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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1414760188

PHYSICS **9702/24**

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 **16** pages. Any blank pages are indicated.

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[Turn over

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)** Define the moment of a force.

.....

..... [1]

(b) A trapdoor has a hinge at end A, as shown in Fig. 1.1.

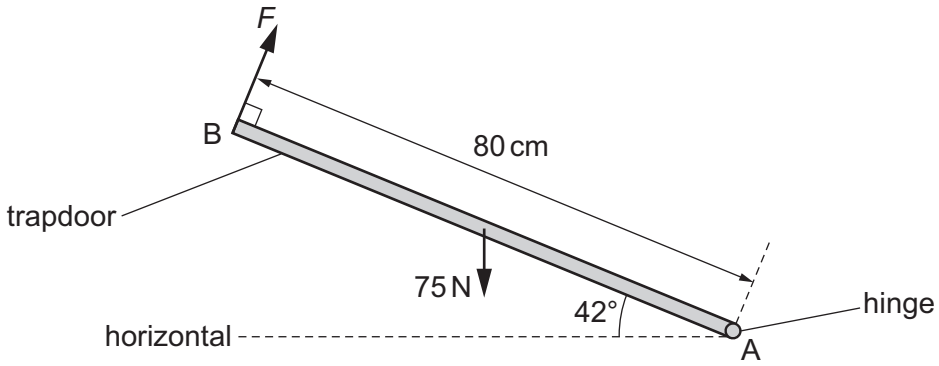


Fig. 1.1 (not to scale)

The trapdoor has length 80 cm and weight 75 N. The mass of the trapdoor is uniformly distributed along its length.

A force *F* acts at right angles to the trapdoor at end B so that the trapdoor is held in equilibrium at an angle of 42° to the horizontal.

(i) State the principle of moments.

.....

.....

..... [2]

(ii) Calculate the component of the weight that is perpendicular to the trapdoor.

component of weight = ... N [1]

(iii) Calculate the magnitude of the force *F*.

F = ... N [2]

[Total: 6]

2 An object of constant mass moves in a straight line. The variation with time t of the momentum p of the object is shown in Fig. 2.1.

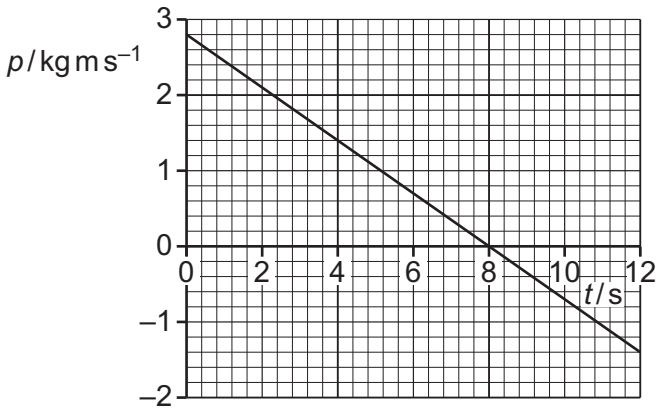


Fig. 2.1

(a) Define momentum.

.....

..... [1]

(b) Calculate the change in momentum of the object from time $t = 0$ to $t = 12\,s$.

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

(c) Calculate the magnitude of the resultant force acting on the object.

force = ... N [2]

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(d) Describe the variation of the speed of the object from time $t = 0$ to $t = 8.0$ s.

.....

..... [1]

(e) By reference to Fig. 2.1, explain why the resultant force acting on the object during the first 8.0 s of its motion cannot be due to air resistance.

.....

.....

.....

..... [2]

(f) At time $t = 0$ the displacement d of the object is zero.

On Fig. 2.2, sketch the variation of d with time t from $t = 0$ to $t = 12$ s.

Numerical values of d are not required.

