Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

Leave blank

General Certificate of Education
June 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1

Friday 6 June 2003 Afternoon Session

In addition to this paper you will require:
- a calculator;
- a ruler;
- a protractor.

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B** in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- All working must be shown, otherwise you may lose marks.
- A *Formulae Sheet* is provided on page 3. Detach this perforated page at the start of the examination.

Information
- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- Marks are awarded for units in addition to correct numerical answers, and for the use of appropriate numbers of significant figures.
- You are expected to use a calculator where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

Advice
- You are advised to spend about 30 minutes on **Section A** and about 1 hour on **Section B**.

For Examiner's Use			
Number	Mark	Number	Mark
A			
6			
7			
8			
9			
10			
11			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

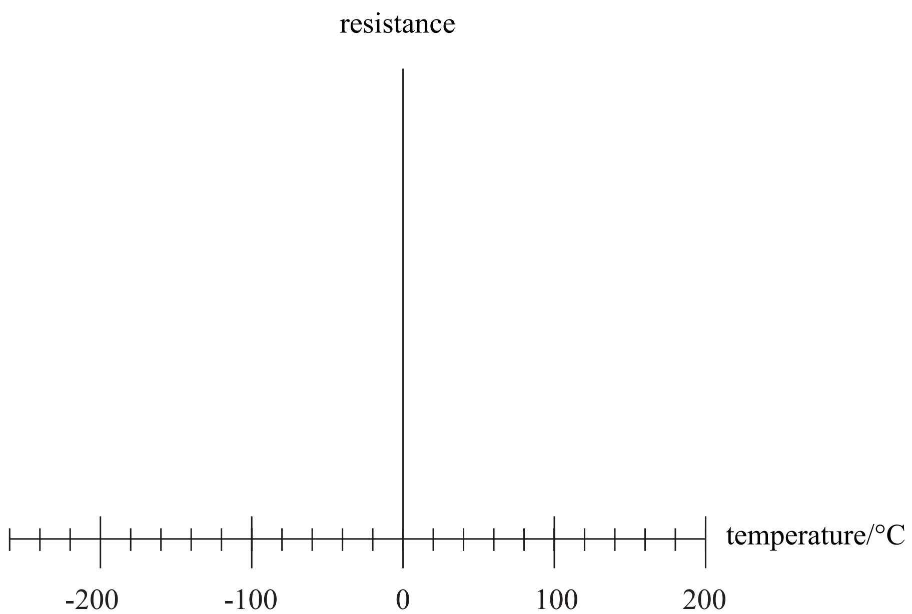
LEAVE MARGIN BLANK

SECTION A

Answer **all** questions in this section.

Total for this section: ***25 marks***

1 Sketch on the axes below the variation of resistance with temperature for a metal that becomes superconducting at -120 °C.



(2 marks)

2 **Figure 1** shows three children **A**, **B** and **C** sitting on a balanced, horizontal see-saw of mass 35 kg. The centre of mass of the see-saw is vertically above the pivot.
A has a weight of 650 N and **B** has a weight of 550 N. **A** sits 1.2 m from the pivot and **B** sits 0.5 m from the pivot of the see-saw.

