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CAMBRIDGE
International Education

Cambridge International AS & A Level

CANDIDATE NAME										
CENTRE NUMBER						CANDIDATE NUMBER				

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PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **May/June 2026**

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. Do **not** use correction fluid or tape.
- 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 (WW/CB) 356120/3

[Turn over

Data

acceleration of free fall	g	=	$9.81\,\text{m}\,\text{s}^{-2}$
speed of light in free space	c	=	$3.00 \times 10^{8}\,\text{m}\,\text{s}^{-1}$
elementary charge	e	=	$1.60 \times 10^{-19}\,\text{C}$
unified atomic mass unit	$1\,\text{u}$	=	$1.66 \times 10^{-27}\,\text{kg}$
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	=	$8.31\,\text{J}\,\text{K}^{-1}\,\text{mol}^{-1}$
Boltzmann constant	k	=	$1.38 \times 10^{-23}\,\text{J}\,\text{K}^{-1}$
gravitational constant	G	=	$6.67 \times 10^{-11}\,\text{N}\,\text{m}^{2}\,\text{kg}^{-2}$
permittivity of free space	ε_0	=	$8.85 \times 10^{-12}\,\text{F}\,\text{m}^{-1}$
	$(\dfrac{1}{4\pi\varepsilon_0}$	=	$8.99 \times 10^{9}\,\text{m}\,\text{F}^{-1})$
Planck constant	h	=	$6.63 \times 10^{-34}\,\text{J}\,\text{s}$
Stefan–Boltzmann constant	σ	=	$5.67 \times 10^{-8}\,\text{W}\,\text{m}^{-2}\,\text{K}^{-4}$

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

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1 (a) Define force.

....

.... [1]

(b) A rocket is launched vertically upwards from a launch pad. The initial mass of the rocket, with all of its fuel, is 2.83×10^6 kg. For the first 60 s after lift-off, the rocket engine burns fuel at a rate of 2.0×10^4 kg s^{-1} to produce a constant thrust force.

Figure 1.1 shows the variation of the speed of the rocket with time for the first 60 s after lift-off.

