Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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General Certificate of Education
June 2005
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1 Foundation Physics

Friday 10 June 2005 Morning 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			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

SECTION A

Answer **all** questions in this section.

There are **25** marks in this section.

1 **Figure 1** shows an arrow about to be released from a bow.

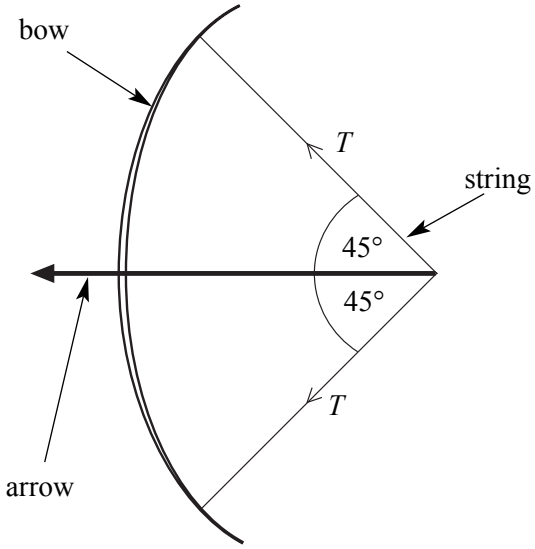


Figure 1

When the arrow is released the initial forward force on it is 25 N.

(a) Find, by means of a calculation or scale drawing, the initial tension, *T*, in the string of the bow.

tension .....

(2 marks)

Detach this perforated page at the start of the examination.

Foundation Physics Mechanics Formulae

moment of force $= Fd$

$v = u + at$

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

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

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

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

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

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

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		
υ_e	1		
$\overline{\upsilon}_e$	−1		
μ^-		1	
μ^+		−1	
υ_μ		1	
$\overline{\upsilon}_\mu$		−1	
τ^-			1
τ^+			−1
υ_τ			1
$\overline{\upsilon}_\tau$			−1

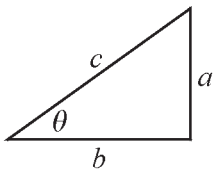
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

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(b) The graph in **Figure 2** shows the variation of F with d, where F is the force on the arrow and d is the distance the string is pulled back.

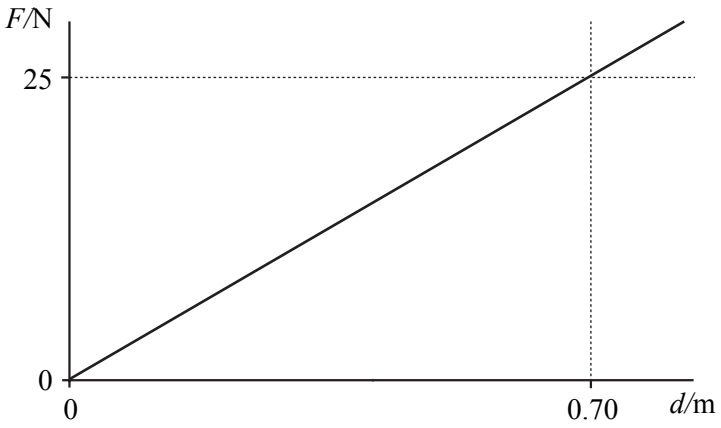


Figure 2

Calculate the initial energy stored in the bow as the arrow is about to be released.

energy .....

(2 marks)

(c) Calculate the energy stored in the bow when the string is pulled back a distance of 0.60 m.

energy .....

(2 marks)

