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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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* 5 4 5 2 6 0 5 5 7 0 *

PHYSICS **9702/24**

Paper 2 AS Level Structured Questions **October/November 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. Any blank pages are indicated.

DC (CE) 359087

Data

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

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}	$= \dfrac{f_{\mathrm{s}} v}{v \pm v_{\mathrm{s}}}$
electric current	I	$= Anvq$
resistors in series	R	$= R_1 + R_2 + \ldots$
resistors in parallel	$\dfrac{1}{R}$	$= \dfrac{1}{R_1} + \dfrac{1}{R_2} + \ldots$

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1 A child kicks a ball so that it leaves horizontal ground with a velocity of $28\,m\,s^{-1}$ at an angle of 34° to the horizontal, as shown in Fig. 1.1.

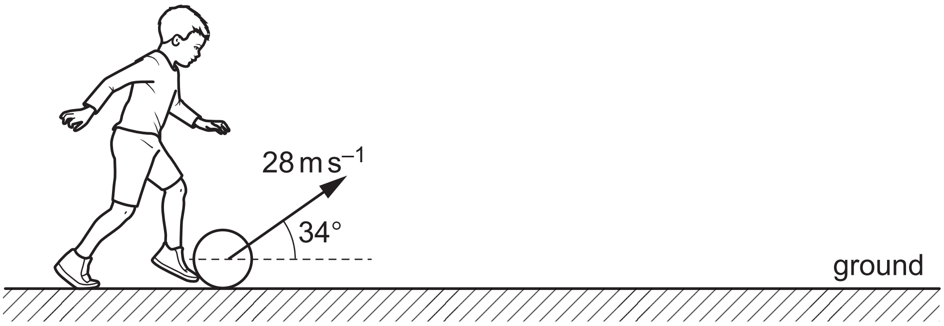

Fig. 1.1

Air resistance is negligible. The ball leaves the ground at time $t = 0$.

(a) **(i)** Calculate the horizontal component v_H and the vertical component v_V of the velocity of the ball immediately after it has left the ground.

v_H = ... $m\,s^{-1}$

v_V = ... $m\,s^{-1}$

[2]

(ii) Show that the ball reaches its maximum height at time $t = 1.6\,s$.

[1]

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(iii) On Fig. 1.2, sketch the variation of v_H with time t between $t = 0$ and $t = 3.2\,s$. Label your line H.

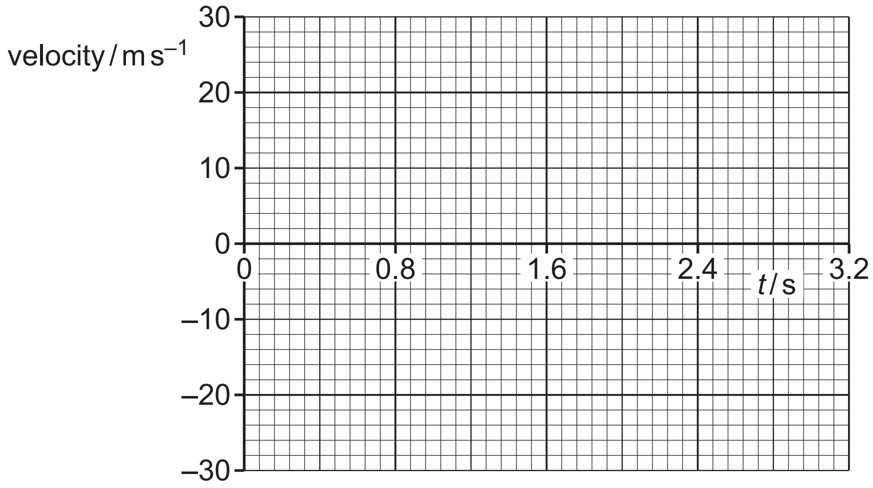

Fig. 1.2

[1]

(iv) On Fig. 1.2, sketch the variation of v_V with time t between $t = 0$ and $t = 3.2\,s$. Assume that velocity in the upward direction is positive. Label your line V. [3]

(b) The total change in momentum of the ball between leaving the ground at $t = 0$ and landing on the ground at $t = 3.2\,s$ is $13\,kg\,m\,s^{-1}$.

