OCR
Oxford Cambridge and RSA

A Level Physics A

H556/02 Exploring physics

Question Set 13

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

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

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

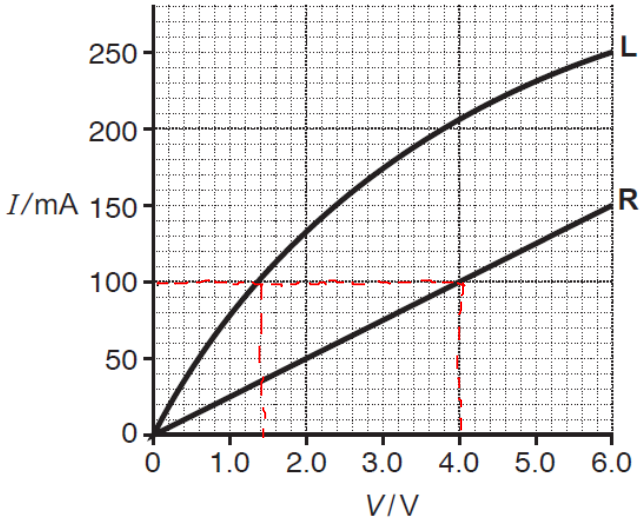

Fig. 16.1

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

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

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

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

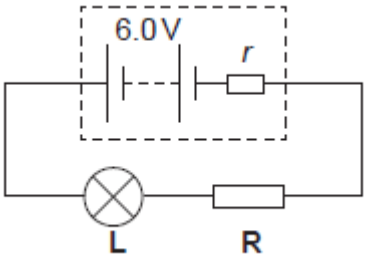

Fig. 16.2

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

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

At $I = 100mA$ $V_L = 1.4$ and $V_R = 4$

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

$r =$ 6 Ω **[3]**

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

$R = \frac{\rho L}{A} \Rightarrow \rho = \frac{AR}{L}$

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

ρ = 0.012 Ωm **[2]**

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 = no. density charge carriers

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

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

v = 7.7×10^{-3} m s^{-1} **[3]**

Total Marks for Question Set 13: 11