2 A student set up the apparatus shown in **Figure 3** to demonstrate the principle of moments.

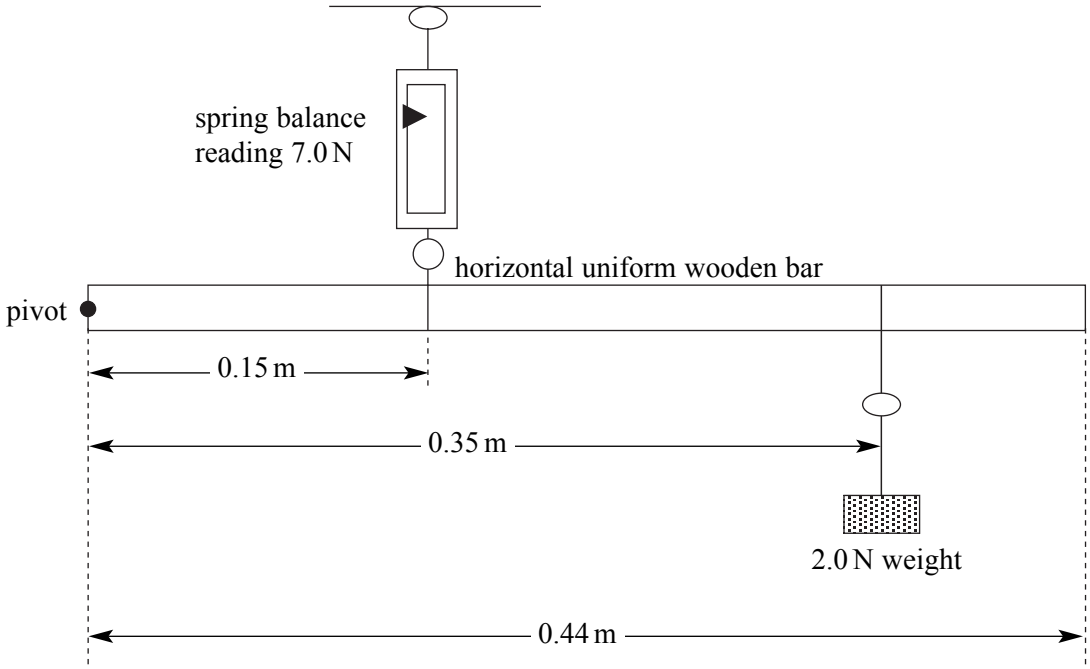


Figure 3

(a) Using the values on **Figure 3** calculate:

(i) the magnitude of the moment about the pivot due to the tension of the spring in the spring balance;

moment due to spring tension .....

(1 mark)

(ii) the magnitude of the moment about the pivot produced by the 2.0 N weight;

moment due to 2.0 N weight .....

(1 mark)

(iii) the weight of the wooden bar.

weight .....

(1 mark)

(b) (i) Calculate the magnitude of the force exerted on the bar by the pivot.

magnitude of force .....
(1 mark)

(ii) State the direction of the force on the pivot.

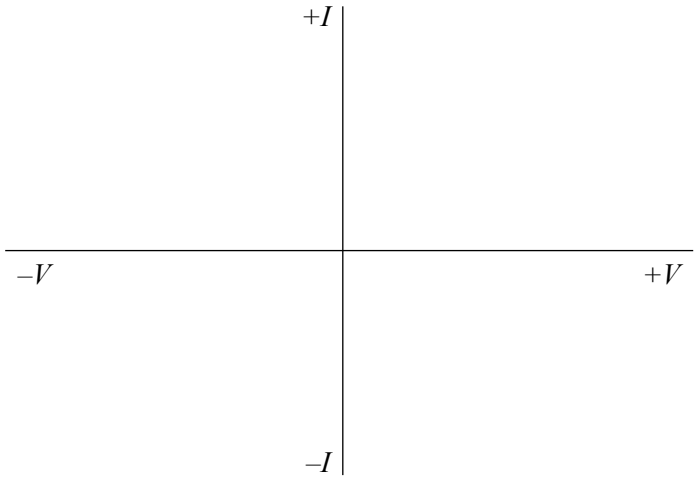
.....
(1 mark)

3 A resistance wire has a diameter 2.0×10^{-4} m and a resistivity of $4.5 \times 10^{-7}\,\Omega$ m.

(a) Calculate the length of this wire that has a resistance of $25\,\Omega$.

length of wire .....
(3 marks)

(b) The resistivity of the wire increases as the current increases. Sketch, on the axes below, the variation of current, I, with potential difference, V, across the wire for both positive and negative potential differences.



(2 marks)

Turn over ▶

4 **Figure 4** shows an EHT supply of emf 5000 V and internal resistance 2 MΩ.