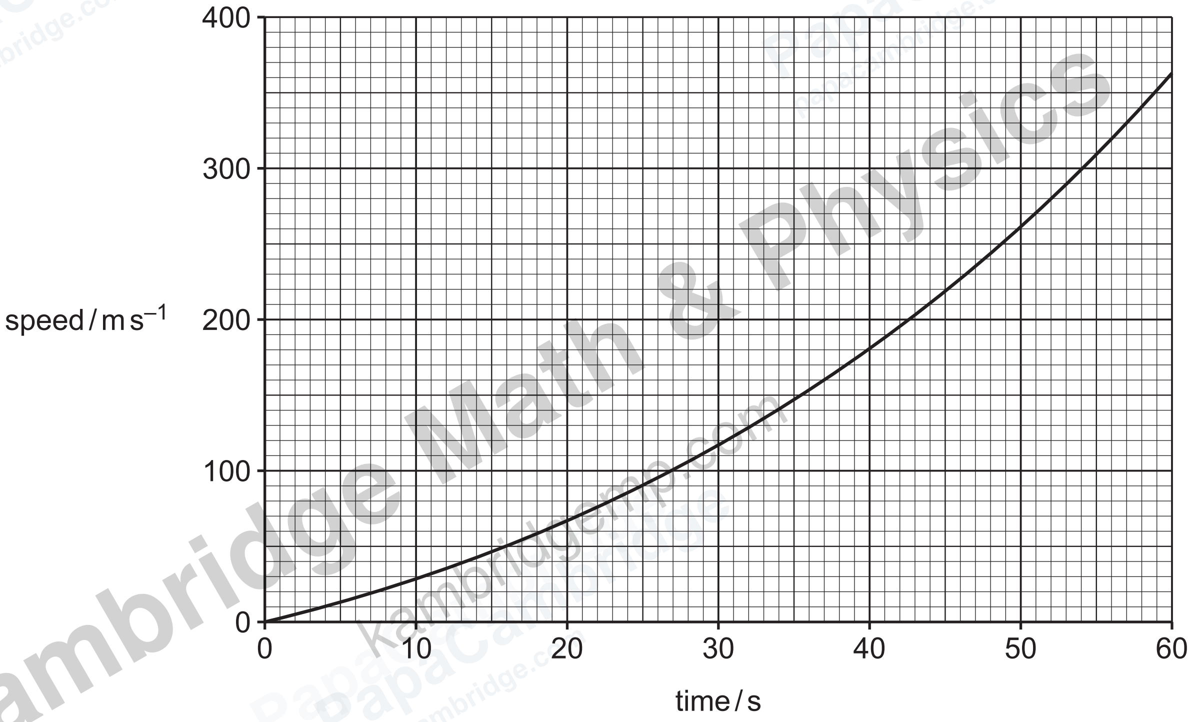

Figure 1.1

Assume that the drag force acting on the rocket is negligible over this time.

(i) By considering the mass of unburnt fuel in the rocket, explain why the speed of the rocket does **not** increase linearly with time, despite the thrust force from the engine being constant.

....

....

....

.... [2]

(ii) Describe how Figure 1.1 may be used to determine the acceleration of the rocket at lift-off. No calculations are required.

....

....

.... [2]

(iii) The acceleration of the rocket at lift-off is $2.5\,\mathrm{m\,s^{-2}}$.

Determine a value for the thrust force T produced by the rocket engine.

T = ... N [2]

(iv) Determine the kinetic energy of the rocket at time 60 s after lift-off.

kinetic energy = ... J [3]

(v) Use Figure 1.1 to estimate the height of the rocket above the launch pad at time 60 s after lift-off. Explain your reasoning.

height = ... m [2]

(c) The mass of the emitted exhaust gases is the same as the mass of fuel burnt by the engine.

Use your answer in **1(b)(iii)** to calculate the speed at which the exhaust gases are emitted from the rocket in **1(b)**.

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

(d) In practice, the drag force on the rocket in **1(b)** is not negligible.

By placing **one** tick (✓) in each row, complete Table 1.1 to show the effect of the drag force on the acceleration at lift-off and on the kinetic energy at time 60 s, compared with the values in **1(b)** that assumed negligible drag force.

Table 1.1

	less	**same**	**greater**
acceleration at lift-off			
kinetic energy at time 60 s			

[2]

[Total: 16]

Turn over

2 **(a)** State what is meant by the spring constant of a spring.

....

.... [1]

(b) A block of mass 0.086 kg is suspended in equilibrium from a spring that obeys Hooke's law. In this position, the extension of the spring is 0.026 m.

The block is pulled vertically down a distance of 0.015 m from the equilibrium position and then released from rest so that it starts moving upwards. Air resistance is negligible.

(i) Identify **one** possible source of random error in determining experimentally the extension of the spring using a ruler.

....

.... [1]

(ii) Calculate the spring constant k of the spring.

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

(iii) Show that, in the equilibrium position, the elastic potential energy of the spring is 0.011 J.

[2]

(iv) Assume that the spring has not exceeded its elastic limit when the block is in the position from which it is released.

Calculate the additional elastic potential energy stored in the spring when the block moves from its equilibrium position to the position from which it is released.

additional elastic potential energy = ... J [2]

(v) Use the principle of conservation of energy to determine the kinetic energy of the block as it passes the equilibrium position moving upwards.

kinetic energy = ... J [2]

(c) Suggest, with a reason, how the answer in **2(b)(iv)** is affected if the spring in **2(b)** has exceeded its elastic limit when the block is at the position from which it is released.

....

....

.... [2]

[Total: 12]

3 **(a)** State what is meant by a progressive wave.

....

.... [1]

(b) A transverse progressive wave travels along a long string PQ from P to Q.

Figure 3.1 shows the string at time $t = 0$.

