



# Cambridge International AS & A Level

CANDIDATE NAME



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## PHYSICS

9702/22

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.



### 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	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
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	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
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	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $\left(\frac{1}{4\pi\epsilon_0}\right) = 8.99 \times 10^9 \text{ m F}^{-1}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

### Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
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	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$



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- 1 Scientists are investigating the variation in air pressure at different locations on a mountain.
- (a) The scientists take measurements of several physical quantities at each location.

Complete Table 1.1 by stating the SI base unit for each quantity and identifying with a tick (✓) whether each quantity is a scalar or a vector. Use the space for any working.

**Table 1.1**

quantity measured	SI base unit	scalar	vector
air temperature			
air pressure			

[2]

- (b) (i) At one location, the density of the air is  $1.1 \text{ kg m}^{-3}$ . A spherical weather balloon is filled with a gas and released from rest. The balloon has radius 0.90 m.

Calculate the upthrust acting on the balloon when it is released.

upthrust = ..... N [2]

- (ii) Explain why an upthrust acts on the balloon.

.....  
 .....  
 .....  
 ..... [2]

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(iii) The balloon has weight 19 N.

Calculate the magnitude of the initial acceleration of the balloon.

acceleration = .....  $\text{ms}^{-2}$  [3]

(c) A quantity  $c$  relating to the motion of the balloon is calculated from three measured quantities  $k$ ,  $F$  and  $v$  using the formula

$$c = \frac{2kF}{v^2}.$$

The percentage uncertainties in the measured quantities are given in Table 1.2.

**Table 1.2**

measured quantity	percentage uncertainty
$k$	5%
$F$	3%
$v$	4%

The calculated value of  $c$  is 1.8.

Determine the absolute uncertainty in  $c$ .

absolute uncertainty = ..... [2]

[Total: 11]



- 2 A spacecraft in deep space uses jets of hot gas from its thrusters to change its velocity. Fig. 2.1 shows a side view of the spacecraft and some of its thrusters.

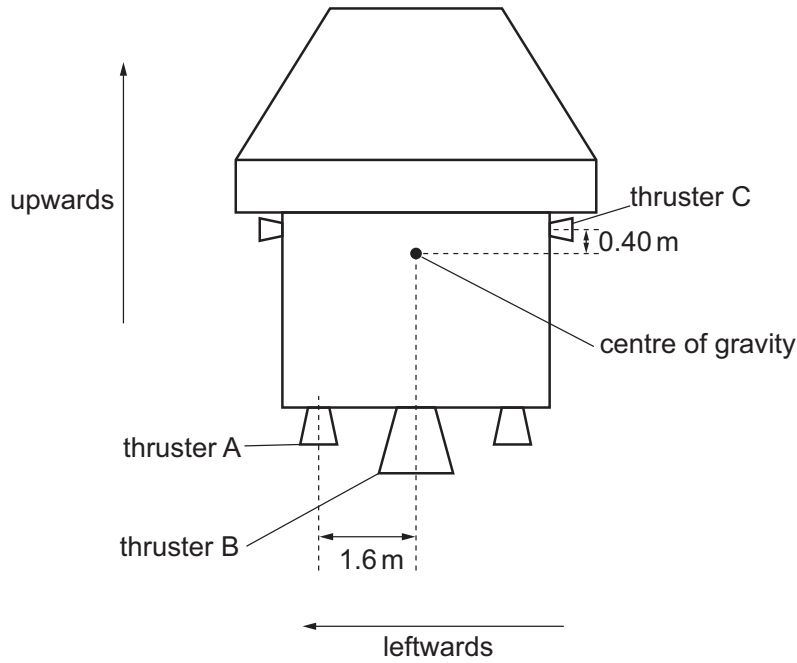


Fig. 2.1 (not to scale)

Thruster A is a distance of 1.6 m leftwards from the centre of gravity of the spacecraft. Thruster C is a distance of 0.40 m upwards from the centre of gravity of the spacecraft.

Thrusters A and B can produce forces on the spacecraft in the upwards direction only. Thruster C can produce a force on the spacecraft in the leftwards direction only. All the thrusters shown produce forces entirely in the same plane as the centre of gravity.

- (a) (i) Thruster A is activated, producing a force of 60 N upwards on the spacecraft. Thruster C is also activated, producing a force of 220 N in the leftwards direction on the spacecraft.

Calculate the resultant moment due to these forces about the centre of gravity.

resultant moment = ..... N m [2]

- (ii) State and explain whether the forces from A and C are a couple.

.....

.....

..... [1]



- (b) Thrusters A and C are now switched off and the spacecraft is stationary. Thruster B is activated at time  $t_1$ , producing a constant force on the spacecraft until the fuel runs out at time  $t_2$ . As the fuel is used, the total mass of the spacecraft decreases.

