Cambridge Assessment International Education

Cambridge International AS & A Level

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PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **February/March 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

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Data

acceleration of free fall	g	=	$9.81\ \text{m s}^{-2}$
speed of light in free space	c	=	$3.00 \times 10^{8}\ \text{m s}^{-1}$
elementary charge	e	=	$1.60 \times 10^{-19}\ \text{C}$
unified atomic mass unit	1 u	=	$1.66 \times 10^{-27}\ \text{kg}$
rest mass of proton	m_p	=	$1.67 \times 10^{-27}\ \text{kg}$
rest mass of electron	m_e	=	$9.11 \times 10^{-31}\ \text{kg}$
Avogadro constant	N_A	=	$6.02 \times 10^{23}\ \text{mol}^{-1}$
molar gas constant	R	=	$8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$
Boltzmann constant	k	=	$1.38 \times 10^{-23}\ \text{J K}^{-1}$
gravitational constant	G	=	$6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
permittivity of free space	ε_0	=	$8.85 \times 10^{-12}\ \text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0}\right.$	=	$\left.8.99 \times 10^{9}\ \text{m F}^{-1}\right)$
Planck constant	h	=	$6.63 \times 10^{-34}\ \text{J s}$
Stefan–Boltzmann constant	σ	=	$5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$

Formulae

uniformly accelerated motion	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
hydrostatic pressure	Δp	=	$\rho g \Delta h$
upthrust	F	=	$\rho g V$
Doppler effect for sound waves	f_o	=	$\frac{f_\text{s} v}{v \pm v_\text{s}}$
electric current	I	=	$Anvq$
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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1 **(a)** Explain what is meant by the accuracy of a measured value.

.....

..... [1]

(b) Two solid cubes, A and B, are measured to determine the density of their materials.

Table 1.1 shows the measurements for cube A.

Table 1.1

quantity	measurement
length of side	(1.53 ± 0.01) cm
mass	(31.3 ± 0.5) g

(i) Show that the calculated density of the material of cube A is 8.7×10^3 kg m^{-3}.

[2]

(ii) Calculate the percentage uncertainty in the density of the material of cube A.

percentage uncertainty = ...% [2]

(iii) The density of the material of cube B is determined to be 9.2×10^3 kg m^{-3} ± 6%.

State and explain whether cube A and cube B could be made from the same material.

.....

.....

.....

..... [2]

[Total: 7]

2 **(a)** State the principle of moments.

.....

.....

..... [2]

(b) A solid plastic cylinder floats in water. It is used to support one end of a horizontal uniform beam AB as shown in Fig. 2.1.

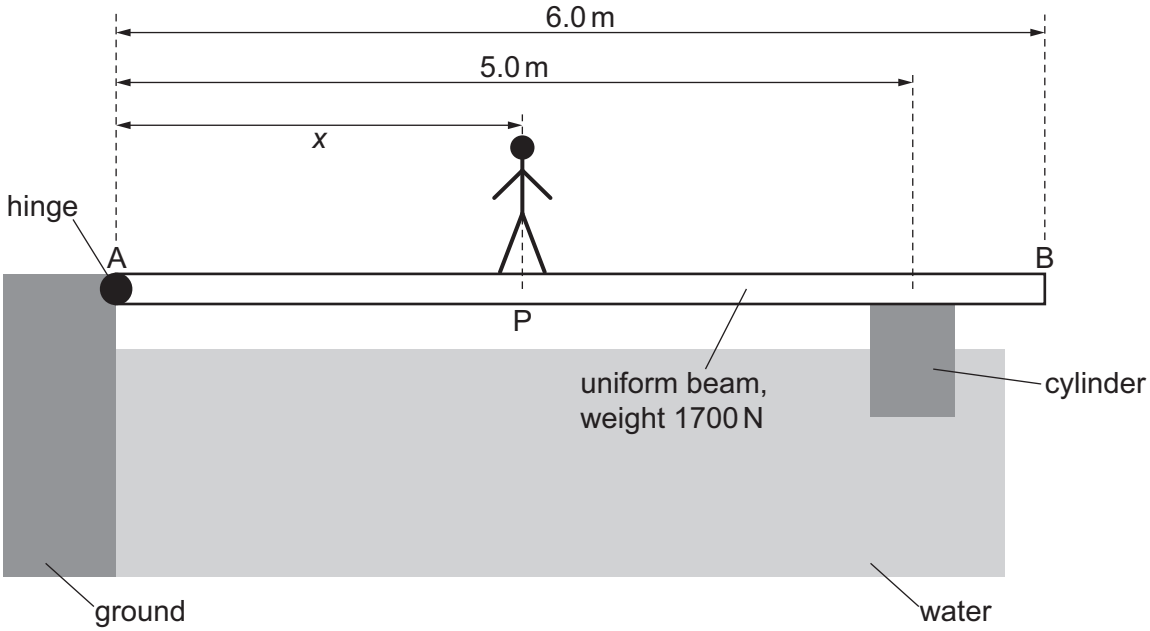

Fig. 2.1 (not to scale)

The beam has length 6.0 m and weight 1700 N. The beam is attached to solid ground with a hinge at end A.

The cylinder is floating vertically in the water. The top of the cylinder is attached at its centre to the beam at a horizontal distance of 5.0 m from end A. The cylinder applies a vertical force of 1300 N to the beam.

A person of weight 660 N stands on the beam at point P.

The beam AB is in equilibrium.

(i) By taking moments about end A, determine the distance *x* from A to P.

distance = ... m [3]

(ii) The bottom of the cylinder is submerged in the water to depth y as shown in Fig. 2.2. The beam is still attached to the cylinder but not shown.

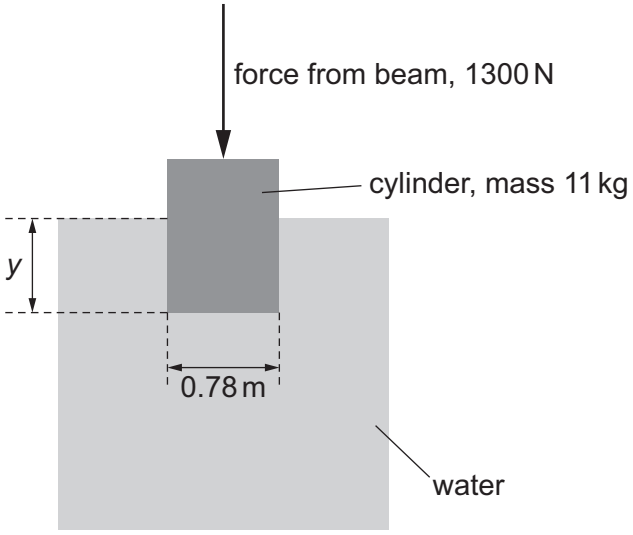

Fig. 2.2 (not to scale)

The cylinder has mass 11 kg and diameter 0.78 m. The beam exerts a vertical force of 1300 N on the cylinder. The cylinder is in equilibrium.

Show that the upthrust acting on the cylinder is 1400 N.

[1]

(iii) The water has density 990 kg m^{-3}.

Calculate the depth y.

y = ... m [2]

(iv) The person can stand anywhere between A and B.

On Fig. 2.3, sketch the variation of the depth of the bottom of the cylinder with the distance of the person from A, for distances between 0 and 6.0 m. Numerical values are not required.

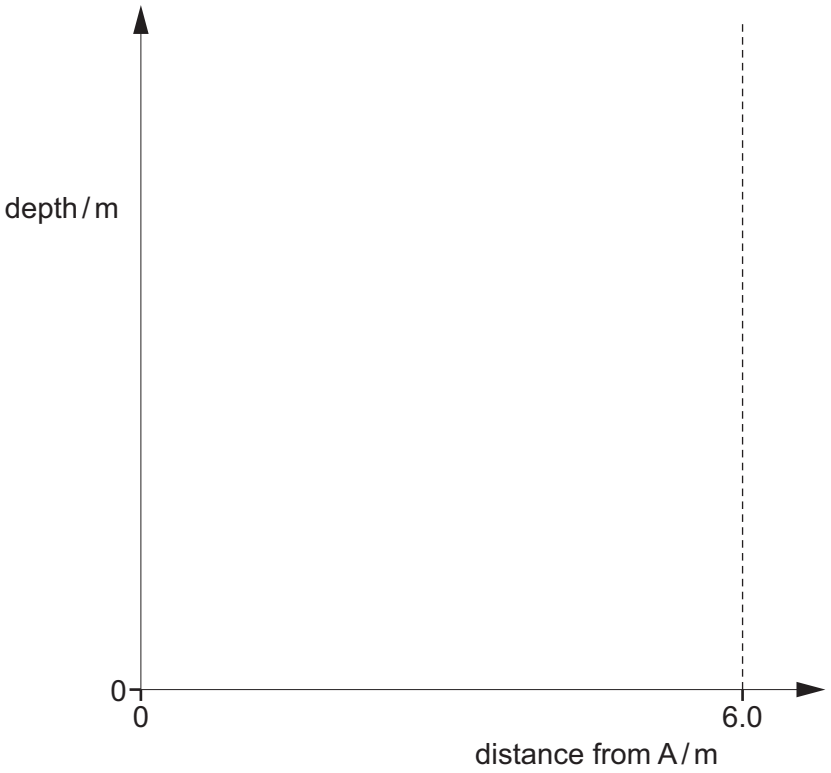

Fig. 2.3

[2]

[Total: 10]

3 **(a)** A truck R of mass 9400 kg moves with constant acceleration in a straight line down a slope, as illustrated in Fig. 3.1.

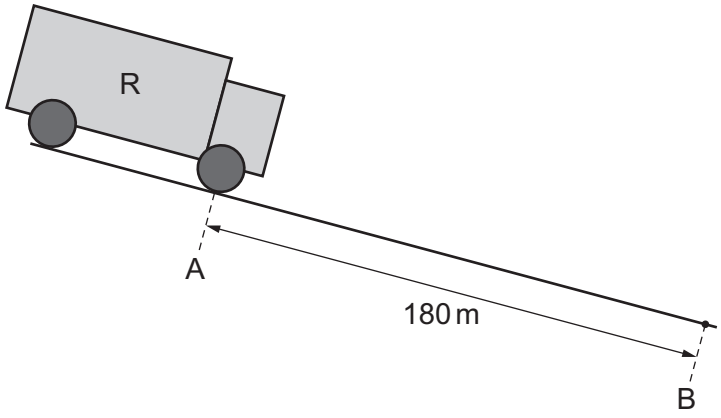

Fig. 3.1

At point A the speed of the truck is 13 m s^{-1} and at point B the speed of the truck is 22 m s^{-1}. A and B are a distance of 180 m apart.

(i) Calculate the acceleration of the truck between A and B.

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

(ii) Determine the gain in kinetic energy of the truck between A and B.

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

(b) A short time after passing point B truck R moves in a straight line on horizontal ground. The driver of the truck applies the brakes. Fig. 3.2 shows the variation with time of the momentum of the truck.

