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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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* 7 7 4 0 7 2 3 1 1 8 *

PHYSICS **9702/23**

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 (WW/SW) 342397/3

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	=	$8.85 \times 10^{-12}\ \text{F m}^{-1}$
	$(\frac{1}{4\pi\varepsilon_0}$	=	$8.99 \times 10^{9}\ \text{m F}^{-1})$
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	=	$\frac{f_s v}{v \pm v_s}$
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 acceleration.

....

.... [1]

(b) A rocket is launched vertically from the surface of the Earth.

Fig. 1.1 shows the variation of the velocity of the rocket with time for the first 20 s after its launch.

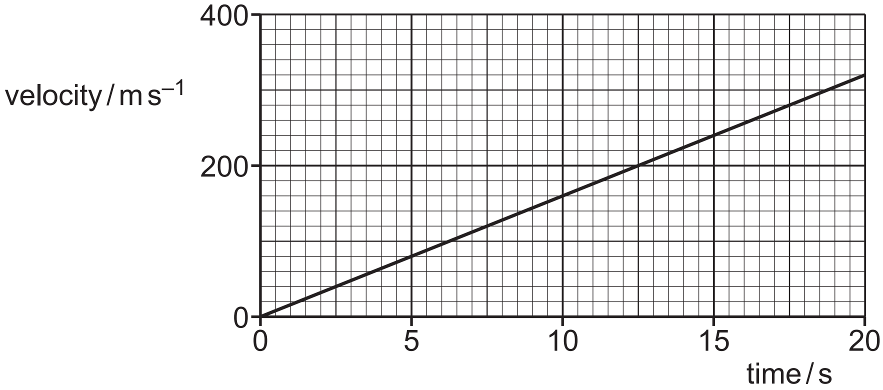

Fig. 1.1

(i) Determine the acceleration of the rocket.

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

(ii) Show that the height of the rocket above the surface of the Earth at a time of 20 s after launch is 3.2 km.

[2]

(c) The mass of the rocket in **(b)** is 2.9×10^6 kg. Assume that this mass remains constant.

For this rocket, from launch to its height at a time of 20 s after launch:

(i) calculate the gain in gravitational potential energy ΔE_P

ΔE_P = ... J [2]

(ii) calculate the gain in kinetic energy ΔE_K

ΔE_K = ... J [2]

(iii) determine the average power output of the rocket engines. Assume that resistive forces are negligible.

power = ... W [2]

[Total: 10]

2 **(a)** **(i)** Define pressure.

....

.... [1]

(ii) Explain how hydrostatic pressure results in an upthrust force acting on a solid object immersed in a liquid.

....

....

....

.... [2]

(b) A small steel ball of radius *r* and mass *m* falls vertically at terminal speed *v* through oil.

The viscous drag force *D* that acts on the ball is given by

$$D = 6\pi\eta r v$$

where η is a property of the oil called its viscosity.

(i) On Fig. 2.1, draw labelled arrows from the ball to show the directions of the **three** forces that act on the ball as it falls.

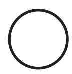

Fig. 2.1

[3]

(ii) Determine the SI base units of η.

base units .... [2]

(c) The oil in **(b)** has a density of $920\,\text{kg}\,\text{m}^{-3}$ and a viscosity of 4.7 in SI units.

The steel ball has a mass of 2.4×10^{-3} kg and a radius of 4.2×10^{-3} m.

(i) Show that the upthrust force acting on the ball is 2.8×10^{-3} N.

[1]

(ii) Determine the terminal speed v of the ball.

v = ... $\text{m}\,\text{s}^{-1}$ [3]

[Total: 12]

3 A wire has length L and cross-sectional area A. The wire is made from a metal that has Young modulus E and resistivity ρ.

(a) Define the Young modulus of a material.

....

.... [1]

(b) **(i)** State an expression, in terms of some or all of L, A, E and ρ, for the resistance R_0 of the wire.

R_0 = ... [1]

(ii) Show that the spring constant k_0 of the wire is given by

$$k_0 = \frac{EA}{L}.$$

[2]

(c) The wire is stretched, within the limit of proportionality, by a tensile force F. Assume that any changes in the cross-sectional area of the wire are negligible.

(i) On Fig. 3.1, sketch the variation with F of the resistance R of the wire.

Fig. 3.1

[1]

(ii) On Fig. 3.2, sketch the variation with F of the spring constant k of the wire.

Fig. 3.2

[1]

(d) Copper has a resistivity of $1.8 \times 10^{-8}\,\Omega\,m$ and a Young modulus of 1.3×10^{11} Pa.

A copper wire of diameter 1.6 mm has a resistance of $0.034\,\Omega$.

(i) Show that the length of the wire is 3.8 m.

