Resistance, Components and Resistivity - Mark Scheme

Q1.

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>* a</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5–4</td><td>3</td></tr>
<tr><td>3–2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
Indicative content

• When temperature is higher, greater energy to electrons (in thermistor)
• When temperature is higher, more conduction/free electrons
• When temperature is higher, lower resistance in thermistor
• Decreased p.d. across thermistor / YZ
Or current in circuit/thermistor increases
• Increased p.d. across fixed resistor Or increased p.d. across XY
• So for the air conditioning application, secondary circuit should be across XY

(Allow converse statements for IC 1,2, 3 and 4)
(Do not allow contradicting statements for IC4 e.g. lower V so lower I)
</td><td>(6)</td></tr>
</table>

b	Ratio of p.d.s to resistances	(1)	
	See either 775 Ω **or** 263 Ω for light dependent resistor	(1)	
	Difference = (−) 512 Ω	(1)	
	Or		
	Use of $R = V/I$ to calculate current	(1)	
	See either 775 Ω **or** 263 Ω for light dependent resistor	(1)	
	Difference = (−) 512 Ω	(1)	**(3)**
	Example of calculation $\frac{7.29\text{ V}}{4.71\text{ V}} = \frac{1200\ \Omega}{R}$ so $R = 775\ \Omega$ $\frac{9.84\text{ V}}{2.16\text{ V}} = \frac{1200\ \Omega}{R}$ so $R = 263\ \Omega$ Difference in resistance = 263 Ω - 775 Ω = (−) 512 Ω		
	Total for question		**9**

Q2.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as this is the graph for a fixed resistor B is not the correct answer as this is the graph for a filament lamp D is not the correct answer as this graph does not match any component	**(1)**

Q3.

Question Number	Answer		Mark
	Use of $A = \pi r^2$	(1)	
	Use of $R = \rho l/A$	(1)	
	Resistivity = 2.5×10^{-8} (Ω m) so aluminium	(1)	3
	(If candidates calculate A as 1.02×10^{-7} m^2 they get 2.6×10^{-8} Ω m) Example of calculation $A = \pi (0.18 \times 10^{-3})^2 = 1.0 \times 10^{-7}$ m^2. $\rho = RA/l = (50 \times 10^{-3}\ \Omega)\ (1.0 \times 10^{-7}\ \text{m}^2) / (0.200\ \text{m}) = 2.5 \times 10^{-8}\ \Omega\ \text{m}$		
	Total for question		**3**

Q4.

Question Number	Answer	Mark
a	The average/mean velocity of the (free) electrons (1) (allow "speed" for "velocity", and "charge carriers" for "electrons").	1
b	Use of $I = nqvA$ with e = (−)1.60 × 10^{-19} (C) (1) v = (−) 3.65 × 10^{-4} m s^{-1} (1) Example of calculation $v = I/nqA = \frac{1.31\ \text{A}}{(8.49 \times 10^{28}\ \text{m}^{-3})(1.60 \times 10^{-19}\ \text{C})(2.64 \times 10^{-7}\ \text{m}^2)}$ $v = 3.65 \times 10^{-4}$ m s^{-1}	2
	Total for question	3

Q5.

Question Number	Answer	Mark
a	Diameter of wire with a micrometer **or** digital calliper (1) Length 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)	(3)
b	Use of πr^2 or $\pi d^2/4$ (1) Suitable axes (1) Corresponding gradient to give resistivity (MP3 dependent on MP2) (1) Some examples of appropriate axes	(3)
	Total for question	6

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

Q6.

Question Number	Answer	Mark
	C is the correct answer as the resistance of both listed components decreases as the applied potential difference increases. A is not the correct answer as the resistance of an ohmic conductor remains constant when the applied potential difference increases. B is not the correct answer as the resistance of a filament lamp increases when the applied potential difference increases. D is not the correct answer as the resistance of a filament lamp increases when the applied potential difference increases.	**(1)**

Q7.

Question Number	Answer		Mark
a	See $V_T = V_1 + V_2$ See $IR_T = IR_1 + IR_2$ (Divides by I to give) $R_T = R_1 + R_2$	(1) (1) (1)	**3**
b	Use of $V = IR$ with 7.0V and 0.5A Use of $\frac{1}{Rtot} = \frac{1}{R1} + \frac{1}{R2}$ $R = 12\Omega$ **Or** Use of $V = IR$ with 6Ω and 0.5A (to get 3V across 6Ω resistor) Second use of $V = IR$ with $V = 4V$ $R = 12\Omega$ <u>Example of calculation</u> R for whole circuit = (7.0V/0.5A) = 14Ω So R for parallel section = $14 - 6 = 8\Omega$ $1/8 = 1/24 + 1/R_2$ $R_2 = 12\Omega$	(1) (1) (1) (1) (1) (1)	**3**

ci	Use of $V = IR$ to determine circuit current Use of $P = I^2R$ or $P = V^2/R$ or $P = VI$ $P = 1.5 \times 10^{-2}$ W **Or** Ratio of resistances used to calculate p.d. across R Use of $P = V^2/R$ $P = 1.5 \times 10^{-2}$ W Example of calculation $I = 12.0\ V / (8000 + 670\ \Omega) = 1.38 \times 10^{-3}$ A $P = (1.38 \times 10^{-3}\ A)^2 \times 8000 = 0.015$ W	(1) (1) (1) (1) (1) (1)	**3**
cii	Decrease in the number of conduction/ free electrons Greater resistance of LDR Less p.d. across the fixed resistor (allow "voltage" for "p.d.") Use of a suitable power equation to conclude that less power dissipated in the fixed resistor. (Converse argument not allowed for MP1 & MP2) (For MP4, do not accept an answer that includes an incorrect statement about one of the variables)	(1) (1) (1) (1)	**4**
	Total for question		**13**

Q8.

Question Number	Answer	Mark
	D is the correct answer (Drift velocity is I/nqA) A is not the correct answer as drift velocity is not I/nA B is not the correct answer as drift velocity is not nqA/I C is not the correct answer as drift velocity is not nA/I	**(1)**