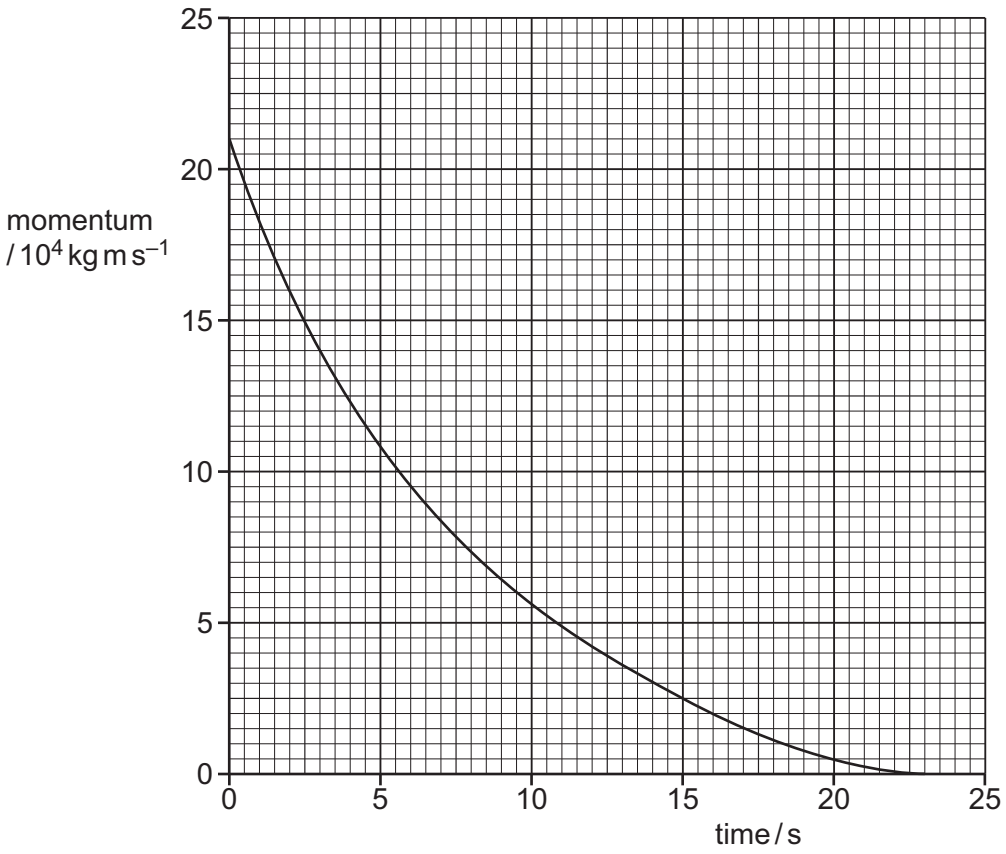

Fig. 3.2

(i) Define force.

.....

..... [1]

(ii) Show that the average resultant force F acting on truck R between time $t = 0$ and $t = 15\,s$ is $-1.2 \times 10^4\,N$.

[1]

(iii) An identical truck S has the same initial momentum as truck R. Truck S experiences a constant force equal to the force *F* in **(b)(ii)**.

State and explain whether truck S will take more, less or the same amount of time to come to rest as truck R.

.....

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.....

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.....

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..... [3]

[Total: 10]

4 A device containing a microwave emitter and receiver is placed in front of a large metal sheet in a vacuum as shown in Fig. 4.1.

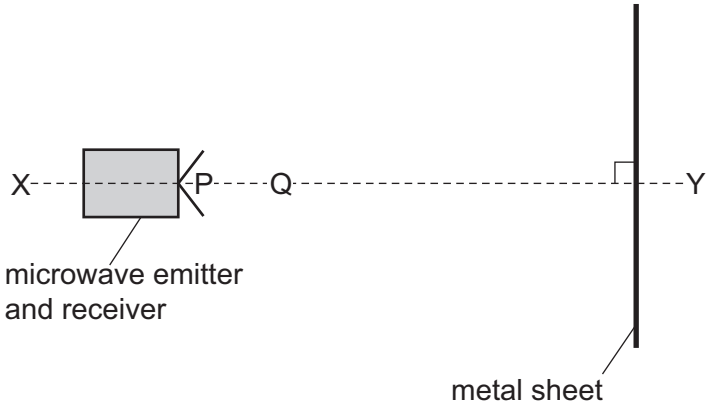

Fig. 4.1 (not to scale)

The line XY is perpendicular to the metal sheet. The device emits microwaves of frequency 6.3 GHz.

(a) When the device is at position P, a stationary wave is formed between the device and the sheet.

Explain how the stationary wave, including the nodes and the antinodes, is formed.

.....

.....

.....

.....

.....

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.....

.....

.....

..... [4]

(b) **(i)** Calculate the wavelength of the microwaves.

wavelength = ... m [2]

[Total: 8]

(ii) At point P the receiver detects a maximum amplitude of the stationary wave.

The device is moved slowly from point P along the line XY and the receiver detects a series of minimum and maximum amplitudes. The first time a minimum amplitude is detected by the receiver is when the device is at point Q.

Determine the distance between P and Q.

distance = ... m [1]

(iii) The intensity of the microwaves emitted by the device is increased. The frequency of the microwaves is unchanged. The device is moved slowly along the line XY from point Q until the next maximum amplitude is detected at point R.

State and explain whether the distance QR is greater than, less than or the same as distance PQ.

.....

.....

..... [1]

5 A stationary loudspeaker emits sound of constant frequency. A microphone is placed near to the loudspeaker and connected to a cathode-ray oscilloscope (CRO). The trace on the screen of the CRO is shown in Fig. 5.1.

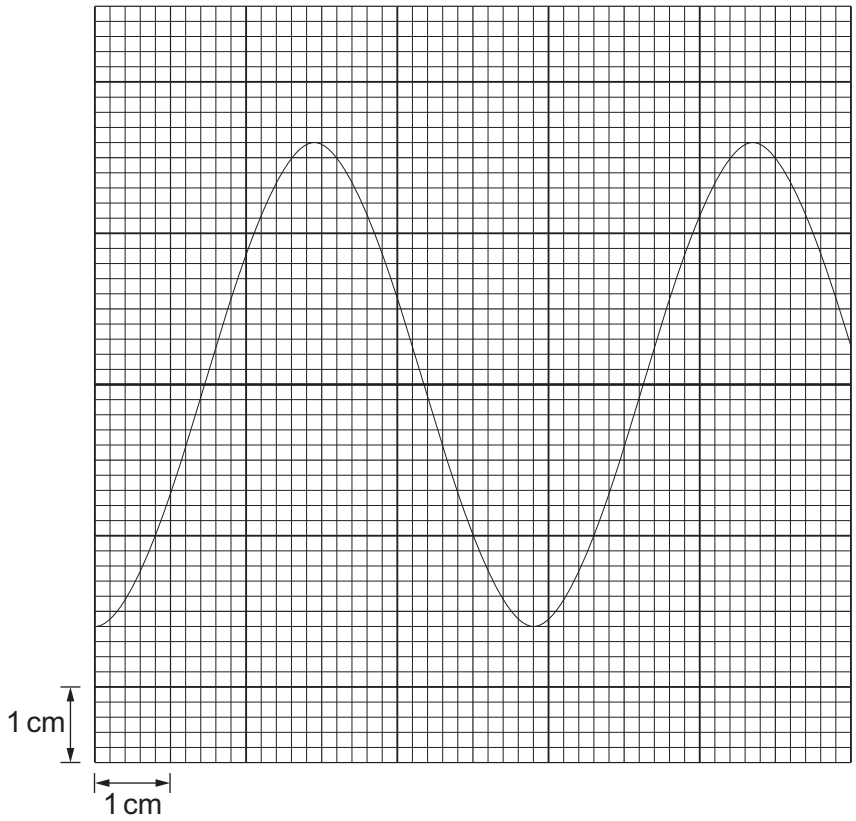

Fig. 5.1

The time-base of the CRO is set to $5.0 \times 10^{-4}\,\text{s}\,\text{cm}^{-1}$.

(a) The speed of the sound emitted by the loudspeaker is $330\,\text{m}\,\text{s}^{-1}$.

Determine the wavelength of the sound.

wavelength = ... m [3]

(b) The loudspeaker now moves in a straight line while emitting the same sound of constant frequency. The period of the trace on the CRO increases continuously.

Describe the motion of the loudspeaker.

.....

.....

..... [2]

[Total: 5]

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6 A cylindrical copper wire P of length 0.24 m is shown in Fig. 6.1.

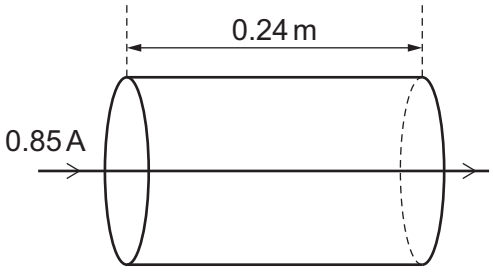

Fig. 6.1 (not to scale)

The current in the wire is 0.85 A.
The resistance of the wire is 3.3 mΩ.
The **total** number of charge carriers N in the wire is 2.6×10^{22}.
The resistivity of copper is $1.8 \times 10^{-8}\,\Omega\,\text{m}$.

(a) Calculate the potential difference between the two ends of the wire.

potential difference = ... V [2]

(b) **(i)** Show that the cross-sectional area of the wire is $1.3 \times 10^{-6}\,\text{m}^2$.

[2]

(ii) Show that the number density of charge carriers in the wire is $8.3 \times 10^{28}\,\text{m}^{-3}$.

[1]

(iii) Calculate the average drift speed of the charge carriers (electrons) in the wire.

average drift speed = ... m s^{-1} [2]

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[Turn over

(c) A different copper wire Q has the same volume as wire P, but non-uniform radius, as shown in Fig. 6.2.

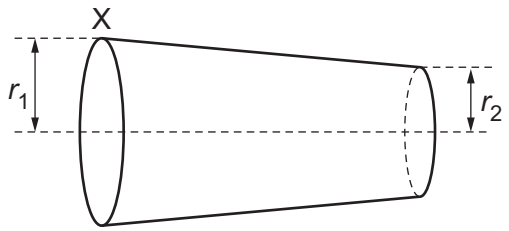

Fig. 6.2 (not to scale)

The radius r_1 at end X of wire Q is the same as the radius of wire P. Radius r_2 is less than r_1.

(i) State and explain how the resistance of wire Q compares with the resistance of wire P.

.....

.....

.....

.....

.....

.....

..... [4]

(ii) On Fig. 6.3, sketch a graph of the variation of the average drift speed of the charge carriers with distance from end X of wire Q.

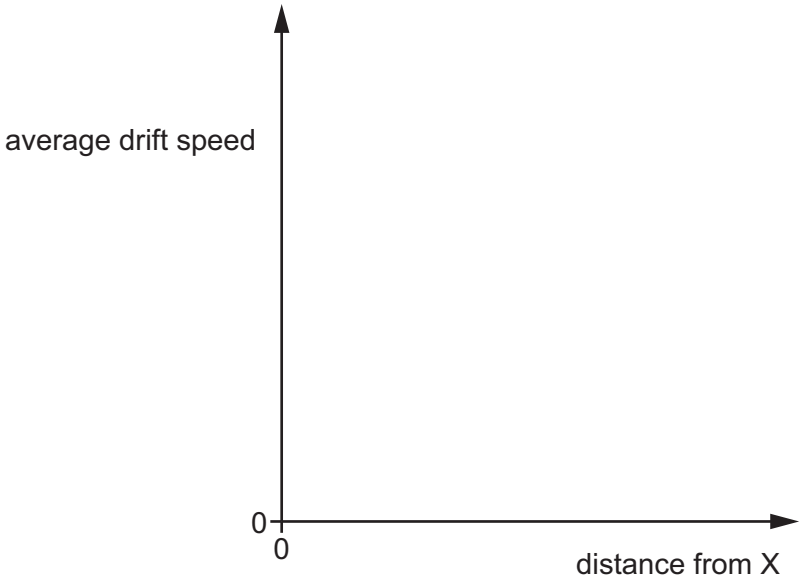

Fig. 6.3

[2]

[Total: 13]

7 An isolated stationary nucleus Q decays into nucleus R and an α-particle. The α-particle has speed $1.5 \times 10^7\,\text{m s}^{-1}$.

(a) Complete the equation for this decay.

$$^{.....}_{88}\text{Q} \rightarrow {}^{222}_{.....}\text{R} + {}^{4}_{2}\alpha$$

[1]

(b) By considering momentum, calculate the speed of nucleus R after the decay.

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

(c) State **three** quantities that are conserved during the decay.

1 .....

2 .....

3 .....

[3]

[Total: 7]

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PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **May/June 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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This document has **16** pages. Any blank pages are indicated.

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1 **(a)** Define acceleration.

.....

..... [1]

(b) In an experiment, two objects A and B are released from the side of a building, as shown in Fig. 1.1.

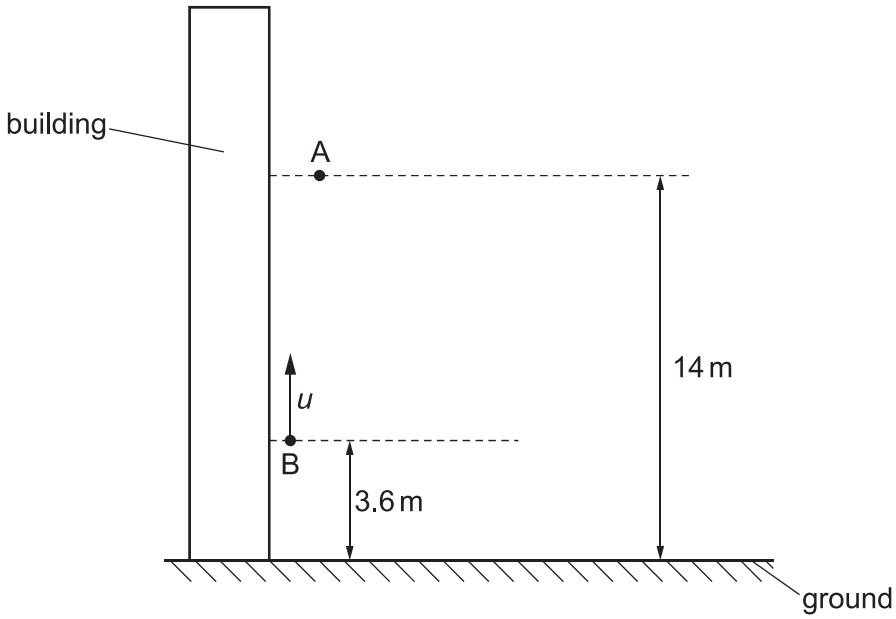

Fig. 1.1 (not to scale)

Object A is released from rest at a height of 14 m above the horizontal ground.
Object B is released with an initial upwards vertical velocity u at a height of 3.6 m above the ground.
Both objects take the same time to reach the ground and they do not collide with each other.
Air resistance is negligible.

(i) Calculate the time taken for object A to reach the ground.

time = ... s [2]

(ii) Use your answer in **(b)(i)** to calculate u.

u = ... $m\,s^{-1}$ [2]

(c) In a second experiment, object B is released from the same height and given the same initial speed as in **(b)** but at a release angle θ to the vertical, as shown in Fig. 1.2.

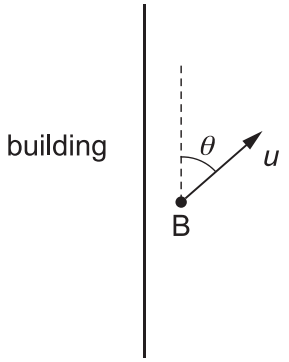

Fig. 1.2

(i) State and explain whether the time taken for object B to reach the ground is less than, the same as or greater than the time in **(b)(i).**

.....

.....

..... [2]

(ii) By considering energy, state and explain the effect of the change in release angle on the speed at which B reaches the ground.

.....

.....

..... [2]

[Total: 9]

2 **(a)** State the principle of moments.

.....

.....

..... [2]

(b) Three objects A, B and C are placed on a horizontal beam. The beam is in equilibrium, as shown in Fig. 2.1.

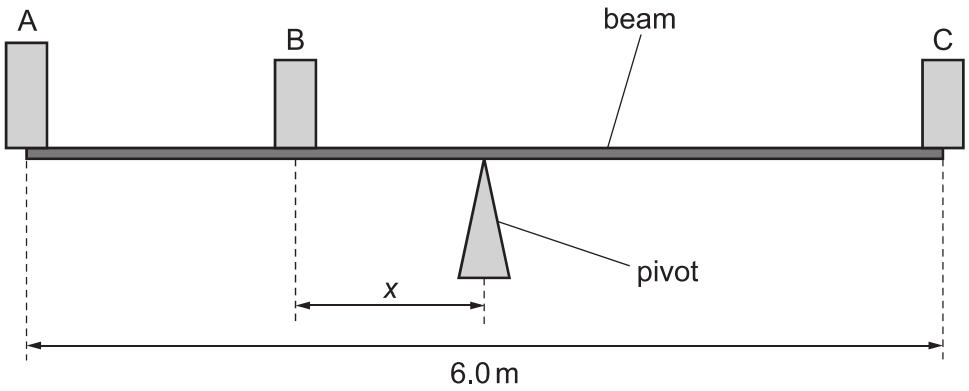

Fig. 2.1 (not to scale)

The beam is uniform and has length 6.0 m.
The pivot is at the midpoint of the beam.
Object A has mass 60 kg and is at one end of the beam.
Object B has mass 45 kg and is at a distance *x* from the pivot.
Object C has mass 80 kg and is at the other end of the beam.

Calculate *x*.

x = ... m [3]

(c) The beam is 0.80 m above horizontal ground.

Object A is removed and replaced by a spring connected to the ground and the beam, as shown in Fig. 2.2.

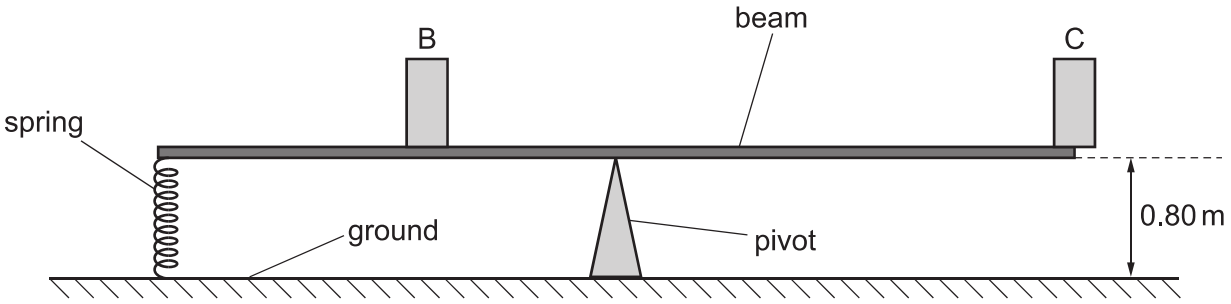

Fig. 2.2

After the change, the beam is again horizontal and in equilibrium. The positions of B and C are unchanged.

The spring has an unstretched length of 0.59 m and obeys Hooke's law.

(i) Calculate the spring constant of the spring.

spring constant = ... $N\,m^{-1}$ [3]

(ii) Calculate the elastic potential energy of the spring.

elastic potential energy = ... J [2]

[Total: 10]

3 **(a)** Define power.

.....

..... [1]

(b) An electric car is powered by a motor. The car is travelling at a constant speed of $35\,m\,s^{-1}$ along a straight horizontal road, as shown in Fig. 3.1.

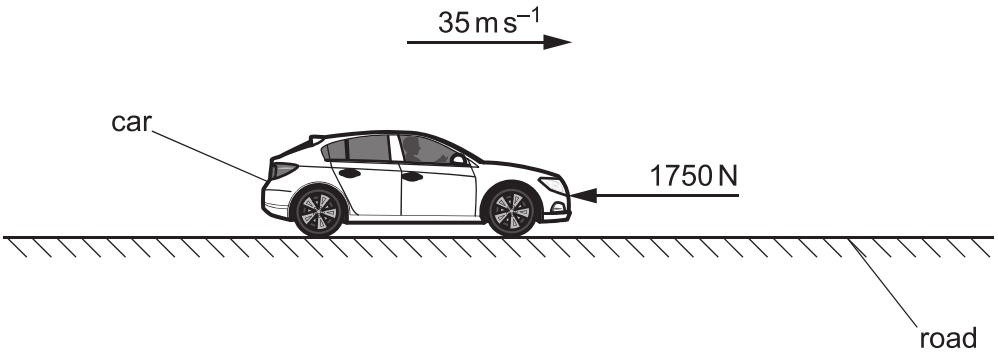

Fig. 3.1

There is a total resistive force of 1750 N acting on the car.

(i) Calculate the power transmitted to the wheels of the car by the motor.

power = ...W [2]

(ii) Calculate the useful work done by the motor when the car travels a distance of 17 km.

work done = ... J [2]

(iii) The potential difference (p.d.) across the motor has a constant value of 600 V and the motor has an efficiency of 85%.

Calculate the current in the motor.

current = ...A [3]

(c) The car in **(b)** now reaches a slope, as shown in Fig. 3.2.

