Question	Answer	Marks
1 (a)	Graph showing finite resistance value at 0°C. Resistance decreases as the temperature increases, see sketch graph. As temperature increases, the number density of the free electrons also increases.	1 1 1
1 (b)	The resistance of the LDR decreases as the intensity of light incident on it increases. The current in the circuit increases, hence the ammeter reading increases. The current $I = \frac{3.0}{R}$, where R is the resistance of the LDR. Hence $I \propto \frac{1}{R}$. The potential difference across the LDR remains at 3.0 V. Hence the voltmeter reading does not change as the intensity of light is increased.	1 1 1 1
2 (a)	Both have the same unit, the volt. For potential difference, the charge carriers (electrons) lose energy and for e.m.f., the charge carriers gain energy. Or For potential difference, the energy change is from electrical energy to thermal (heat) energy, whereas for e.m.f., the energy change is from chemical (etc) to electrical energy.	1 1 (1)
2 (b)	$W = VQ$; $100 = 1.5 \times Q$ $Q = 67$ C	1 1
2 (c)	energy gained by electron = kinetic energy; $eV = \frac{1}{2}mv^2$ $v = \sqrt{\frac{2 \times 1.60 \times 10^{-19} \times 1.5}{9.11 \times 10^{-31}}}$ $v = 7.3 \times 10^5$ m s^{-1} This speed is greater than 10 km s^{-1}; the suggestion is correct.	1 1 1 1
3 (a)	$\rho = \frac{RA}{L}$; R has unit Ω, A has units m^2 and L has unit m. Therefore resistivity ρ has units $\frac{\Omega\,m^2}{m} = \Omega\,m$	1 1
3 (b)	$R = \frac{\rho L}{A}$; $5.0 = \frac{5.0 \times 10^{-2} \times x}{x^2}$ $x = \frac{5.0 \times 10^{-2}}{5.0}$ $x = 1.0 \times 10^{-2}$ m	1 1 1
3 (c) (i)	Connect an ammeter in series with the wire and measure the current I. Connect a voltmeter across the wire (parallel) and measure the p.d. V. The resistance R is calculated using the equation $R = \frac{V}{I}$.	1 1 1
3 (c) (ii)	gradient of line = $\frac{\rho}{A}$ gradient = 1.5 Ω m^{-1} (allow ± 0.1 Ω m^{-1}) $\rho = 1.5 \times 7.8 \times 10^{-7}$ $\rho = 1.17 \times 10^{-6}$ Ω m	1 1 1 1
4 (a)	power = $\frac{\text{work done}}{\text{energy transferred per unit time}}$	1
4 (b) (i)	$P = VI$ $I = \frac{40}{230} = 0.174$ A	1 1
4 (b) (ii)	$R = \frac{230}{0.17} = 1400$ Ω	1
4 (c)	$l = \frac{RA}{\rho}$ $l = \frac{1.3 \times 10^3 \times 3.0 \times 10^{-8}}{7.0 \times 10^{-5}}$ $l = 0.56$ m	1 1 1

Question	Answer	Marks
5 (a) (i)	resistance = $\frac{\text{potential difference (across a component)}}{\text{current (in it)}}$	1
5 (a) (ii)	read 10 V from graph $R = \frac{V}{I} = \frac{10}{0.04}$ $R = 250\ \Omega$	1 1
5 (b)	$R = \frac{\rho l}{A}$ **or** $\rho = \frac{RA}{l}$ $\rho = 250 \times 1.2 \times 10^{-3}$ $\rho = 0.30\ \Omega\ \text{m}$	1 1 1
5 (c)	(graph curves so) R changes qualification: I increases faster than V increased temperature is caused by (larger) current in slice qualification: $P = I^2 R$ as R decreases, ρ decreases	1 1 1 1
6 (a)	The power dissipated is equal to VI, where V is the same. Hence the ratio of the powers is equal to the ratio of the currents. ratio = $\frac{6.0}{2.0} = 3.0$	1 1 1
6 (b)	The temperature of the thermistor increases due to the current in it. Therefore the resistance of the thermistor decreases. The current I in the thermistor increases because $I = \frac{V}{R}$ (V = constant). After about 15 s, the temperature of the thermistor stays constant and hence the current is also constant.	1 1 1 1
7 (a)	resistivity = $\frac{\text{resistance} \times \text{area (of cross-section)}}{\text{length}}$	1
7 (b) (i)	$R = \frac{\rho l}{A} = \frac{1.7 \times 10^{-8}}{6.4 \times 10^{-3}}$ $R = 2.7 \times 10^{-6}\ \Omega$	1 1
7 (b) (ii)	$P = I^2 R$ $P = 8000^2 \times 2.7 \times 10^{-6}$ $P = 170\ \text{W}$	1 1 1
7 (b) (iii)	170 × 9.0 = 1530 W **or** 170 × 24 = 4080 W 1.5 × 24 = 36 kW h 4.08 × 9 = 36.7 kW h	1 1
7 (b) (iv)	36 × 15 = 540 p	1
8 (a)	resistivity = $\frac{\text{resistance} \times \text{cross-sectional area}}{\text{length}}$	1
8 (b)	Connect the ends of the 'lead' to a supply/cell/battery (using crocodile clips). Connect an ammeter in series and place a voltmeter across the lead. Calculate the resistance R by dividing the voltage by the current. Measure the diameter d of the lead using a micrometer (screw gauge) and the length L using a ruler. Calculate the resistivity ρ using: $\rho = \frac{R \times \pi d^2}{4L}$	1 1 1 1 1
8 (c) (i)	$h = \frac{8.0 \times 10^{-6}}{1.2 \times 10^{-4}}$ $h = 6.67 \times 10^{-2}\ \text{m}$	1 1
8 (c) (ii)	$R = \frac{\rho L}{A} = \frac{5.2 \times 10^{-4} \times 0.0667}{1.2 \times 10^{-4}}$ $(L = h)$ $R = 0.29\ \Omega$	2 1
8 (c) (iii)	The cross-sectional area A increases by a factor of 4. The height h of the paint column will therefore decrease by a factor of 4. $R \propto \frac{h}{A}$, hence the resistance will decrease by a factor of $4^2 = 16$.	1 1 1

9 Energy, power, and resistance
Answers to practice questions

Question	Answer	Marks
9 (a) (i)	$R = \frac{\rho l}{A}$ $A = \pi \times (3.5 \times 10^{-5})^2$ or $A = 3.849 \times 10^{-9}$ $R = \frac{1.70 \times 10^{-8} \times 12}{\pi(3.50 \times 10^{-5})^2}$ resistance = 53 Ω	1 1 1
9 (a) (ii)	The (26) wires are in parallel	1
9 (b) (i)	$P = \frac{V^2}{R} = VI$ $I = \frac{24}{6.0} = 4.0$ A $R = \frac{6.0^2}{24} = \frac{6.0}{4.0}$ resistance = 1.5 Ω	1 1
9 (b) (ii)	There is a potential difference across the cable(s)	1
9 (b) (iii)	potential difference across cable = 4.0 × 2.04 = 8.16 V or potential difference across cable = 4.0 × 2 = 8 V e.m.f = 6.0 + 2 × 8.16 ≈ 6.0 + 2 × 8 e.m.f = 22.3 V	1 1