1. (a) resistors in series add to 20 Ω and current is 0.60 A

__accept__ potential divider stated __or__ formula **B1**

so p.d. across XY is 0.60 × 12 (= 7.2 V)

gives (12 /20) × 12 V (= 7.2)V **B1**

(b) (i) the resistance of the LDR decreases **M1**

(so total resistance in circuit decreases) and current increases **A1**

(ii) resistance of LDR and 12 Ω (in parallel)/across **XY** decreases **B1**

so has smaller share of supply p.d. (and p.d. across XY falls)

***alternative** I increases so p.d. across 8.0 Ω increases; so p.d. across **XY** falls* **B1**

[6]

2. (a) Line crosses 'y-axis' at 1.4 (V) / $V = E$ or 1.4(V) when $I = 0$
$V = E - Ir$; since $I = 0$ (Hence $V = E$ or 1.4(V)) B1

(b) (i) (Graph extrapolated to give) current = 2.0 (A)
(Allow tolerance ± 0.1A) B1

(ii) $E = I_{(max)}\, r$ gradient = r (Ignore sign) C1

$\left(r = \frac{1.4}{2.0}\right)$ (Attempt made to find gradient)

r = 0.7(0) (Ω) r = 0.7(0) (Ω) (Possible ecf) A1

(iii) (excessive) heating of cell / energy wasted internally /
cell might 'explode' / cell goes 'flat' (quickly) B1

[5]

3. (a) No current (in circuit) / 'open' circuit / p.d. between **X** and **Y** is 5.0 V — B1

(b) $V = \frac{R_2}{R_1 + R_2} \times V_0$ / $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ / $I = \frac{3.4}{168}(= 2.02) \times 10^{-2}$ mA — C1

$3.4 = \frac{168}{168 + R} \times 5.0$ / $\frac{1.6}{3.4} = \frac{R}{168}$ / $R = \frac{1.6}{2.02 x 10^{-2}}$ — C1

resistance ≈ 79 (kΩ) (Total resistance of 250 kΩ scores 2/3) — A1

[4]

4. (a) <u>Energy</u> (transformed by a device working) at 1 kW for 1 hour — B1

(b) $E = Pt$ / 5.8 = 0.12 × time / (time =) 48.3 (hr) — C1
(time =) $1.74 \times 10^5 \approx 1.7 \times 10^5$ (s) — A1

[3]

5. (a) (i) Correctly selected and re-arranged: $\rho = RA/L$; — M1
symbols defined: A = <u>cross-sectional</u> area, R = resistance, L = length — A1

(ii) ρ is independent of dimensions of the specimen of the material/AW — B1

(b) $R = 1.7 \times 10^{-8} \times 0.08/3.0 \times 10^{-4}$ — C1
$R = 4.5(3)\ 10^{-6}$ (Ω) — A1

[5]

6. (a) (i) Q = It with knowledge of what the symbols mean (1)
= 0.050 × 4.0 × 3600 (1)
= 720 (C) (1) — 3

(ii) E = QV with knowledge of what the symbols mean (1)
= 720 × 6.0 = 4320 (J) (1) — 2

(b) chemical (potential) (energy) (1) — 1

(c) (i) I = 4.0/48 = 0.5/r (ie by proportion or by finding current) (1)
r = 24/4 = 6 (Ω) (1) — 2

(ii) E = V2t/R with knowledge of what the symbols mean (1)
= 4.02 × 2700 / 48 (1)
= 900 (J) (1) — 3

(iii) 900/4320 = 5/24 = (0.208) (1) 1

(d) because the p.d. across it (4.5 – 4.0) is known only to 1 sig.fig. 1

[13]

7. (i) **M** marked at the end of the graph B1

(ii) current is 5 (A) and p.d is 6 (V) C1
$P = VI$ \ $p = 6.0 \times 5.0$
(Allow $p = I^2 R$ or $p = V^2$ \ R) C1
power = 30 (W) A1

(iii) **1.** $V_L = 1.0$ (V) (From the I/V graph) \ $R_L = 1.0/2.0$ or 0.5 (Ω) M1
$V_R = 1.2 \times 2.0$ \ $R_T = 1.2 + 0.5$ M1
$V = 1.0 + 2.4$ \ $V = 1.7 \times 2.0$ A1
voltmeter reading = 3.4 (V) A0

2. Vr = 4.5 – 3.4 (= 1.1 V) \ 4.5 = 2.0r + 3.4 (Possible ecf) C1

$$r = \frac{1.1}{2.0}$$

r = 0.55 (Ω) (1.05 Ω scores 0/2 since the lamp is ignored) A1

[9]

8. (i) p.d.: energy transferred per unit charge from electrical form (into other forms, e.g. light/heat) B1
e.m.f.: energy transferred per unit charge into electrical form (from other forms, e.g. chemical/mechanical) B1

(ii) $J\,C^{-1}$ B1

[3]

9. (a) (i) resistance decreases/falls/drops (with increase in temperature) B1

(ii) 100 ± 10 Ω B1

(iii) for low temps ΔR is large for $\Delta\theta$ and at high temps ΔR is small for same $\Delta\theta$; so sensitivity decreases (continuously)from low to high temperatures B1 B1

(b)	(i)	correct circuit symbol	B1
	(ii)	connections in parallel with fixed resistor B1	B1
	(iii)	R_{th} = 100 to 105 Ω	B1
		$R_{tot} = 200 + R_{th}$	M1
		$I = V/R_{tot} = 6/R_{tot}$ (= 0.02 A)	A1
	(iv)	(V = IR = 0.02 × 200) = 4.0 (V)	A1

[10]

10. Current is (directly) proportional to potential difference (for a metal conductor) M1
provided the temperature \ (all) physical condition(s) remains constant A1

[2]