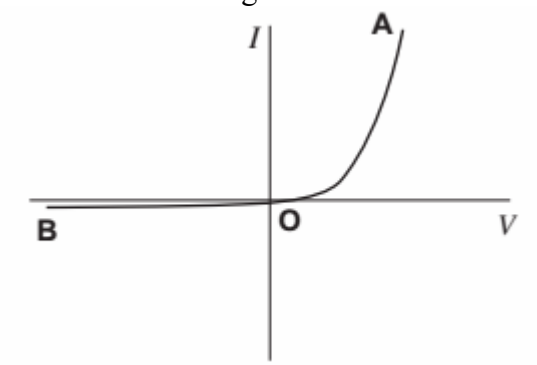
Electricity Revision Questions 1

1. The graph in **Figure 1** shows the current–voltage (I–V) characteristic curve for a semiconductor diode.

Figure 1



In order to produce this characteristic a student is given suitable equipment including an ammeter and a voltmeter.

(a) (i) Draw a labelled circuit diagram of the apparatus that the student could use to obtain the part of the characteristic from O to A.

[2 marks]

(ii) Describe how the student could use the circuit in part (a)(i) to obtain sufficient measurements to draw the part of the characteristic from O to A.
Your account should include:
details of how different readings of I and V are obtained
a consideration of safety precautions when using the diode
a discussion of the range and number of measurements that need to be taken
a discussion of the advantages of using a data logger to obtain the measurements.
The quality of your written communication will be assessed in your answer.

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[6 marks]

(iii) Suggest how the circuit you drew in part (a)(i) could be modified to obtain the characteristic from O to B.

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[1 mark]

(b) The student wants to find out how the resistance of the diode changes between O and A.

(i) Describe how the student could use the characteristic to determine how the resistance varies as the potential difference (pd) between O and A increases.

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[2 marks]

(ii) State how you would expect the resistance of the diode to vary as the pd increases.

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[1 mark]

[12]

2. An electric oven is connected to a 230 V root mean square (rms) mains supply using a cable of negligible resistance.

(a) (i) Calculate the peak-to-peak voltage of the mains supply.

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[2 marks]

(ii) The resistance of the heating element in the oven at its working temperature is 12 Ω.

Calculate the power dissipated by the heating element in the oven.
Give your answer to an appropriate number of significant figures.

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[3 marks]

(b) In practice the resistance of the cable connecting the oven to the mains supply is not negligible. Each of the two wires connecting the heating element to the mains electricity supply has a length of 3.15 m. Each metre of wire has a resistance of 0.0150 Ω.

(i) Explain why the rms voltage across the heating element in the oven will be less than 230 V.

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[2 marks]

(ii) Calculate the rms voltage across the heating element in the oven when it is at its working temperature.

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[3 marks]

(iii) Calculate the average power wasted in the cable due to the heating effect of the electric current.

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[2 marks]

(iv) State two reasons why it is important that the cable has a low resistance.

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[2 marks]

[14]

