1 (a) State what is meant by drift velocity when applied to a metal conductor.

(1)

(b) Two conductors of the same material and length carry the same current. Conductor X has twice the cross-sectional area of conductor Y.

(i) By referring to an appropriate equation, compare the drift velocities for conductor X and conductor Y.

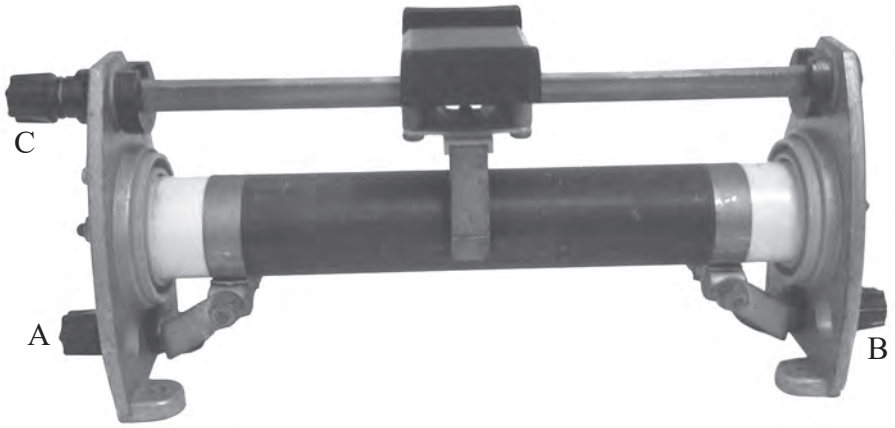
(2)

*(ii) Explain the difference in resistance of conductor X and conductor Y in terms of the difference in drift velocity.

(3)

(Total for Question 6 marks)

2 Photograph 1 shows a rheostat (a variable resistor).

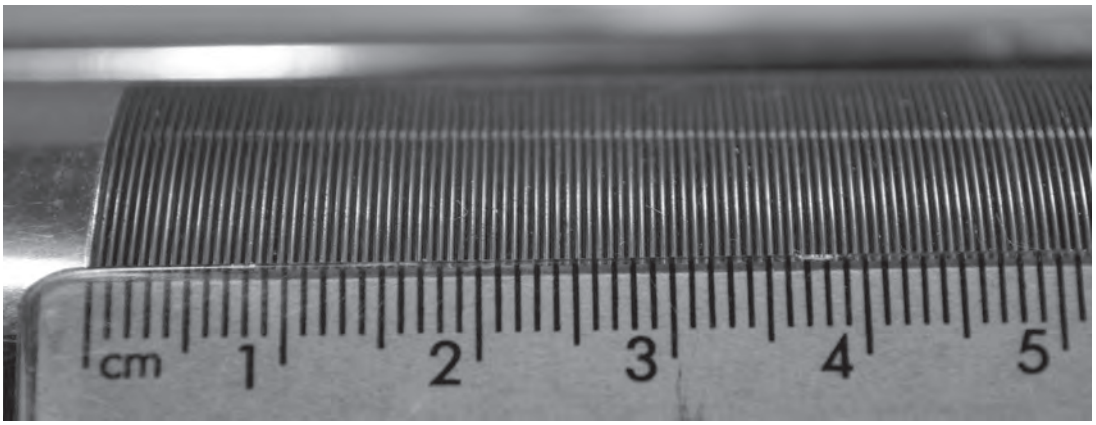


Photograph 1

The rheostat is made of a long resistance wire coiled around an insulating cylinder. The turns of wire are also separated from each other by insulation of negligible thickness. The ends of the wire are connected to the sockets A and B at either end and there is a sliding contact in the centre connected to the socket C. The resistance between A and C is varied by moving the sliding contact.

(a) A student decides to determine the resistivity of the material from which the wire is made by measuring the dimensions of the wire and its resistance.

Photograph 2 shows a section of the rheostat and a scale.



Photograph 2

(i) Take measurements from the photograph and use them to show that the cross-sectional area of the wire is about 2×10^{-7} m^2.

(3)

(ii) Calculate the resistivity of the material from which the wire is made.

resistance of wire = 22 Ω

length of wire = 12 m

(3)

Resistivity =

(iii) Suggest an advantage for the student of using a photograph rather than taking direct measurements.