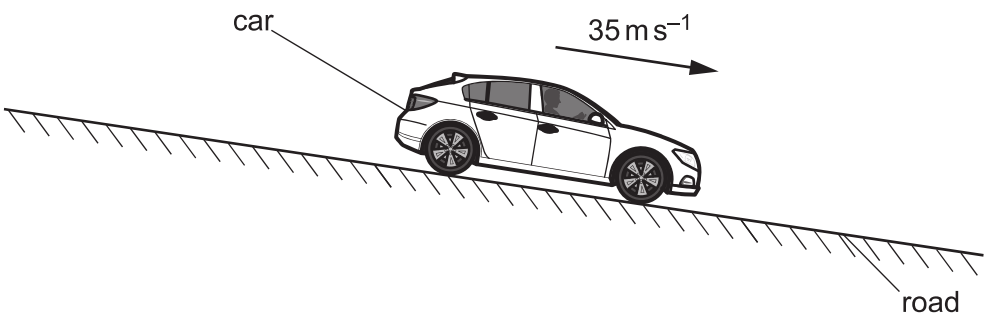

Fig. 3.2

The car continues down the slope at the same speed as in **(b).**

State and explain the effect, if any, of the slope on:

(i) the air resistance acting on the car

.....

..... [1]

(ii) the current in the motor.

.....

..... [1]

[Total: 10]

4 **(a)** State the principle of superposition.

.....

.....

..... [2]

(b) Light of wavelength 7.2×10^{-7} m is incident normally on a double slit, as shown in Fig. 4.1.

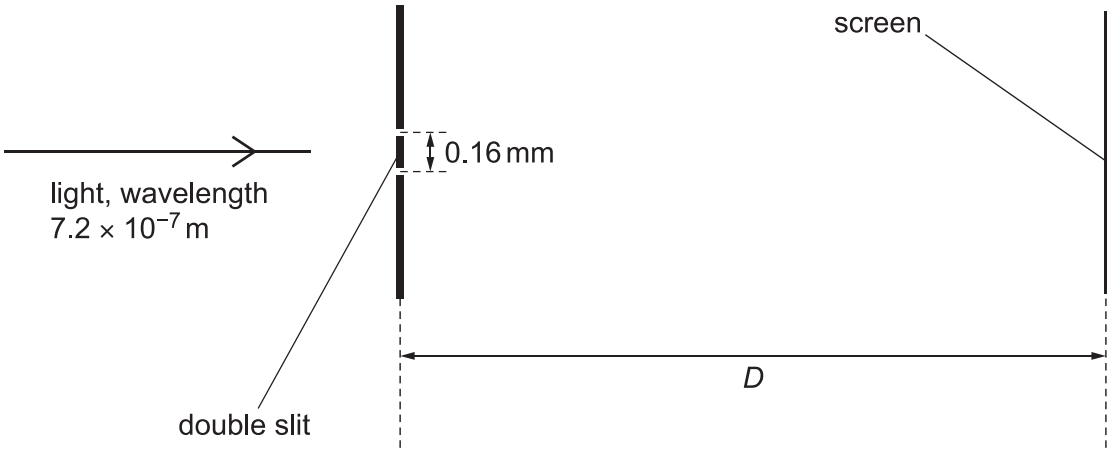

Fig. 4.1 (not to scale)

A screen is at a distance *D* from the double slit. The double slit and the screen are parallel.

The separation of the slits in the double-slit arrangement is 0.16 mm. The resulting interference pattern on the screen contains nine dark fringes, as shown in Fig. 4.2.

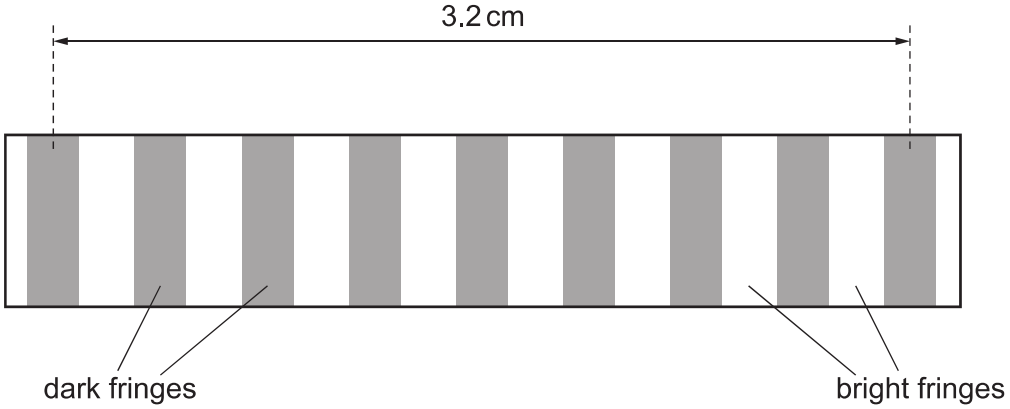

Fig. 4.2 (not to scale)

The distance between the centres of the first and ninth dark fringes is 3.2 cm.

(i) Calculate D.

D = ... m [3]

(ii) The slit separation is now gradually decreased from 0.16 mm to 0.04 mm. The distance between the centres of adjacent dark fringes is x.

On Fig. 4.3, sketch the variation of x with slit separation.

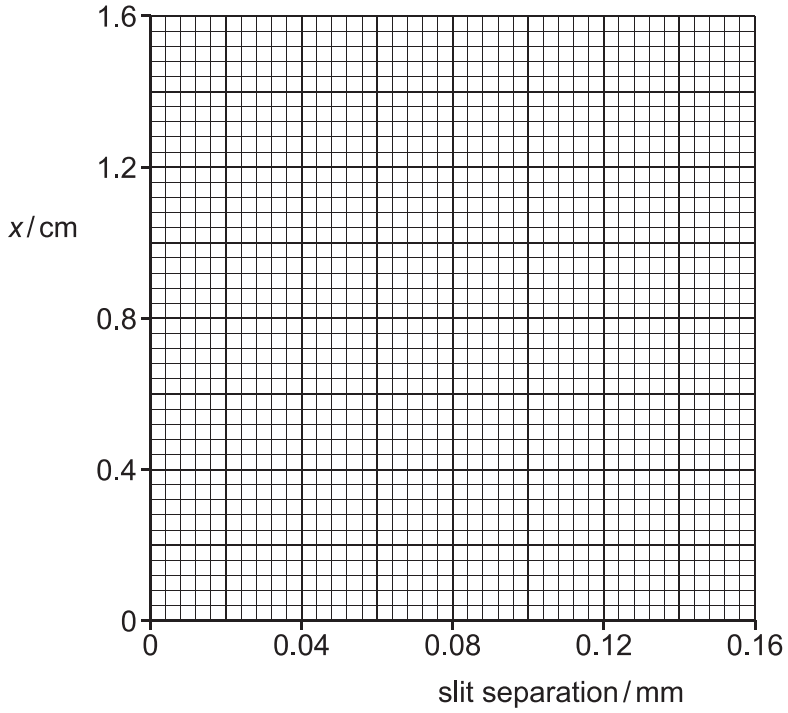

Fig. 4.3

[3]

[Total: 8]

5 **(a)** Use the definitions of speed v, frequency f and wavelength λ to derive the wave equation

$$v = f\lambda.$$

[2]

(b) A source of sound waves of frequency 236 Hz is travelling at a constant velocity of $20\,m\,s^{-1}$.

A stationary observer has a microphone connected to a cathode-ray oscilloscope (CRO). The microphone detects the sound waves as the source moves directly towards the observer.

The resulting trace on the CRO is shown in Fig. 5.1.

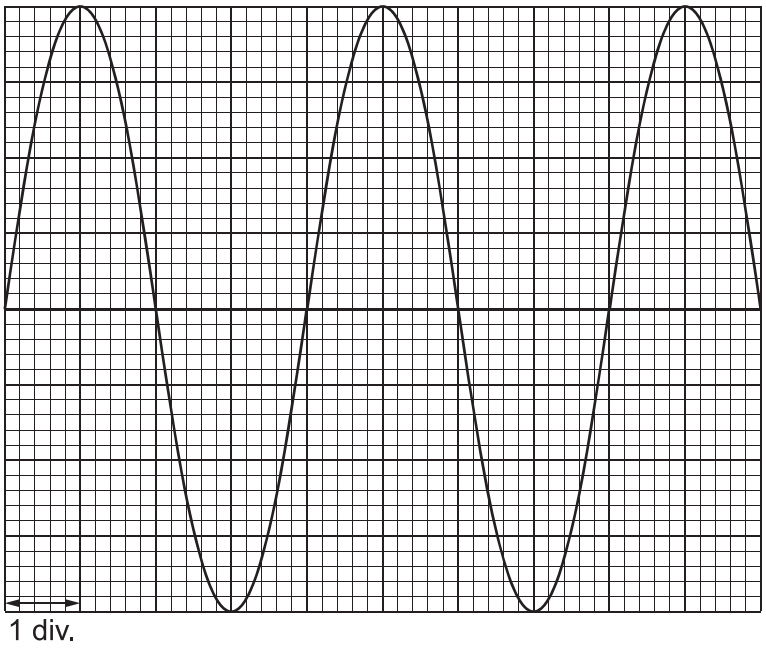

Fig. 5.1

The time-base on the CRO is set to $1.0\,ms\,div^{-1}$.

(i) Calculate the frequency of the sound waves detected by the microphone.

frequency = ... Hz [2]

(ii) Determine the speed of the sound in air.

speed of sound = ... $m\,s^{-1}$ [2]

[Total: 6]

6 A nichrome wire X of length 45 cm and cross-sectional area $4.7 \times 10^{-7}\,m^2$ is connected into the circuit shown in Fig. 6.1.

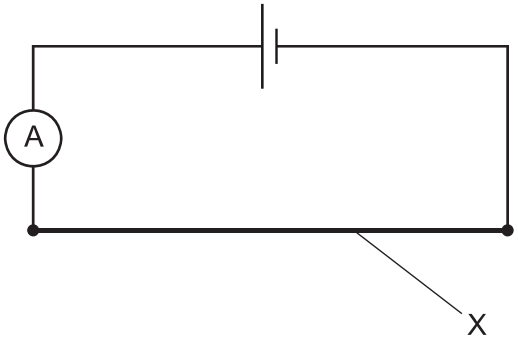

Fig. 6.1

The resistance of X is 1.1 Ω. The cell has electromotive force (e.m.f.) 1.3 V and negligible internal resistance.

(a) (i) Calculate the current in X.

current = ...A [1]

(ii) The number density of charge carriers (electrons) in nichrome is $8.5 \times 10^{28}\,m^{-3}$.

Calculate the average drift speed of the charge carriers in X.

average drift speed = ... $m\,s^{-1}$ [2]

(iii) Calculate the resistivity of the nichrome.

resistivity = ... Ω m [3]

(b) Wire Y is identical to wire X. Wire Y is added to the circuit in parallel with wire X, as shown in Fig. 6.2.

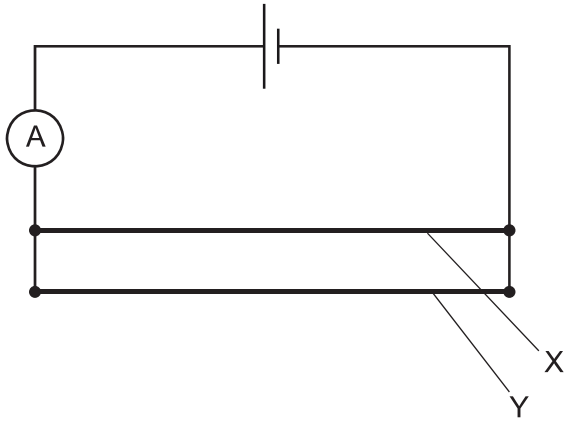

Fig. 6.2

State and explain the effect, if any, of this change on:

(i) the reading on the ammeter

.....