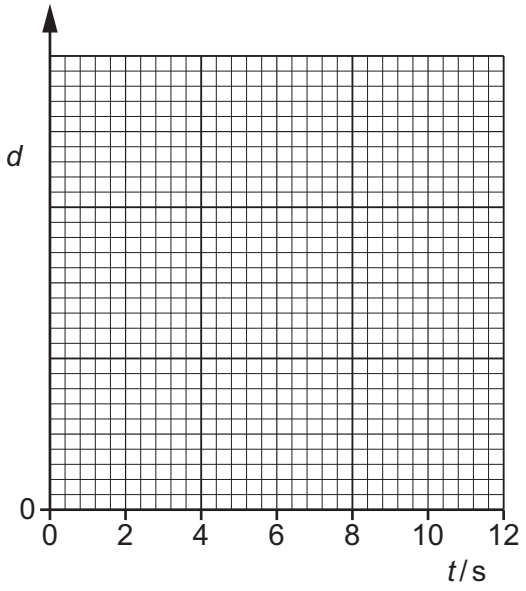


Fig. 2.2

[3]

[Total: 10]

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3 The lower end of a vertical spring is fixed to a horizontal surface, as shown in Fig. 3.1.

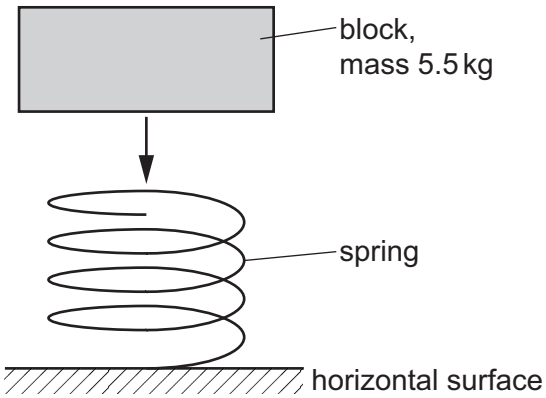


Fig. 3.1

The mass of the spring is negligible. A block of mass 5.5 kg drops vertically onto the spring and is brought to rest as the spring is compressed.

(a) The block has kinetic energy 110 J as it makes contact with the spring.

Calculate the speed of the block as it makes contact with the spring.

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

(b) The gravitational potential energy of the block decreases by 20 J as the spring is compressed to its maximum compression x_0.

Show that x_0 is 0.37 m.

[2]

(c) Assume that, as the spring compresses, all of the energy lost by the block is converted into the elastic potential energy of the spring.

Use the data from **(a)** and **(b)** to determine the maximum elastic potential energy of the spring.

Show your working.

maximum elastic potential energy = ... J [1]

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(d) The variation of the force F acting on the spring with the compression x of the spring is shown in Fig. 3.2.

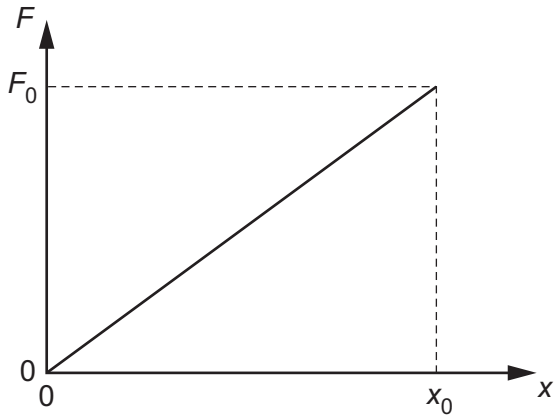


Fig. 3.2

Use the information in **(b)** and your answer in **(c)** to show that the maximum force F_0 exerted on the spring by the block is 700 N.

[2]

(e) Use the information in **(d)** to determine, for the instant that the block is first brought to rest by the spring, the magnitude of:

(i) the resultant force acting on the block

resultant force = ... N [2]

(ii) the acceleration of the block.

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

[Total: 11]

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4 **(a)** A source oscillates with frequency f to produce a progressive wave of wavelength λ. The source takes time t to produce n complete oscillations.

(i) State what is meant by a progressive wave.

.....

..... [1]

(ii) State expressions, in terms of some or all of f, λ and n, for:

- the distance moved by a wavefront in time t

distance = ...

- time t.

time t = ...

[2]

(iii) Use your answers in **(ii)** to determine an expression for the speed v of the wave in terms of f and λ.

[1]

(b) Two identical microwave sources X and Y emit waves in phase. The sources are separated by a distance of 30 cm, as shown in Fig. 4.1.



Fig. 4.1 (not to scale)

The intensity of the microwaves is to be investigated at points P and Q.
Line PQ is parallel to line XY. Distance XP is equal to distance YP. Distance YQ is 72 cm and angle XYQ is 90°.
The wavelength of the microwaves is 4.0 cm.

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(i) Calculate the frequency, in GHz, of the microwaves.

frequency = ... GHz [2]

(ii) Show that the difference between the path lengths XQ and YQ is 6 cm.

[1]

(iii) State and explain what may be deduced about the intensity of the microwaves at point Q.

.....

.....

.....

.....

..... [3]

(iv) A microwave detector is positioned at P and connected to a cathode-ray oscilloscope (CRO). The controls of the CRO are adjusted so that a waveform is shown on the screen.

Describe the changes to the amplitude of the waveform as the detector is moved from P to Q.

.....

.....

.....

..... [2]

[Total: 12]

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5 **(a)** **(i)** State and explain the effect, if any, on the resistance of a filament wire in a lamp as the current in the wire decreases.

.....

..... [1]

(ii) On Fig. 5.1, sketch the I–V characteristic of a filament lamp.

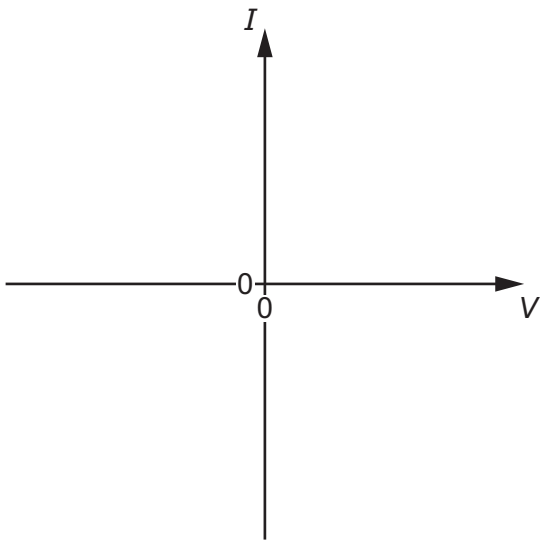


Fig. 5.1

[2]

(b) A battery of electromotive force (e.m.f.) E and negligible internal resistance is connected in parallel with two filament lamps A and B, as shown in Fig. 5.2.

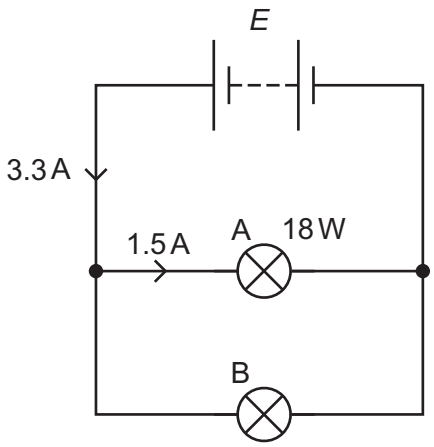


Fig. 5.2

The current in the battery is 3.3A and the current in lamp A is 1.5A. The power dissipated in lamp A is 18 W.

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(i) Calculate the e.m.f. E of the battery.

E = ... V [2]

(ii) The filament wire of lamp B has a cross-sectional area of $1.4 \times 10^{-9}\,m^2$. The number of free (conduction) electrons per unit volume in the metal of the filament wire is $3.4 \times 10^{28}\,m^{-3}$.