(i) Define momentum.

....

.... [1]

(ii) Calculate the force that acts on the ball while it is in the air.

force = ... N [2]

(iii) Determine the mass of the ball.

mass = ... kg [1]

[Total: 11]

2 Fig. 2.1 shows a square metal sheet of non-uniform density, with a thin wooden rod fixed at its centre. One of the corners of the sheet is labelled X.

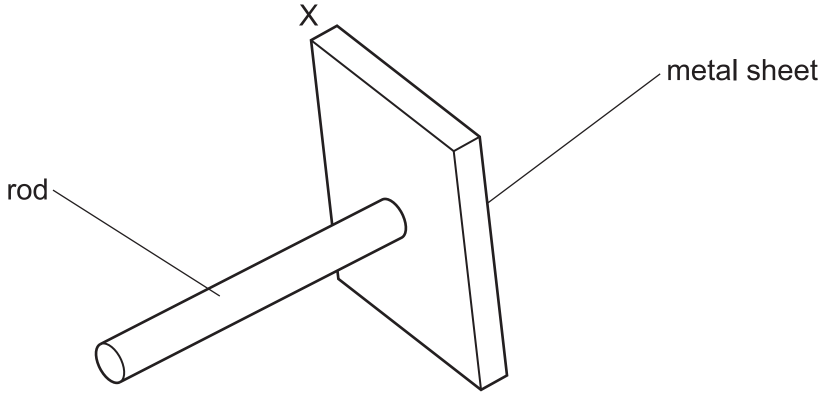

Fig. 2.1

The rod has negligible mass. The mass of the metal sheet is 2.8 kg.
The rod is supported so that the rod is horizontal and the metal sheet is vertical.

(a) Define the torque of a couple.

....

....

.... [2]

(b) When the rod is supported in such a way that it can rotate freely within its support, the sheet hangs in equilibrium with point X vertically above the rod, as shown in Fig. 2.2.

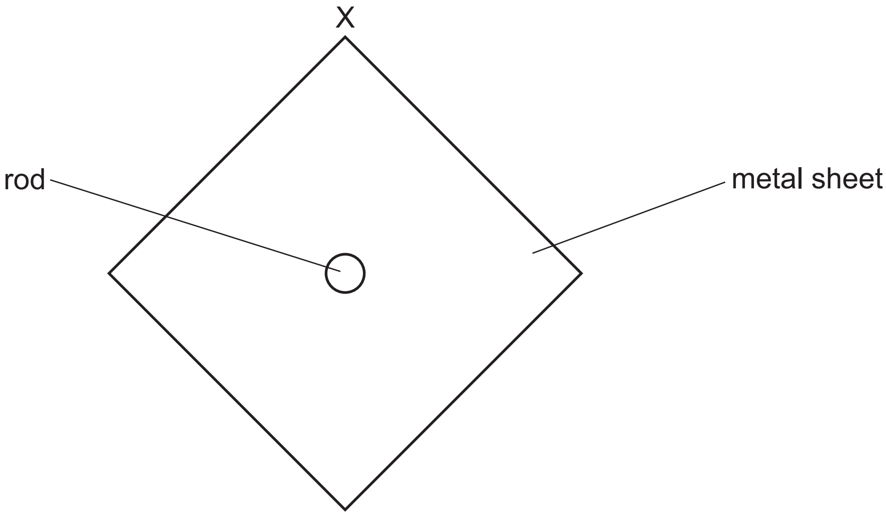

Fig. 2.2

On Fig. 2.2, draw a line to indicate the range of possible positions for the centre of gravity of the metal sheet. [1]

(c) When a torque of 3.3 N m is applied to the rod, the sheet is held in equilibrium with two of its edges horizontal, as shown in Fig. 2.3. Point X is at the top-left corner.