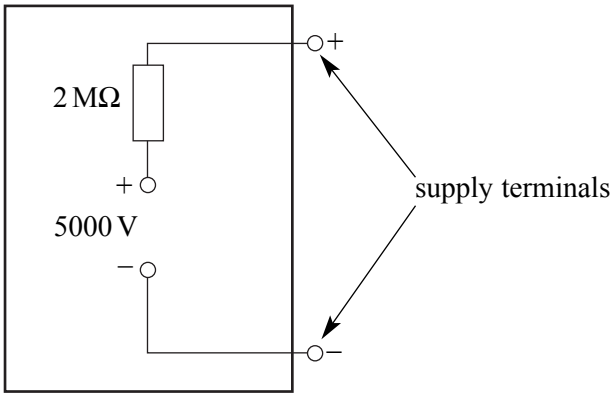


Figure 4

(a) A lead of negligible resistance is connected between the supply terminals producing a short circuit.

(i) State the magnitude of the terminal potential difference between the supply terminals.

(1 mark)

(ii) Calculate the current in the circuit.

current .....

(1 mark)

(iii) Calculate the minimum power rating for the resistor used to provide the internal resistance.

minimum power rating .....

(2 marks)

(b) Explain briefly why the supply is designed with such a high internal resistance.

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(1 mark)

5 Scientists have suggested that carbon dioxide emissions produced by power stations in the European Union could be reduced considerably if high temperature superconductors were used instead of ordinary conductors to improve the efficiency of power plants.

(a) Explain what is meant by a superconductor.

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(2 marks)

(b) Explain why the use of superconductors would improve the efficiency of power stations and hence reduce carbon dioxide emissions.

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(2 marks)

25

TURN OVER FOR THE NEXT SECTION

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SECTION B

Answer **all** questions in this section.

Total for this question: *15 marks*

6 **Figure 5** shows how the velocity of a falling object of mass 2.0 kg varied with time from the instant it was released from a stationary hot-air balloon.

