

1. (a) resistors in series add to 20Ω and current is 0.60 A
accept potential divider stated or formula B1
- so p.d. across XY is $0.60 \times 12 (= 7.2 \text{ V})$
gives $(12/20) \times 12 \text{ V} (= 7.2 \text{ V})$ 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 12Ω (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 8.0Ω increases; so p.d. across XY falls B1
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 $\pm 0.1 \text{ A}$) B1
- (ii) $E = I_{(\text{max})} r$ gradient = r (Ignore sign) C1
 $(r = \frac{1.4}{2.0})$ (Attempt made to find gradient)
 $r = 0.7(0) \text{ (}\Omega\text{)}$ $r = 0.7(0) \text{ (}\Omega\text{)}$ (Possible ecf) A1
- (iii) (excessive) heating of cell / energy wasted internally /
 cell might 'explode' / cell goes 'flat' (quickly) B1

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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
- $3.4 = \frac{168}{168 + R} \times 5.0$ / $\frac{1.6}{3.4} = \frac{R}{168}$ / $R = \frac{1.6}{2.02 \times 10^{-2}}$ C1
- resistance ≈ 79 (k Ω) (Total resistance of 250 k Ω scores 2/3) A1

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4. (a) Energy (transformed by a device working) at 1 kW for 1 hour B1
- (b) $E = Pt / 5.8 = 0.12 \times \text{time} / (\text{time} =) 48.3$ (hr) C1
- (time =) $1.74 \times 10^5 \approx 1.7 \times 10^5$ (s) A1

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5. (a) (i) Correctly selected and re-arranged: $\rho = RA/L$; M1
symbols defined: $A =$ cross-sectional 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

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6. (a) (i) $Q = It$ with knowledge of what the symbols mean (1)
 $= 0.050 \times 4.0 \times 3600$ (1)
 $= 720$ (C) (1) 3
- (ii) $E = QV$ with knowledge of what the symbols mean (1)
 $= 720 \times 6.0 = 4320$ (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) $E = V^2t/R$ with knowledge of what the symbols mean (1)
 $= 4.02 \times 2700 / 48$ (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
- 7.**
- (i) **M** marked at the end of the graph B1
- (ii) current is 5 (A) and p.d is 6 (V) C1
 $P = VI \setminus p = 6.0 \times 5.0$
 (Allow $p = I^2 R$ or $p = V^2 \setminus R$) C1
 power = 30 (W) A1
- (iii) **1.** $V_L = 1.0$ (V) (From the I/V graph) $\setminus R_L = 1.0/2.0$ or 0.5 (Ω) M1
 $V_R = 1.2 \times 2.0 \setminus R_T = 1.2 + 0.5$ M1
 $V = 1.0 + 2.4 \setminus V = 1.7 \times 2.0$ A1
 voltmeter reading = 3.4 (V) A0
- 2.** $V_r = 4.5 - 3.4 (= 1.1 \text{ V}) \setminus 4.5 = 2.0r + 3.4$ (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
- 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
- 9.**
- (a) (i) resistance decreases/falls/drops (with increase in temperature) B1
 (ii) $100 \pm 10 \Omega$ 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

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

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

[2]