



A Level Physics A

H556/02 Exploring physics

Question Set 13

1 (a) Derive the S.I. base units for resistance.

$$R = \frac{W}{QI} \rightarrow \frac{kgm^2s^{-2}}{As \times A} = kgm^2A^{-2}s^{-3} \text{ base units: } kgm^2A^{-2}s^{-3} \dots [2]$$

(b) Fig. 16.1 shows the I - V characteristics of two electrical components **L** and **R**.

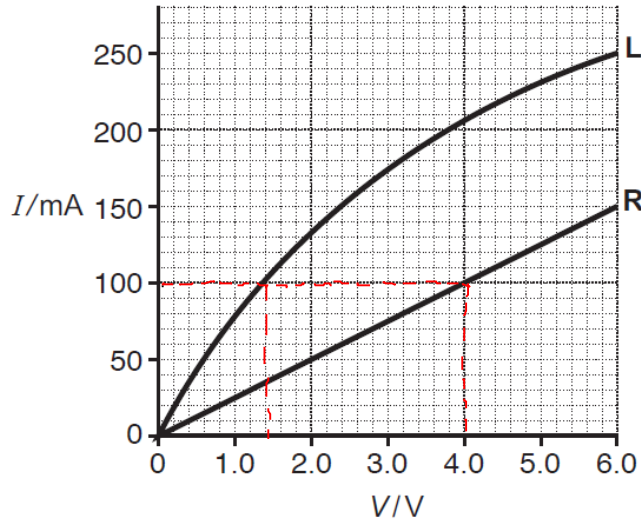


Fig. 16.1

The component **L** is a filament lamp and the component **R** is a resistor.

(i) Show that the resistance of **R** is 40Ω .

$$R = \frac{V}{I} = \frac{6}{0.15} = 40 \Omega \quad \frac{1}{\text{gradient}} = R \quad [1]$$

(ii) Fig. 16.2 shows the components **L** and **R** connected in series to a battery of e.m.f. 6.0 V .

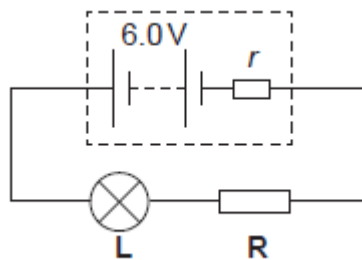


Fig. 16.2

The resistor **R** is a cylindrical rod of length 8.0 mm and cross-sectional area $2.4 \times 10^{-6} \text{ m}^2$. The current in the circuit is 100 mA .

1 Use Fig. 16.1 to determine the internal resistance r of the battery.

$$\text{At } I = 100 \text{ mA } V_L = 1.4 \text{ and } V_R = 4$$

$$\text{Lost volts} = 6 - [1.4 + 4] = 0.6 \Rightarrow r = \frac{V}{I} = \frac{0.6}{100 \times 10^{-3}} = 6 \Omega$$

$$r = \dots \dots \dots 6 \dots \dots \dots \Omega [3]$$

2 Calculate the resistivity ρ of the material of the resistor **R**.

$$R = \frac{\rho L}{A} \Rightarrow \rho = \frac{AR}{L} \quad \rho = \dots 0.012 \dots \Omega\text{m} \text{ [2]}$$

$$\Rightarrow \rho = \frac{2.4 \times 10^{-6} \times 40}{8 \times 10^{-3}}$$

3 There are 6.5×10^{17} charge carriers within the volume of **R**.

Calculate the mean drift velocity v of the charge carriers within the resistor **R**.

$I = nAvc$ where $n = \text{no. density charge carriers}$

$$n = \frac{\text{no. charge carriers}}{\text{unit volume}} = \frac{6.5 \times 10^{17}}{AL} = \frac{6.5 \times 10^{17}}{2.4 \times 10^{-6} \times 8 \times 10^{-3}} = 3.4 \times 10^{25} \text{ m}^{-3}$$

$$v = \frac{I}{nAe} = \frac{100 \times 10^{-3}}{3.4 \times 10^{25} \times 2.4 \times 10^{-6} \times 1.6 \times 10^{-19}} = 7.7 \times 10^{-3} \text{ ms}^{-1}$$

$$v = \dots 7.7 \times 10^{-3} \dots \text{ms}^{-1} \text{ [3]}$$

Total Marks for Question Set 13: 11

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