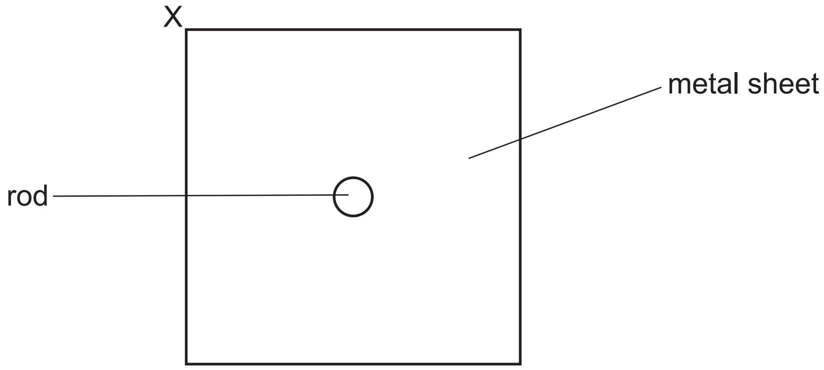

Fig. 2.3

(i) Explain whether the torque applied to the rod to hold the sheet in equilibrium is clockwise or anticlockwise.

....

.... [1]

(ii) Show that the centre of gravity of the sheet has a horizontal displacement of 0.12 m from the rod.

[1]

(d) The square metal sheet has an average density of 3000 kg m^{-3} and a uniform thickness of 4.0 mm.

Show that the side length of the sheet is 0.48 m.

[3]

(e) Use the answer in **(b)** and the information in **(c)** and **(d)** to determine the position of the centre of gravity of the sheet. Indicate this position on Fig. 2.3 with a point labelled Y. [2]

[Total: 10]

3 A bungee jumper of mass 64 kg secures one end of an elastic rope to a bridge. The other end is attached to the bungee jumper. The jumper falls from rest from the bridge and descends into the valley below, as shown in Fig. 3.1.

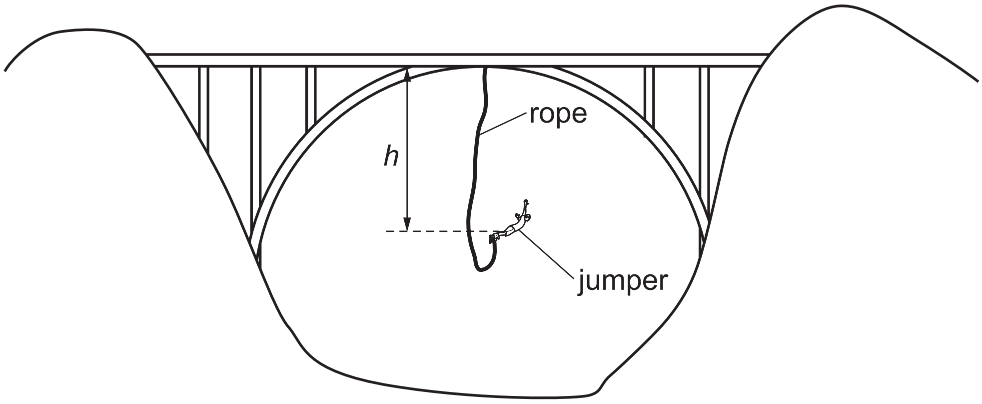

Fig. 3.1 (not to scale)

Fig. 3.2 shows the variation of the tension T in the rope with the vertical distance h of the jumper below the level of the bridge.