[1]

(ii) Use the equation in **(b)(ii)** to determine the spring constant of the wire.

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

[Total: 9]

4 (a) State what is meant by diffraction of a wave.

....

....

.... [2]

(b) A beam of vertically polarised light of wavelength 540 nm is incident normally on a diffraction grating, as shown in Fig. 4.1.

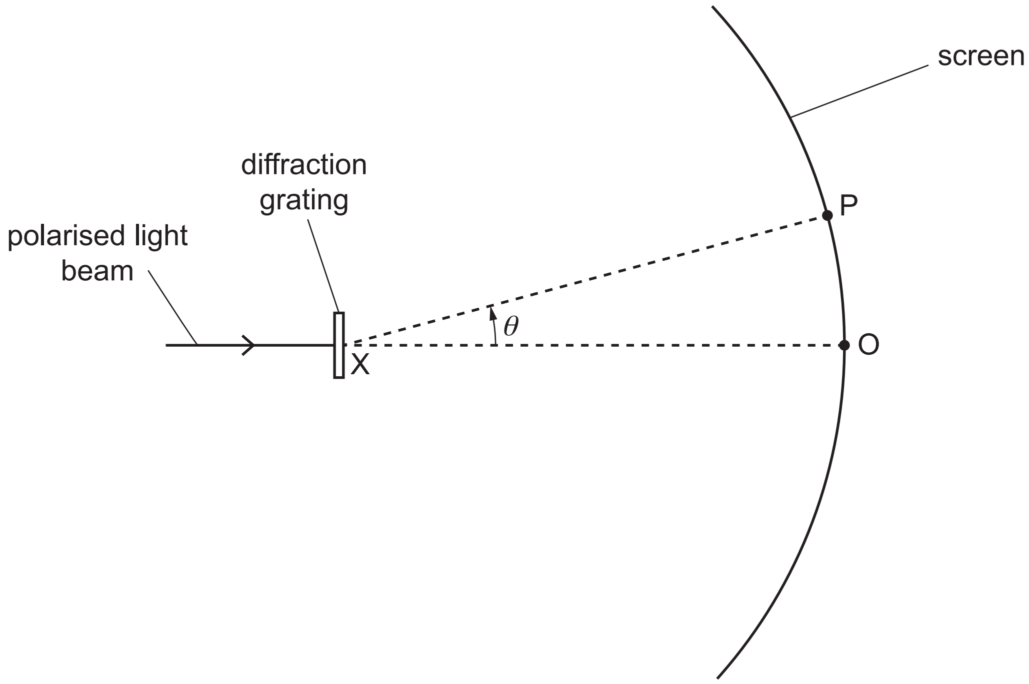

Fig. 4.1 (not to scale)

The diffraction grating has a line spacing of 5.0×10^{-6} m.

The light transmitted by the diffraction grating illuminates a circular screen. The diffraction grating is at the centre X of the circle.

The central bright fringe is formed at point O on the screen and has intensity I_0.

P is a point on the screen where the line XP is at a variable angle θ to the line XO. The intensity I of light on the screen at P varies with θ.

(i) Show that the angle θ at which the first-order bright fringe is formed is 6.2°.

[2]

(ii) Determine the value of θ at which the second-order bright fringe is formed.

θ = ...° [1]

(iii) On Fig. 4.2, sketch the variation of the intensity I with θ for values of θ from –15° to +15°.

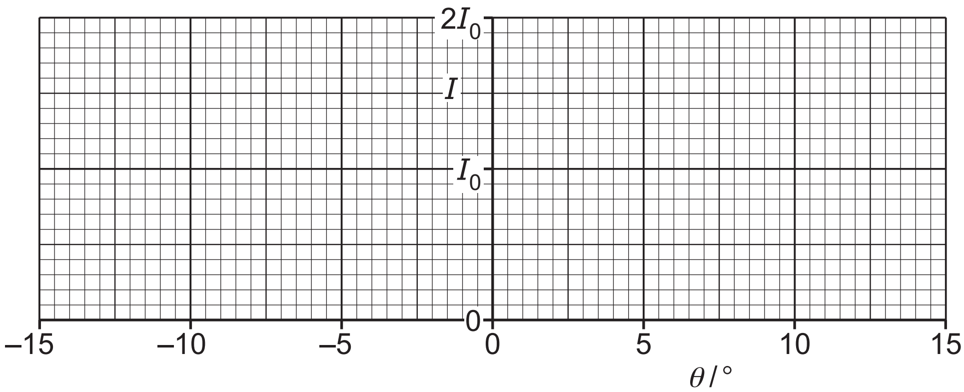

Fig. 4.2

[3]

(c) A polarising filter is placed in the path of the light beam that is incident on the diffraction grating in Fig. 4.1. The transmission axis of the filter is at 45° to the vertical.

