Marking Scheme

1.

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		Rate of flow of electric charge/electrons (1)	1			1		
	(b)	(i)	During t = 0 to t = 0.8 s current (or I) = 0 (1) Then there is a sudden increase at 0.8 s (1) Value of current = $\frac{1.5}{0.2}$ = 7.5 A (1) Current = 0 from t = 1.0 to 2.5 s (1)		4		4		
		(ii)	Tangent drawn to the graph at t = 3.0 s (1) Gradient calculated correctly (ignore negative sign) (1) Current in the range 1.0 ± 0.1 A (1)			3	3	3	
			Question 4 total	1	4	3	8	3	0

2.

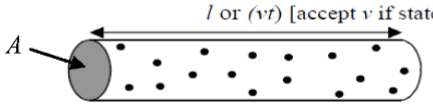
(a) n- number of free/conducting electrons (charge carriers) per unit volume (1) accept free electron density
v- drift velocity (1) [2]

(b) LHS: $C\,s^{-1}$ (1)
RHS: $m^{-3} \times m^2 \times m\,s^{-1} \times C$ (1)
Clear manipulation to show/state LHS = RHS (1) [3]

(c) (i) $v = \frac{I}{nAe}$ (1) (or correct substitution)
$v = 1.30 \times 10^{-4}\ m\,s^{-1}$ (1) (-1 for slips in powers of 10)
$t = \frac{5.0}{1.30 \times 10^{-4}} = 3.85 \times 10^{4}$ [s] (1) ecf for incorrect value of v [3]

(ii) Reduced CSA (or diameter) **and** n, e constant..... (1)
...Increased v ..... (1)
.....Hence reduced t (1) [3]

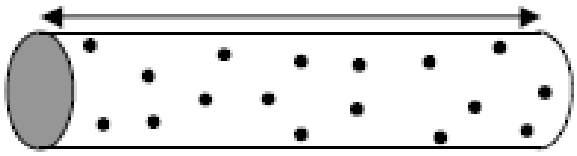
3.

Question				Marking details	Marks Available
3	*(a)*	(i)		[Free] electrons forced to move by applied pd (Need a reference to drift velocity or electron flow but does not need to be explicitly stated) (1) They collide with atoms/nuclei/ions/lattice of the wire (1) don't accept particles or molecules	2
		(ii)		Power = $\frac{1.8}{60}$ = 0.03 [W] (1) $R = \frac{0.03(\text{ecf})}{1.6^2}$ = 0.0117 [Ω] (1) **Alternative solution possible** for the first 2 marks using $V = \frac{W}{Q}$ and $R = \frac{V}{I}$ $\rho = \frac{0.0117 \text{x} 2 \text{x} 10^{-6}}{0.4}$ (1) [**ecf** on R] = 5.9×10^{-8} [Ω m] (1)	4
	(b)	(i)		l or (vt) [accept v if stated dist travelled in 1 s]  [NB free electrons not required to be labelled] Number of free electrons = $nAvt$ [**or** nAl] (1) Total change = $nAvte$ [**or** $nAle$] (1) $I = \frac{nAvte}{t}$ with cancelling shown [or $\frac{nAle}{t}$, where $\frac{l}{t} = v$ shown] (1) Volume defined either from diagram [e.g. A and l labelled as shown] or in body of derivation [e.g. vol = Al] and n identified correctly– **for the first mark**	4
		(ii)		$1.6 = 6.4 \times 10^{28} \times 2 \times 10^{-6} \times v \times 1.6 \times 10^{-19}$ (1: substitution) $v = 7.8 \times 10^{-5}$ [m s^{-1}] (1)	2
		(iii)	(I) (II) (III)	**less than 1.6 A** identified/circled (1) **the same as** identified/circled (1) **half** identified/circled (1)	3
				Question 3 Total	**[15]**

4.

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

(1)



[NB free electrons not required to be labelled]

Number of free electrons = $nAvt$ [**or** nAl] (1)
Total change = $nAvte$ [**or** $nAle$] (1)
$I = \frac{nAvte}{t}$ with cancelling shown [or $\frac{nAle}{t}$, where $\frac{l}{t} = v$ shown] (1) 4

$2.0 = 1.0\times10^{29}\times1.7\times10^{-6}v\times1.6\times10^{-19}$ (1) [substitution]
$v = 7.4\times10^{-5}$ m s^{-1} ((**unit**))(1) 2

collisions [accept obstructions](1)
between free electrons and copper atoms / ions / lattice (1) [accept: delocalised / moving / conducting electrons] 2

$R = \frac{P}{I^2}$ [or $P = I^2R$] (1); $R = \frac{0.1}{4}$ [=0.025 Ω] (1)
$\rho = \frac{0.025[\text{e.c.f.}]\times1.7\times10^{-6}}{2.5}$ (1) [manipulation i.e $\rho = \frac{RA}{l}$ or with figures]
$\rho = 1.7\times10^{-8}$ Ω m. (1) 4

cross-sectional area	smaller (1)
n	the same (1)
resistivity	the same (1)

3

[15]