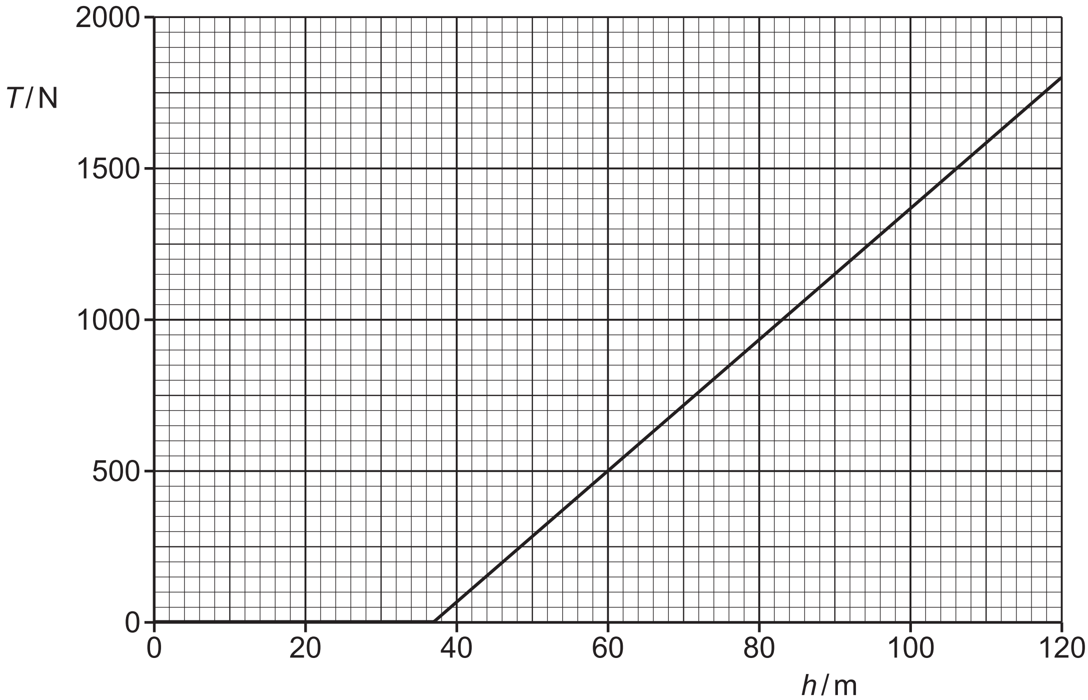

Fig. 3.2

(a) The rope obeys Hooke's law.

State Hooke's law.

....

.... [1]

(b) **(i)** Determine the unstretched length of the rope.

length = ... m [1]

(ii) Determine the spring constant *k* of the rope.

k = ... $N\,m^{-1}$ [2]

(c) For the position of the bungee jumper at a distance of 120 m below the bridge:

(i) show that the loss of gravitational potential energy since leaving the bridge is 75 kJ

[2]

(ii) show that the elastic potential energy in the rope is 75 kJ.

[2]

(d) Explain what can be deduced from the information in **(c)** about the speed of the bungee jumper when at a distance of 120 m below the bridge.

....

....

.... [2]

[Total: 10]

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

....

....

.... [2]

(b) An electromagnetic wave of wavelength 0.026 m in free space is incident normally on an aluminium sheet, as shown in Fig. 4.1.

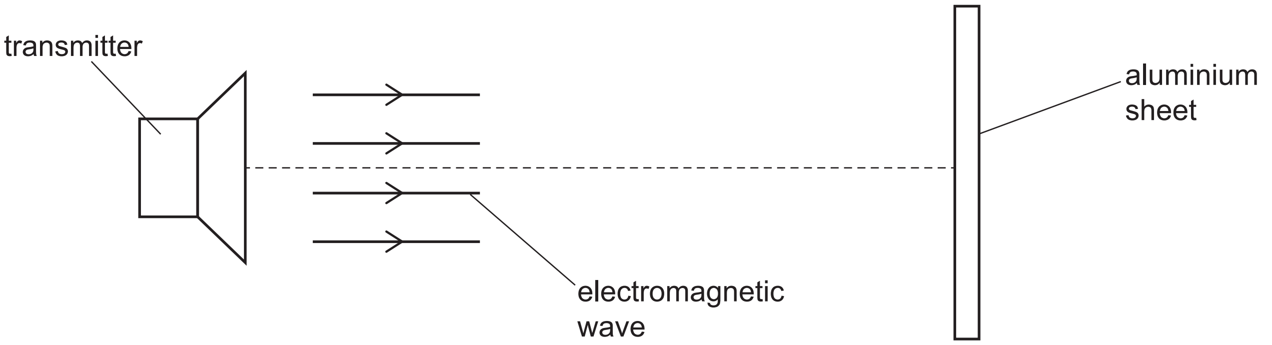

Fig. 4.1

The wave reflects at the aluminium sheet and a stationary wave is formed in the region between the transmitter and the sheet.

(i) Explain how the stationary wave, including its nodes and antinodes, is formed.

....

....

....

....

.... [3]

(ii) Calculate the frequency of the electromagnetic wave.

frequency = ... Hz [2]

(iii) State the principal region of the electromagnetic spectrum to which the wave belongs.

.... [1]

(iv) Determine the distance between a node and an adjacent antinode.

distance = ... m [1]

[Total: 9]

5 A student uses a circuit containing an ammeter, a voltmeter and a cell to take measurements to determine the resistance of a length of nichrome wire.