On Fig. 2.2, sketch the variation of speed of the spacecraft with time from  $t_1$  to  $t_2$ .

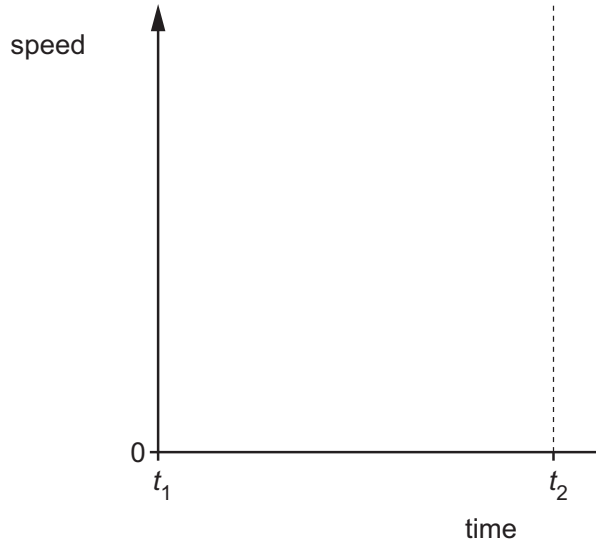


Fig. 2.2

[2]

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(c) The spacecraft now splits apart into a carrier and a payload as shown in Fig. 2.3.

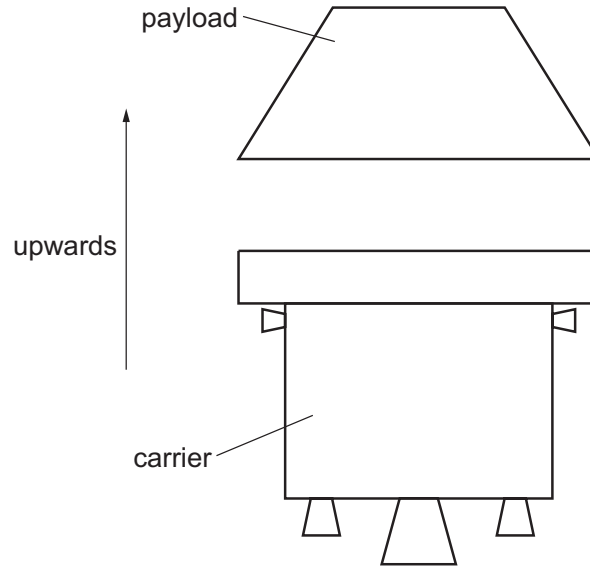


Fig. 2.3

During the split, an average force of 5500 N acts on the payload for a time of 0.36 s. The velocity of the payload increases by  $8.5 \text{ m s}^{-1}$  in the upwards direction.

The combined mass of the carrier and payload is  $2.5 \times 10^3 \text{ kg}$ .

(i) State the principle of conservation of momentum.

.....

.....

..... [2]

(ii) Show that the mass of the payload is 230 kg.

[2]



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(iii) Calculate the magnitude of the change in velocity of the carrier.

change in velocity = .....  $\text{ms}^{-1}$  [3]

[Total: 12]



- 3 A spring is fixed at one end and attached to the frame of a pulley at the other end. A cable is passed around the wheel of the pulley. The spring is stretched to a fixed length using the cable and pulley.

Fig. 3.1 shows the view from above of the spring, cable and pulley.

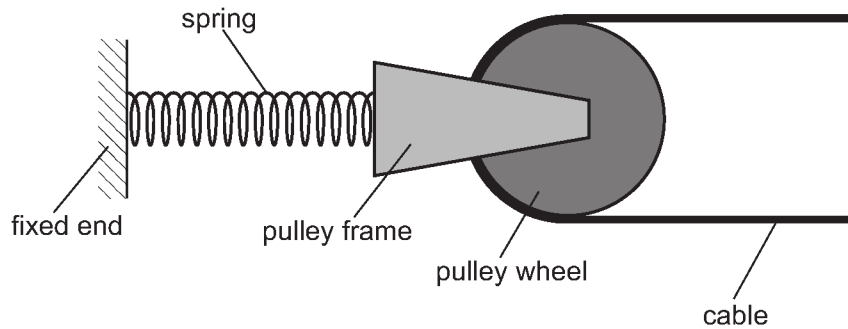


Fig. 3.1

The spring obeys Hooke's law and has a spring constant  $k$  of  $250 \text{ N m}^{-1}$ . A force  $F$  acts on the spring. The tension in the cable is  $T$ . The pulley is in equilibrium.

- (a) On Fig. 3.2, draw labelled arrows to show the directions of the forces acting on the pulley.

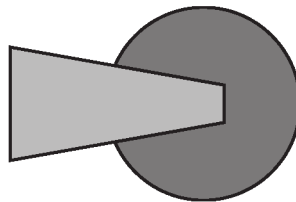


Fig. 3.2

[2]

- (b) The force  $F$  is 110N.