.....

..... [2]

(ii) the average drift speed of the charge carriers in X.

.....

..... [1]

[Total: 9]

7 **(a)** Nitrogen-12 ($^{12}_{7}N$) is an unstable isotope of nitrogen that decays by the emission of radiation to carbon-12 ($^{12}_{6}C$).

Complete the full nuclear equation for the decay, including all the particles involved.

$^{12}_{7}N \rightarrow$

[3]

(b) Hydrogen-1 ($^{1}_{1}H$) is an isotope of hydrogen. An atom of hydrogen-1 comprises a proton with an orbiting electron.

An antiparticle equivalent of hydrogen-1 comprises an antiproton with an orbiting positron. The antiquarks in the antiproton are the antiparticles of the quarks in a proton.

(i) State the charge on the positron in terms of the elementary charge *e*.

charge = ... *e* [1]

(ii) State the group (class) of fundamental particle to which the positron belongs.

..... [1]

(iii) In Table 7.1, state the flavour and charge of the three antiquarks that comprise the antiproton.

Table 7.1

flavour	charge / *e*

[3]

[Total: 8]

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7026467468

PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **May/June 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

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1 **(a)** Table 1.1 lists some physical quantities. Identify with ticks (✓) which quantities are vectors and which are scalars.

Table 1.1

quantity	scalar	vector
acceleration		
displacement		
gravitational potential energy		
speed		
temperature		

[2]

(b) A constant resultant force F acts on a car of mass m. The car moves from rest with constant acceleration a along horizontal ground. When the car has displacement s, the speed of the car is v.

(i) Using the concept of work done on the car, show that the kinetic energy E_K of the car is given by the equation

$$E_K = \frac{1}{2}mv^2.$$

[3]

(ii) The mass of the car is 920 kg. At time $t = 0$, the car is at rest. At time $t = 5.8$ s, its velocity is 17 m s^{-1}.

Calculate the kinetic energy of the car at time $t = 5.8$ s.

kinetic energy = ... J [1]

(iii) Between time t = 0 and time t = 5.8 s, the work done against resistive forces is 4.7×10^4 J.

Determine the average output power of the car during this time.

power = ... W [3]

(iv) At time t = 5.8 s, the speed of the car becomes constant.

State and explain whether the output power of the car is greater than, less than or the same as the output power just before t = 5.8 s.

.....

..... [1]

[Total: 10]

2 **(a)** Define the moment of a force about a point.

.....

..... [1]

(b) A tree of mass 270 kg grows out of sloping ground and is supported by a post, as shown in Fig. 2.1.

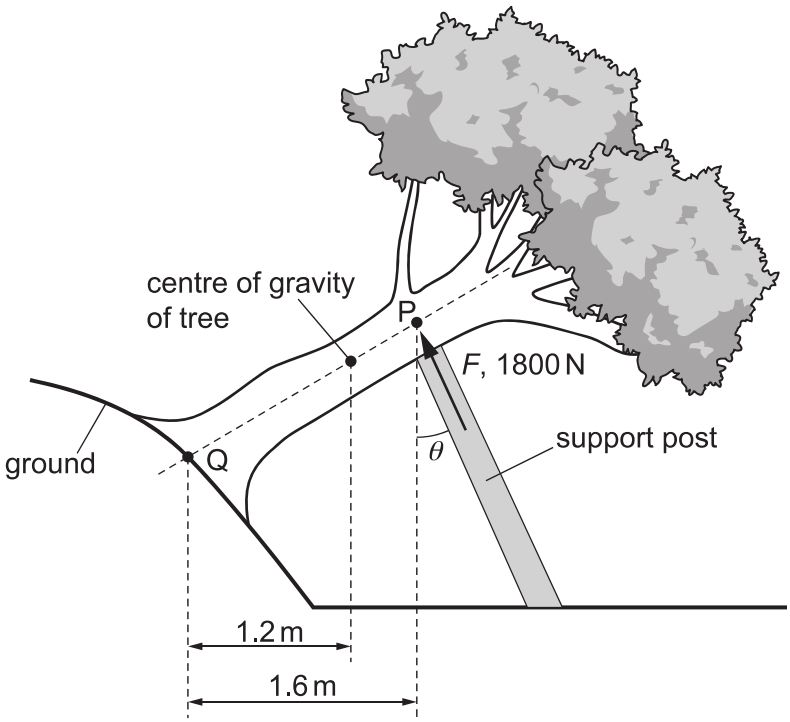

Fig. 2.1 (not to scale)

The ground applies a total force R on the tree at point Q.
The centre of gravity of the tree is a horizontal distance of 1.2 m from Q.
The post applies a force F of 1800 N perpendicular to the line PQ. The line of action of F passes through point P at an angle θ to the vertical. P is a horizontal distance of 1.6 m from Q.
The tree is in equilibrium and all forces act on the tree in the same plane.

(i) By taking moments about point Q, show that θ is 25°.

[3]

(ii) On Fig. 2.2, draw a labelled scale vector triangle to represent the forces acting on the tree. The weight of the tree has been drawn to scale.

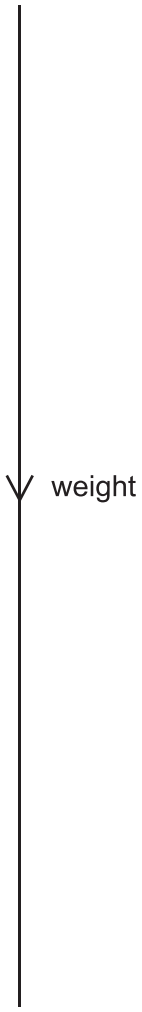

Fig. 2.2

[2]

(iii) The tree exerts a pressure of 150 kPa on the top of the post.

Determine the surface area of the tree in contact with the post.

area = ... m^2 [2]

[Total: 8]

3 Two progressive water waves X and Y travel along a straight line from point A to point B. The variation of displacement of the waves with distance from A at an instant in time is shown in Fig. 3.1.

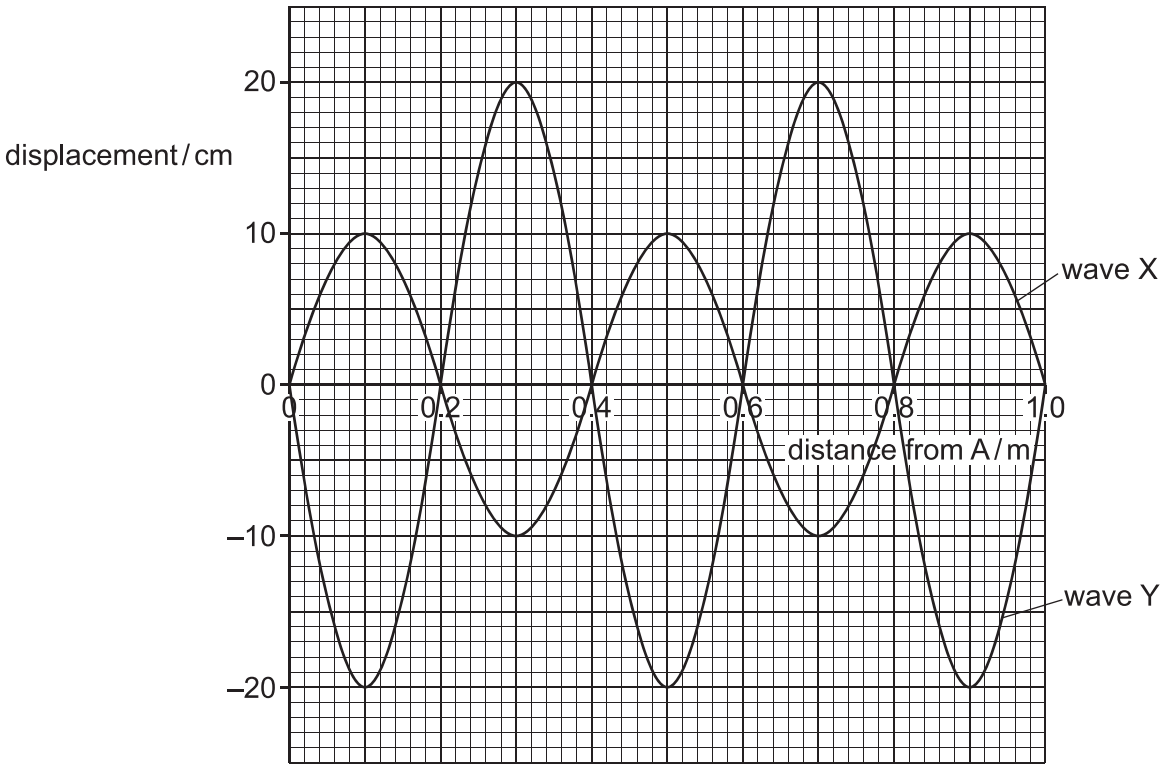

Fig. 3.1

(a) State the amplitude of wave X.

amplitude = ... cm [1]

(b) Both waves have frequency 16 Hz.

(i) Determine the speed of wave X.

speed = ... $m\,s^{-1}$ [2]

(ii) State and explain whether X and Y are coherent.

.....

.....

..... [1]

(c) Wave X and wave Y superpose to form a resultant wave.

On Fig. 3.2, sketch the variation of displacement of the resultant wave with distance from A at the instant of time shown in Fig. 3.1.