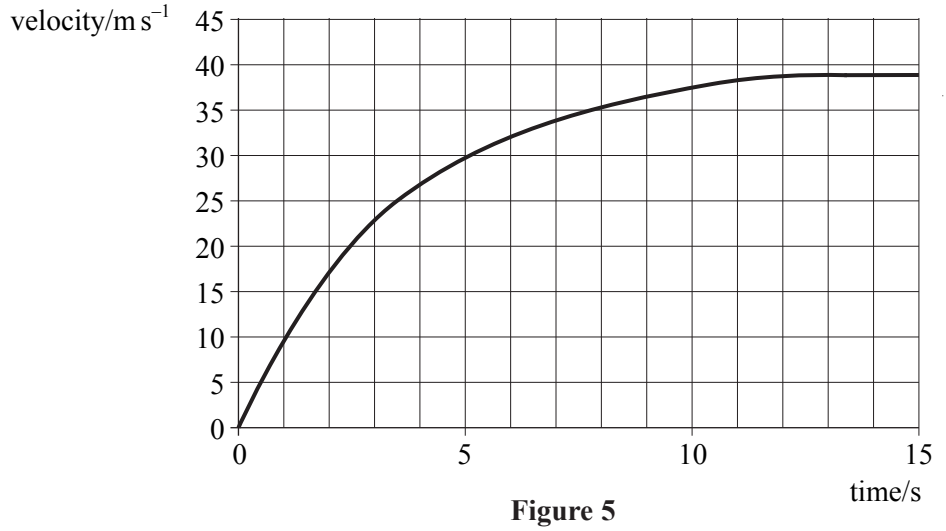


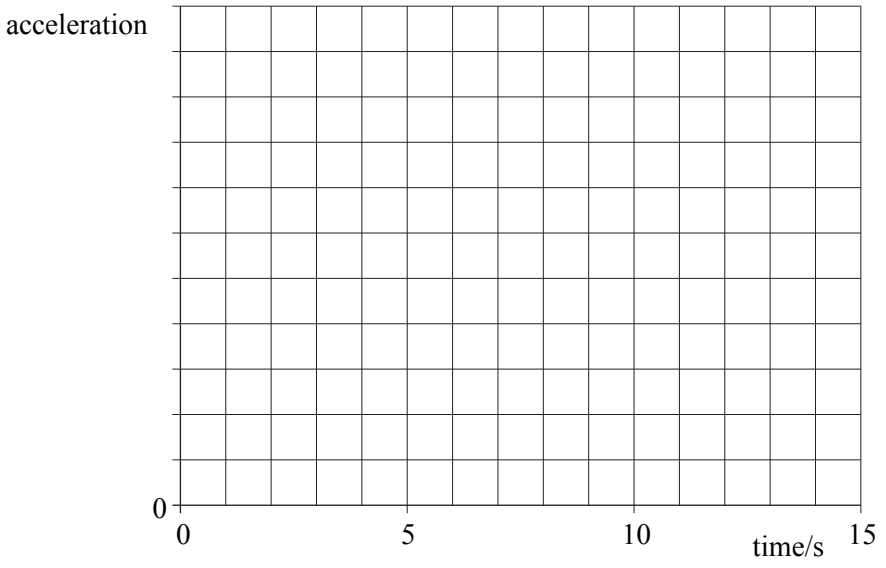
Figure 5

(a) (i) Showing your working clearly, determine the acceleration of the object 5.0 s after it was released.

acceleration .....

(2 marks)

(ii) Sketch, on the axes below, a graph showing how the acceleration varied with time over the 15 s time interval. Include a suitable scale on the acceleration axis.



(2 marks)

(b) Show that the distance fallen in the first 15 s was approximately 450 m.

(3 marks)

(c) (i) Calculate the change in gravitational potential energy, ΔE_p, of the 2.0 kg mass that occurred during the first 15 s.

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

ΔE_p .....

(1 mark)

(ii) Calculate the corresponding change in the kinetic energy, ΔE_k, of the 2.0 kg mass.

ΔE_k .....

(2 marks)

(iii) Explain why ΔE_p was different from ΔE_k.

Two of the 5 marks for this question are available for the quality of your written communication.

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(5 marks)

15

Total for this question: *9 marks*

7 **Figure 6** shows a cable car being pulled up a 35° slope of length 120 m.

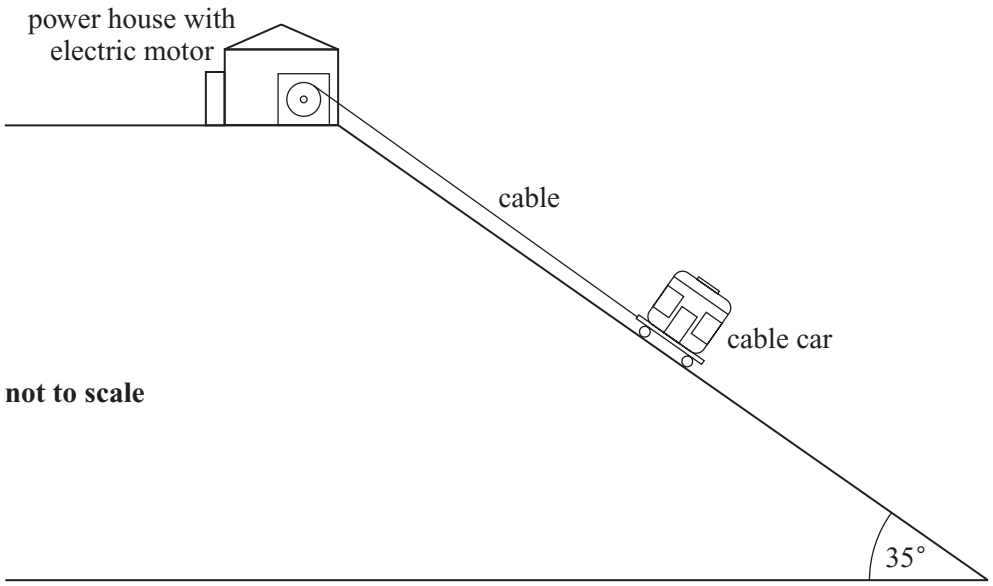

Figure 6

The cable car has a weight of 1.5×10^4 N. The total frictional force resisting motion is 3.0×10^3 N.

the gravitational field strength, $g = 9.8\,\text{N kg}^{-1}$

(a) (i) Show that the component of the weight of the cable car parallel to the slope is 8600 N.

(1 mark)

(ii) Calculate the tension in the cable when the cable car is moving at a constant speed up the slope.

tension .....

(1 mark)

(b) The cable snaps when the cable car is at rest at the top of the slope. The frictional force remains constant at 3.0×10^3 N.

Calculate:

(i) the acceleration of the cable car down the slope;

acceleration .....

(3 marks)

(ii) the speed of the cable car when it reaches the bottom of the slope;

speed .....

