Question	Answer	Marks
1 (a) (i)	The minimum resistance is when the resistors are all connected in **parallel**. $R = (10^{-1} + 20^{-1} + 40^{-1})^{-1}$ $R = 5.7\ \Omega$	1 1 1
1 (a) (ii)	The maximum resistance is when the resistors are all connected in **series**. $R = 10 + 20 + 40 = 70\ \Omega$	1 1
1 (b)	The resistance of the filament lamp depends on its temperature. At maximum brightness, the resistance of the lamp is a maximum. When the voltage is halved, the resistance of the lamp is not halved because it is a non-ohmic component; hence the current is not halved.	1 1
2 (a) (i) (1)	360 Ω	1
2 (a) (i) (2)	current	1
2 (a) (ii) (1)	$\frac{1}{10} + \frac{1}{20} + \frac{1}{40} = \frac{1}{R}$ R = 5.7 Ω	1 1
2 (a) (ii) (2)	potential difference	1
3 (a)	$R = (100^{-1} + 180^{-1})^{-1}$ $R = 64.3\ \Omega$	1 1
3 (b) (i)	p.d. across the resistors = 0.100 × 64.3 p.d across the resistors = 6.43 V p.d across the LED = 8.2 – 6.43 ≈ 1.8 V	1 1 1
3 (b) (ii)	$P = I^2 R = 0.100^2 \times 64.3$ $P = 0.64$ W	1 1
4 (a) (i)	Total current into a junction equals the total current out conservation of charge	1 1
4 (a) (ii)	sum of e.m.fs = sum (or total) of p.ds **or** sum of voltages in (or around) a closed loop in a circuit. energy is conserved	1 1
4 (b) (i)	current in 750 Ω = 0.020 A	1
4 (b) (ii)	V across 750 Ω = 0.02 × 750 = 15 V	1
4 (b) (iii)	$R_1 = \frac{45-15}{0.03} = 1000\ \Omega$ $R_2 = \frac{15}{0.01} = 1500\ \Omega$	1 1
5 (a)	R of thermistor decreases as temperature increases supply V is constant because the total R is smaller current increases as $V = I R$	1 1 1
5 (b)	R_{th} = 40 Ω at 240 °C should be stated or used in calculation total R in circuit = 240 Ω $I = \frac{6}{240} = 0.025$ A $V = 200 \times 0.025 = 5.0$ V	1 1 1 1
5 (c) (i)	correct symbol for LDR	1
5 (c) (ii)	R of LDR decreases as the current in the circuit increases so V increases across the fixed 200 Ω resistor	1 1
6 (a) (i)	$\frac{12}{2.0} = 6.0\ \Omega$	1
6 (a) (ii)	attempt to use resistors in parallel formula $\frac{1}{R} = \frac{8}{6}$ $R = 0.75\ \Omega$	1 1 1
6 (a) (iii)	$P = \frac{V^2}{R} = \frac{12^2}{0.75}$ or $8\ V I = 8 \times 12 \times 2$ or $I^2 R = 16^2 \times 0.75$ $P = 192$ W	1 1

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6 (b)</td><td>$\rho = \frac{RA}{L}$
$\rho = \frac{6.0 \times 0.24 \times 2.0 \times 10^{-6}}{0.9}$
$\rho = 3.2 \times 10^{-6}$
Ω m</td><td>1
1
1
1</td></tr>
<tr><td>7 (a)</td><td>e.m.f = sum of p.d.s
1.5 = 0.50 r + (0.50 × 1.0)
r = 2.0 Ω</td><td>1
1
1</td></tr>
<tr><td>7 (b) (i)</td><td>All values of I are correct
All values of P are correct
<table>
<tr><td>R / Ω</td><td>I / A</td><td>P / W</td></tr>
<tr><td>1.0</td><td>0.50</td><td>0.25</td></tr>
<tr><td>2.0</td><td>0.375 ≈ 0.38</td><td>0.28</td></tr>
<tr><td>4.0</td><td>0.25</td><td>0.25</td></tr>
</table></td><td>1
1</td></tr>
<tr><td>7 (b) (ii)</td><td>The power dissipated in maximum when resistance R of the variable resistor is equal to the internal resistance r of the cell.</td><td>1</td></tr>
<tr><td>8 (a)</td><td>The resistance between the contacts is very large / infinite.
Hence the current in the circuit is zero with no p.d. across the 200 kΩ resistor.</td><td>1
1</td></tr>
<tr><td>8 (b)</td><td>current = $\frac{6.5}{200 \times 10^{3}}$ = 3.25×10^{-5} A
$R = \frac{9.0 - 6.5}{3.25 \times 10^{-5}}$
$R = 7.7 \times 10^{3}$ Ω</td><td>1
1
1</td></tr>
<tr><td>8 (c)</td><td>The current in the circuit would be larger.
The p.d. across the contacts (when in water) would be larger.
Hence, the voltmeter reading would be smaller.</td><td>1
1
1</td></tr>
</table>