Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

UMUTECH

General Certificate of Education
Advanced Subsidiary Examination

Physics A

Unit 1 Electricity

For this paper you must have:
- a pencil and a ruler
- a calculator
- a Data and Formulae Booklet (enclosed).

Time allowed
- 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

5 A student investigates how the power dissipated in a variable resistor, Y, varies as the resistance is altered.

Figure 1 shows the circuit the student uses. Y is connected to a battery of emf ε and internal resistance r.

Figure 1

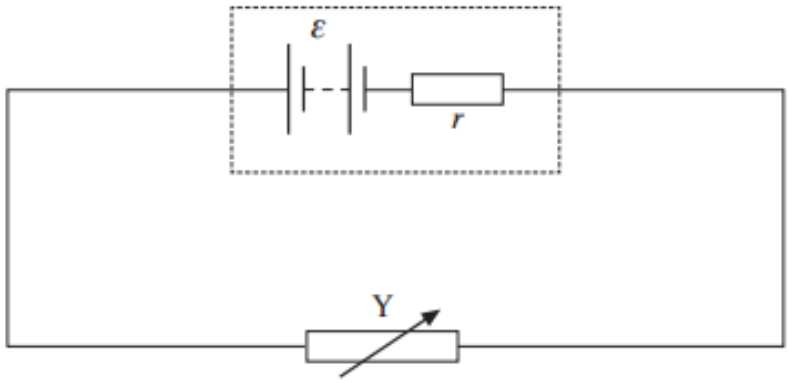
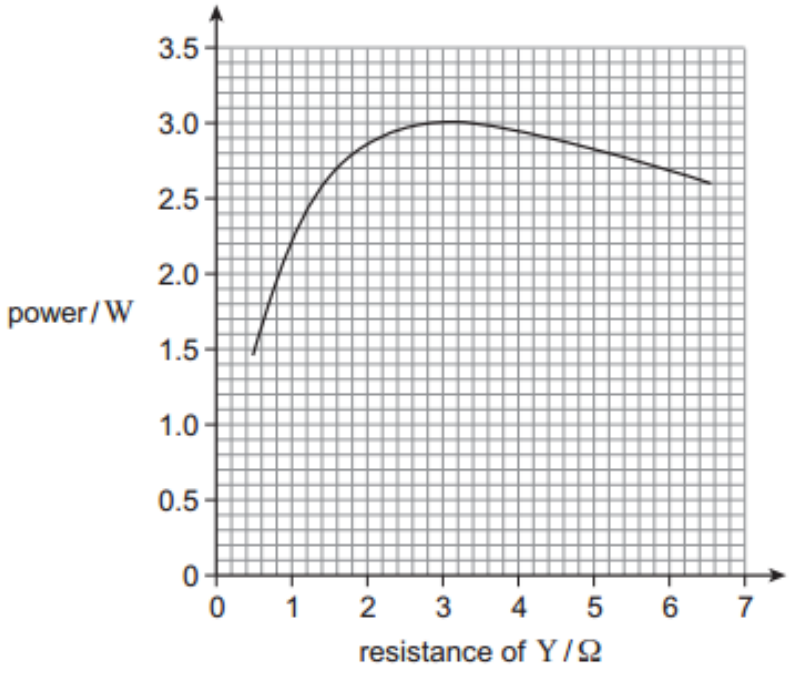


Figure 2 shows the results obtained by the student as the resistance of Y is varied from $0.5\,\Omega$ to $6.5\,\Omega$.

Figure 2



5 (a) Describe how the power dissipated in Y varies as its resistance is increased from $0.5\,\Omega$ to $6.5\,\Omega$.

[2 marks]

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5 (b) The emf of the battery is $6.0\,V$ and the resistance of Y is set at $0.80\,\Omega$.

5 (b) (i) Use data from **Figure 2** to calculate the current through the battery.

[3 marks]

current ..... A

5 (b) (ii) Calculate the voltage across Y.

[2 marks]

voltage V

5 (b) (iii) Calculate the internal resistance of the battery.

[2 marks]

internal resistance ..... Ω

Question 5 continues on the next page

5 (c) The student repeats the experiment with a battery of the same emf but negligible internal resistance. State and explain how you would now expect the power dissipated in Y to vary as the resistance of Y is increased from $0.5\,\Omega$ to $6.5\,\Omega$.

[3 marks]

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6 The critical temperature of tin is –269 °C. The resistivity of tin increases as its temperature rises from –269 °C.

6 (a) (i) Define resistivity.

