1

(a)	Electron flow is in opposite direction (to conventional current)	B1
(b)	Correct symbol for the LDR	B1
	(Resistance of LDR) decreases with increased intensity / brightness / light (AW)	B1
(c)	current ∝ p.d. (Allow 'voltage' instead of p.d.)	B1
	(provided the) temperature (of metallic conductor) remains constant	B1
	(voltage = current × resistance scores 0/2)	
	($V = IR$ and R = constant scores 0/2)	
(d)(i)1.	R-V graph for metallic conductor:	
	shows R = constant / 'horizontal line'	B1
(d)(i)2.	R-V graph for thermistor:	
	shows R has a <u>finite</u> value at $V = 0$	B1
	shows R decreases as V increases (Allow a 'curve' or 'straight line')	B1
(d)(ii)1.	Any <u>two</u> from:	
	The resistances larger / line (graph) higher (and horizontal) (Can score on Fig.1.2 a)	
	The electrons collide more often / frequently (with vibrating atoms)	
	The atoms / ions vibrate 'more' (Do not allow '*particles*' vibrate)	B1 × 2
(d)(ii)2.	The resistance increases / doubles (Can be scored on Fig.1.2a)	M1
	Mention of: $R \propto L$ or $R = \frac{\rho l}{A}$.	A1

[Total: 12]

2

(a)	(Magnetic) flux density / (magnetic) field strength	B1
(b)	$B = \frac{F}{Il}$ and T → N/(Am)	B1
(c)(i)	First / index (finger): (Direction of magnetic) field Second / middle (finger): (Direction of conventional) current Thumb: (Direction of) force or motion	
	Correct identification of fingers and thumb	B1
(c)(ii)	Out from (the plane of) paper (Do not allow 'upwards')	B1
(d)	$F = BIl$ Allow any subject	C1
	$B = \frac{1.4}{0.078}$	C1
	$B = 17.949 \approx 18$ (T) (10^n error: 1.8×10^{-2} (T) scores 2/3)	A1
		[Total: 7]

3

(a)	The energy transformed by a 1 kW device in a time of 1 hour	B1
(b)(i)1.	time = 4.0 × 7 = 28 (hours) / power = 0.11 (kW)	C1
	number of kW h = 0.110 × 28	
	number of kW h = 3.08 ≈ 3.1 (If 4 hours used, them 0.44 scores 1/2)	A1
(b)(i)2.	cost = 3.08 × 7.5 (Possible ecf)	
	cost = 23 (p)	B1
(b)(ii)	$Q = It$ (With or without Δ notation)	C1
	$Q = 0.48 \times 28 \times 3600$ / $Q = 0.48 \times (1.008 \times 10^5)$ (Allow $t = 1 \times 10^5$ (s))	C1
	$Q = 4.84 \times 10^4 \approx 4.8 \times 10^4$ (C)	A1
	(If $t = 28$ used, then $Q = 13.4$ allow 2/3) (If $t = 4$ used, then $Q = 1.92$ allow 1/3) (If 1.44×10^4 s used, then 6.91×10^3 scores 2/3)	
(b)(iii)1.	$E = hf$ / $E = \frac{hc}{\lambda}$ / $f \approx 5.4 \times 10^{14}$ (Hz)	C1
	$E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{5.5 \times 10^{-7}}$ / $E = 6.63 \times 10^{-34} \times 5.455 \times 10^{14}$	C1
	$E = 3.62 \times 10^{-19} \approx 3.6 \times 10^{-19}$ (J)	A1
(b)(iii)2.	number = $\frac{8.0}{3.62 \times 10^{-19}}$	C1
	number = $2.21 \times 10^{19} \approx 2.2 \times 10^{19}$ (s^{-1}) (Possible ecf)	A1
		[Total: 12]

4

(a) **Maximum** of **five** marks

Up to four from:

$\lambda = \dfrac{h}{mv}$ / $\lambda = \dfrac{h}{p}$	M1
All symbols (λ, h, m and v or p) defined	A1
Electrons travel / move / propagate (through space) as a wave	B1
Electrons are diffracted / 'spread out'	M1
by the atoms / spacing between the atoms	A1
The electrons are diffracted when their wavelength is less than or comparable or same as size of atoms / gap between the atoms	B1

Up to two from:

(When the speed of electrons is increased) the rings 'get smaller'	B1
(At greater speed of electrons) the wavelength is shorter	B1
(At greater speed of electrons) there is less diffraction	B1

QWC	Organisation	B1
	Spelling, punctuation & grammar	B1

(b) Electrons have mass / momentum / charge / can be 'accelerated' B1

[Total : 8]

5

(a) For e.m.f. the energy transfer to electrical / from other forms or 'charges gain energy'

Or

For p.d. the transfer is from electrical / to heat / to other forms or 'charges lose energy' B1

(b) The sum of currents entering point / junction is equal to the sum of currents out of that point / junction B2

(The algebraic sum of current at a point = 0 scores 2/2)

(-1 if sum is not mentioned and -1 if point / junction is not mentioned)

(c)(i) current = 0.80 – 0.20

current = 0.60 (A) B1

(c)(ii) $V = IR$ / $V = 0.60 \times 18$ (Possible ecf) C1

$V = 10.8 \approx 11$ (V) A1

(c)(iii) $R_T = \frac{10.8}{0.20} = 54\ \Omega$ (Possible ecf) C1

$R_{\text{diode}} = 54 - 46$ C1

$R_{\text{diode}} = 8.0$ (Ω) A1

(Alternatively: $V_{46\Omega} = 46 \times 0.20 = 9.2$ (V) C1

$V_{\text{diode}} = 10.8 - 9.2$ (= 1.6) C1

$R_{\text{diode}} = \frac{1.6}{0.20} = 8.0$ (Ω) A1)

(c)(iv) $P = \frac{V^2}{R}$ / $P = I^2R$ / $P = VI$ C1

$P = 0.20^2 \times 8.0$ (Possible ecf)

$P = 0.32$ (W) A1

[Total: 11]

6

(a)(i)	Photoelectric (effect)		B1
(a)(ii)	10^{-9} (m) $\leq$ wavelength $\leq 4 \times 10^{-7}$ (m)		B1
(b)(i)	(Minimum) energy needed to free an electron /an electron to escape (from the metal surface)		B1
(b)(ii)	speed of light / 3×10^8 (m s^{-1}) / c		B1
(b)(iii)1.	$hf = \phi + KE_{(max)}$	(Allow any subject)	C1
	$KE_{max} = 2.8 - 1.1 = 1.7$ (eV)		C1
	$KE_{max} = 1.7 \times 1.6 \times 10^{-19}$		
	$KE_{max} = 2.7 \times 10^{-19}$ (J)		A1
(b)(iii)2.	$\frac{1}{2} mv^2 = 2.7 \times 10^{-19}$	(Possible ecf)	C1
	$v = \sqrt{\frac{2 \times 2.7 \times 10^{-19}}{9.1 \times 10^{-31}}}$		
	$v = 7.7 \times 10^5$ (m s^{-1})		A1
(b)(iv)	No change (because the energy of the photon remains the same)		B1

[Total: 10]