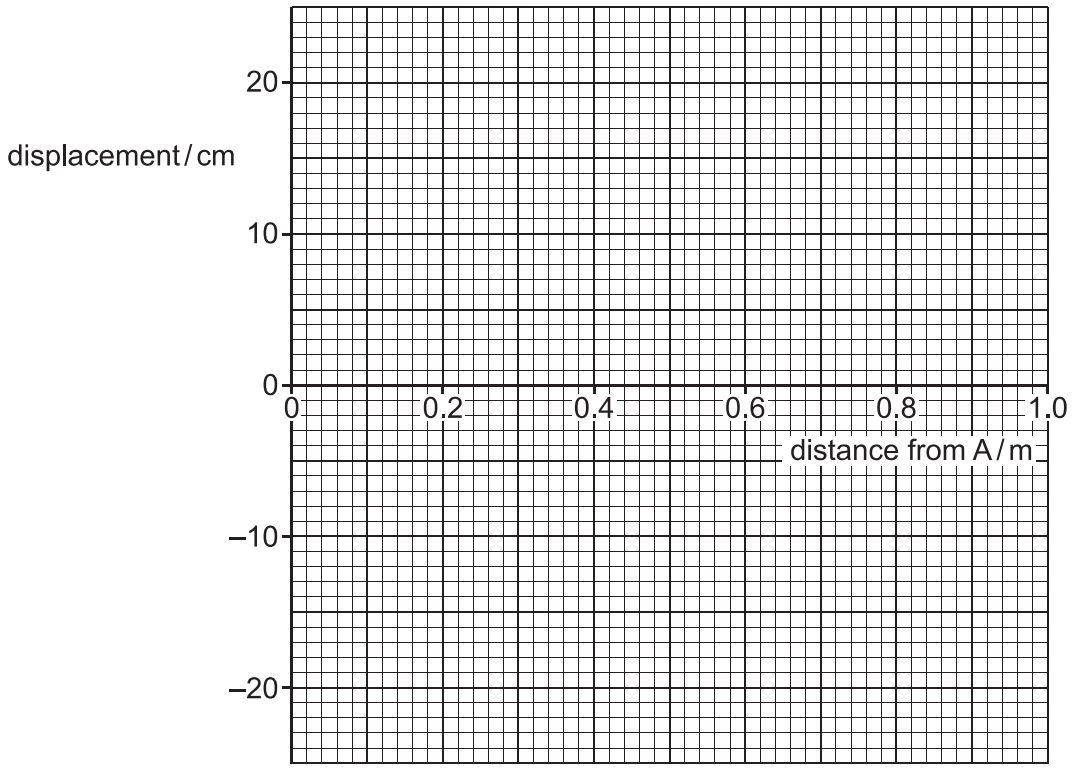

Fig. 3.2

[2]

(d) The intensity of wave X is I_X. The intensity of wave Y is I_Y.

Use Fig. 3.1 to determine the ratio $\frac{I_X}{I_Y}$.

ratio = ... [2]

[Total: 8]

4 A small ball is dropped from rest from height h_1 above the ground and falls vertically downwards. The ball collides with the ground and bounces back vertically upwards, reaching a maximum height h_2. Fig. 4.1 shows the ball just before and just after hitting the ground.

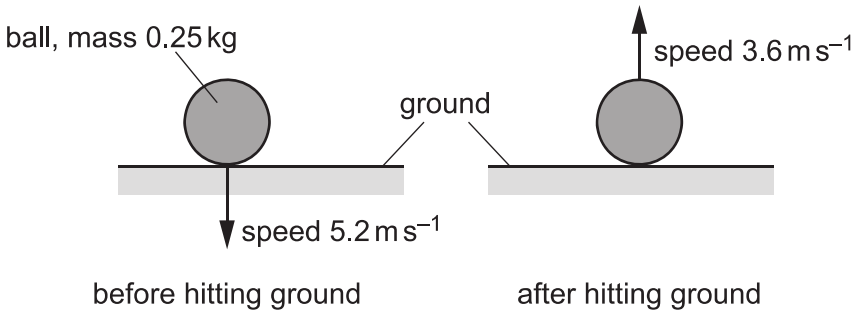

Fig. 4.1

The ball has mass 0.25 kg and is in contact with the ground for a time of 0.18 s.
Just before the ball hits the ground, it has speed 5.2 m s^{-1}. Just after it leaves the ground, it has speed 3.6 m s^{-1}.
Air resistance acting on the ball is negligible.

(a) State and explain whether the collision is elastic or inelastic.

.....

.....

..... [1]

(b) **(i)** Calculate the change in momentum of the ball during the collision with the ground.

change in momentum = ... kg m s^{-1} [2]

(ii) Determine the average force on the ball during the collision with the ground.

force = ... N [2]

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(c) Calculate the ratio $\frac{h_2}{h_1}$.

ratio = ... [3]

[Total: 8]

5 **(a)** Define the Young modulus.

.....

..... [1]

(b) A wire of unstretched length 0.81 m is made of a metal with Young modulus 95 GPa. The wire obeys Hooke's law and has a constant cross-sectional area. Fig. 5.1 shows the force–extension graph for the wire.

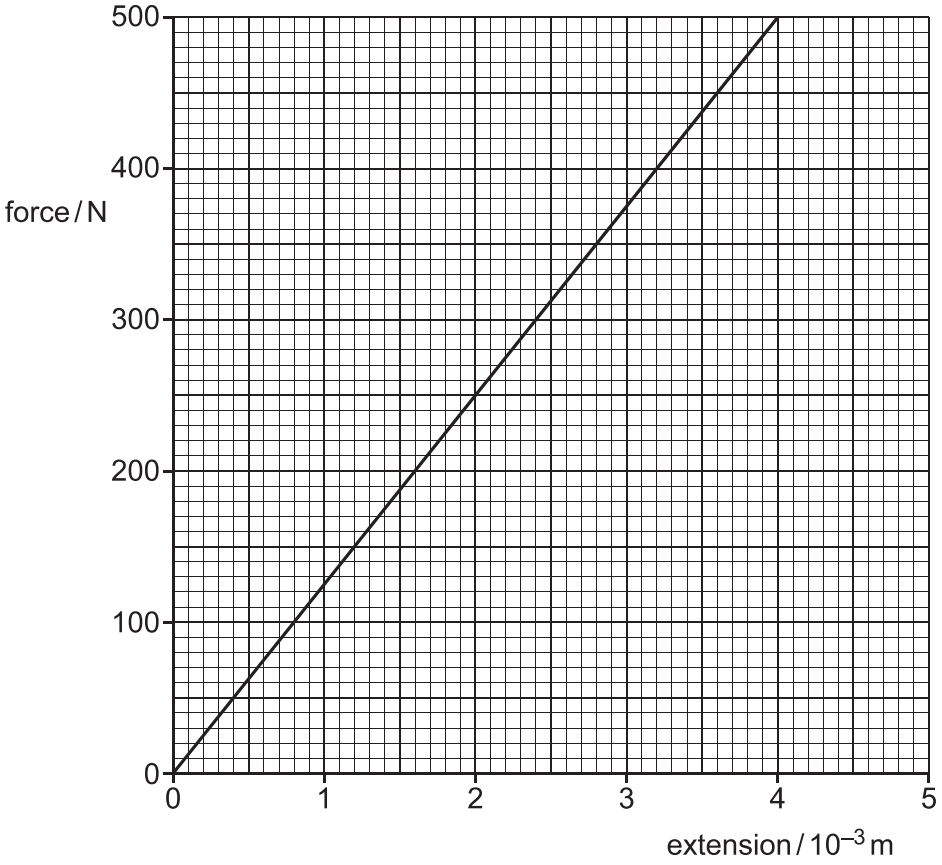

Fig. 5.1

(i) Determine the cross-sectional area of the wire.

area = ... m^2 [3]

(ii) The extension of the wire is initially 2.0×10^{-3} m.

Determine the work done to increase the extension of the wire to 3.0×10^{-3} m.

work done = ... J [3]

[Total: 7]

6 **(a)** Define electric potential difference across a component.

.....

..... [1]

(b) A circuit contains four resistors and a battery of electromotive force (e.m.f.) 8.0 V with negligible internal resistance. When the variable resistor has resistance *R*, the currents in the circuit are 0.030 A, I_1 and I_2, as shown in Fig. 6.1.

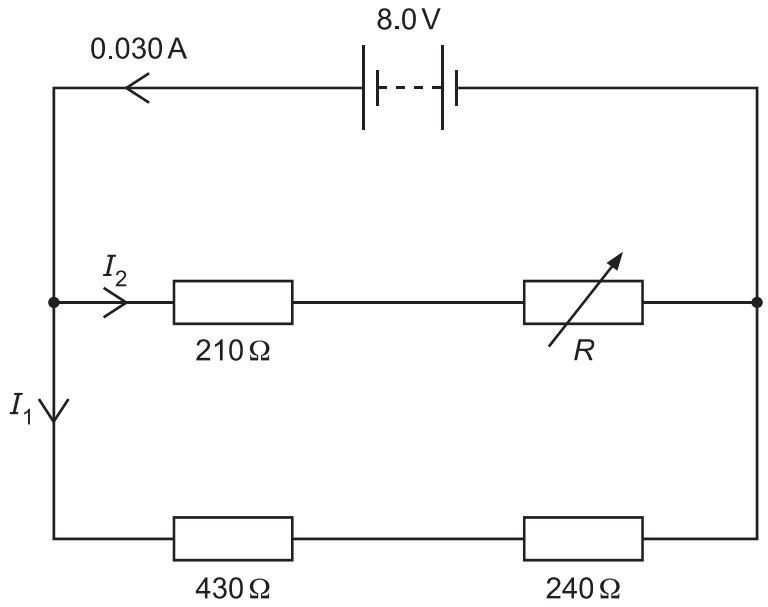

Fig. 6.1

(i) Determine the charge passing through the battery in a time of 4.0 minutes.

charge = ... C [2]

(ii) Calculate I_1.

I_1 = ... A [2]

(iii) Calculate I_2.

I_2 = ... A [1]

(iv) Determine R.

R = ... Ω [2]

(c) The variable resistor in **(b)** is fitted with a scale so that its resistance can be accurately determined.
The resistor of resistance 240 Ω is now replaced by a new resistor X of unknown resistance.
A galvanometer is connected as shown in Fig. 6.2.

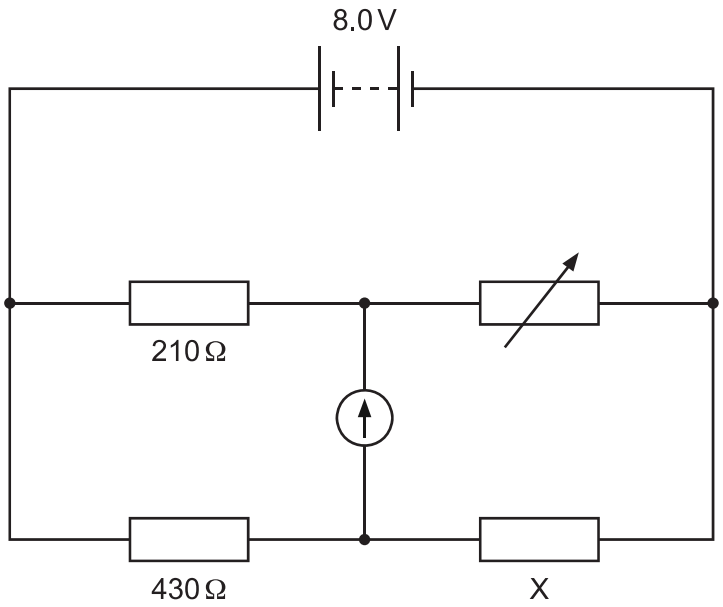

Fig. 6.2

With reference to ratios of resistances, explain how this circuit can be used to determine the resistance of X.

.....

.....

.....

.....

..... [2]

[Total: 10]

7 **(a)** State what is meant by a fundamental particle.

.....

..... [1]

(b) A nucleus X has 14 nucleons and p protons. The ratio of charge to mass for nucleus X is $4.1 \times 10^7\,\text{C kg}^{-1}$.

(i) Determine p.

p = ... [3]

(ii) Nucleus X undergoes β^- decay to form nucleus Z.

Complete the equation representing this decay.

$$^{14}\text{X} \rightarrow \text{Z} + \quad + \quad$$

[3]

(c) A sample of a radioactive substance emits particles that are positively charged and have a continuous range of kinetic energies.