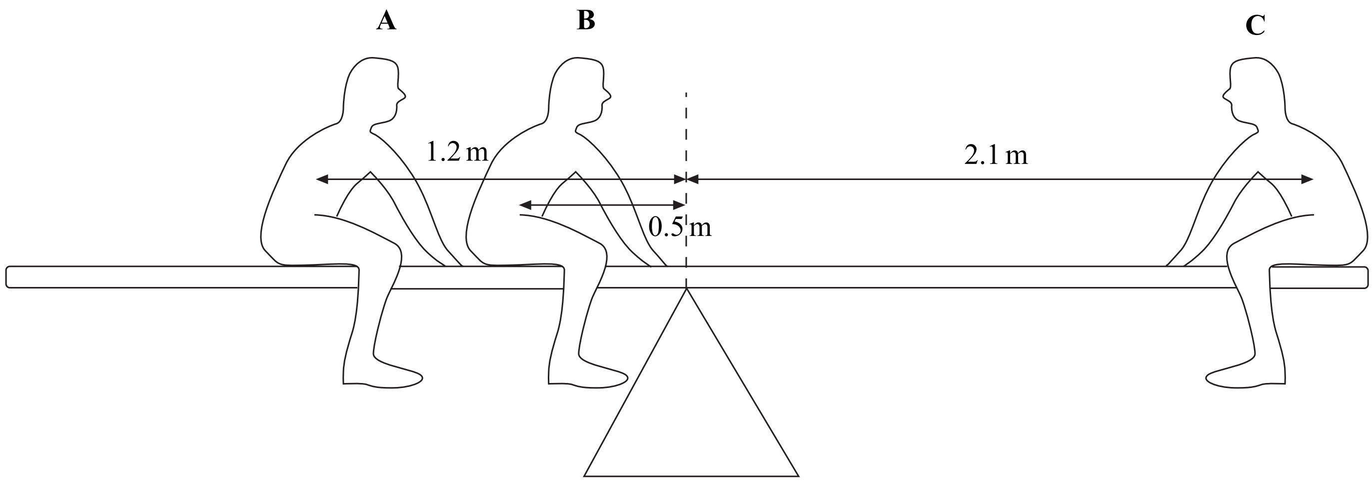


Figure 1

Detach this perforated page at the start of the examination.

Foundation Physics Mechanics Formulae

moment of force $= Fd$

$$v = u + at$$

$$s = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$s = \tfrac{1}{2}(u + v)t$$

for a spring, $F = k\Delta l$

energy stored in a spring $= \tfrac{1}{2}F\Delta l = \tfrac{1}{2}k(\Delta l)^2$

$$T = \frac{1}{f}$$

Foundation Physics Electricity Formulae

$$I = nAvq$$

terminal p.d. $= E - Ir$

in series circuit, $R = R_1 + R_2 + R_3 + ...$

in parallel circuit, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$

output voltage across $R_1 = \left(\frac{R_1}{R_1 + R_2}\right) \times$ input voltage

Waves and Nuclear Physics Formulae

fringe spacing $= \frac{\lambda D}{d}$

single slit diffraction minimum $\sin\theta = \frac{\lambda}{b}$

diffraction grating $n\lambda = d\sin\theta$

Doppler shift $\frac{\Delta f}{f} = \frac{v}{c}$ for $v << c$

Hubble law $v = Hd$

radioactive decay $A = \lambda N$

Properties of Quarks

Type of quark	Charge	Baryon number
up u	$+\frac{2}{3}e$	$+\frac{1}{3}$
down d	$-\frac{1}{3}e$	$+\frac{1}{3}$
$\overline{\text{u}}$	$-\frac{2}{3}e$	$-\frac{1}{3}$
$\overline{\text{d}}$	$+\frac{1}{3}e$	$-\frac{1}{3}$

Lepton Numbers

Particle	Lepton number L		
	L_e	L_μ	L_τ
e^-	1		
e^+	−1		
ν_e	1		
$\overline{\nu}_e$	−1		
μ^-		1	
μ^+		−1	
ν_μ		1	
$\overline{\nu}_\mu$		−1	
τ^-			1
τ^+			−1
ν_τ			1
$\overline{\nu}_\tau$			−1

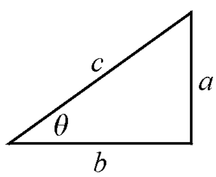
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

area of a circle $= \pi r^2$

surface area of sphere $= 4\pi r^2$

volume of sphere $= \tfrac{4}{3}\pi r^3$



$$\sin\theta = \frac{a}{c}$$

$$\cos\theta = \frac{b}{c}$$

$$\tan\theta = \frac{a}{b}$$

$$c^2 = a^2 + b^2$$

Turn over ▶

(a) **C** sits 2.1 m from the pivot.