- (i) Determine  $T$ .

$T = \dots\dots\dots \text{ N [1]}$





- (ii) Calculate the extension of the spring.

extension = ..... m [2]

- (c) A second identical spring with the same spring constant of  $250 \text{ N m}^{-1}$  is now also connected to the pulley, as shown in Fig. 3.3.

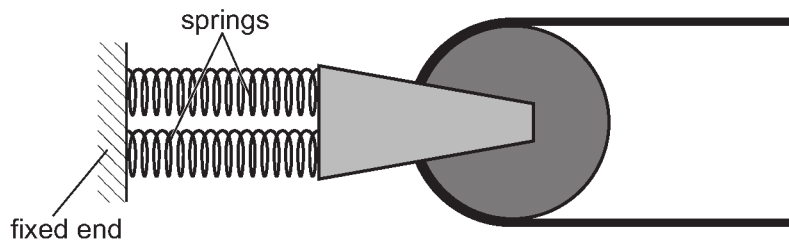


Fig. 3.3

The tension in the cable is kept the same. The pulley is again in equilibrium.

- (i) Determine the extension of the springs.

extension = ..... m [2]

- (ii) The elastic potential energy stored in the spring in Fig. 3.1 is  $E_1$ . The **total** elastic potential energy stored in the two springs in Fig. 3.3 is  $E_2$ .

Calculate the ratio  $\frac{E_1}{E_2}$ .

ratio = ..... [2]

[Total: 9]



- 4 A laser emits visible light of a single frequency in a vacuum. The light is incident normally on a double slit and then forms a pattern of bright and dark fringes on a screen, as shown in Fig. 4.1.

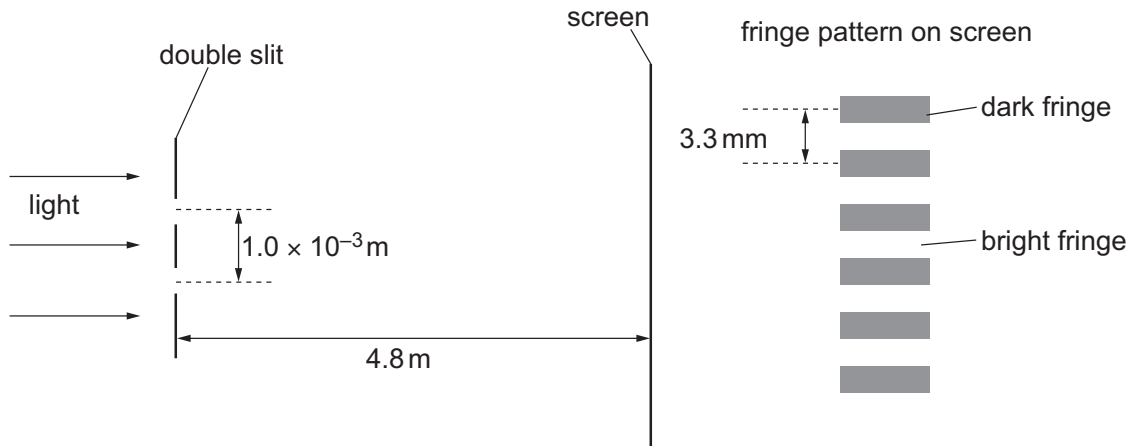


Fig. 4.1 (not to scale)

The separation of the slits is  $1.0 \times 10^{-3} \text{ m}$ . The distance from the slits to the screen is  $4.8 \text{ m}$ . The distance between the centres of adjacent dark fringes on the screen is  $3.3 \text{ mm}$ .

- (a) Explain how the pattern of bright and dark fringes is formed.

.....

.....

.....

.....

.....

..... [3]

- (b) Calculate the frequency of the light emitted by the laser.

frequency = ..... Hz [4]





- (c) The double slit is removed. A second laser is placed beside the first laser. The second laser produces visible light of a different frequency from that of the first laser. The beams of light from the two lasers overlap on the screen.

Explain why a steady pattern of bright and dark fringes is **not** formed on the screen.

.....

..... [1]

[Total: 8]



- 5 Fig. 5.1 shows a circuit containing a battery, two fixed resistors X and Y, and a light-dependent resistor (LDR) Z.

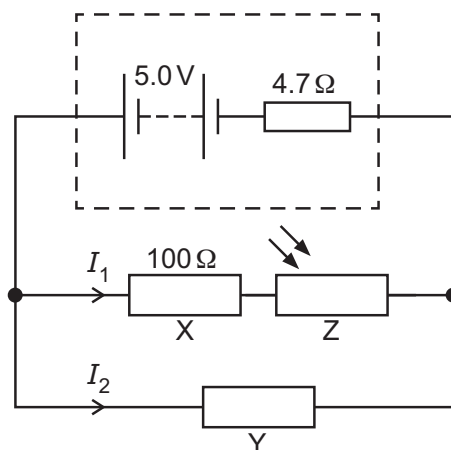


Fig. 5.1

The battery has electromotive force (e.m.f.) 5.0V and internal resistance  $4.7\Omega$ . The current in X is  $I_1$  and the current in Y is  $I_2$ .