State and explain whether the nuclei in the sample are undergoing α-decay, β^+ decay or β^- decay.

.....

.....

.....

.....

.....

..... [2]

[Total: 9]

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PHYSICS **9702/23**

Paper 2 AS Level Structured Questions **May/June 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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1 **(a)** Define velocity.

.....

..... [1]

(b) In an experiment, two objects A and B are released from the side of a building, as shown in Fig. 1.1.

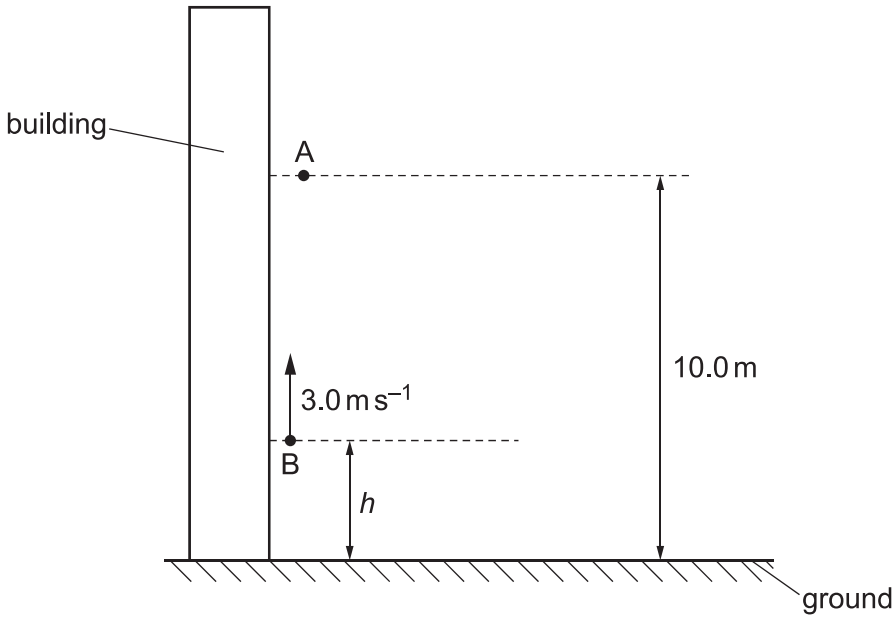

Fig. 1.1 (not to scale)

Object A is released from rest at a height of 10.0 m above horizontal ground.
Object B is released with an initial upward velocity of 3.0 m s^{-1} at a height *h* above the ground.
Both objects take the same time to reach the ground and they do not collide with each other.
Air resistance is negligible.

Calculate *h*.

h = ... m [3]

(c) In a second experiment, object B is released from the same height as in **(b)** but with a speed of $6.0\,m\,s^{-1}$ at an angle of 60° to the vertical, as shown in Fig. 1.2.

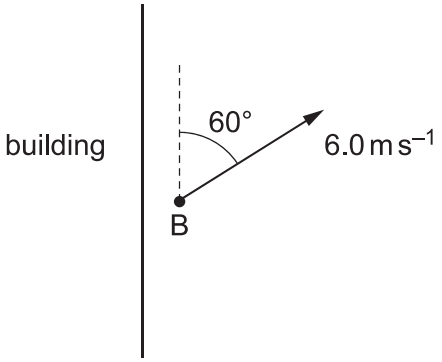

Fig. 1.2

(i) State and explain whether the time taken for object B to reach the ground is less than, the same as, or greater than the time taken in the first experiment.

.....

.....

..... [2]

(ii) By considering energy, state and explain whether the speed at which object B reaches the ground is less than, the same as, or greater than in the first experiment.

.....

.....

..... [2]

[Total: 8]

2 **(a)** Define the moment of a force about a pivot.

.....

..... [1]

(b) Three objects A, B and C are placed on a horizontal beam. The beam is in equilibrium, as shown in Fig. 2.1.

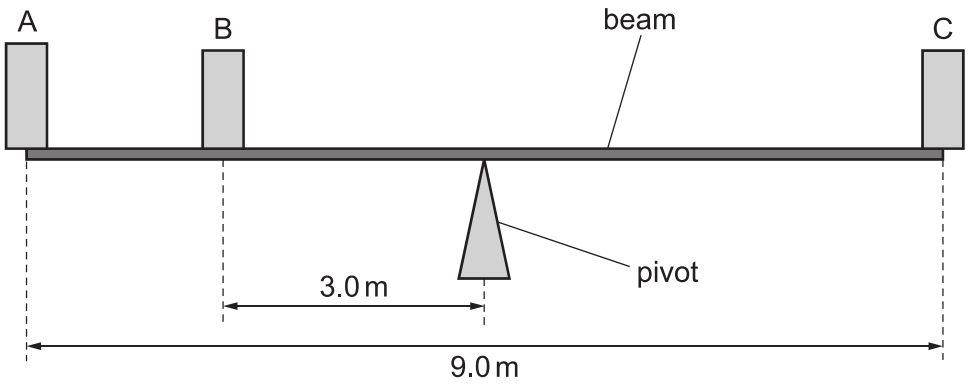

Fig. 2.1 (not to scale)

The beam is uniform and has length 9.0 m.
A pivot is at the midpoint of the beam.
Object A has mass 90 kg and is at one end of the beam.
Object B has mass *m* and is a distance of 3.0 m from the pivot.
Object C has mass 150 kg and is at the other end of the beam.

(i) Calculate *m*.

m = ... kg [3]

(ii) Object A is removed and replaced by a wire fixed to the end of the beam and to the ground, as shown in Fig. 2.2.

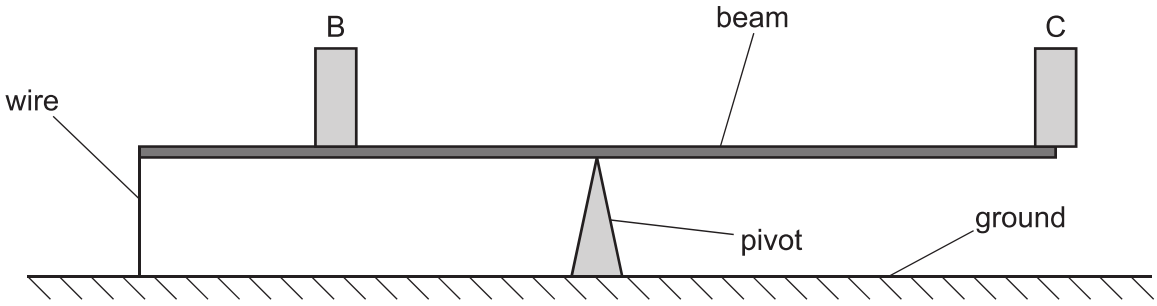

Fig. 2.2

After the change, the beam is again horizontal and in equilibrium. The positions of B and C are unchanged.

The wire has a diameter of 1.8×10^{-3} m and has a strain of 1.2×10^{-3}.
The wire is not extended beyond its limit of proportionality.

Calculate the Young modulus of the wire.

Young modulus = ... Pa [3]

(iii) Object B is now moved to a new position closer to the pivot without passing it. The beam is again horizontal and in equilibrium.

State and explain the effect, if any, that this has on the strain in the wire.

.....

.....

..... [2]

[Total: 9]

3 A car of mass 1500 kg is travelling along a straight horizontal road at constant velocity v. The car is subject to a total resistive force F, as shown in Fig. 3.1.

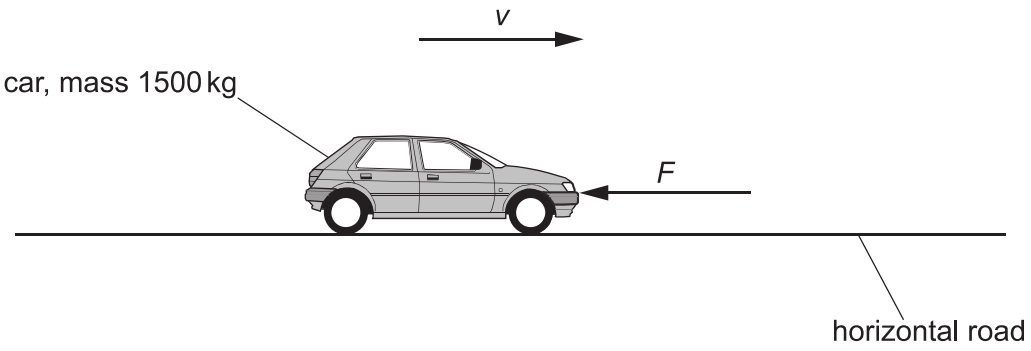

Fig. 3.1

(a) Show that the power P developed by the engine in overcoming the total resistive force is given by the equation

$$P = Fv .$$

[2]

(b) The car now moves up a slope at a constant speed of $30\,m\,s^{-1}$.
The slope is at an angle to the horizontal of 6.0°, as shown in Fig. 3.2.

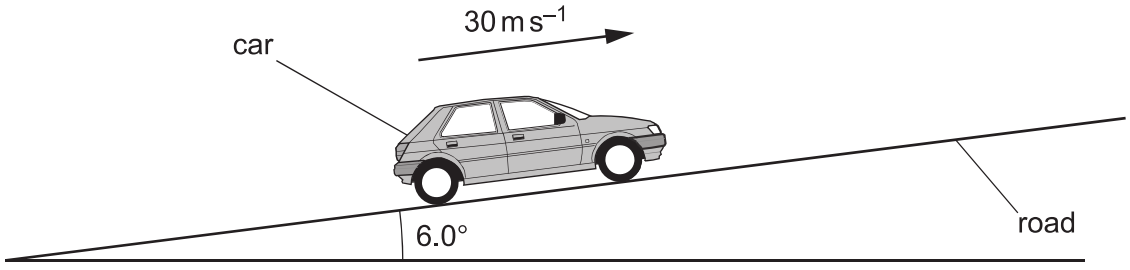

Fig. 3.2

The total resistive force acting on the car is 1600 N.

(i) Show that the increase in gravitational potential energy of the car in a time of 1.0 s is 46 000 J.

[2]

(ii) Use the information in **(b)(i)** to determine the power developed by the engine to move the car up the slope.

power = ... W [2]

(c) The car picks up a passenger and then continues up the slope at the same speed as in **(b)**.

State and explain the effect, if any, that the passenger has on:

(i) the air resistance acting on the car

.....

..... [1]

(ii) the power developed by the engine.

.....

..... [1]

[Total: 8]

4 **(a)** State the principle of conservation of momentum.

.....

.....

..... [2]

(b) An object A of mass 4.0 kg travels at a velocity of 6.0 m s^{-1} to the right on a horizontal frictionless surface. It moves towards a second object B of mass 2.0 kg that is moving at a velocity of 3.0 m s^{-1} in the same direction as A, as shown in Fig. 4.1.