By taking moments about a suitable point, calculate the weight of **C**.

Weight of **C** ....
(3 marks)

(b) Calculate the force on the pivot of the see-saw.

gravitational field strength of Earth, $g = 9.8\,\mathrm{N\,kg^{-1}}$

Force on pivot ....
(2 marks)

TURN OVER FOR THE NEXT QUESTION

3 **Figure 2** shows a power supply connected to a car battery in order to charge the battery. The terminals of the same polarity are connected together to achieve this.

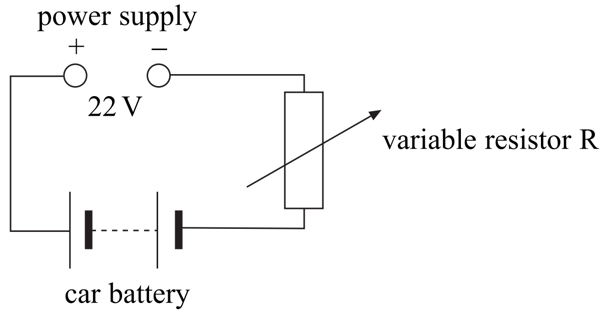


Figure 2

(a) The power supply has an emf of 22 V and internal resistance 0.75 Ω. When charging begins, the car battery has an emf of 10 V and internal resistance of 0.15 Ω. They are connected together via a variable resistor R.

(i) Calculate the total emf of the circuit when charging begins.

Total emf of circuit ....
(1 mark)

(ii) The resistor R is adjusted to give an initial charging current of 0.25A. Calculate the value of R.

Resistance of R ....
(3 marks)

(b) The car battery takes 8.0 hours to charge. Calculate the charge that flows through it in this time assuming that the current remains at 0.25 A.

Charge ....
(1 mark)

LEAVE MARGIN BLANK

4 **Figure 3** shows a simple pendulum that consists of a large mass at the end of a long string. **A**, **B** and **C** are positions of the pendulum as it oscillates in the air. **A** and **C** are the extreme positions of the motion and **B** is the centre of the motion.

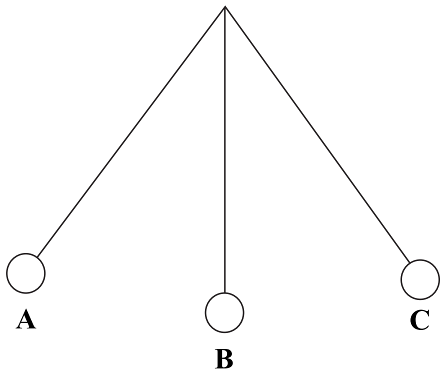


Figure 3

(a) State clearly in terms of the positions shown on the diagram what is meant by the *period of oscillation* of the pendulum.

....

....

....

....
(2 marks)

(b) **Figure 3** shows positions of the bob during an oscillation. State at which position the damping is greatest. Explain why the damping is greatest in the position you have quoted.

....

....

....

....
(3 marks)

5 **Figure 4** shows a potential divider consisting of a resistor in series with a light dependent resistor. The voltmeter connected in parallel with the light dependent resistor has an infinite resistance. The battery has an emf of 16 V with a negligible internal resistance.

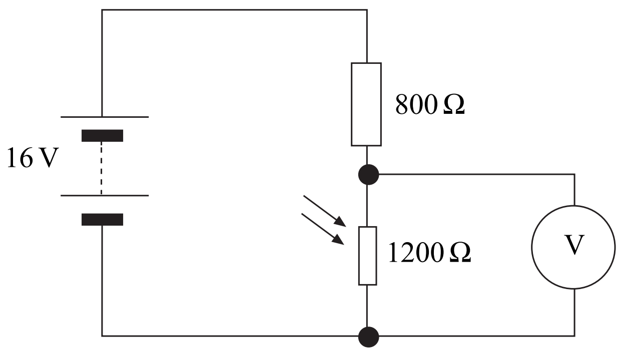


Figure 4

(a) Calculate the reading on the voltmeter when the light dependent resistor has a resistance of 1200 Ω.