(2 marks)

(iii) the time taken for the cable car to reach the bottom of the slope.

time taken .....

(2 marks)

9

Total for this question: ***10 marks***

8 The circuits in **Figure 7** and **Figure 8** both contain a 6.0 V supply of negligible internal resistance. Each circuit is designed to operate a 2.5 V, 0.25 A filament lamp **L**.

The lamp works normally in both circuits.

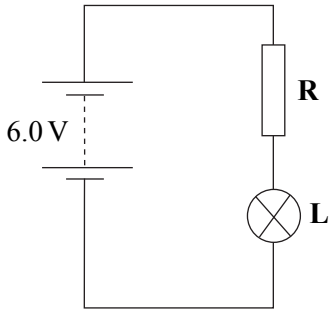

Figure 7

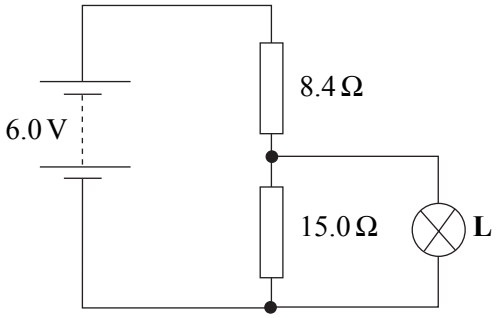

Figure 8

(a) Calculate the resistance of the filament lamp when working normally.

`

resistance .....

(2 marks)

(b) Calculate the resistance of the resistor that should be used for **R** in **Figure 7**.

resistance .....

(2 marks)

(c) Calculate the total resistance of the circuit in **Figure 8**.

total resistance .....

(3 marks)

(d) Explain which circuit dissipates the lower total power.

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(3 marks)

10

Total for this question: *6 marks*

9 The table shows the potential differences, ***V***, and the corresponding currents, ***I***, for laboratory experiments with three conductors.

	***V*/V**	***I*/A**
copper wire	0.2	4.0
copper sulphate solution	3.0	0.3
hydrogen gas	2000	1.0×10^{-3}

(a) For each conductor state the charge carriers involved.

copper wire .....

copper sulphate solution .....

hydrogen gas .....

(3 marks)

(b) The data suggest that the resistance of the conductors in each experiment are very different.

Explain in terms of charge carriers why this is the case.

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(3 marks)

6

Total for this question: ***10 marks***

10 **Figure 9** shows the general shape of the current-time graph during the two seconds after a 12 V filament lamp is switched on.

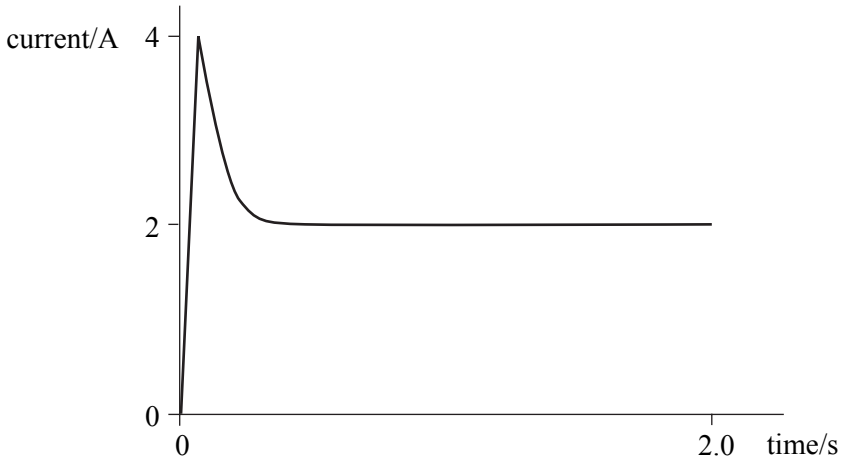

Figure 9

(a) A student wishes to perform an experiment to obtain this graph.

(i) Explain why sampling data using a sensor and a computer is a sensible option.

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(1 mark)

(ii) Suggest a suitable sampling rate for such an experiment, giving a reason for your answer.

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(2 marks)

(b) Explain why the current rises to a high value before falling to a steady value and why a filament is more likely to fail when being switched on than at other times.

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

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(7 marks)

10

END OF QUESTIONS

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