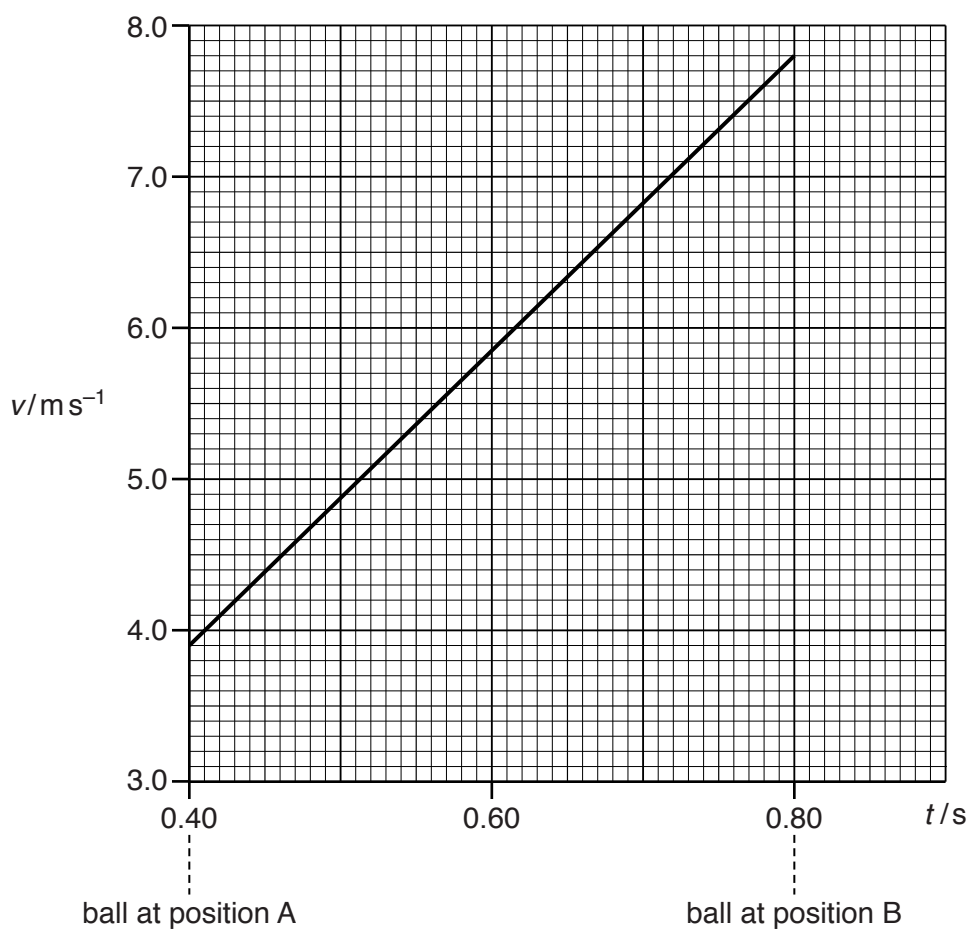


Fig. 3.2

Use Fig. 3.2 to calculate, for the ball falling from A to B,

(i) the displacement,

displacement = ...m [3]

(ii) the acceleration,

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

(iii) the change in kinetic energy.

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

(c) Show that the work done by the gravitational field on the ball in (b) as it moves from A to B is equal to the change in kinetic energy.

[2]

[Total: 12]

- 4 A spring balance is used to weigh a cylinder that is immersed in oil, as shown in Fig. 4.1.

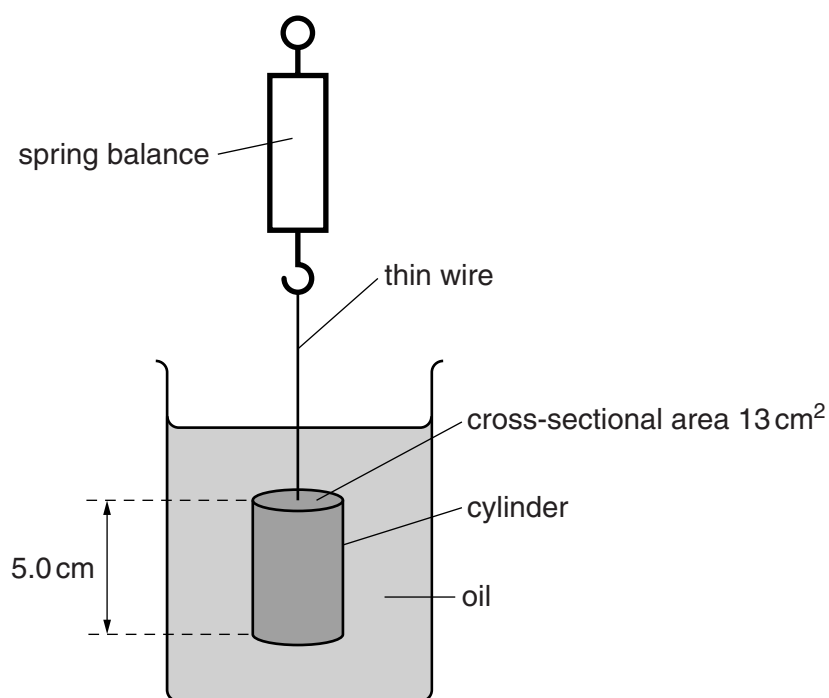


Fig. 4.1

The reading on the spring balance is 4.8 N. The length of the cylinder is 5.0 cm and the cross-sectional area of the cylinder is 13 cm². The weight of the cylinder is 5.3 N.

- (a) The cylinder is in equilibrium when it is immersed in the oil. Explain this in terms of the forces acting on the cylinder.

.....
 [1]

- (b) Calculate the density of the oil.

density = ... kg m⁻³ [3]

[Total: 4]

- 5 (a) State the law of conservation of momentum.

.....

.....

..... [2]

- (b) Two particles A and B collide elastically, as illustrated in Fig. 5.1.

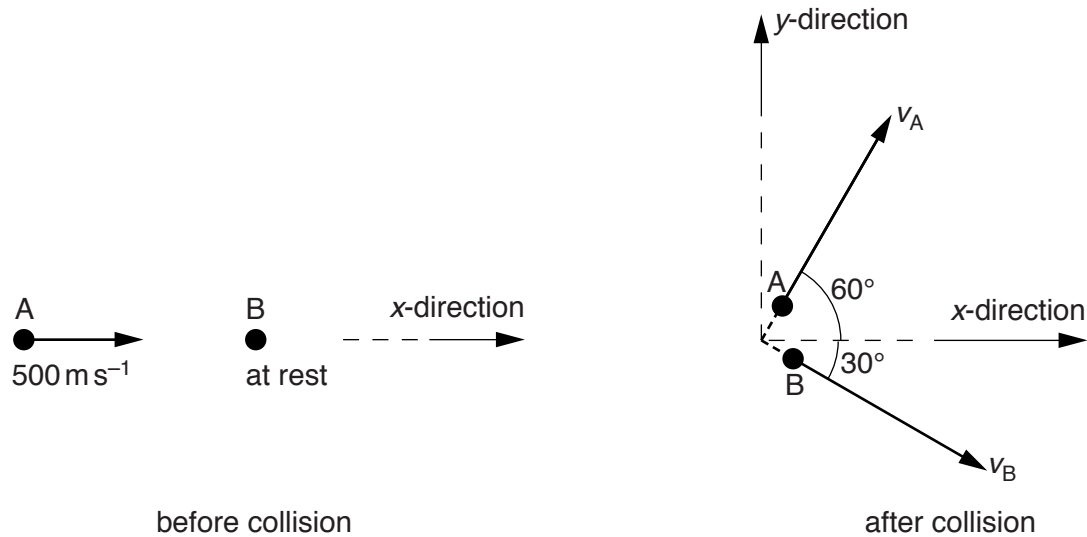


Fig. 5.1

The initial velocity of A is 500 m s^{-1} in the x-direction and B is at rest.

The velocity of A after the collision is v_A at 60° to the x-direction. The velocity of B after the collision is v_B at 30° to the x-direction.

The mass m of each particle is $1.67 \times 10^{-27} \text{ kg}$.

- (i) Explain what is meant by the particles colliding *elastically*.

..... [1]

- (ii) Calculate the total initial momentum of A and B.

momentum = ...Ns [1]

- (iii) State an expression in terms of m , v_A and v_B for the total momentum of A and B after the collision

1. in the x -direction,

.....

2. in the y -direction.

.....

[2]

- (iv) Calculate the magnitudes of the velocities v_A and v_B after the collision.

$$v_A = \dots\dots\dots \text{ms}^{-1}$$

$$v_B = \dots\dots\dots \text{ms}^{-1}$$

[3]

[Total: 9]

- 6 (a) Define the *ohm*.

..... [1]

- (b) A 15V battery with negligible internal resistance is connected to two resistors P and Q, as shown in Fig. 6.1.

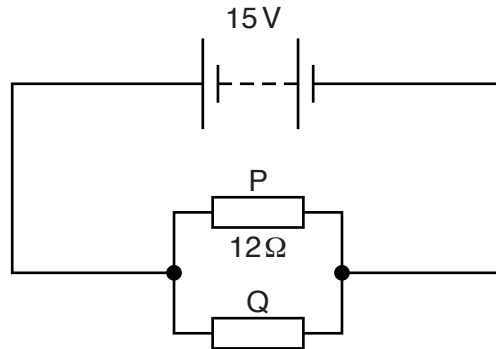


Fig. 6.1

The resistors are made of wires of the same material. The wire of P has diameter d and length $2l$. The wire of Q has diameter $2d$ and length l .

The resistance of P is $12\ \Omega$.