3. Figure 2 shows a circuit that includes an oscilloscope used to find the internal resistance r of a battery.

Figure 2

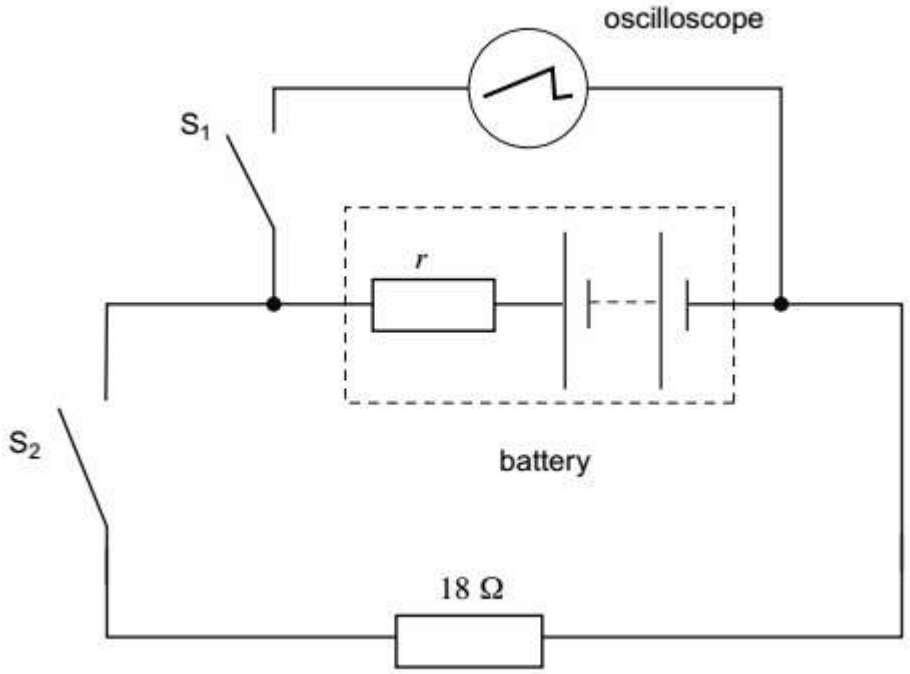
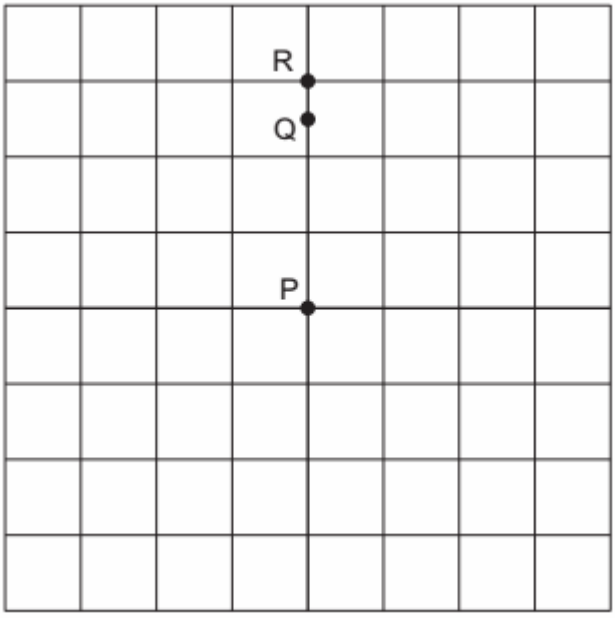


Figure 3 represents the screen of the oscilloscope. With switches S1 and S2 open, a bright spot is seen on the screen at P.

Figure 3



The vertical sensitivity of the oscilloscope is set at 2.0 V per division.

(a) Explain why the oscilloscope shows a bright spot rather than a horizontal line.

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[1 mark]

(b) When switch S1 is closed, the spot moves to R.

(i) State the electrical property of the battery represented by the deflection PR.

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[1 mark]

(ii) Determine the value of the electrical quantity represented by the deflection PR.

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[1 mark]

(c) With switch S1 kept closed, switch S2 is also closed. The spot moves to Q. Explain why the spot moves from R to Q.

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[3 marks]

(d) Calculate the current in the battery when both switches are closed.

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[2 marks]

(e) Calculate the internal resistance of the battery.

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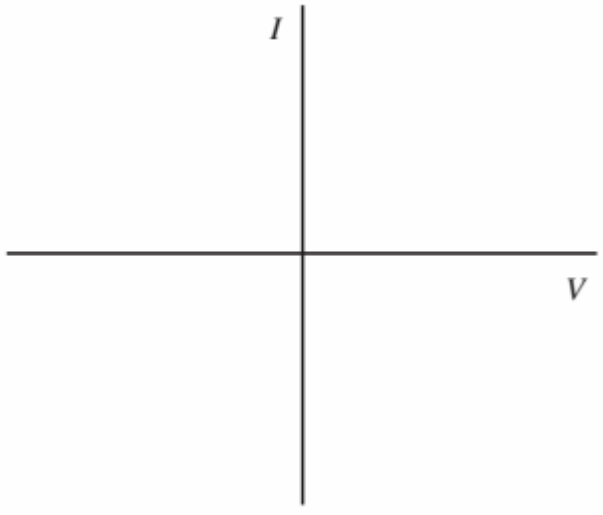
[2 marks]

[10]

4. (a) Sketch, on Figure 1, the current–voltage (IV) characteristic for a filament lamp for currents up to its working power.

Figure 1



[2 marks]

(b) (i) State what happens to the resistance of the filament lamp as the current increases.

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[1 mark]

(ii) State and explain whether a filament lamp is an ohmic or non-ohmic conductor up to its working power.