The resistance of X is  $100\Omega$ . The resistance of Z varies with the intensity of light incident on it as shown in Fig. 5.2.

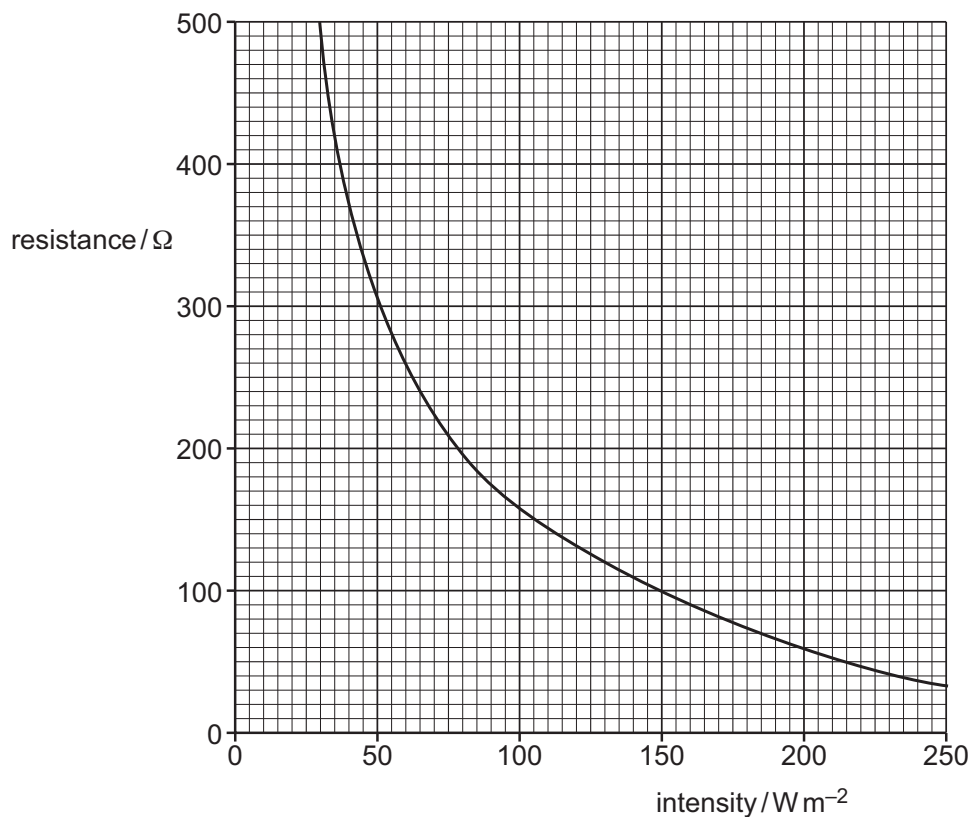


Fig. 5.2





(a) State Kirchhoff's first law.

.....  
..... [1]

(b) The intensity of light incident on Z is  $130 \text{ W m}^{-2}$ . The current in the battery is 38 mA.

(i) Show that the terminal potential difference of the battery is 4.8 V.

[2]

(ii) Calculate the current  $I_2$  in Y.

$I_2 = \dots\dots\dots \text{ A}$  [3]

(iii) Calculate the power dissipated in Y.

power =  $\dots\dots\dots \text{ W}$  [2]

(iv) The intensity of the light incident on Z decreases.

State and explain the effect on the terminal potential difference of the battery.

.....  
.....  
.....  
.....  
..... [3]

[Total: 11]





6 (a) State what is meant by a fundamental particle.

.....  
..... [1]

(b) (i) Particle Q is a meson with a charge of 0.

Determine a possible quark composition for Q.

..... [2]

(ii) Particle Q has a mass of 0.67 u and a kinetic energy of  $2.1 \times 10^{-16}$  J.

Calculate the speed of particle Q.

speed = .....  $\text{ms}^{-1}$  [3]

(c) Radium-228 ( $^{228}_{88}\text{Ra}$ ) is a radioactive nuclide.

(i) State the number of electrons in a neutral atom of radium-228.

number of electrons = ..... [1]

(ii) A nucleus of radium-228 undergoes a series of decays to form nucleus X.  
During the process, 5  $\alpha$ -particles and 4  $\beta^-$  particles are emitted.

Determine the number of protons and the number of neutrons in nucleus X.

number of protons = .....

number of neutrons = .....

[2]

[Total: 9]

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