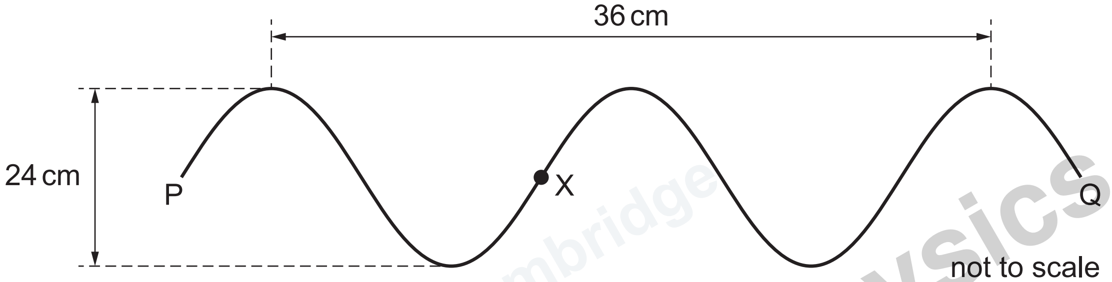

Figure 3.1

A point on the string is labelled X. At $t = 0$, point X is at its equilibrium position.
The speed of the wave on the string is $75\,\text{cm}\,\text{s}^{-1}$.

(i) Show that the period of the wave is 0.24 s.

[2]

(ii) On Figure 3.2, sketch the variation of the displacement from the equilibrium position of point X with t between $t = 0$ and $t = 0.48$ s.

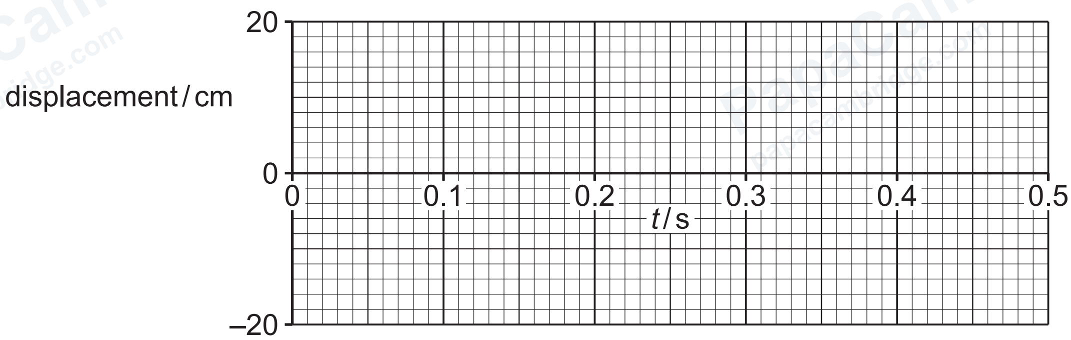

Figure 3.2

[3]

(c) The string in **3(b)** is now fixed to walls at ends P and Q. An oscillator causes transverse oscillations of the string of period 0.24 s. The speed of waves on the string is still $75\,\mathrm{cm\,s^{-1}}$.

The distance between P and Q is 45 cm.

(i) Explain how a stationary wave is formed on the string.

....

....

....

.... [2]

(ii) Figure 3.3 shows the string at one instant in time.

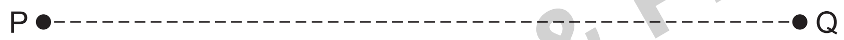

Figure 3.3

On Figure 3.3, draw a solid line to show a possible appearance of the string at a time 0.060 s later. [2]

(iii) On Figure 3.3, draw:

- a cross (×) labelled with the letter N at **one** point on the string that is at a node
- a cross (×) labelled with the letter A at **one** point on the string that is at an antinode. [2]

[Total: 12]

4 **(a)** Define resistance.

....

.... [1]

(b) Figure 4.1 shows the variation with temperature of the resistivity of copper.