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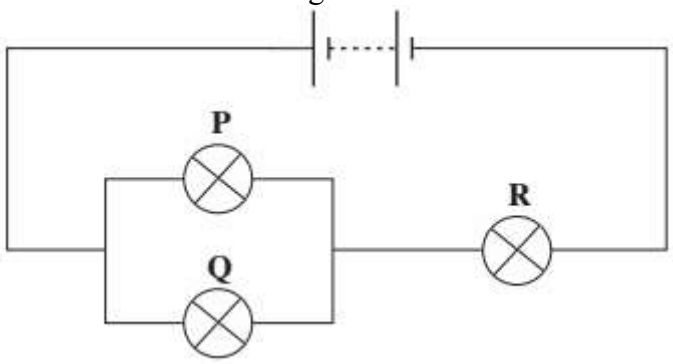
[1 mark]

(c) Three identical filament lamps, P, Q and R are connected in the circuit shown in Figure 2.

Figure 2



The filament in lamp Q melts so that it no longer conducts. Explain why lamp P becomes brighter and lamp R becomes dimmer.

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[2 marks]

(d) A filament lamp, X, is rated at 60W 230V. Another type of lamp, Y, described as 'energy saving' has the same light intensity output but is rated at 11W 230V.

(i) Calculate the electrical energy converted by each lamp if both are on for 4 hours a day for a period of 30 days.

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[2 marks]

(ii) Suggest why the two lamps can have different power ratings but have the same light intensity output.

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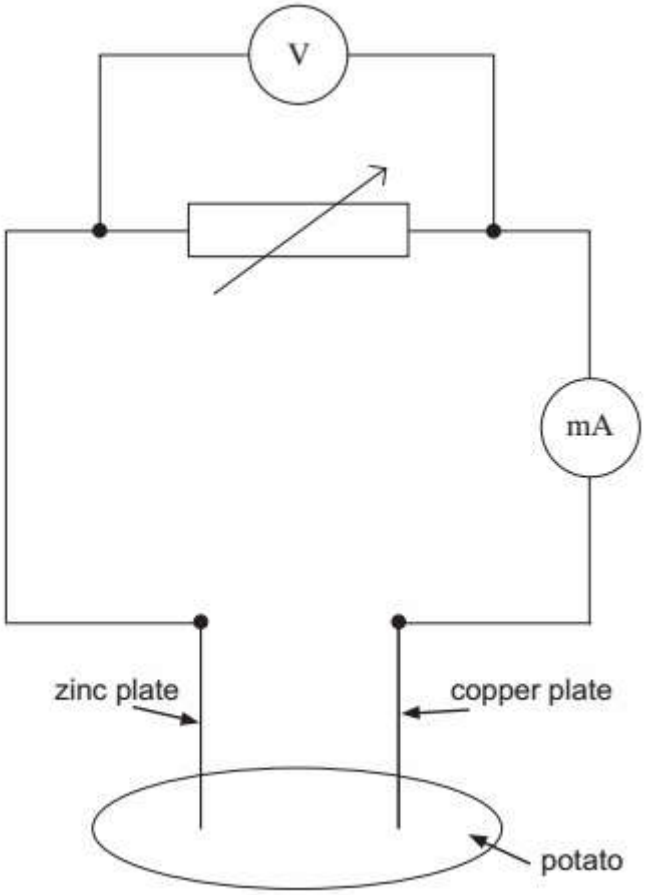
[2 marks]

[10]

5. A ‘potato cell’ is formed by inserting a copper plate and a zinc plate into a potato. The circuit shown in Figure 3 is used in an investigation to determine the electromotive force and internal resistance of the potato cell.

Figure 3.



(a) State what is meant by electromotive force.