(1)

(b) The coil of the rheostat is 10.2 cm long. A potential difference of 12 V is applied across AB and the slider C is 7.0 cm from the end of the coil near A.

Calculate the potential difference across AC.

(2)

Potential difference =

(Total for Question = 9 marks)

3 A strain gauge measures changes in the resistance of a metal under strain to find the applied force. The kitchen balance in the photograph uses strain gauges to measure the weight of cooking ingredients.

A student tests this method by measuring the resistance of a wire before a force is applied and while it is under tension.

(a) Calculate the initial resistance of the wire.

length of wire = 1.0 m

cross sectional area of wire = 2.9×10^{-8} m^2

resistivity of wire = 4.9×10^{-7} Ω m

(2)

Resistance of wire =

(b) The student applies a force to the wire and measures the new length. He calculates the increase in the resistance to be 0.035 Ω. He measures the increase in resistance and finds it to be 0.070 Ω.

The student suggests that the difference between these two values is because the cross-sectional area of the wire changes under strain.

Explain why a change in cross-sectional area would cause this difference.

(3)

(Total for Question = 5 marks)

4 The photograph shows a typical hairdryer.

(a) The hairdryer contains a heating element which consists of a long nichrome wire wound around an insulator. The heating element operates at 230 V and has a power rating of 1 kW.

Show that the resistance of the heating element is about 50 Ω.

(3)

(b) The nichrome wire has a cross-sectional area of 1.3×10^{-7} m^2.

Calculate the length of the wire.

resistivity of nichrome = 1.1×10^{-6} Ωm

(2)

Length =

(c) The nichrome wire has a diameter of 0.40 mm. A manufacturer wishes to make a hairdryer of the same resistance but using half the length of wire.

Calculate the diameter of nichrome wire that must be used.

(3)

Diameter =

(Total for Question = 8 marks)

5 The photograph shows a marble statue. The statue is protected by a lightning conductor.

During a storm, a flash of lightning passes between a cloud and the lightning conductor. As a result a current of 15 000 A flows for a time of 3.0×10^{-2} s.

(a) Calculate the charge that flows in the lightning conductor during this time.

(2)

Charge =

(b) The lightning conductor is 1 m taller than the statue and is made from copper, which has a resistivity of 1.7×10^{-8} Ω m. The lightning conductor has a cross-sectional area of 1.5×10^{-4} m^2 and a resistance of 2.7×10^{-3} Ω.

Calculate the height of the statue and state an assumption that you have made.

(4)

Height of statue =

Assumption:

(c) Suggest why the lightning conductor is taller than the statue.

(1)

(Total for Question = 7 marks)

6 (a) Explain the difference between resistance and resistivity.

(2)

(b) The resistivity of copper is 1.7×10^{-8} Ω m. A copper wire is 0.50 m long and has a cross sectional area of 1.0×10^{-6} m^2. Calculate its resistance.

(2)

Resistance =

(Total for Question = 4 marks)

7 A length of wire has a cross-sectional area of 3.1×10^{-6} m^2. A current of 1.5 A flows through the wire when there is a p.d. of 3.0 V across it.

(a) Draw a diagram of the circuit you would use to check these current and p.d. values.

(2)

(b) Calculate the rate at which energy is transferred to the wire.

(2)

Rate of energy transfer =

(c) (i) The wire has 1.0×10^{29} electrons per metre cubed.

Calculate the drift velocity of the electrons.

(2)

Drift velocity =

(ii) The temperature of the wire increases. Explain what happens to the drift velocity of the electrons if the potential difference remains constant.

(3)

(Total for Question = 9 marks)

8 A thermistor has a negative temperature coefficient. With reference to the equation $I = nqvA$, explain what happens to the resistance of the thermistor when its temperature increases.

(3)

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(Total for Question 3 marks)

9 When tidying a prep room, a teacher discovers a tray of resistance wires that have lost their labels. She decides to ask her students to carry out experiments to determine the material that each wire is made of by measuring the resistivity of the wires.

(a) Explain why the teacher asks the students to measure the resistivity and not the resistance of the wires.

(2)

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*(b) You are to describe a method to determine accurately the resistivity of one of the metal wires.

Your description should include:

- the circuit diagram you would use
- the quantities you would measure
- the graph you would plot
- how you would determine the resistivity.

(9)

(Total for Question 11 marks)