[2 marks]

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6 (a) (ii) State the significance of the critical temperature of a material.

[2 marks]

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6 (b) A sample of tin in the form of a cylinder of diameter 1.0 mm and length 4.8 m has a resistance of 0.70 Ω.

Use these data to calculate a value of the resistivity of tin.
State an appropriate unit for your answer.

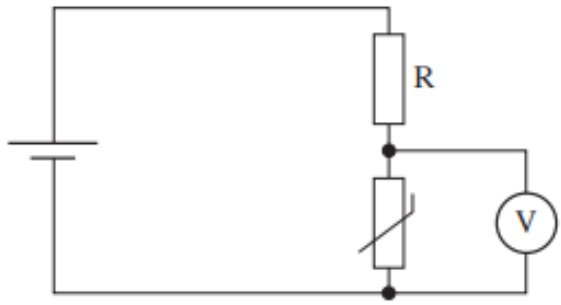
[4 marks]

resistivity ..... unit .....

Turn over for the next question

7 A thermistor is to be used as a temperature sensor. In order to find out how the voltage across the thermistor varies with temperature the circuit shown in **Figure 3** is set up.

Figure 3



7 (a) Data have to be obtained so that a graph can be plotted to show how the reading on the voltmeter varies with temperature between 0 °C and 100 °C. Design an experiment, using this circuit, to obtain enough data to plot the graph. Your answer should include:

- details of the measurements taken
- details of how the temperature of the thermistor can be varied
- an explanation of the need for resistor R
- an explanation of how the thermistor can then be used to measure the temperature of a room.

The quality of your written communication will be assessed in your answer.

[6 marks]

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7 (b) The experiment you designed in part (a) is repeated with the voltmeter connected across R instead.
State and explain how the readings on the voltmeter would be different.

[3 marks]

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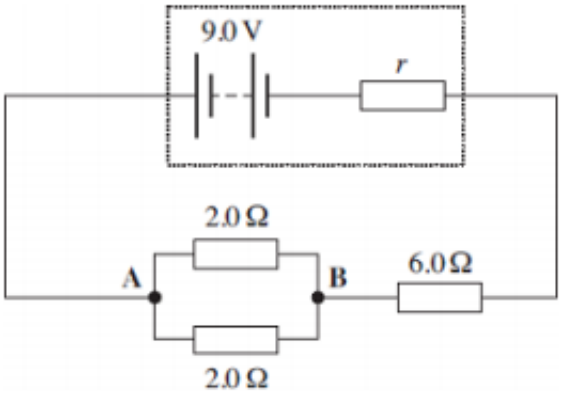
END OF QUESTIONS

Q1. A battery of emf 9.0 V and internal resistance, *r*, is connected in the circuit shown in the figure below.



(a) The current in the battery is 1.0 A.

(i) Calculate the pd between points **A** and **B** in the circuit.

answer = ... V

(2)

(ii) Calculate the internal resistance, *r*.

answer = ... Ω

(2)

(iii) Calculate the **total** energy transformed by the battery in 5.0 minutes.

answer = ... J

(2)

(iv) Calculate the percentage of the energy calculated in part (iii) that is dissipated in the battery in 5.0 minutes.

answer = ...

(2)

(b) State and explain **one** reason why it is an advantage for a rechargeable battery to have a low internal resistance.

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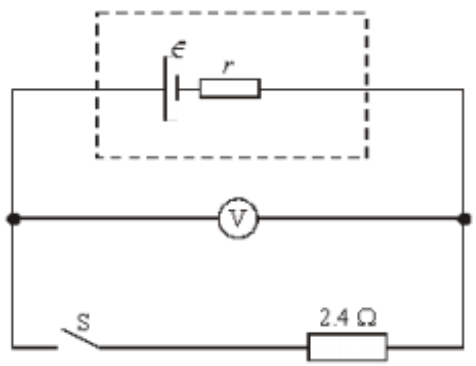
(2)
(Total 10 marks)

Q2. In the circuit shown the battery has emf $\in$ and internal resistance *r*.



(a) (i) State what is meant by the emf of a battery.

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(ii) When the switch S is open, the voltmeter, which has infinite resistance, reads 8.0 V. When the switch is closed, the voltmeter reads 6.0 V.
Determine the current in the circuit when the switch is closed.

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(iii) the power dissipated in resistor A,

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(iv) the energy dissipated by resistor A in 20 s.

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(Total 8 marks)

5 An experiment can be performed to determine whether a particular component is an ohmic conductor.

5 (a) State what is meant by an ohmic conductor.

