Extension Worksheet – Topic 5, Worksheet 1

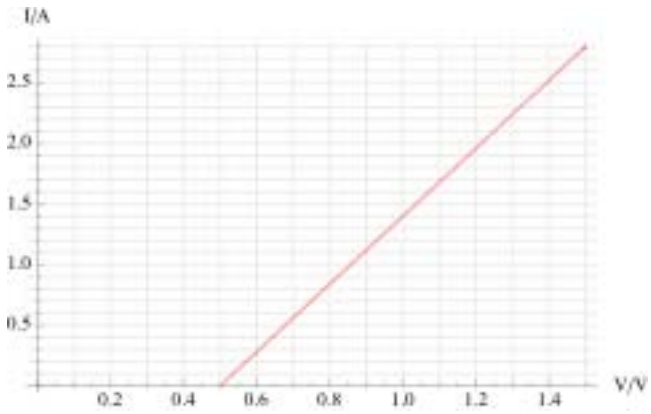
1 A cylindrical wire of radius r and length L has resistance R. Calculate, in terms of R, the resistance of a wire of the same material with double the radius and double the length. [2]

2 The resistivity of a copper is $1.68\times10^{-8}\ \Omega\text{m}$. Calculate the length of a cylindrical copper wire of resistance $12\ \Omega$ and radius $2.35\times10^{-3}\ \text{m}$. [2]

3 Show that the current in a wire of cross-sectional area A is given by the expression $I = nevA$ where v is the drift speed of the electrons and n is the number of free electrons per unit volume. [3]

4 Electrons leave a metallic surface of area A at a rate of R electrons per unit time per unit area. The average electron speed is v. Deduce that the current leaving the surface is $I = ReA$ and is thus independent of the electron speed. [2]

5 The graph shows the variation with applied voltage V (in V) of the current I (in A) in a device.



a Explain why the device is not ohmic. [1]

b Determine whether the resistance of the device increases or decreases as the voltage increases past 0.5 V. [2]

6 Define the electromotive force (emf) of a battery. [1]

7 A battery has negligible internal resistance and emf ε. The battery is connected in series to two resistors. The potential difference across the resistors is V_1 and V_2. The total current leaving the battery is I.

a State an expression, in terms of the symbols given, for the total power delivered by the battery. [1]

b State expressions for the power dissipated in each of the resistors. [1]

c Deduce that $\varepsilon = V_1 + V_2$. [1]

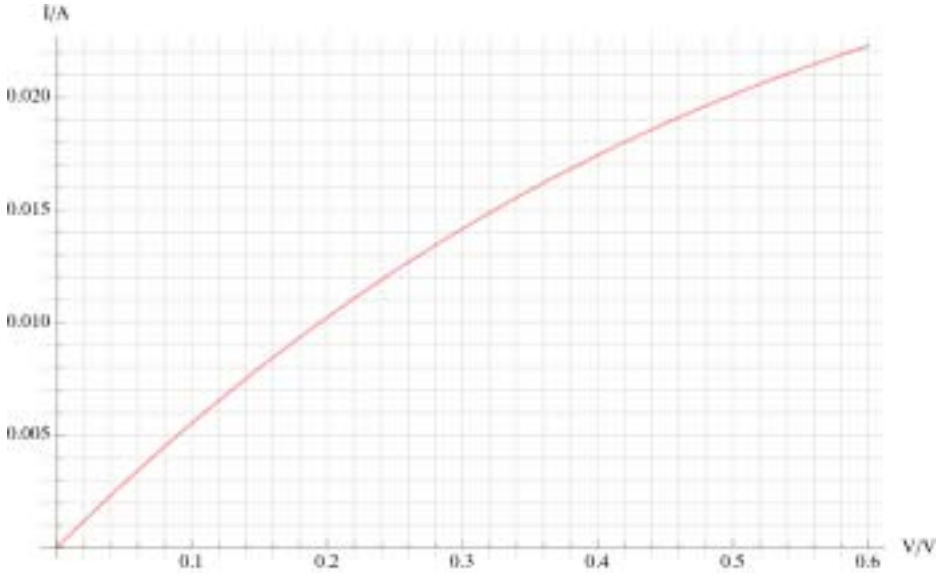
d The two resistors have resistance R_1 and R_2. Use the result in **c** to deduce that the total (effective) resistance of the two resistors in series is $R_1 + R_2$. [2]

8 A battery has negligible internal resistance and emf. The battery is connected in parallel to two resistors of resistance R_1 and R_2.

a State an expression for the current in each of the resistors. [1]

b Deduce that the total (effective] resistance R of the two resistors in parallel is given by $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$. [2]

9 The current I (in A) in a certain device D varies with applied voltage V (in V) at the ends of the device according to the graph below.



a Explain how it may be deduced that the device does not obey Ohm's law. [1]

b Assuming the device is a filament lamp, explain the shape of this graph. [3]

c On the same axes draw a graph to show the variation with applied voltage of the current in another device that has a constant resistance of $25\,\Omega$. [1]

d A battery of emf 0.90 V and negligible internal resistance is connected in series to the two devices above. Estimate the current leaving the battery. [2]

10 The potential difference across a device is V and the current through it is I.

a State an expression for the work that must be done to move a quantity of charge Q across the device. [1]

b Use your answer to **a** to derive an expression for the power dissipated in the device. [1]