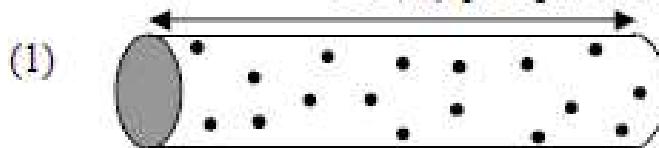


## Marking Scheme

1.	(a)	<u>Electrical energy (or work done) transferred [to other forms passing] between two points (1) per coulomb of charge (1)</u> Definition of 1 V award 1 mark only	[2]
	(b) (i)	$V_{\text{supply}} = V_1 + V_2 + V_3$	[1]
	(ii)	Energy	[1]
	(c) (i)	$R_1 + 12 = \frac{9}{0.5}$ (1) Clear manipulation seen to show $R_1 = 6 [\Omega]$ (1)	[2]
	(ii) (I)	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ to show effective parallel combination = $6 \Omega$ (1) this can be implied $V$ across upper $6 \Omega$ resistor shown = $4.5 [V]$ (ecf on parallel combination) (1)	[2]
	(II)	Total resistance = $12 \Omega$ (1) $I = \frac{9.0}{12} = 0.75 [A]$ (1) (accept $\frac{4.5}{6} = 0.75 [A]$ )	[2]
	(III)	$1.2 = \frac{9}{(6 + R_{\text{parallel}})}$ (1) $R_{\text{parallel}} = 1.5 [\Omega]$ (1) $n \times \left(\frac{1}{12}\right) = \frac{1}{1.5}$ (1) ecf on $1.5 [\Omega]$ $n = 8$ (1) Full marks for correct answer based on trial and error Alternative solution: $\frac{9}{1.2} = 7.5 [\Omega]$ (1) $7.5 - 6 = 1.5 [\Omega]$ (1) $\frac{12}{n} = 1.5 [\Omega]$ (1) $n = 8$ (1)	[4]

2.

 $l$  or  $(vt)$  [accept  $v$  if stated dist travelled in 1 s]

[NB free electrons not required to be labelled]

$$\text{Number of free electrons} = nAvt \text{ [or } nAl] \text{ (1)}$$

$$\text{Total charge} = nAvte \text{ [or } nAle] \text{ (1)}$$

$$I = \frac{nAvte}{t} \text{ with cancelling shown [or } \frac{nAle}{t} \text{, where } \frac{l}{t} = v \text{ shown]} \text{ (1)} \quad 4$$

$$2.0 = 1.0 \times 10^{29} \times 1.7 \times 10^{-6} v \times 1.6 \times 10^{-19} \text{ (1) [substitution]}$$

$$v = 7.4 \times 10^{-5} \text{ m s}^{-1} \text{ ((unit)) (1)} \quad 2$$

collisions [accept obstructions] (1)

between free electrons and copper atoms / ions / lattice (1) [accept: delocalised / moving / conducting electrons]

$$R = \frac{P}{I^2} \text{ [or } P = I^2 R] \text{ (1); } R = \frac{0.1}{4} [=0.025 \Omega] \text{ (1)}$$

$$\rho = \frac{0.025[\text{e.c.f.}] \times 1.7 \times 10^{-6}}{2.5} \text{ (1) [manipulation i.e. } \rho = \frac{RA}{l} \text{ or with figures]} \quad 4$$

$$\rho = 1.7 \times 10^{-8} \Omega \text{ m. (1)} \quad 4$$

cross-sectional area

smaller (1)

 $\pi$ 

the same (1)

resistivity

the same (1)

3

[15]

3.	2	<p>(a) Ammeter shown in series with bulb [or in series with bulb/voltmeter parallel combination] (1)            Voltmeter shown in parallel with bulb [or across bulb/ammeter series combination] (1)</p> <p>(b) (i) 2.0 A               (ii) 6.0 Ω</p> <p>(c) Either: <math>\frac{1}{18} + \frac{1}{6(\text{ecf})} = \frac{1}{R_1}</math> (1); <math>R_{\text{par}} = 4.5 \Omega</math> (1)            Subst into pot div equations: <math>12 = \frac{4.5}{4.5 + R} \times 16</math> (1)  <math>R = 1.5 \Omega</math> (1)            Or: <math>I_{18\Omega} = \frac{12}{18}</math> [=0.67 A] (1); So <math>I_{\text{total}} = 2.67 \text{ A}</math> [ecf from (a)](1)  <math>R = \frac{4(1)}{2.67(\text{ecf})} = 1.5 \Omega</math> (1)</p> <p>(d) Graph shown with positive gradient and linear through the origin for low values (1) and smoothly reducing gradient for higher values [NB – not negative gradients at end](1)</p>	2 1 1 4 2 [10]
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4.	(a)	(i)	[For a metallic conductor] the potential difference and current are [directly] proportional/ $I \propto V$ (1), provided the temperature remains constant / all physical factors remain constant (1) $V = IR$ only no marks	2
		(ii)	It is constant / stays the same /increases as the temperature increases	1
	(b)	(i)	$A = 1.5(3) \times 10^{-3} [\text{m}^2]$ (1)	
			$R = \frac{\rho l}{A} = \frac{95 \times 10^{-8} \times 3.2}{1.5(3) \times 10^{-3}}$ (1) = 199 $[\Omega]$ (1)	3
		(ii)	$\frac{230^2}{200} = 265$ [W] allow e.c.f. from (b)(i)	1
		(iii)	$\frac{1}{66.7(1)} = \frac{1}{200} + \frac{1}{R_2}$ (1)	
			$R_2 = 100$ $[\Omega]$ (1)	3
		(iv)	$R_2$ (1) either reference to $\frac{V^2}{R}$ so lower $R$ / same $V$ across lower $R$ or reference to $I^2R$ so greater $I$ or reference to $IV$ so $I$ increased [for constant $V$ ] or correct calculation of $R_2$ (1)	2
		(v)	$\frac{230}{66.7} = 3.5$ [A] allow e.c.f. from (b)(iii)	1

(a)	(i)	[For a metallic conductor] the potential difference and current are [directly] proportional/ $I \propto V$ (1), provided the temperature remains constant / all physical factors remain constant (1) $V = IR$ only no marks	2
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	(v)	$\frac{230}{66.7} = 3.5$ [A] allow e.c.f. from (b)(iii)	1

5.	(a)	(i)	Metal wire at constant temperature - straight diagonal line. Filament of lamp - curved line.	[1]
		(ii)	Straight line: $R$ constant throughout [or $VI$ constant] as... (1) ... $T$ constant throughout (1) Curve: Initially $R$ constant [or $VI$ constant] as... (1) Then $T$ increases (1) so $R$ increases - accept explanation in terms of particles (1)	[5]
	(b)	(i)	$I = 2 \text{ [A]}$	[1]
		(ii) (I)	Voltage across X = 12 [V]	[1]
		(II)	$12 \text{ V} - 6 \text{ V} = 6 \text{ [V]}$ ecf from (I)	[1]
		(III)	$R_1 = \frac{6}{4} = 1.5 \text{ [\Omega]}$ ecf from (II)	[1]
		(IV)	$V$ across $R_1 = 3 \text{ [V]}$ (1) $I$ through $R_1 = 6 \text{ [A]}$ (1) $R_1 = \frac{3}{6}$ (ecf on $I$ and/or $V$ ) = $0.5 \text{ [\Omega]}$ (1)	[3]