Voltmeter reading ....

(2 marks)

(b) The light intensity in the room is increased. State and explain what happens to the resistance of the LDR and the reading on the voltmeter.

....

....

....

....

....

(3 marks)

LEAVE MARGIN BLANK

6 (a) Name the charge carriers in a metal wire.

....

(1 mark)

(b) The equation $I = nAvq$ is used to calculate the current I in a conductor.
State what the symbols n and v represent in this equation.

n ....

....

....

v ....

....

....

(2 marks)

25

TURN OVER FOR SECTION B

LEAVE MARGIN BLANK

SECTION B

Answer **all** questions in the spaces provided.

Total for this question: ***8 marks***

7 (a) State Ohm's law.

....

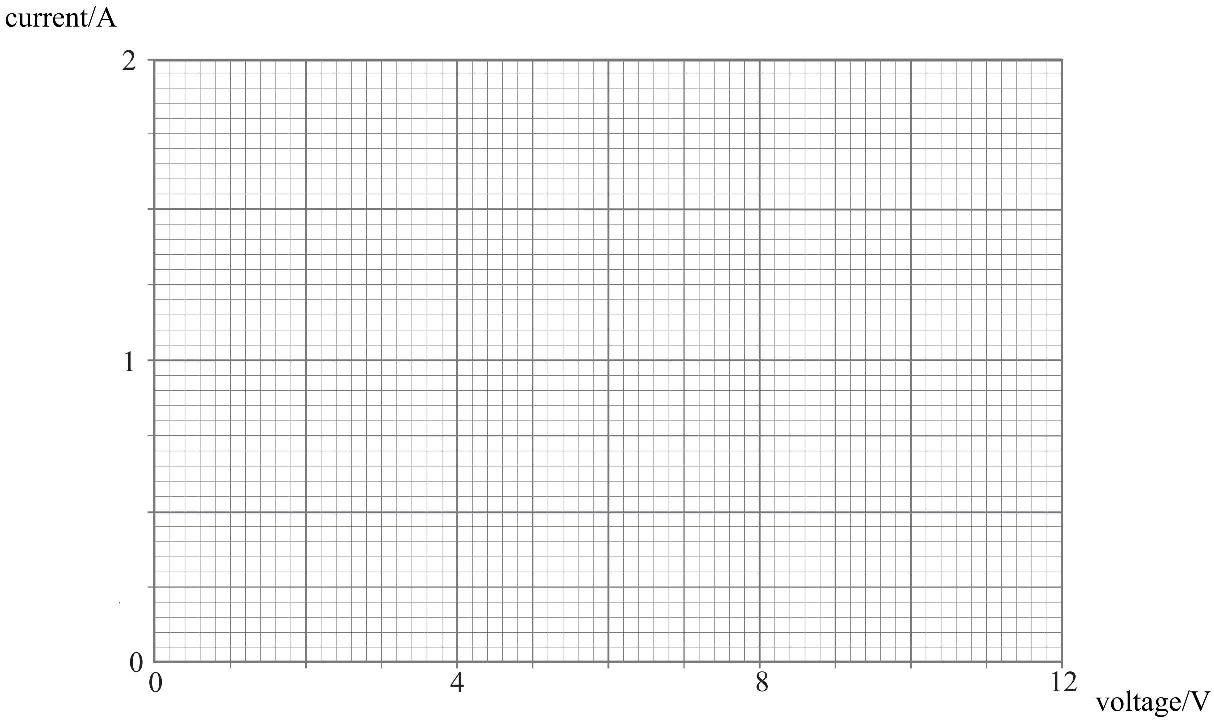
....

....

(2 marks)

(b) A filament lamp labelled '12 V, 2.0 A' has a constant resistance of 2.0 Ω for electrical currents up to 0.50 A.