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(1 mark)

5 (b) (i) Draw a suitable circuit diagram for such an experiment.

(2 marks)

5 (c) (i) State the principal property of a superconductor.

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(1 mark)

5 (c) (ii) State what is meant by critical temperature.

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(1 mark)

5 (c) (iii) Give **one** use of a superconductor.

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(1 mark)

5 (b) (ii) For the circuit diagram you have drawn, describe a suitable experiment. Your account should include details of:

- what measurements you would take
- how you would use your measurements
- how you would reach a conclusion.

The quality of written communication will be assessed in your answer.

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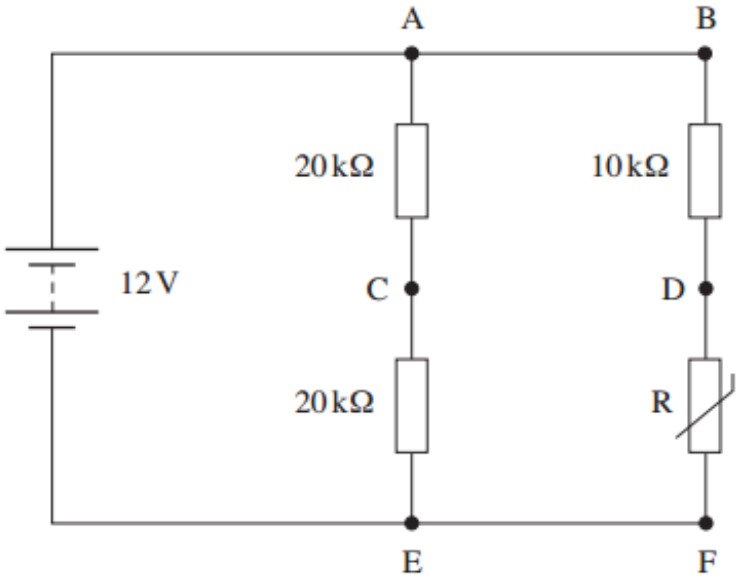
(6 marks)

6 **Figure 2** shows a 12 V battery of negligible internal resistance connected to a combination of three resistors and a thermistor.

Figure 2



6 (a) When the resistance of the thermistor is 5.0 kΩ

6 (a) (i) calculate the total resistance of the circuit,

total resistance = ... kΩ

(3 marks)

6 (a) (ii) calculate the current in the battery.

current = ... mA

(1 mark)

7 A copper connecting wire is 0.75 m long and has a cross-sectional area of $1.3 \times 10^{-7}\ m^2$.

7 (a) Calculate the resistance of the wire.

resistivity of copper = $1.7 \times 10^{-7}\ \Omega m$

resistance = ... Ω

(2 marks)

7 (b) A 12 V 25 W lamp is connected to a power supply of negligible internal resistance using two of the connecting wires. The lamp is operating at its rated power.

7 (b) (i) Calculate the current flowing in the lamp.

current = ... A

(1 mark)

7 (b) (ii) Calculate the pd across each of the wires.

pd = ... V

(1 mark)

7 (b) (iii) Calculate the emf (electromotive force) of the power supply.

emf = ... V

(2 marks)

7 (c) The lamp used in part (b) is connected by the same two wires to a power supply of the same emf but whose internal resistance is not negligible.

State and explain what happens to the brightness of the lamp when compared to its brightness in part (b).

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(2 marks)

5 (a) Some materials exhibit the property of *superconductivity* under certain conditions.

- State what is meant by superconductivity.
- Explain the required conditions for the material to become superconducting.

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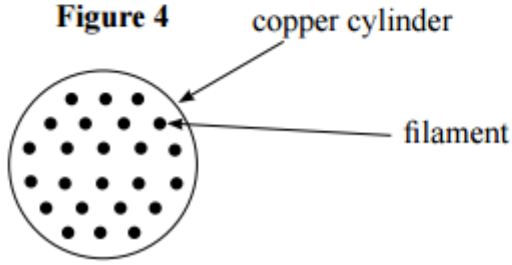
(3 marks)

5 (b) **Figure 4** shows the cross-section of a cable consisting of parallel filaments that can be made superconducting, embedded in a cylinder of copper.

Figure 4



5 (b) (i) The cross-sectional area of the copper in the cable is $2.28 \times 10^{-7} m^2$. The resistance of the copper in a 1.0m length of the cable is 0.075Ω. Calculate the resistivity of the copper, stating an appropriate unit.

answer = ...

