Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2024

Centre Number

Candidate Number

Physics

Assessment Unit AS 1
assessing
Forces, Energy and Electricity

MV18

[SPH11]

WEDNESDAY 15 MAY, MORNING

Time

1 hour 45 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write on blank pages.
Complete in black ink only.
Answer **all nine** questions.

Information for Candidates

The total mark for this paper is 100.
Figures in brackets printed at the end of each question indicate the marks awarded to each question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

1 **(a)** An electric car is powered by a battery which can store 270 MJ of energy when fully charged. The battery is charged by attaching a cable that transfers 7 kW of power at a voltage of 240 V.

(i) After a journey, there is 60 MJ of energy remaining in the battery. Calculate the time taken to fully charge the battery, assuming the charging process is 100% efficient. Give your answer in hours. [6 marks]

Charging time = _____ h

(ii) Calculate the current that flows through the charging cable when the battery is being charged.
[3 marks]

Current = _____ A

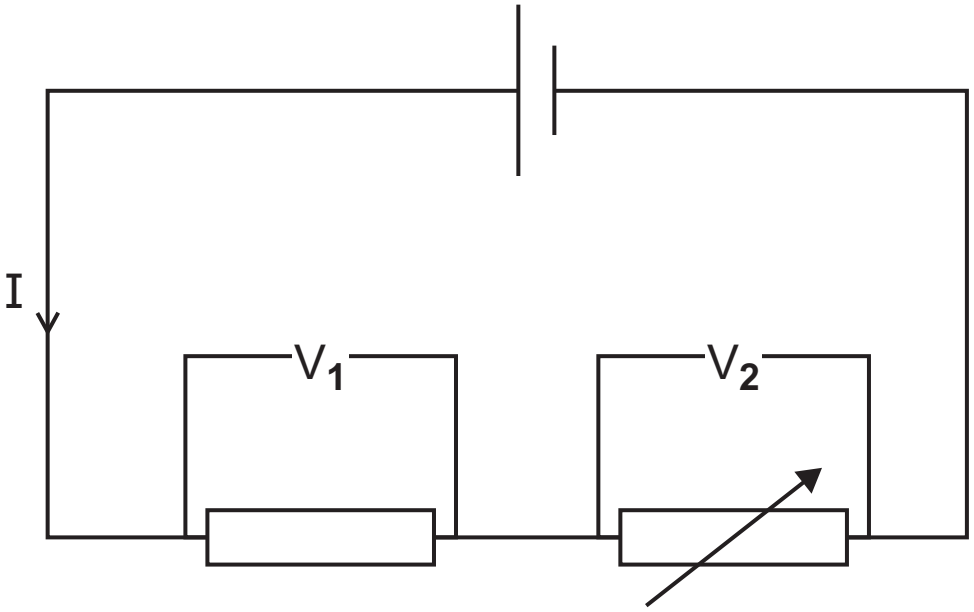
(b) The wire in the charging cable has a circular cross-section and is 3.0 m long. It is made of copper, of resistivity $1.7 \times 10^{-8}\,\Omega$ m, and resistance 1.1 mΩ. [6 marks]

Calculate the diameter of the wire.

Diameter = _____ m

2 A student connects a cell of e.m.f. 5.00 V in series with a resistor and variable resistor causing current I to flow, as shown in **Fig. 2.1**.

Fig. 2.1



(i) The student measures the voltages as $V_1 = 1.21\,V$ and $V_2 = 3.62\,V$. Calculate the total voltage across the two resistors and explain any difference between this value and the e.m.f. of the cell. [3 marks]

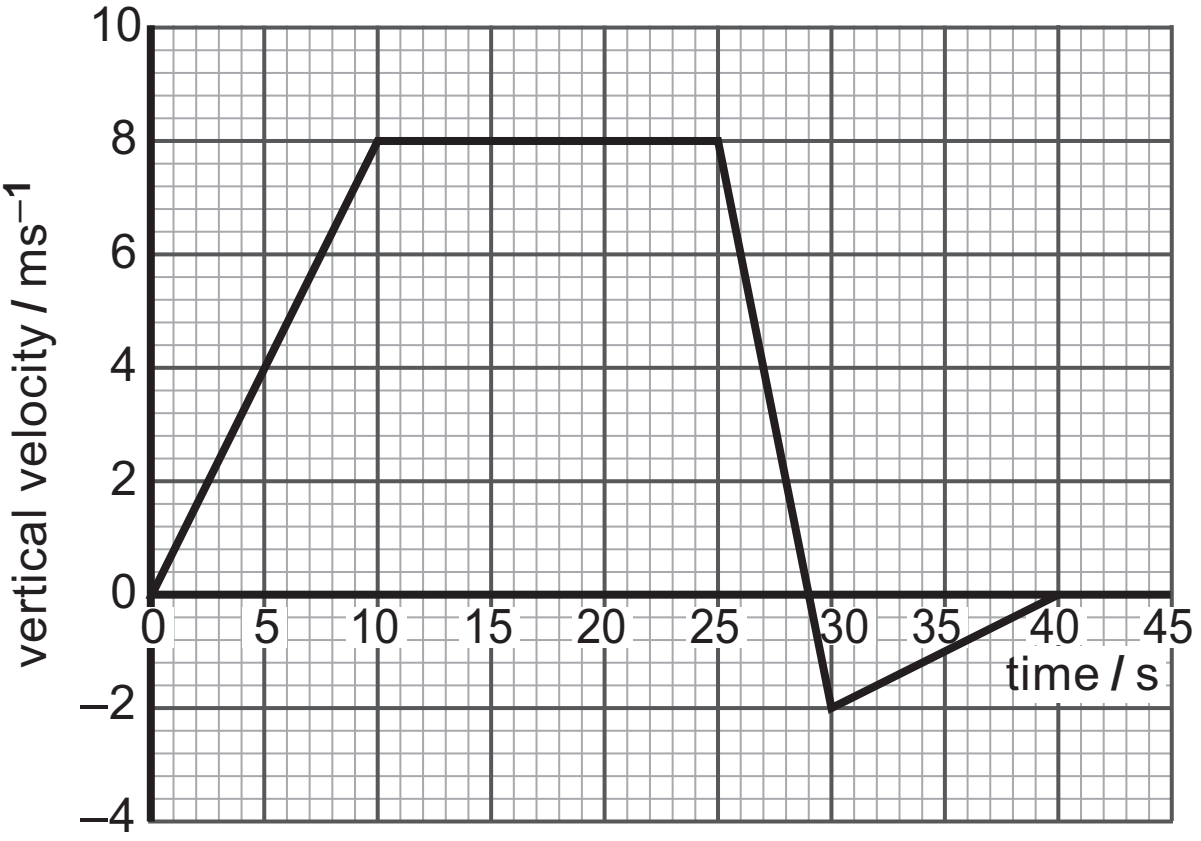
(ii) The resistance of the variable resistor is then increased. Place a tick (✓) in each row of **Table 2.1** to state how this will affect the quantities listed in the table.
[4 marks]

Table 2.1

Quantity	Increases	Decreases	Remains the same
I			
V_1			
V_2			
$V_1 + V_2$			

3 A drone takes off from ground level and remains directly above the take off point for the duration of its flight. The graph in **Fig. 3.1** shows how the upwards vertical velocity of the drone changes with time after taking off.

Fig. 3.1



(i) By examining **Fig. 3.1**, complete **Table 3.1** opposite to show how the height and speed of the drone changes during the time periods by placing **two** ticks in each row. [4 marks]

Table 3.1

Time Period / s	Height increasing	Height decreasing	Height constant	Speed increasing	Speed decreasing	Speed constant
0–10						
10–25						
25–29						
30–40						

(ii) Calculate the initial acceleration of the drone.
[3 marks]