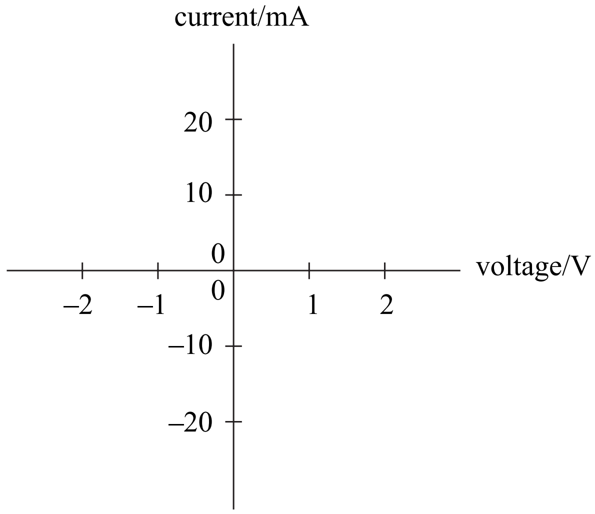
Sketch on the axes below the current–voltage graph for this lamp over the range of voltages shown. Show clearly any calculations you made in order to answer the question.



(3 marks)

LEAVE MARGIN BLANK

(c) Sketch on the axes below the current-voltage characteristic for a semi-conductor diode.



(3 marks)

—
8

TURN OVER FOR THE NEXT QUESTION

LEAVE MARGIN BLANK

Total for this question: ***17 marks***

8 **Figure 5** shows a graph of velocity against time for an aircraft of mass 2.8×10^4 kg landing on a stationary aircraft-carrier.

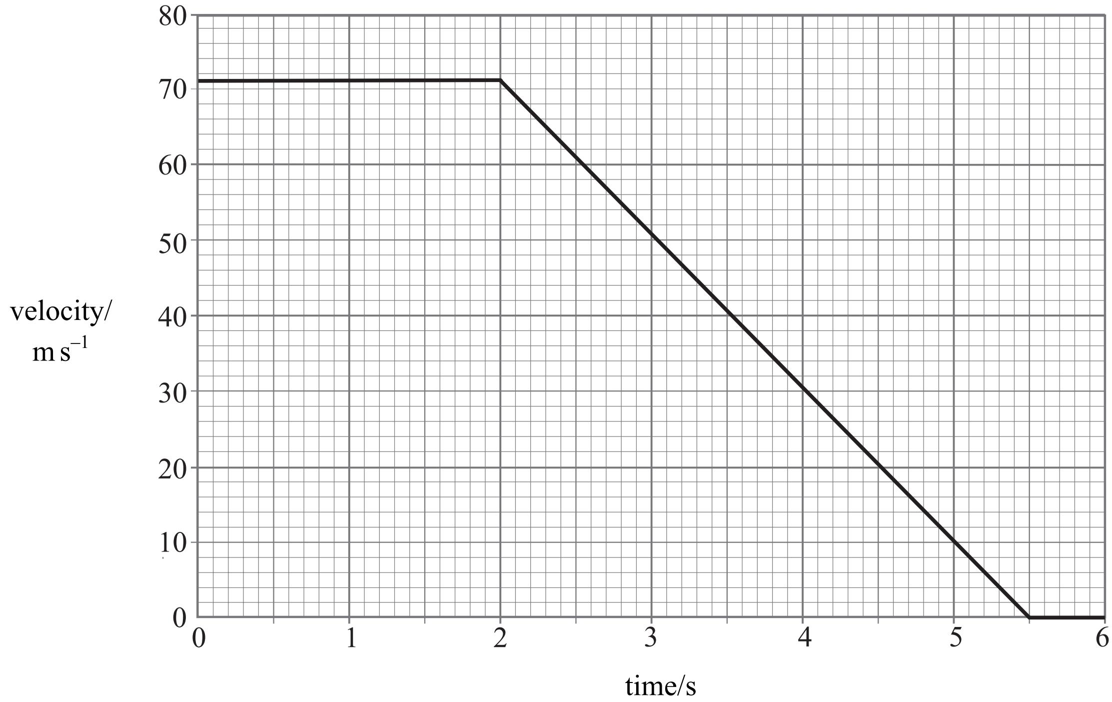


Figure 5

(a) (i) Calculate the initial kinetic energy of the aircraft.

