

Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
	Calculates cross-sectional area of wire (1) Reading two pairs of corresponding values from the graph (1) Uses gradient = $\frac{\rho}{A}$ (1) Or Use of $R = \frac{\rho l}{A}$ ρ in the range $4.75 \times 10^{-7} \Omega \text{ m}$ to $4.95 \times 10^{-7} \Omega \text{ m}$ (1) Calculated value of ρ compared with value in table and consistent conclusion (1)	<u>Example of calculation</u> $A = \frac{\pi \times (2.4 \times 10^{-4} \text{ m})^2}{4}$ $= 4.52 \times 10^{-8} \text{ m}^2$ Gradient = $10.7 \Omega \text{ m}$ $10.7 \Omega \text{ m} = \frac{\rho}{4.52 \times 10^{-8} \text{ m}^2}$ $\rho = 4.83 \times 10^{-7} \Omega \text{ m}$ $4.83 \times 10^{-7} \Omega \text{ m}$ is closest to $4.90 \times 10^{-7} \Omega \text{ m}$ so wire is constantan	5
	Total for question		5

Q2.

Question Number	Answer	Mark																								
a	<u>Diameter</u> of wire with a micrometer or digital calliper (1)	(3)																								
	<u>Length</u> of wire using a metre rule (1)																									
	Potential difference (in parallel with the wire) with a voltmeter and current (in series with the wire) with an ammeter																									
	Or resistance, using an ohmmeter (in parallel with the wire) (1)																									
b	Use of πr^2 or $\pi d^2/4$ (1)	(3)																								
	Suitable axes (1)																									
	Corresponding gradient to give resistivity (MP3 dependent on MP2) (1)																									
	Some examples of appropriate axes																									
	<table><tr><td>y-axis</td><td>x-axis</td><td>gradient</td></tr><tr><td>R</td><td>l</td><td>ρ / A</td></tr><tr><td>R</td><td>l/A</td><td>ρ</td></tr><tr><td>RA</td><td>l</td><td>ρ</td></tr><tr><td>l</td><td>R</td><td>A / ρ</td></tr><tr><td>l</td><td>RA</td><td>$1 / \rho$</td></tr><tr><td>l/A</td><td>R</td><td>$1 / \rho$</td></tr><tr><td>V</td><td>Il</td><td>ρ / A</td></tr></table>		y-axis	x-axis	gradient	R	l	ρ / A	R	l/A	ρ	RA	l	ρ	l	R	A / ρ	l	RA	$1 / \rho$	l/A	R	$1 / \rho$	V	Il	ρ / A
	y-axis		x-axis	gradient																						
	R		l	ρ / A																						
	R		l/A	ρ																						
	RA		l	ρ																						
	l		R	A / ρ																						
l	RA	$1 / \rho$																								
l/A	R	$1 / \rho$																								
V	Il	ρ / A																								
Total for question		6																								

Q3.

Question Number	Answer	Mark
(a)	Power supply, ammeter, variable resistor and nichrome wire all in series (1) Voltmeter in parallel across nichrome wire (1)	2
(b)(i)	Gradient calculated (1) Or value of p.d. read off for a corresponding length (1) Gradient uses more than half of the graph Or value of p.d. used is greater than 2.0V (1) Or value of length used is greater than 0.5m (1) Use of $R = \rho l / A$ and $R = V / I$ (1) Or Use of $\rho = (\text{gradient} \times A) / l$ (1) $\rho = 1.1 \times 10^{-6} \Omega \text{m}$ (1) (MP1 – Values read off graph need to be within $\frac{1}{2}$ a square) (MP1 – Gradient should be in the range $4.1 - 4.2 \text{ Vm}^{-1}$) <u>Example of calculation</u> Gradient = $V / l = (4.15 \text{ V} / 1.00 \text{ m}) = 4.15 \text{ Vm}^{-1}$ $V / l = \rho l / A$, so $\rho = (\text{gradient} \times A) / l$ $= (4.15 \text{ Vm}^{-1} \times 5.31 \times 10^{-8} \text{ m}^2) / 0.200 \text{ A} = 1.10 \times 10^{-6} \Omega \text{m}$	4
(b)(ii)	V value read from graph = 3.1V (1) Use of $P = VI$ (1) $P = 0.62 \text{ W}$ (1) (MP1 – allow use of resistivity equation with answer from (i) used to calculate V or R) (MP2 – allow combination of equations e.g. $R = V/I$ followed by $P = I^2 R$) (MP3 – allow variation of value if using resistivity value that rounds to $1.1 \times 10^{-6} \Omega \text{m}$ from (i)) <u>Example of calculation</u> $P = VI = (3.1 \text{ V} \times 0.200 \text{ A}) = 0.62 \text{ W}$	3
Total for Question		9

Q4.

Question Number	Answer	Mark
(a)(i)	The resistance of a sample of the material of unit <u>cross sectional area</u> and unit length Or $\rho = \frac{RA}{l}$ with terms defined (1)	1
(a)(ii)	Measure the L using a metre rule (1) Measure the thickness of the material using a micrometer Or Measure the thickness of the material using vernier callipers (1) Use an ammeter and voltmeter to determine the resistance using $R = \frac{V}{I}$ Or Use an ohmmeter to measure the resistance of the sample (1) Use $\rho = \frac{RA}{l}$ to determine the resistivity (1) Or valid description of a graph and gradient calculation to determine the resistivity (1)	4
(b)	Copper has a high concentration of charge carriers (1) $I = nAqv$ so (for a given current) drift velocity is small (1)	2

(c)	The same potential difference is applied across each additional panel (1) So each panel dissipates the same power, and power output of the system increases (1) OR As more panels are connected, the resistance (of the system) decreases (and potential difference remains the same) (1) And $P = \frac{V^2}{R}$ so power output of the system increases (1) OR As more panels are connected, the current in the power supply increases (and potential difference across each panel is the same) (1) And $P = VI$ so power output of the system increases (1) OR As more panels are connected, the current in the power supply increases and the resistance of the system decreases by the same factor (1) And $P = I^2R$ so power output of the system increases (1)	2
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(d)	Use of $A = \text{length} \times \text{thickness}$	(1)	5
	Use of $\rho = \frac{RA}{l}$	(1)	
	Use of $R_{\text{total}} = \frac{R_{1 \text{ panel}}}{5}$	(1)	
	Use of $P = \frac{V^2}{R}$	(1)	
	680 W is greater than 350 W so the system is not safe	(1)	
	OR		
	Use of $A = \text{length} \times \text{thickness}$	(1)	
	Use of $\rho = \frac{RA}{l}$	(1)	
	Use of $P = \frac{V^2}{R}$	(1)	
	Use of $P_{\text{total}} = 5 \times P_{1 \text{ panel}}$	(1)	
	680 W is greater than 350 W so the system is not safe	(1)	
	<u>Example of calculation</u>		
	$A = 1.60 \text{ m} \times 0.48 \times 10^{-3} \text{ m} = 7.68 \times 10^{-4} \text{ m}^2$		
$R = \frac{6.4 \times 10^{-3} \Omega \text{ m} \times 0.51 \text{ m}}{7.68 \times 10^{-4} \text{ m}^2} = 4.25 \Omega$			
$R_{\text{total}} = \frac{4.25 \Omega}{5} = 0.85 \Omega$			
$P = \frac{(24 \text{ V})^2}{0.85 \Omega} = 678 \text{ W}$			
Total for question			14