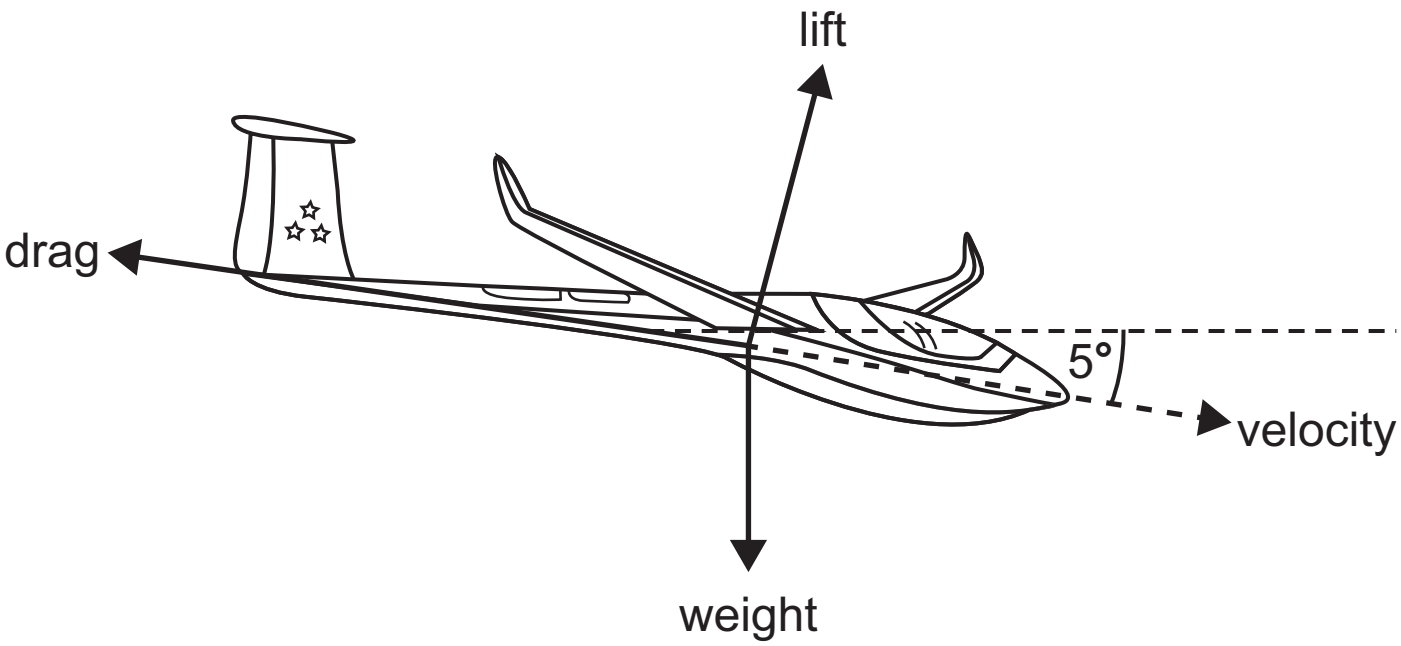
Acceleration = _____ m s^{-2}

(iii) Calculate the final height of the drone above its initial starting position. [4 marks]

Height = _____ m

4 The pilot of a glider places it into a shallow dive so that it travels at a constant velocity of 60 m s^{-1} at a constant angle of 5° to the horizontal, as shown in **Fig. 4.1**. The three forces that act on the glider, lift, weight, and drag are shown on the diagram.

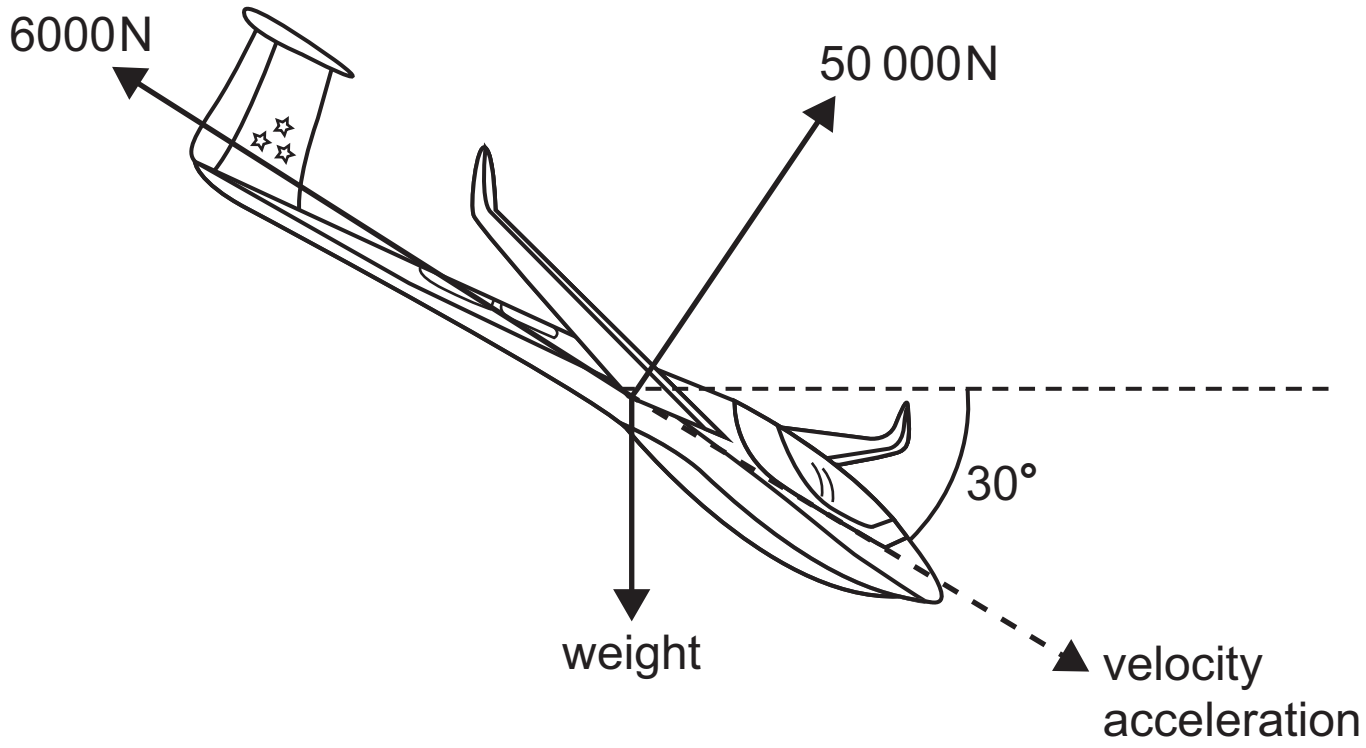
Fig. 4.1



(a) Explain how Newton's first law applies in this situation. [2 marks]

(b) The pilot then increases the angle of the glider's dive, causing it to move with a constant acceleration.
The velocity and acceleration are now both in a direction of 30° to the horizontal. The lift on the glider from the wings is 50 000 N and is perpendicular to the direction of travel. The drag on the glider is 6000 N. The forces acting on the glider are shown in **Fig. 4.2**.

Fig. 4.2



(i) Calculate the mass of the glider. [4 marks]

Mass = _____ kg

(ii) Calculate the acceleration of the glider. [5 marks]

Acceleration = _____ m s^{-2}

5 **(a)** State the principle of moments. [3 marks]

