Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION A) PHA3/W
Unit 3 Current Electricity and Elastic Properties of Solids

Thursday 17 January 2002 Afternoon Session

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

Time allowed: 1 hour 15 minutes

Instructions
- Use a blue or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 50.
- Mark allocations are shown in brackets.
- The paper carries 25% of the total marks for Physics Advanced Subsidiary and carries $12\frac{1}{2}$% of the total marks for Physics Advanced.
- A *Data Sheet* is provided on pages 3 and 4. You may wish to detach this perforated sheet at the start of the examination.
- You are expected to use a calculator where appropriate.
- In questions requiring description and explanation 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.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Data Sheet

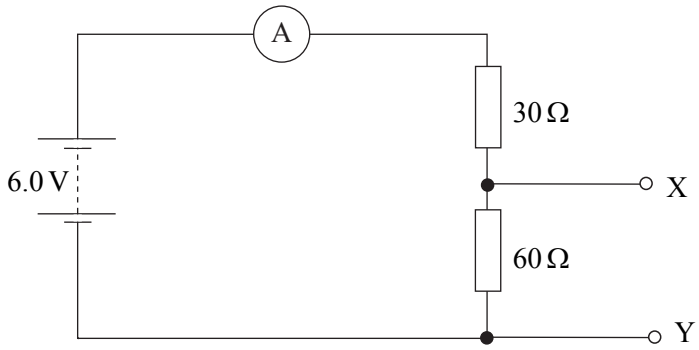
- A perforated *Data Sheet* is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

The data sheet will replace this page

The data sheet will replace this page

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

1 In the circuit shown, the battery has negligible internal resistance.



Calculate the current in the ammeter when

(a) the terminals X and Y are short-circuited i.e. connected together,

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(2 marks)

(b) the terminals X and Y are connected to a 30 Ω resistor.

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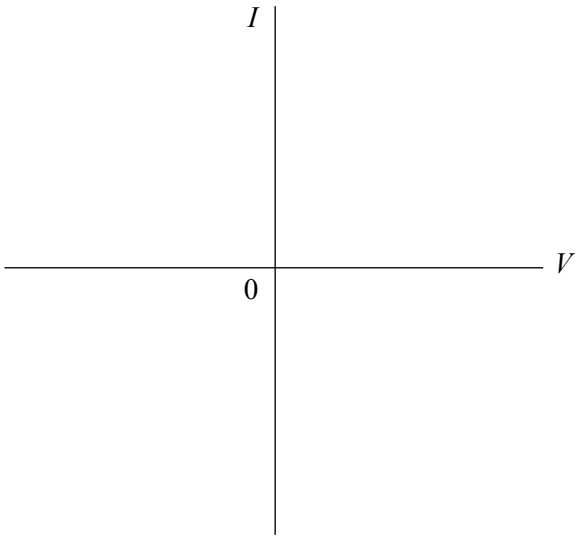
(4 marks)

6

2 (a) Using the axes below, sketch the characteristic of a silicon semiconductor diode for forward bias and reverse bias.

Indicate approximate values on the voltage axis.



(4 marks)

(b) Describe, with reference to the characteristic you have drawn, how the resistance of the diode changes with the voltage across the diode.

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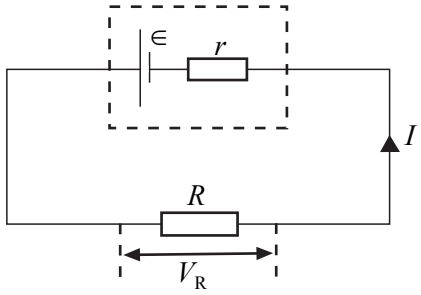
(3 marks)

7

3 (a) A cell of emf $\in$ and internal resistance r is connected in series to a resistor of resistance R as shown. A current I flows in the circuit.



(i) State an expression which gives $\in$ in terms of I, r and R.

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(ii) Hence show how V_R, the potential difference across the resistor, is related to $\in$, I and r.

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(2 marks)

(b) A lamp, rated at 30 W, is connected to a 120 V supply.

(i) Calculate the current in the lamp.

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(ii) If the resistor in part (a) is replaced by the lamp described in part (b), determine how many cells, each of emf 1.5 V and internal resistance 1.2 Ω, would have to be connected in series so that the lamp would operate at its proper power.

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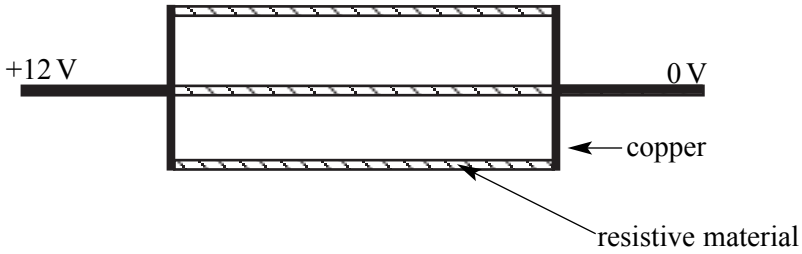
(5 marks)

7

4 A heating element, as used on the rear window of a car, consists of three strips of a resistive material, joined, as shown in the diagram, by strips of copper of negligible resistance. The voltage applied to the unit is 12 V and heat is generated at a rate of 40 W.