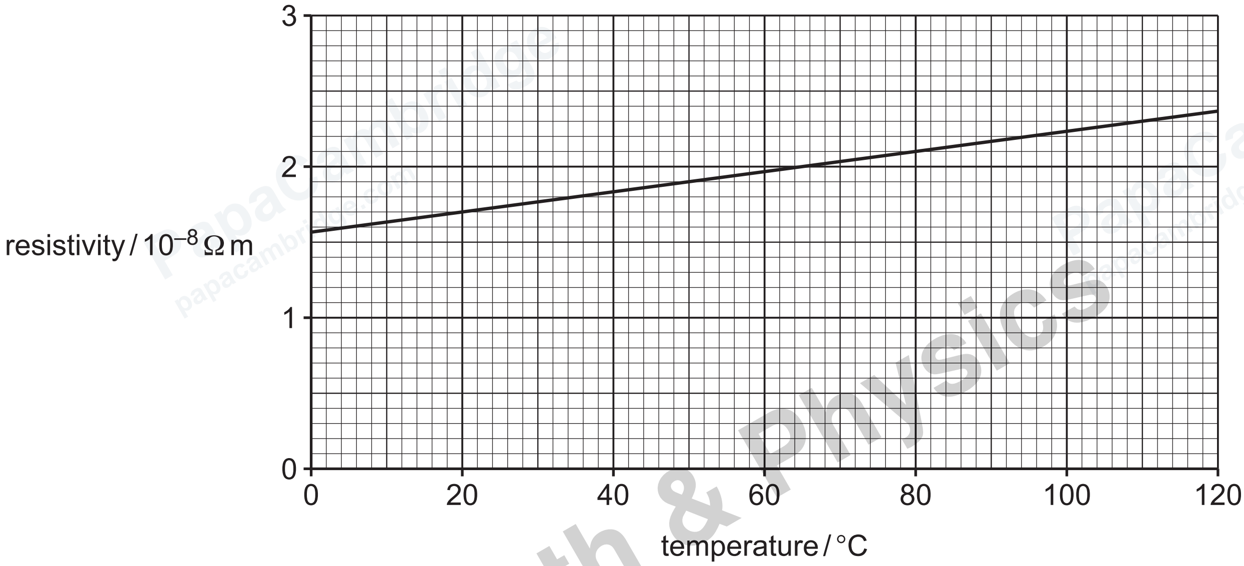

Figure 4.1

A copper wire has a length of 2.0 m and a diameter of 0.60 mm.

(i) Show that the cross-sectional area of the wire is $2.8 \times 10^{-7}\,m^2$.

[1]

(ii) Determine the resistance of the wire at 20 °C.

resistance = ... Ω [2]

(iii) A different copper wire has the same resistance as the answer in **4(b)(ii)**. This wire also has a diameter of 0.60 mm but has a length that is greater than 2.0 m.

With reference to Figure 4.1, state and explain whether the temperature of this wire is less than, equal to or greater than 20 °C.

....

....

.... [2]

(iv) State **one** way in which the variation of resistance with temperature for a thermistor is different from that of a copper wire.

.... [1]

(c) Each metal has a property known as its temperature coefficient of resistivity α. This is given by

$$\alpha = \frac{\text{change in resistivity}}{\text{initial resistivity} \times \text{change in temperature}}.$$

(i) Deduce the SI unit for α.

unit .... [1]

(ii) Use Figure 4.1 to determine a value of α, in its SI unit, for copper at a temperature of 0 °C.

α = ... SI unit [2]

(d) There is a current of 5.6 A in the wire in **4(b)**.
The number density of charge carriers (free electrons) for copper is $8.5 \times 10^{28}\,m^{-3}$.

Calculate the mean drift speed v of the charge carriers in the wire.

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

[Total: 12]

5 **(a)** The general quark composition of a meson is a quark and an antiquark.

State the general quark composition of a baryon.

....

.... [1]

(b) **(i)** Explain, in terms of quark composition, how a meson may have an overall charge of +1e, where e is the elementary charge.

....

....

.... [2]

(ii) State and explain the **two** other possible overall charges for a meson.

....

....

....

.... [2]

(c) State the names of **two** particles that are classed as leptons.

1 ....

2 ....

[2]

(d) A similarity between leptons and mesons is that they both have the same possible overall charges as those described in **5(b)(i)** and **5(b)(ii)**.

State **one** difference between leptons and mesons.

....

.... [1]

[Total: 8]

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