_____

_____

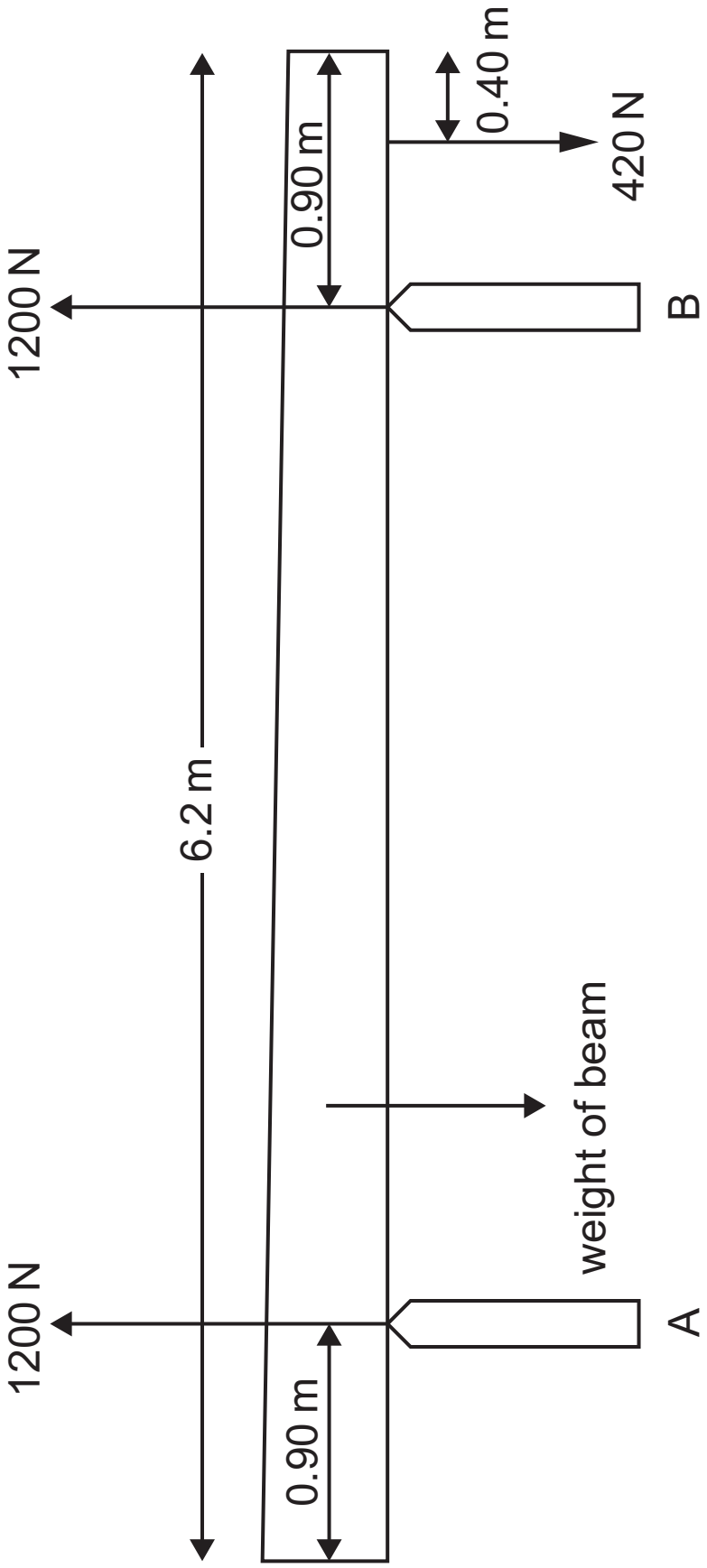
_____

_____

(b) A non-uniform beam of length 6.2 m rests on two supports, A and B, a distance of 0.90 m from each end as shown in **Fig. 5.1** opposite. A weight of 420 N is placed 0.40 m from the end of the beam.

(i) Given that the reaction at each of the supports is 1200 N, show that the weight of the beam is 1980 N. [2 marks]

Fig. 5.1



(ii) Calculate the distance of the centre of gravity of the beam from the support A. [4 marks]