(3 marks)

5 (b) (ii) State and explain what happens to the resistance of the cable when the embedded filaments of wire are made superconducting.

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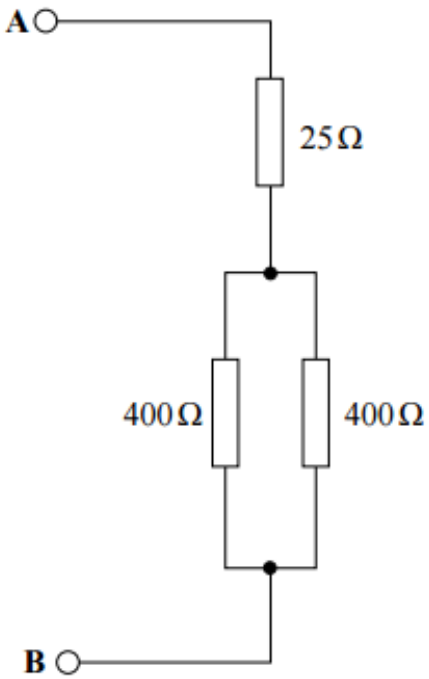
(3 marks)

6 **Figure 5** shows an arrangement of resistors.

Figure 5



6 (a) Calculate the total resistance between terminals **A** and **B**.

answer = ... Ω

(2 marks)

Q5. (a) A student wishes to investigate how the resistance of a thermistor changes with temperature.

(i) Draw a labelled diagram of a suitable circuit that would enable the student to measure the resistance of the thermistor.

(2)

(ii) Describe the procedure the student would follow in order to obtain accurate and reliable measurements of the resistance of the thermistor at different temperatures.

The quality of your written communication will be assessed in this question.

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(6)

3. A student wishes to collect data so he can plot the *I*-*V* curve for a semiconductor diode.

(a) (i) Draw a suitable diagram of the circuit that would enable the student to collect this data.

(3)

(ii) Describe the procedure the student would follow in order to obtain an *I*-*V* curve for the semiconductor diode.

The quality of your written communication will be assessed in this question.

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(6)

Q3. **X** and **Y** are two lamps. **X** is rated at 12 V 36 W and **Y** at 4.5 V 2.0 W.

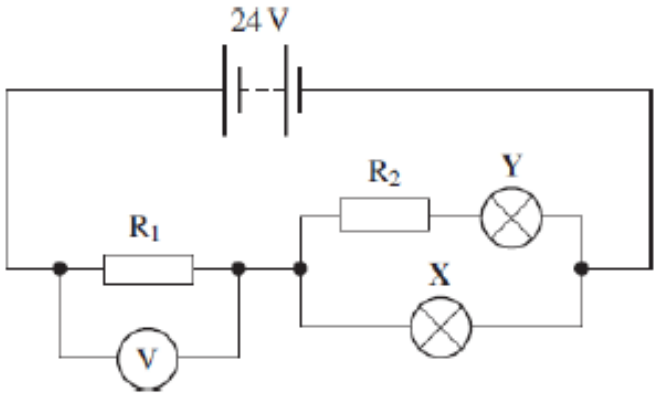
(a) Calculate the current in each lamp when it is operated at its correct working voltage.

X ..... A

Y ..... A

(2)

(b) The two lamps are connected in the circuit shown in the figure below. The battery has an emf of 24 V and negligible internal resistance. The resistors, R_1 and R_2 are chosen so that the lamps are operating at their correct working voltage.



(i) Calculate the pd across R_1.

answer V

(1)

(ii) Calculate the current in R_1.

answer ..... A

(1)

(iii) Calculate the resistance of R_1.

answer ..... Ω

(1)

(iv) Calculate the pd across R_2.

answer V

(1)

(v) Calculate the resistance of R_2.

answer ..... Ω

(1)

7 A car battery has an *emf* of 12V and an *internal resistance* of $5.0 \times 10^{-3}\Omega$.

7 (a) (i) Explain what is meant by the emf of the battery.

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(1 mark)

7 (a) (ii) Explain what is meant by the internal resistance of the battery.

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(1 mark)

7 (b) The battery is used to provide the starting motor of a car with a current of 800 A.

7 (b) (i) Calculate the potential difference across the terminals of the battery.

answer = ... V

(2 marks)

7 (b) (ii) Calculate the rate of dissipation of energy due to its internal resistance stating an appropriate unit.

answer = ...

(3 marks)

7 (c) State and explain the effect of attempting to use a battery with a much higher internal resistance to start the car.

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(2 marks)

END OF QUESTIONS