Question	Expected Answers	Marks
1		
(a)	10^{-2} to 10^{-1} (m) (A low range 0.0005 m to 0.15 m)	B1
(b)	Any one from: 1. Travels at the speed of light / 3×10^8 (ms^{-1} in vacuum) 2. Travel in vacuum (A low 'free space' but not just 'space') 3. Transverse (wave) / can be polarised 4. Consists of oscillating electric and magnetic fields 5. Can be reflected / refracted / diffracted / shows interference 6. (Behave as) photon(s) 7. Warms food	B1
(c)	(e.m.f. =) $\frac{W}{Q}$ / (e.m.f. =) $\frac{78}{24}$ (e.m.f. =) 3.25 = 3.3 (V)	C1 A1 **[Total: 4]**
2		
(a)	Energy (transformed by a device working) at 1 kW for 1 hour	B1
(b)	$E = Pt$ / 5.8 = 0.12 × time / (time =) 48.3 (hr) (time =) $1.74 \times 10^5 = 1.7 \times 10^5$ (s)	C1 A1 **[Total: 3]**

Question 3	Expected Answers	Marks
(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
(b)(ii)	$E = I_{short}\, r$ $(r = \frac{1.4}{2.0})$ $r = 0.7$ (Ω) (Ω) gradient = r (Ignore sign) (Attempt made to find gradient) $r = 0.7$(0) (Ω) (Possible ecf)	C1 A1
(b)(iii)	(excessive) heating of cell / energy wasted internally / cell might 'explode' / cell goes 'flat' (quickly)	B1
		[Total: 5]

Question 4	Expected Answers	Marks
(a)	Correct circuit for both lamps in parallel (ignore ammeter here) Ammeter placed correctly in series with P	B1 B1
(b)(i)	The resistance of LDR/circuit changes (as light intensity changes) When blade blocks light, resistance of LDR/circuit is large(r) (ora) Correct statement about p.d. (Possible ecf)	B1 B1 B1
(b)(ii)1.	$(V = 5.0 - 3.0)$ 2.0 (V) (Allow 1 sf answer)	B1
(b)(ii)2.	$V = \frac{R_2}{R_1 + R_2} \times V_S$ | $I = 2.0/2200$ / 9.1×10^{-4} (A) $(3.0 = \frac{R}{R + 2200} \times 5.0)$ | $(R = 3.0 / 9.1 \times 10^{-4})$ $R = 3300\ (\Omega)$ | $R = 3300\ (\Omega)$ Possible ecf (For $V_{OR} = 2.0$ V, $R = 1.47$ kΩ. This scores 1/2) (If 3.5 V given in **(b)(ii)**1., then $R = 940\ \Omega$. This scores 2/2)	C1 A1
		[Total: 8]

Question	Expected Answers	Marks
5		
(a)	(resistance =) p.d./current (Allow use of 'voltage') ((resistance =) ratio of p.d. to current 2/2) ((resistance =) voltage per (unit) current 2/2) ((*R* =) *V*/*I* scores 1/2) ((resistance =) voltage per (unit) ampere scores 1/2)	B2
(b)(i)	Parallel	B1
(b)(ii)1.	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ / $\frac{1}{R} = \frac{3}{15}$	C1
	(*R* =) 5 Ω (Allow 1 sf answer)	A1
(b)(ii)2.	$P = \frac{V^2}{R}$ (Allow $P = VI$ or $P = I^2R$)	C1
	$(P = \frac{12^2}{5})$	A1
	P = 24 (W) (Possible ecf from (b)(ii)1.) (If 15 Ω used, *P* = 8 (W) Allow 1/2)	
(b)(ii)3.	$R = \frac{\rho L}{A}$ (Allow other subject)	C1
	$15 = \frac{6.9\times10^{-6}\times0.85}{A}$	C1
	$A = 3.26 \times 10^{-7} = 3.3 \times 10^{-7}$ (m^2)	A1
	(3.3×10^{-5} (m^2) scores 2/3) (If *R* = 6.0 Ω then $A = 9.8 \times 10^{-7}$ (m^2) This scores 2/3)	[Total: 10]

Question 6	Expected Answers	Marks
(a)	Arrow towards the cloud	B1
(b)	Into the page (No ecf from (a))	B1
(c)(i)1.	$I = \frac{\Delta Q}{\Delta t}$ (Allow other subject, with or without Δ) (charge =) 7800 × 0.23 1.794 × 10^3 = 1.8 × 10^3 (C) (Ignore minus sign) (1.8 × 10^3 (C) scores 2/3)	C1 C1 A1
(c)(i)2.	(number =) $\frac{1.79 \times 10^3}{e}$ (Possible ecf) (number =) 1.12 × 10^{22} = 1.1 × 10^{22}	C1 A1
(c)(ii)	$F = BIl$ (F =) 42 × 10^{-6} × 7800 × 250 (F =) 81.9 = 82 (8.2 × 10^1 scores 2/3) newton / N / TAm / Jm^{-1}	C1 C1 A1 B1
		[Total: 11]

Question	Expected Answers	Marks
7		
(a)	Any five from: 1. Photoelectric (effect) mentioned 2. Photon(s) mentioned in correct context / $E = hf$ 3. One-to-one interaction between photon & electron 4. Surface electrons are involved 5. Electron released / photoelectric (effect) when photon energy > ϕ – work function (energy) 6. Electrons emitted / photoelectric (effect) when frequency > f_0 – threshold frequency 7. Energy is conserved (in the interaction between photon and electron) 8. Reference to Einstein's equation: $hf = \phi + KE_{max}$	B1 × 5
	[QWC: Spelling and Grammar]	B1
(b)(i)1.	(energy of photon = 2.2 + 0.3) 2.5 (eV)	B1
(b)(i)2.	(energy =) $2.5 \times 1.6 \times 10^{-19}$ (Possible ecf from (b)(i)1.) 4.0×10^{-19} (J) (Allow 1 s.f. answer)	C1 A1
(b)(ii)	$(f =) \frac{4.0 \times 10^{-19}}{h}$ (Possible ecf)	C1
	$(f = \frac{4.0 \times 10^{-19}}{6.63 \times 10^{-34}})$ $(f =) 6.03 \times 10^{14} \approx 6.0 \times 10^{14}$ (Hz) (Allow 6×10^{14})	A1
(c)	Each photon has more energy / There are fewer photons (in a given time because intensity is the same) Smaller current	B1 B1
		[Total: 13]

Question	Expected Answers	Marks
8	Any <u>five</u> from: 1. Electrons travel / move as a wave 2. Electrons show diffraction / interference (effects) 3. Diffraction (is noticeable) when λ comparable to 'gap' size 4. Mention of de Broglie equation: $\lambda = \frac{h}{mv}$ 5. λ, h, m and v correctly identified in 4 above 6. Graphite / matter / atoms / nuclei / small gap(s) needed to diffract electrons 7. Experimental evidence '(diffraction) rings' / 'fringes' (Can score on a diagram)	B1 × 5
	[QWC Organisation]	B1
		[Total: 6]