Distance = _____ m

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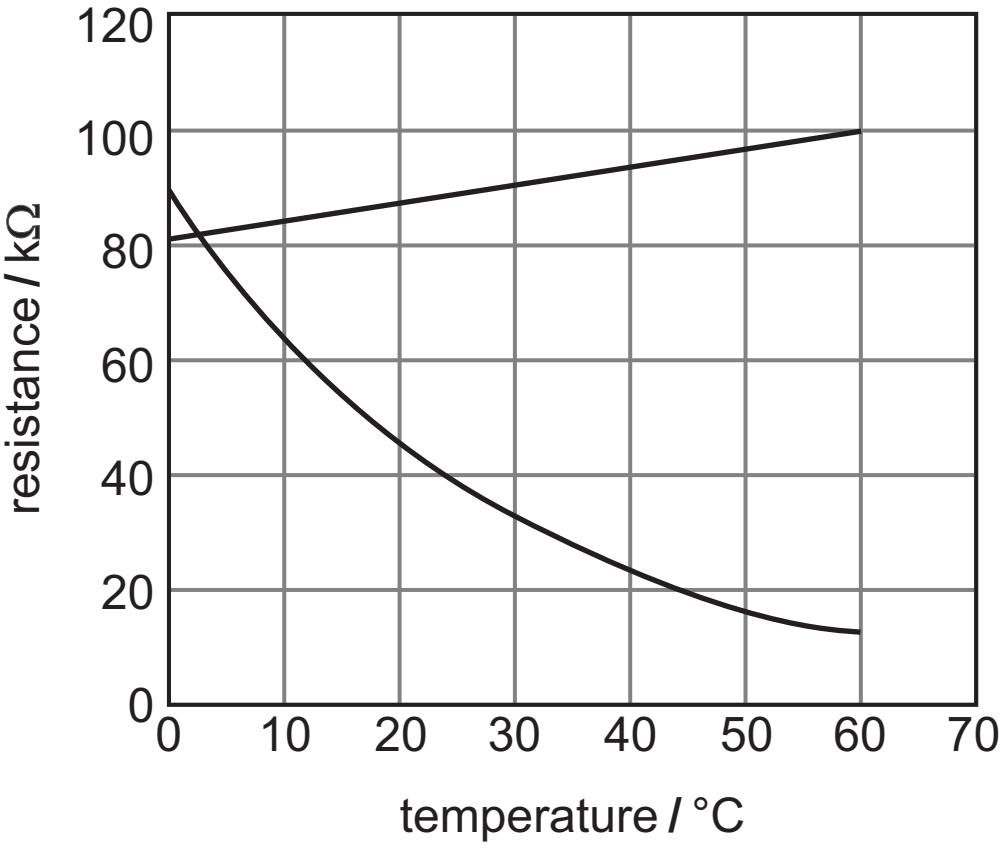
(Questions continue overleaf)

6 **(a)** The graph in **Fig. 6.1** shows how the resistance of a resistor and a negative temperature coefficient (n.t.c.) thermistor change with temperature.

Fig. 6.1



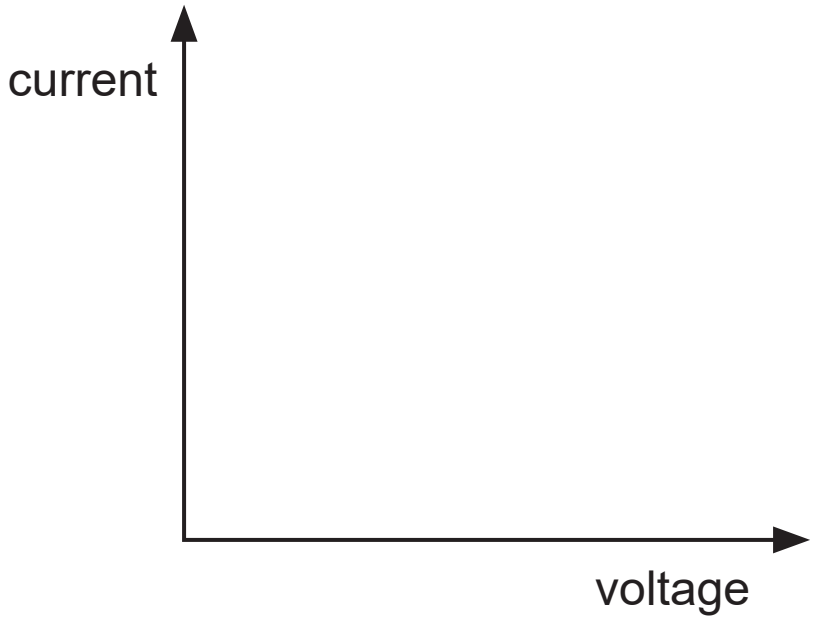
(i) With reference to **Fig. 6.1** compare how the resistance of the two components changes as the temperature is increased. Explain the causes of this behaviour in both components. [6 marks]

Resistor:

n.t.c. thermistor:

(ii) Sketch the current–voltage characteristic of the n.t.c. thermistor on **Fig. 6.2**. [1 mark]