Calculate the average drift speed of the free electrons in the filament wire of lamp B.

average drift speed = ... $m\,s^{-1}$ [3]

[Total: 8]

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6 A battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance is connected in series with a variable resistor and a uniform resistance wire XY, as shown in Fig. 6.1.

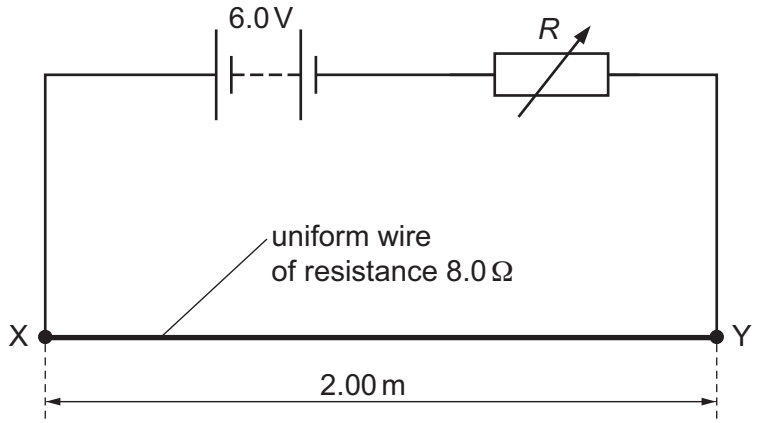


Fig. 6.1

Wire XY has length 2.00 m and resistance 8.0 Ω. The resistance R of the variable resistor is adjusted so that the potential difference across wire XY is 2.4 V.

(a) Determine R.

R = ... Ω [2]

(b) Explain why the potential difference V between any two points on wire XY is proportional to the distance L between those points.

.....

.....

.....

..... [2]

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(c) A cell of e.m.f. E and internal resistance r is connected to the circuit, as shown in Fig. 6.2.

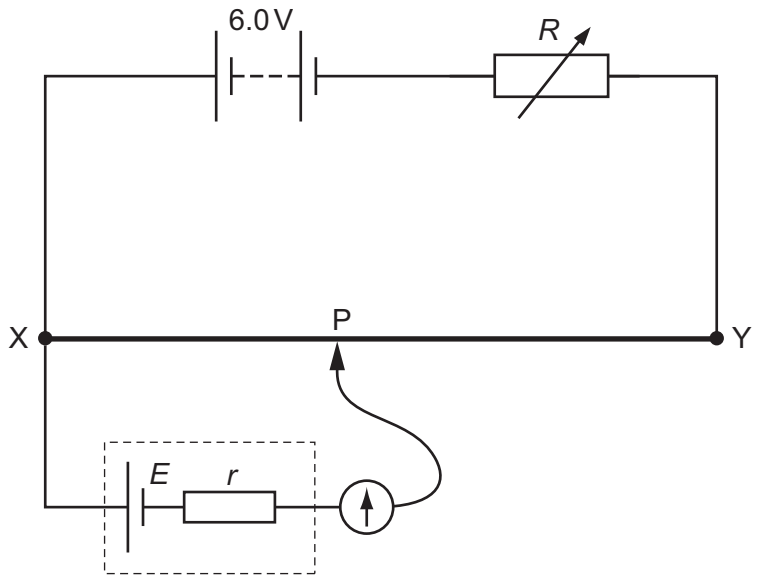


Fig. 6.2

Resistance R is unchanged.
The movable connection P is positioned on wire XY so that the galvanometer reading is zero.
Distance XP is 1.24 m.

(i) Calculate E.

E = ... V [2]

(ii) The value of R is now decreased.

State and explain the change that must be made to the position of P on wire XY so that the galvanometer reads zero again.

.....

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.....

..... [2]

[Total: 8]

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7 **(a)** State the names of **two** different leptons.

1 .....

2 .....

[2]

(b) In the following list, underline all the particles that are hadrons.

antineutrino beta-plus meson neutron

[1]

(c) By reference to quark composition, show that the charge of a proton is $+1.6 \times 10^{-19}$ C.

[2]

[Total: 5]

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