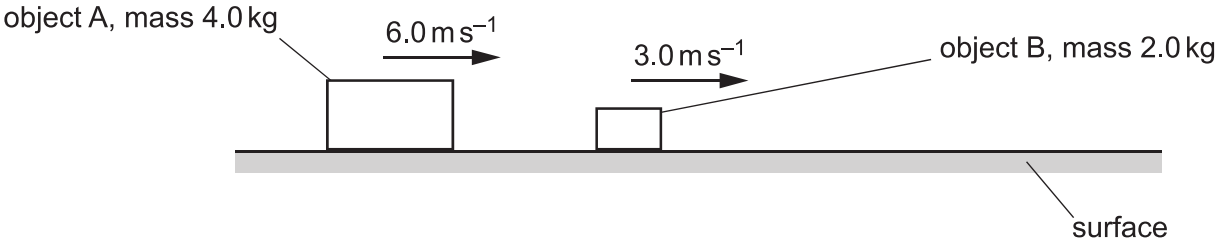

Fig. 4.1

Object A collides with object B. The two objects join and move off together with velocity *v*.

Calculate:

(i) velocity *v*

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

(ii) the percentage of the total initial kinetic energy of the two objects that is transferred to other forms of energy during the collision.

percentage = ...% [2]

[Total: 6]

5 **(a)** State why sound waves **cannot** be polarised.

.....

..... [1]

(b) A plane-polarised light wave is incident on a polarising filter as shown in Fig. 5.1.

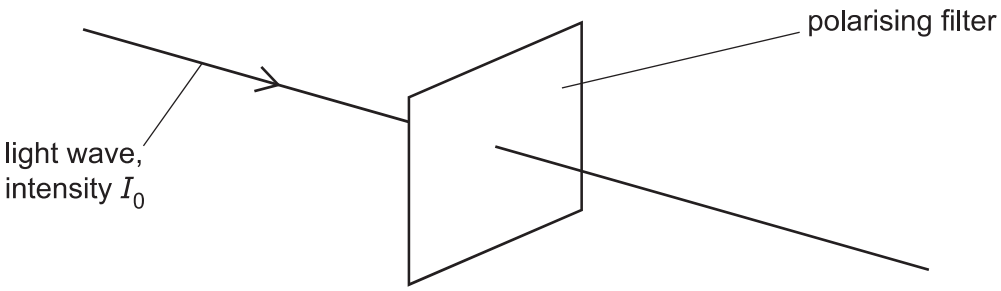

Fig. 5.1

The intensity of the light incident on the filter is I_0.

The light is incident normally on the filter and the transmission axis of the filter is initially perpendicular to the plane of polarisation of the light.

The filter is now rotated through 360° about the direction of travel of the light wave.

(i) On Fig. 5.2, sketch the variation of the intensity I of the transmitted light with the angle of rotation α as the filter is rotated through 360° from its initial position.

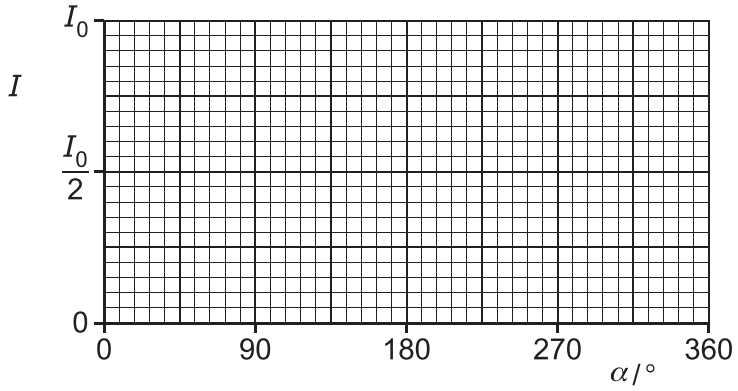

Fig. 5.2

[3]

(ii) The amplitude of the incident light wave is A_0 when the intensity of the wave is I_0.

Use Malus's law to determine, in terms of A_0, the amplitude of the transmitted wave when $\alpha = 20°$.

amplitude = ... A_0 [4]

[Total: 8]

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

.....

..... [1]

(b) Light of wavelength 720 nm in a vacuum is incident normally on a diffraction grating as shown in Fig. 6.1.

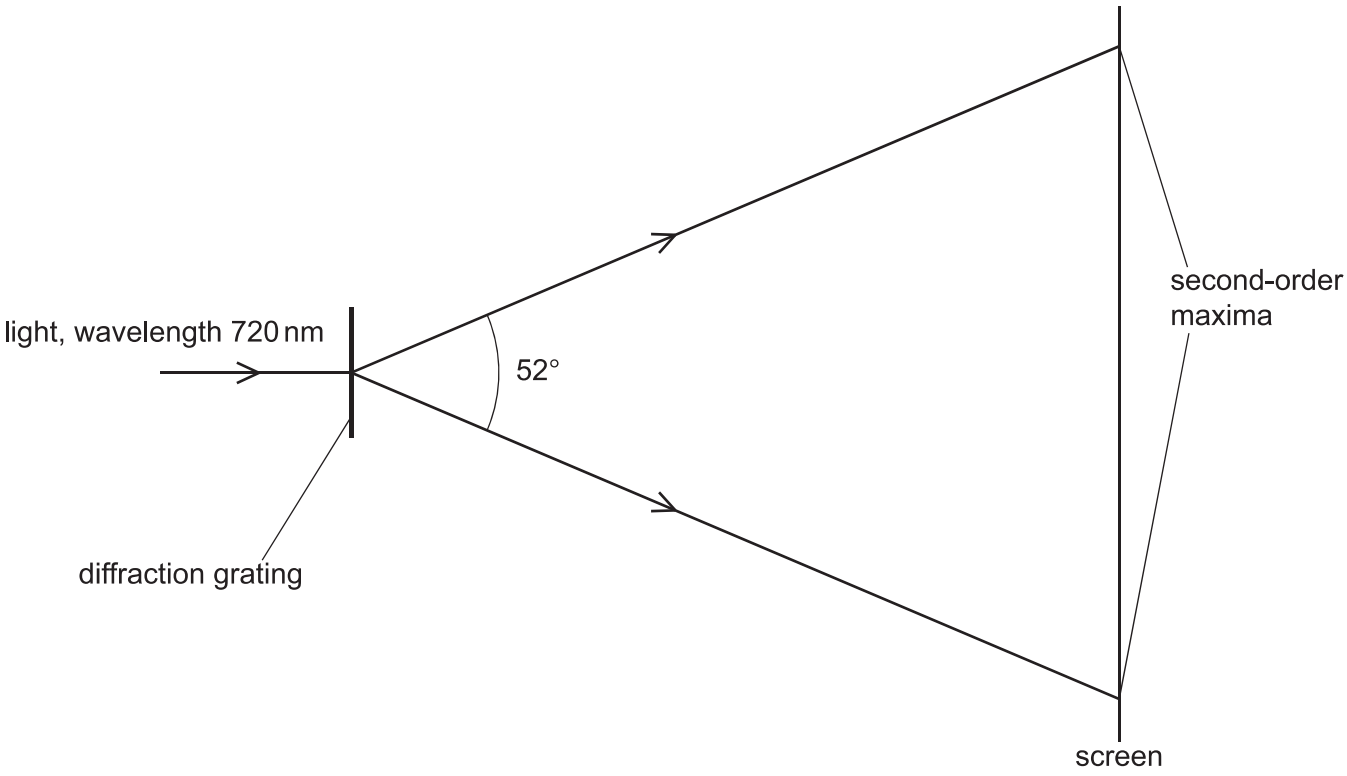

Fig. 6.1 (not to scale)

A screen is parallel to the grating. An interference pattern is seen on the screen and the angle between the **second**-order maxima is 52°.

(i) Calculate the frequency of the light.

frequency = ... Hz [2]

(ii) Calculate the number of lines per unit length in the diffraction grating.

number per unit length = ... m^{-1} [3]

(iii) The light in Fig. 6.1 is now replaced with light of a different wavelength λ. It is observed that the third-order maxima of this light are at the same positions as the second-order maxima of the light in Fig. 6.1.

Calculate, in nm, the wavelength λ.

λ = ... nm [2]

[Total: 8]

7 A nichrome resistance wire has length 150 cm, cross-sectional area $2.45 \times 10^{-7}\,m^2$ and resistivity $1.12 \times 10^{-6}\,\Omega m$.

(a) Calculate, to three significant figures, the resistance of the wire.

resistance = ... Ω [3]

(b) The nichrome wire forms part of a potentiometer circuit together with a cell of electromotive force (e.m.f.) 1.2 V and negligible internal resistance, as shown in Fig. 7.1.

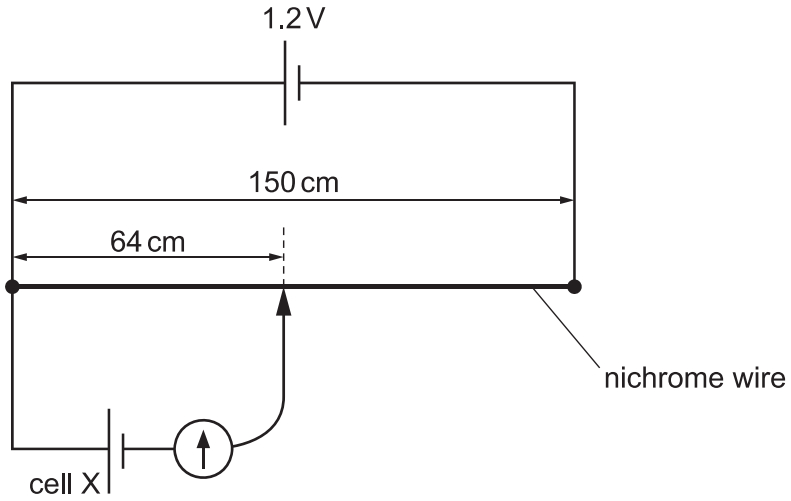

Fig. 7.1 (not to scale)

The circuit is used to determine the e.m.f. of cell X.

The galvanometer is used in a null method to find the null point 64 cm from the left-hand end of the nichrome wire.

(i) Explain what is meant by a null method.

.....

..... [1]

(ii) Calculate the e.m.f. of cell X.

e.m.f. = ... V [2]

(iii) The cell of e.m.f. 1.2 V is replaced by a new cell with the same e.m.f. but with an internal resistance that is **not** negligible.

State and explain the effect, if any, of the internal resistance of the new cell on the position of the null point.

.....

.....

.....

..... [2]

[Total: 8]

8 **(a)** An antiparticle equivalent of the neutron is called the antineutron. The quarks in the antineutron are the antiparticles of the quarks in a neutron.

The elementary charge is *e*.

In Table 8.1, state the flavour and charge of the three antiquarks that comprise the antineutron.

Table 8.1

flavour	charge / *e*

[3]

(b) In β^- decay, a neutron decays to form a proton.

Theory predicts that an antineutron should decay to form an antiproton. A particle and an antiparticle should also be observed.

Suggest the names of the particle and the antiparticle.

particle: .....

antiparticle: .....

[2]

[Total: 5]

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