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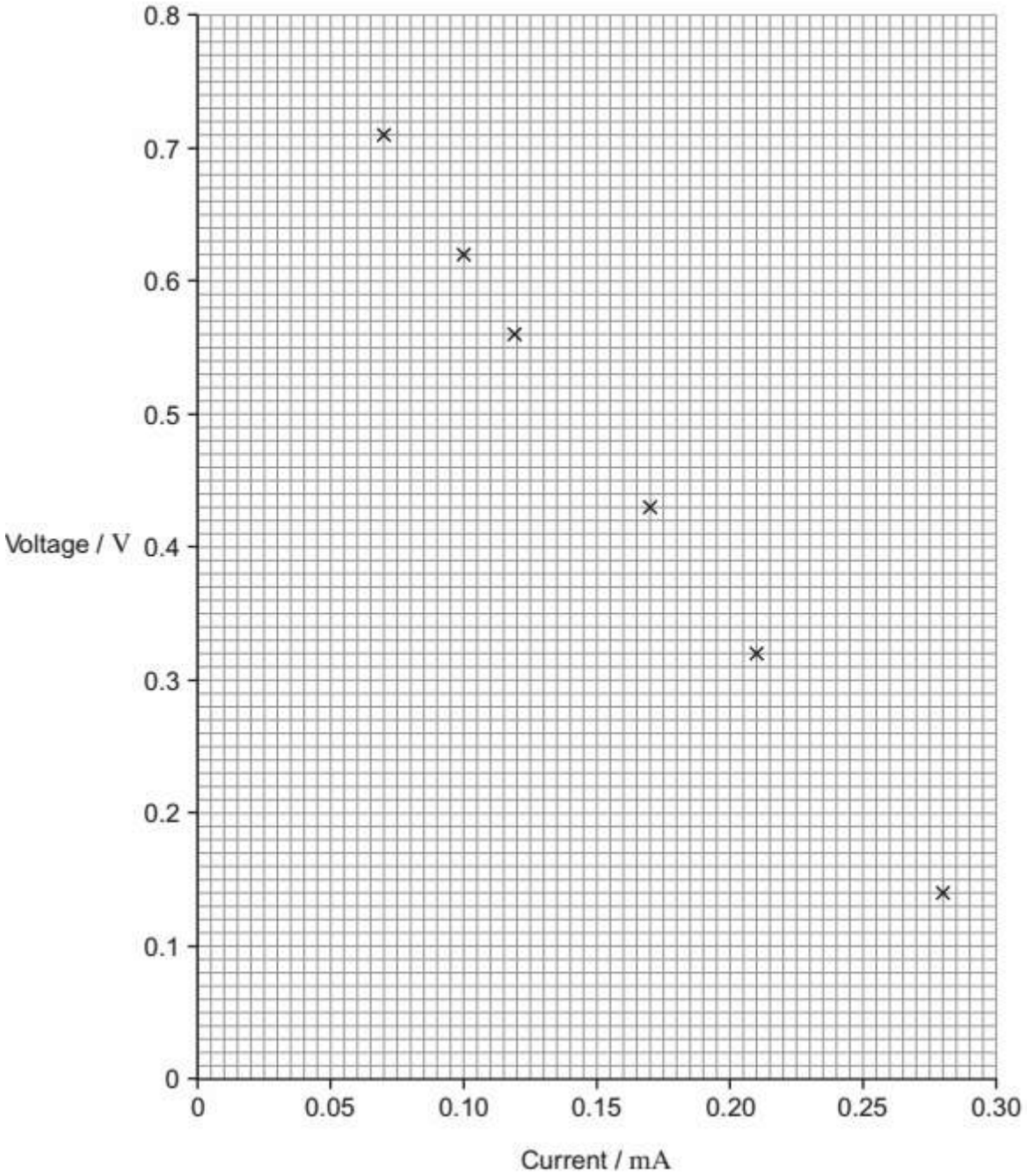
[2 marks]

(b) The plotted points on Figure 4 show the data for current and voltage that were obtained in the investigation.

Figure 4



(b) (i) Suggest what was done to obtain the data for the plotted points.

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[1 mark]

(ii) The electromotive force (emf) of the potato cell is 0.89 V.
Explain why the voltages plotted on Figure 4 are always less than this and why the difference between the emf and the plotted voltage becomes larger with increasing current.

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[3 marks]

(iii) Use Figure 4 to determine the internal resistance of the potato cell.

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[3 marks]

(c) A student decides to use two potato cells in series as a power supply for a light emitting diode (LED). In order for the LED to work as required, it needs a voltage of at least 1.6 V and a current of 20 mA.
Explain whether the LED will work as required.

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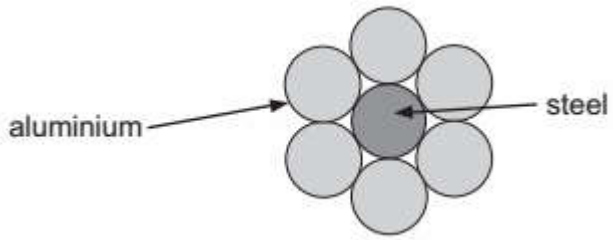
[2 marks]

[11]

6. A cable used in high-voltage power transmission consists of six aluminium wires surrounding a steel wire. A cross-section is shown in Figure 5.

Figure 5



The resistance of a length of 1.0 km of the steel wire is 3.3 Ω. The resistance of a length of 1.0 km of one of the aluminium wires is 1.1 Ω.

(a) The steel wire has a diameter of 7.4 mm.
Calculate the resistivity of steel. State an appropriate unit.

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[4 marks]

(b) Explain why only a small percentage of the total current in the cable passes through the steel wire.

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[3 marks]

(c) The potential difference across a length of 1.0km of the cable is 75V.
Calculate the total power loss for a 1.0km length of cable.

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[3 marks]

[10]