Suggest how the variation of intensity with θ for the light on the screen compares with the answer in **(b)(iii)**.

....

....

.... [2]

[Total: 10]

5 **(a)** State Kirchhoff's first law.

....

.... [1]

(b) Fig. 5.1 shows a circuit containing a thermistor T that has a negative temperature coefficient.

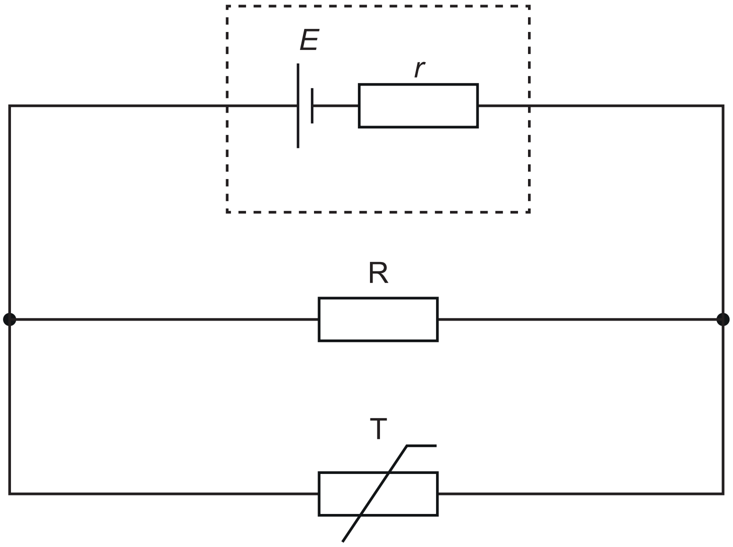

Fig. 5.1

(i) The thermistor has resistance R_0 at a temperature of 0 °C.

On Fig. 5.2, sketch a possible variation of the resistance of the thermistor with temperature between 0 °C and 100 °C.

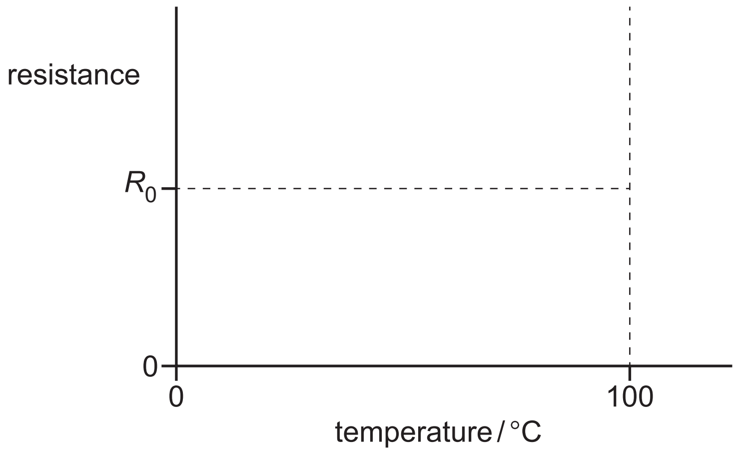

Fig. 5.2

[2]

(ii) With reference to the current in the cell, explain why the current in **resistor R** decreases with increasing temperature of the thermistor.

....

....

....

....

.... [3]

(c) The electromotive force (e.m.f.) E of the cell in Fig. 5.1 is 1.50 V. The internal resistance r of the cell is 0.12 Ω.

Resistor R has a resistance of 6.00 Ω.

At a particular temperature of the thermistor, the current in R is 0.200 A.

For this temperature of the thermistor, determine:

(i) the current in the cell

current = ... A [2]

(ii) the resistance of the thermistor.

resistance = ... Ω [2]

[Total: 10]

6 The nuclide $^{3}_{1}H$ is an isotope of hydrogen that is called tritium.

(a) **(i)** Determine the numbers of protons, neutrons and electrons in a neutral atom of tritium.

number of protons = ...

number of neutrons = ...

number of electrons = ...
[2]

(ii) Draw a labelled diagram to represent a simple model of the arrangement of the protons, neutrons and electrons in a tritium atom.

[2]

(b) Tritium is radioactive and undergoes β⁻ decay to form an isotope of helium (He). Gamma radiation is not emitted during this decay.

(i) Complete the equation to represent the radioactive decay of tritium.

$$^{3}_{1}H \rightarrow \,^{\cdots\cdots}_{\cdots\cdots}He + \,^{\cdots\cdots}_{\cdots\cdots}\beta + \,^{0}_{0}X$$

[2]

(ii) State the name of particle X.

.... [1]

(c) Determine the quark composition of a tritium nucleus.

....

.... [2]

[Total: 9]

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