Fig. 6.2

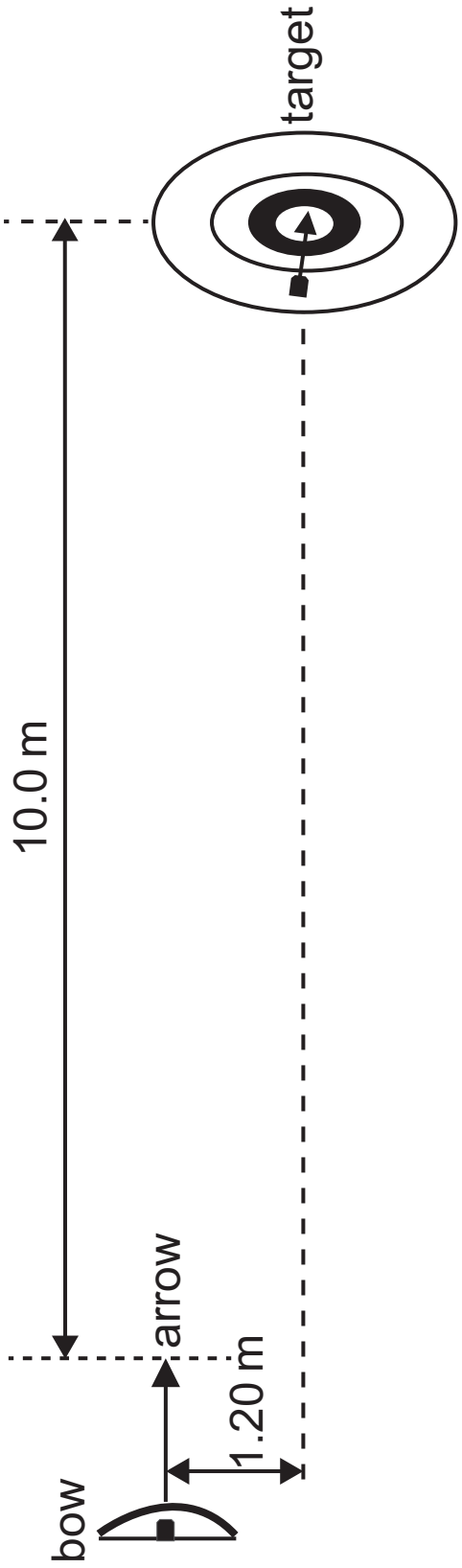


(iii) Explain how the current-voltage characteristic you have sketched in **Fig. 6.2** is related to the graph in **Fig. 6.1**. [3 marks]

(b) In terms of a temperature change, describe how a new alloy could be tested to determine if it is a superconducting material. [2 marks]

7 An archer fired an arrow from his bow. The arrow was released with a horizontal velocity and hit the bullseye of a target 10.0 m away from the archer, 1.20 m below the point that the arrow was released from, as shown in **Fig. 7.1**.

Fig. 7.1



(i) By considering the vertical motion of the arrow, calculate the time taken for the arrow to reach the target.
[4 marks]

Time = _____ s

(ii) Calculate the horizontal velocity of the arrow when it was released. [3 marks]

Horizontal velocity = _____ m s^{-1}

(iii) Calculate the magnitude of the velocity when the arrow hit the target. [5 marks]