Initial kinetic energy ....

(2 marks)

(ii) Show that the deceleration of the aircraft is about $20\,\mathrm{m\,s^{-2}}$.

(3 marks)

(iii) Calculate the decelerating force acting on the aircraft.

Force ....

(2 marks)

LEAVE MARGIN BLANK

(b) (i) The aircraft is brought to rest on the deck by an arrester wire system. A hook on the underside of the aircraft engages with a wire that is part of the system used to decelerate the aircraft. A constant deceleration of the aircraft is maintained by wire braking systems at A and B.

Figure 6 shows a position of the wire during the deceleration.

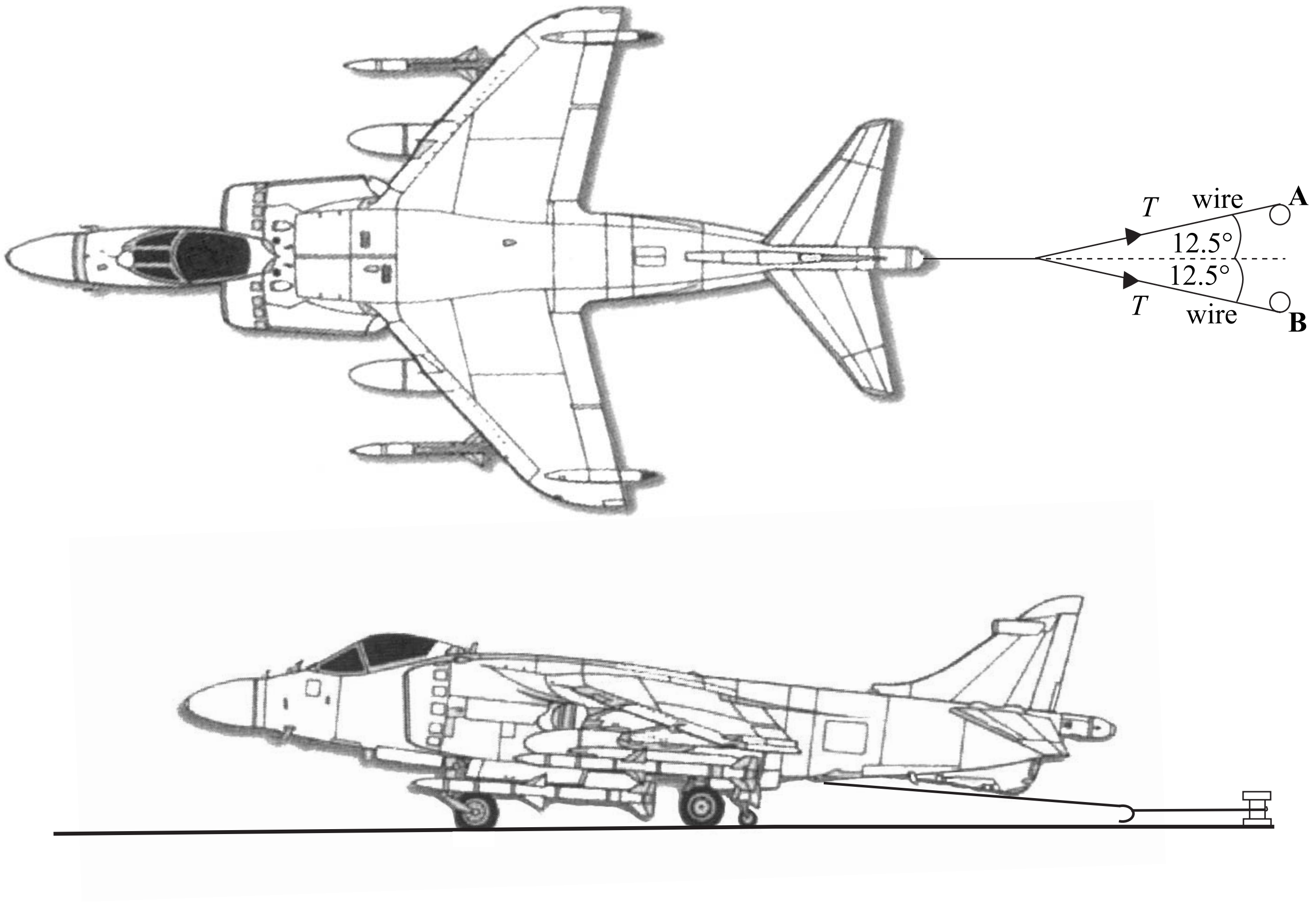


Figure 6

Use your answer to part (a) (iii) to show that the tension T in the arrester wire at the position shown in **Figure 6** is about 290 kN.

(3 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

Turn over ▸

(ii) During manufacture the arrester wire is tested by being extended by 0.15 m. At this extension the tension in the wire is 290 kN. Calculate the energy stored in the wire.

Energy stored in the wire ....

(2 marks)

(c) A steam catapult is used to enable aircraft to take off from the ship. The catapult accelerates the aircraft from rest to its take-off speed of 71 m s^{-1} in a distance of 62 m.

Calculate the acceleration of the aircraft.

Acceleration ....

(2 marks)

(d) In level flight, the pilot sets the course to be $80\,\mathrm{m\,s^{-1}}$ due north. There is a wind blowing from east to west at $20\,\mathrm{m\,s^{-1}}$. Find, by scale drawing or otherwise, the resultant velocity of the aircraft.

Velocity of aircraft: magnitude ....

direction ....

(3 marks)

17

Turn over

LEAVE MARGIN BLANK

Total for this question: ***6 marks***

9 Describe an experiment to measure the value of g (the acceleration due to gravity) using a free-fall method.

Your account should include a labelled diagram in the space provided, a clear description of the method and details of any analysis you would carry out in order to calculate your value of g.

Two of the 6 marks in this question are available for the quality of your written communication.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(6 marks)

6

Total for this question: *12 marks*

10 **Figure 7** shows part of a miniature electronic circuit with two small resistors connected in parallel. The material from which each resistor is made has a resistivity of $1.3 \times 10^5\,\Omega\,\text{m}$ and both resistors have dimensions of 12 mm by 2.5 mm by 1.5 mm.