(a) (i) Calculate the total resistance of the element.

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(ii) Hence show that the resistance of a single strip is about 11 Ω.

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(5 marks)

(b) If each strip is 2.6 mm wide and 1.1 mm thick, determine the length of each strip.

resistivity of the resistive material = $4.0 \times 10^{-5}\,\Omega\,m$

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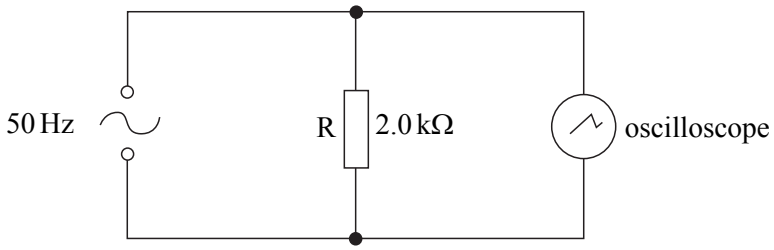
(3 marks)

8

5 A sinusoidal alternating current (ac) source of frequency 50 Hz, is connected to a resistor of resistance 2.0 kΩ and an oscilloscope, as shown. The rms current through the resistor is 5.0 mA.



(a) Calculate the peak value of the voltage across R.

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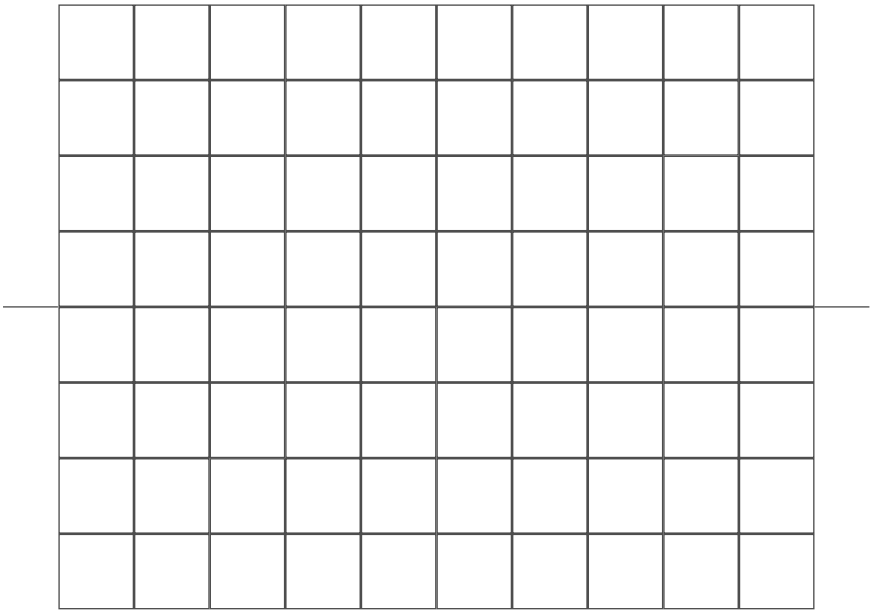
(2 marks)

(b) The grid represents the screen of the oscilloscope, each square being 1cm × 1cm. The time base of the oscilloscope is set at 5 ms cm^{-1} and the voltage sensitivity is 4.0 V cm^{-1}.



(i) Calculate the period of the ac signal.

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(ii) Draw, on the grid, the signal you would expect to see on the oscilloscope.

(4 marks)

6

6 (a) (i) Draw and label suitable apparatus required for measuring the Young modulus of a material in the form of a long wire.

(ii) List the measurements you would make when using the apparatus described in part (i).

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(iii) Describe briefly how the measurements listed in part (ii) would be carried out.

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(iv) Explain how you would calculate the Young modulus from your measurements.

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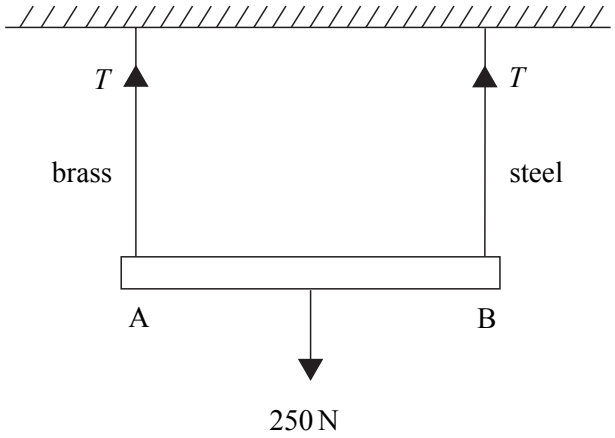
(13 marks)

(b) A uniform heavy metal bar of weight 250 N is suspended by two vertical wires, supported at their upper ends from a horizontal surface, as shown.



One wire is made of brass and the other of steel. The cross-sectional area of each wire is $2.5 \times 10^{-7}\,m^2$ and the unstretched length of each wire is 2.0 m.

the Young modulus for brass = 1.0×10^{11} Pa
the Young modulus for steel = 2.0×10^{11} Pa

(i) If the tension, T, in each wire is 125 N, calculate the extension of the steel wire.

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(ii) Estimate how much lower the end A will be than the end B.

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(3 marks)

16

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE