Mark scheme for Topic 5

1 The first thing to notice is that the circuit has infinite total resistance because of the voltmeter. Hence no current will pass in the circuit and the ammeter will read zero. There is no potential difference across any of the resistances since there is no current. Hence the top side of the voltmeter is at 0 V and the bottom at 6 V. It will then read 6.0 V, so **D**.

2 The new wire must have half the cross-sectional area of the first wire. So the new resistance will be $R' = \rho \frac{2L}{\frac{A}{2}} = 4\rho \frac{L}{A} = 4R$, so **D**.

Exam tip: make sure you understand the mathematics of this question.

3 Because the resistors take the same current, the ratio of their voltages is in the ratio of the resistances and the voltages must add up to V. This means that the voltmeter will read $\frac{R_1}{R_1 + R_2}V$, i.e. **C**.

Or, more explicitly: $V_1 = IR_1 = \underbrace{\left(\frac{V}{R_1 + R_2}\right)}_{\text{current}} R_1$

4 Remember that as the temperature increases the resistance of the thermistor drops and as the light intensity increases the resistance of the LDR drops as well. We want to decrease the resistance of the thermistor (and so increase the temperature) and increase the resistance of the LDR (and so decrease the light intensity), and therefore the answer is **B**.

5 **a** The work done is related to the potential difference across the external resistor, and so $W = qV \Rightarrow V = \frac{W}{q} = \frac{7.2\times10^{-19}}{1.6\times10^{-19}} = 4.5\text{ V}$;

The potential difference across the internal resistor is $0.80\times1.4 = 1.12\text{ V}$ and so the emf is $1.12+4.5 \approx 4.6\text{ V}$; **[2]**

b **i** The potential difference across each of the $12\ \Omega$ resistors is $0.48\times12 = 5.76\text{ V}$ and $0.36\times12 = 4.32\text{ V}$.

So that the emf is the sum $5.76+4.32 = 10.08 \approx 1.0\times10^{1}\text{ V}$. **[2]**

ii The power is the product of the emf and the total current, i.e. $10.08\times0.48 \approx 4.8\text{ W}$. **[1]**

iii The current through R is $0.48-0.36 = 0.12\text{ A}$.

And so $R = \frac{V}{I} = \frac{4.32}{0.12} = 36\ \Omega$. **[2]**

6 **a** **i** Resistance is the ratio of the voltage **across** a device,

to the current **through** the device. **[2]**

Exam tip: you **must** mention the words in bold to get credit here.

ii Neither graph is a straight line through the origin. **[1]**

iii The resistance of A decreases as the current increases.

The resistance of B increases as the current increases. **[2]**

b **i** From the graph, when the current is 2.4 A, the voltage across A is 18 V,

while across B it is 8.0 V. **[2]**

ii Power in A is $18\times2.4 = 43.2 \approx 43\text{ W}$ and in B it is $8.0\times2.4 = 19.2 \approx 19\text{ W}$. **[1]**

iii The sum of the voltages across A and B is 26 V and so the voltage across the internal resistor is 4.0 V,

and so the resistance is $\frac{4.0}{2.4} = 1.7\ \Omega$. **[2]**