Magnitude of velocity = _____ m s^{-1}

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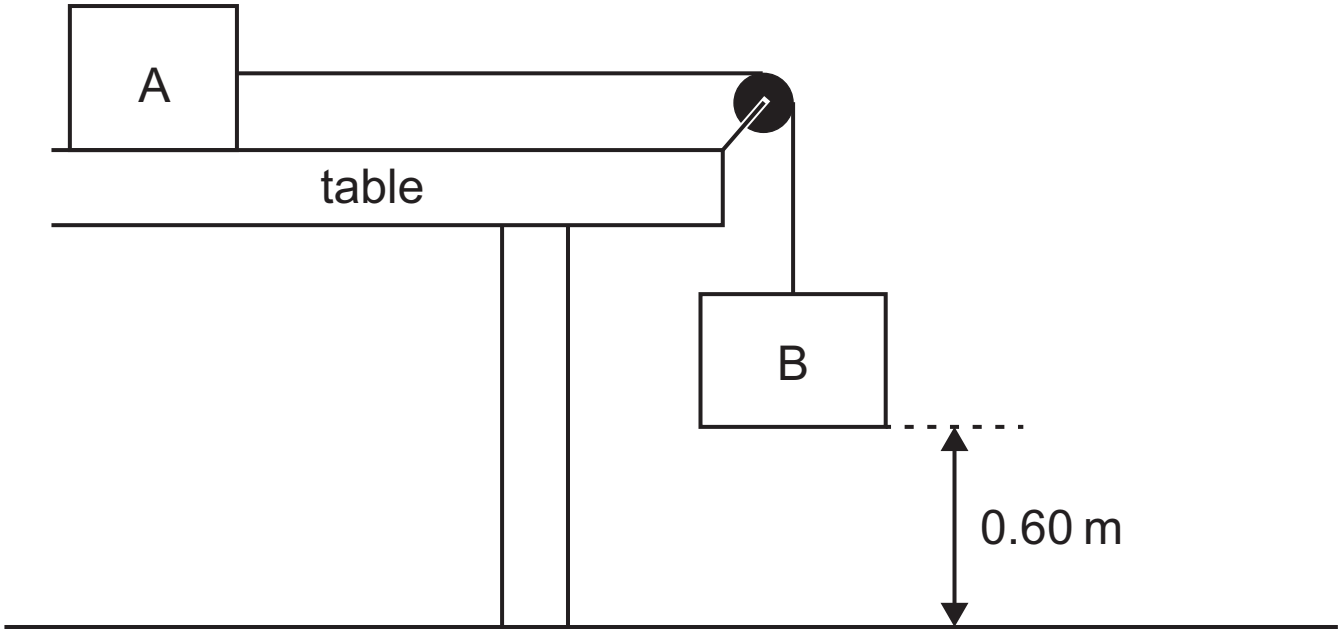
(Questions continue overleaf)

8 Two blocks, A and B, are connected by a string placed over a pulley as shown in **Fig. 8.1**.

Fig. 8.1



Block A has a mass of 4.3 kg and is placed on a table with a rough surface. Block B has a mass of 3.1 kg and is initially held a height of 0.60 m above the ground. When block B is released both blocks accelerate.

(a) Calculate the loss in gravitational potential energy GPE of block B when it falls to the ground. [3 marks]

GPE = _____ J

(b) Blocks A and B are travelling at a speed of 1.4 m s^{-1} when block B hits the ground.

(i) Calculate the energy lost due to friction between block A and the table when block B falls to the ground. [5 marks]

Energy lost = _____ J

(ii) Calculate the average value of the force of friction on block A as it moves across the table. [3 marks]

Friction = _____ N

9 **(a)** A neon atom of mass 3.4×10^{-26} kg moves at a speed of 720 m s^{-1} directly towards a stationary helium atom of mass 6.7×10^{-27} kg. After the collision the neon and helium atoms move in the same direction but at different speeds.

(i) Calculate the momentum of the neon atom before the collision and state the unit. [4 marks]

Momentum = _____

Unit = _____

(ii) State the principle of the conservation of momentum. [2 marks]

_____

_____

_____

_____

(b) The speed of the helium atom after the collision is 1203 m s^{-1}.

(i) Calculate the speed of the neon atom after the collision. [4 marks]

Speed = _____ m s^{-1}

(ii) Describe how you would determine whether the collision is elastic or inelastic. [2 marks]

_____

_____

_____

_____

This is the end of the question paper

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total Marks	

Examiner Number

Rewarding Learning

ADVANCED SUBSIDIARY
General Certificate of Education

Physics

Assessment Units AS 1 and AS 2

[SPH11/SPH21]

DATA AND FORMULAE SHEET

Data and Formulae Sheet for AS 1 and AS 2

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV $= 1.60 \times 10^{-19}$ J
the Hubble constant	$H_0 \approx 2.4 \times 10^{-18}$ s^{-1}

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force

Waves

two-source interference	$\lambda = \frac{ay}{d}$
diffraction grating	$d \sin\theta = n\lambda$

Light

lens equation $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

Electricity

terminal potential difference $V = E - Ir$ (e.m.f., E; Internal Resistance, r)

potential divider $V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$

Particles and photons

Einstein's equation $\frac{1}{2} m v_{max}^2 = hf - hf_0$

de Broglie equation $\lambda = \frac{h}{p}$

Astronomy

red shift $z = \frac{\Delta\lambda}{\lambda}$

recession speed $z = \frac{v}{c}$

Hubble's law $v = H_0 d$