(a) (i) Define resistance.

....

.... [1]

(ii) Draw a circuit diagram to show how the components should be connected. Use the symbol for a resistor to represent the nichrome wire.

[2]

(b) The student also measures the length and the diameter of the wire. Table 5.1 shows the measurements recorded for each quantity.

Table 5.1

quantity	measurement
length	(0.864 ± 0.001) m
diameter	(0.496 ± 0.002) mm
voltmeter reading	(1.38 ± 0.02) V
ammeter reading	(0.276 ± 0.001) A

(i) Show that the resistance of the wire is 5.00 Ω.

[1]

(ii) Calculate, to three significant figures, the resistivity ρ of the nichrome.

ρ = ... Ωm [3]

(iii) Calculate the percentage uncertainty in ρ.

percentage uncertainty = ... % [2]

(iv) Determine the absolute uncertainty in ρ.

absolute uncertainty = ... Ωm [1]

[Total: 10]

6 Fig. 6.1 shows four alpha particles W, X, Y and Z moving towards a gold nucleus that is in thin gold foil.

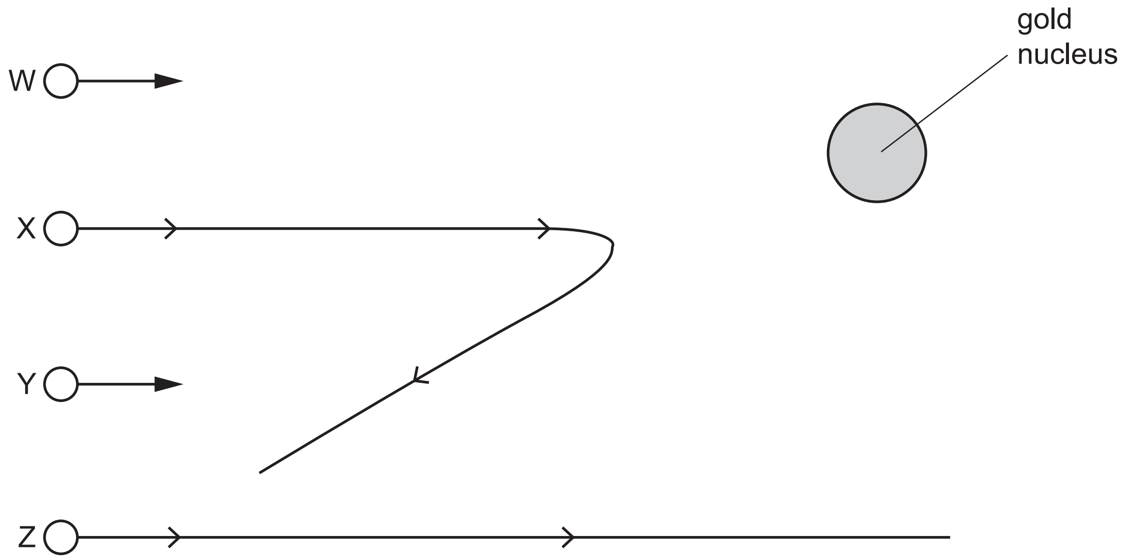

Fig. 6.1 (not to scale)

(a) **(i)** The paths of particles X and Z are shown.

Complete Fig. 6.1 to show possible paths for particles W and Y. [3]

(ii) Describe what may be inferred about the structure of an atom from the path of particle X.

....

....

.... [1]

(iii) When a beam containing many alpha particles is incident on thin gold foil, nearly all of the alpha particles follow paths that are similar to the path of particle Z.

Describe what may be inferred from this about the structure of an atom.

....

....

.... [1]

(b) State the mass and the charge, in terms of the atomic mass unit u and the elementary charge *e*, of an alpha particle.

mass = ... u

charge = ... *e*
[2]

(c) There are two types of hadron.
The hadrons that are in alpha particles are each composed of three quarks.

(i) State the name of this type of hadron.

.... [1]

(ii) Show, by reference to their constituent quarks, that the hadrons in an alpha particle have charges of either zero or +1*e*.

[2]

[Total: 10]

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