- (i) Show that the resistance of Q is $1.5\ \Omega$.

- (ii) Calculate the total power dissipated in the resistors P and Q.

[3]

power = ... W [3]

(iii) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in P}}{\text{average drift speed of the charge carriers in Q}}.$$

ratio = ... [3]

[Total: 10]

- 7 (a) Apparatus used to produce stationary waves on a stretched string is shown in Fig. 7.1.

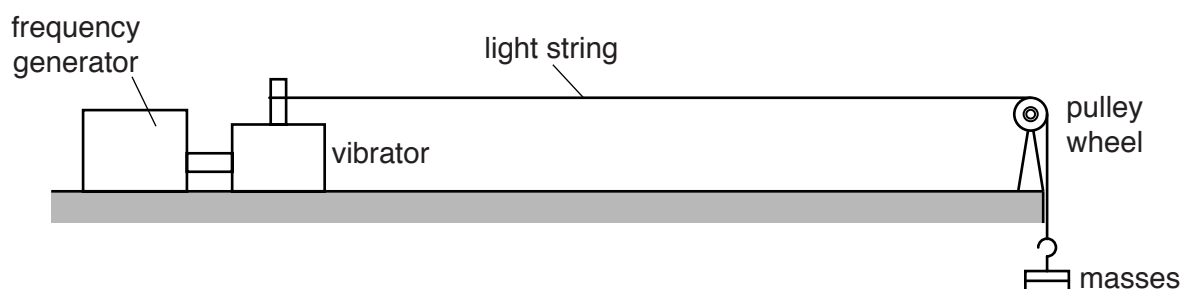


Fig. 7.1

The frequency generator is switched on.

- (i) Describe two adjustments that can be made to the apparatus to produce stationary waves on the string.

1.
-
2.
-

[2]

- (ii) Describe the features that are seen on the stretched string that indicate stationary waves have been produced.

..... [1]

- (b) The variation with time t of the displacement x of a particle caused by a progressive wave R is shown in Fig. 7.2. For the same particle, the variation with time t of the displacement x caused by a second wave S is also shown in Fig. 7.2.

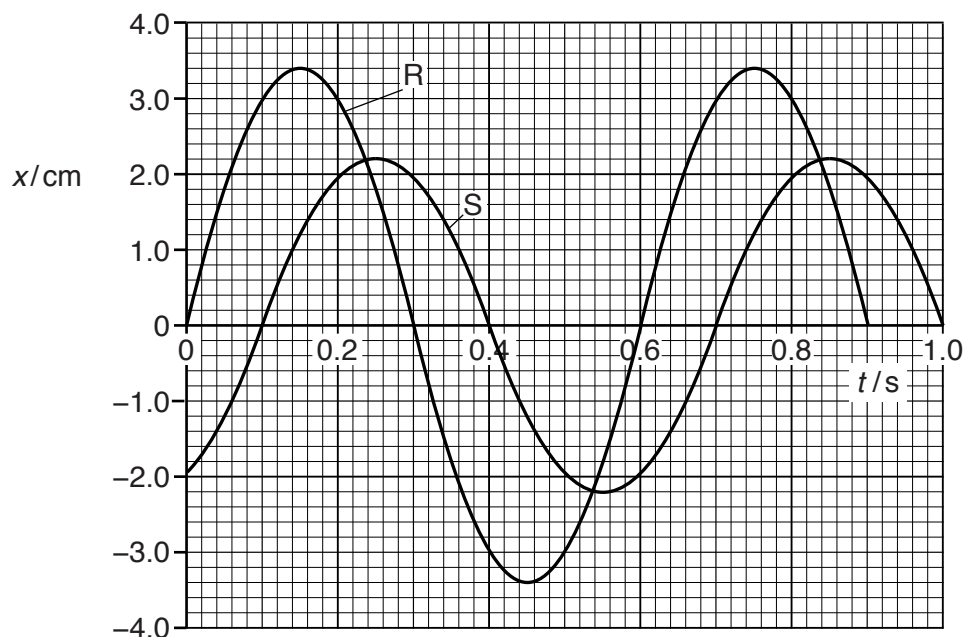


Fig. 7.2

- (i) Determine the phase difference between wave R and wave S. Include an appropriate unit.

phase difference = ... [1]

- (ii) Calculate the ratio

$$\frac{\text{intensity of wave R}}{\text{intensity of wave S}}.$$

ratio = ... [2]

[Total: 6]

- 8 (a) Distinguish between an α -particle and a β^+ -particle.

.....

.....

.....

.....

.....[3]

- (b) State the equation that shows the decay of a particle in a nucleus that results in β^+ emission. All particles in the equation should be shown in the notation that is usually used for the representation of nuclides.

[2]

- (c) (i) State the quark composition of

1. a proton,

.....

2. a neutron.

.....

[2]

- (ii) Use the quark model to explain the charge on a proton.

.....

.....

.....[1]

[Total: 8]

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