Mark scheme for Support Worksheet – Topic 5, Worksheet 1

1 $W = qV = 24 \times 10^{-3} \times 250 = 0.60$ J [1]

2 $W = qV \Rightarrow V = \dfrac{W}{q} = \dfrac{5.8 \times 10^{-3}}{1.2 \times 10^{-9}} = 4.8 \times 10^{6}$ V [1]

3 Since $W = qV$ and $q = 2\text{e}$, $V = 11$ V; hence for the electron with $q = \text{e}$, $W = 11$ eV [2]

4 $W = qV = 1.6 \times 10^{-19} \times 150 = 2.4 \times 10^{-17}$ J;

$\dfrac{1}{2}mv^2 = W \Rightarrow v = \sqrt{\dfrac{2W}{m}} = \sqrt{\dfrac{2qV}{m}} = \sqrt{\dfrac{2 \times 2.4 \times 10^{-17}}{9.1 \times 10^{-31}}}$; $v = 7.3 \times 10^{6}$ m s^{-1} [3]

5 $I = \dfrac{\Delta Q}{\Delta t} = \dfrac{1.6 \times 10^{-19} \times 6.8 \times 10^{16}}{1}$ A; $I = 11$ mA [2]

6 **a** $3R = 18.0\ \Omega$ [1]

b $R + \dfrac{R}{2} = \dfrac{3R}{2} = 9.0\ \Omega$ [1]

c $\dfrac{1}{R_T} = \dfrac{1}{2R} + \dfrac{1}{2R} = \dfrac{1}{R}$, so $R_T = R = 6.0\ \Omega$ [1]

7 Each part of the wire has resistance $\dfrac{R}{2}$; and so the total is given by

$\dfrac{1}{R_T} = \dfrac{1}{\frac{R}{2}} + \dfrac{1}{\frac{R}{2}} = \dfrac{4}{R}$ i.e. $R_T = \dfrac{R}{4}$ [2]

8 $R = \dfrac{\rho L}{A} = 2.2 \times 10^{-6} \times \dfrac{4.5}{\pi \times (0.24 \times 10^{-3})^2}$; $R = 55\ \Omega$ [2]

9 The potential difference across the external resistor is $V = \dfrac{W}{q} = \dfrac{7.2 \times 10^{-19}}{1.6 \times 10^{-19}} = 4.5$ V; the potential difference across the internal resistor is $V = RI = 0.80 \times 1.5 = 1.2$ V; so the emf is $4.5 + 1.2 = 5.7$ V [3]

10 The current leaving the battery is $I = \dfrac{V}{R} = \dfrac{5.4}{15} = 0.36$ A; the potential difference across the internal resistor is $6.0 - 5.4 = 0.6$ V; hence the internal resistance is $r = \dfrac{V}{I} = \dfrac{0.6}{0.36} = 1.7\ \Omega$ [3]

11 The potential difference across the resistor must be $9.0 - 4.5 = 4.5$ V; and so the resistance is $R = \dfrac{V}{I} = \dfrac{4.5}{0.15} = 30\ \Omega$ [2]