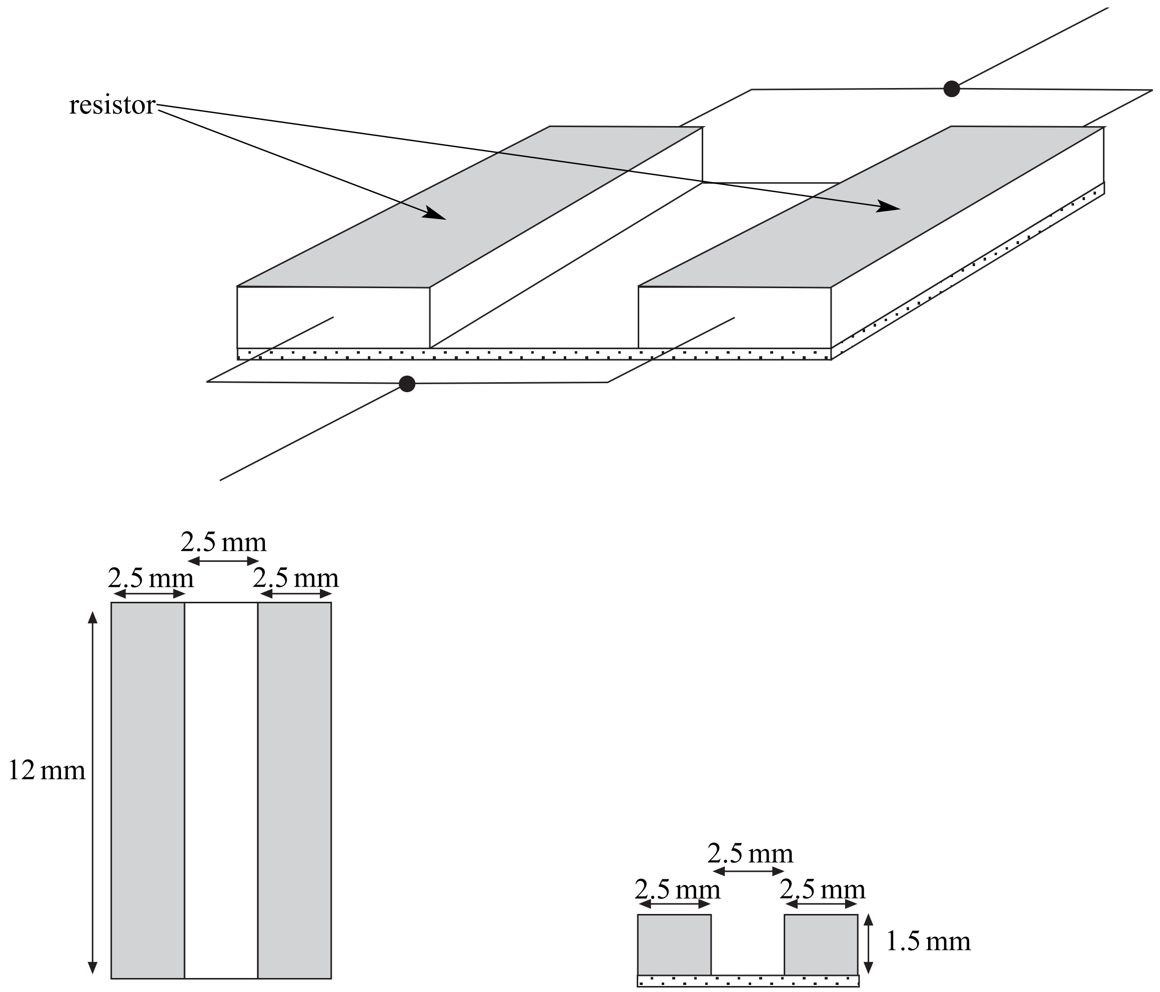


Figure 7

(a) (i) Show that the resistance of **one** of these resistors is about 400 MΩ.

(3 marks)

(ii) The potential difference across the resistors is 5.0 V.

Calculate the power dissipated in **one** resistor.

(2 marks)

(iii) The heat energy from the resistors is lost through a base of size 7.5 mm by 12 mm.

Calculate the total heat energy lost through this base every second.

Total heat energy lost per second ....

(1 mark)

(iv) Calculate the total rate at which heat energy is dissipated per unit area of the base.

Total heat energy lost per unit area every second ....

(2 marks)

(b) The designer reduces the size of the circuit including the base by making every dimension smaller by a factor of 10. The potential difference across the resistors is unchanged.

(i) Show that this reduction in dimensions results in the resistance of each resistor increasing by a factor of 10.

(2 marks)

(ii) Explain why this change results in an increase in the temperature of the components in the circuit.

....

....

....

....

....

(2 marks)

12

Turn over

LEAVE MARGIN BLANK

Total for this question: ***7 marks***

11 Geothermal resources are used in some parts of the world for the generation of electrical energy.

Explain what is meant by geothermal energy, describe its origins, and outline briefly the process of conversion from geothermal to electrical energy. State **one** advantage and **one** disadvantage of geothermal energy.

Two of the 7 marks in this question are available for the quality of your written communication.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(7 marks)

7

END OF QUESTIONS