2822: Electrons and photons

1

(a)	Flow / movement of charge / charged particle(s) (Allow current = rate of flow of charge / current = rate of change of charge)	AW	B1
(b)	The charge (flowing past a point) in 1 s when current is 1 A (Allow 1C = 1A × 1s)		B1
(c)(i)	$I = \dfrac{\Delta Q}{\Delta t}$ / $I = \dfrac{340}{50}$ (Allow any subject - with or without Δ)		C1
	6.8 (A)		A1
(c)(ii)	1. There is <u>magnetic</u> field (around the current-carrying strip(s) and hence a force)	AW	B1
	2. (Fleming's) left-hand rule		B1
	3. Towards A / To the left (Allow direction given on Fig.1.1)		B1
			[Total : 7]

2

(a)	current ∝ voltage / p.d. (for a metal conductor) [Allow $I \propto V$ because of **(b)**]	M1
	as long as temperature remains constant / all physical conditions remain the same ($V = IR$ <u>and</u> R = constant scores 1/2) ($V = IR$ scores 0/2)	A1
(b)(i)	(Semiconductor) diode	B1
(b)(ii)	Any <u>five</u> from: Resistance is given by $R = V/I$ (Allow the use of R for resistance in this question) The resistance is not constant / Diode is a non-ohmic (component) For <u>negative</u> value(s) (of V) resistance is infinite / (very) large (Allow a calculation) For V / value(s) less than 0.6 (V) the resistance is infinite / (very) large (Accept 0.62 V) For V / value(s) greater than 0.6 (V) the resistance is small / less For V / value(s) greater than 0.6 (V) the resistance decreases (as V increases) (Also scores mark above) Resistance correctly calculated at one point (Assume values are in ohms if unit is not given) Resistance correctly calculated at another point (Allow '*voltage increases the resistance decreases*' if there is no reference to 0.6 V and the second mark above is not scored)	B1 × 5
	QWC 'Spelling and grammar'	B1
		[Total : 9]

3

(a)	sum of current(s) into a point / junction = sum of current(s) out (from the point / junction) (-1 for omission of 'point' or 'sum' in the statement of the law) (Algebraic sum of current(s) at a point = 0 scores 2/2)	B2
(b)(i)	Thermistor	B1
(b)(ii)	$I_1 = 51$ (mA)	B1
	$I_2 = 9$ (mA)	B1
	$I_3 = 29$ (mA)	B1
		[Total : 6]

4

(a) $R = R_1 + R_2$ / $R = 200 + 120$ / $R = 320$ — C1

current $= \dfrac{8.0}{320}$ — C1

current $= 2.5 \times 10^{-2}$ (A) — A0

(b) $V = 25 \times 10^{-3} \times 120$ / $V = \dfrac{120}{120+200} \times 8.0$

$V = 3.0$ (V) (Possible ecf) — B1

(c) p.d. across the 360 (Ω) resistor = p.d. across the 120 (Ω) resistor /
There is no current between **A** and **B** / in the voltmeter — B1
(Allow '*A & B have same voltage*' - BOD)

The p.d. calculated across 360 Ω resistor is shown to be 3.0 V /
The ratio of the resistances of the resistors is shown to be the same. — B1

[Total : 5]

5

(a) Correct field direction — B1
Correct field pattern (minimum of three lines) — B1

(b)(i) length $= 2\pi \times 2.8 \times 10^{-2} \times 20$ / length $= 2\pi \times 2.8 \times 20$ — M1
length = 3.52 (m) ≈ 3.5 (m) / length ≈ 350 (cm) — A0

(b)(ii) $R = \dfrac{\rho L}{A}$ (Allow any subject) — C1

$R = \dfrac{4.9 \times 10^{-7} \times 3.5}{8.4 \times 10^{-7}}$ — C1

$R = 2.04 \approx 2.0$ (Ω) (R =2.05 ≈ 2.1 Ω if 3.52 m is used) — A1

(c)(i) $V = 6.0 \times 2.04$ (Possible ecf) (Allow initial current 5.7 A to 6.0 A) — C1
$V = 12.2 \approx 12$ (V) (Allow $V = 2.0 \times 2.04 \approx 4.1$ (V) 1 mark) — A1

(c)(ii) $P = VI$ (Allow $P = I^2R$ or $P = V^2/R$) — C1
$P = 12 \times 6.0$ (Possible ecf)
$P = 72$ — A1
watt / W / J s^{-1} / VA — B1

(c)(iii) Any four from: — B1 × 4
The temperature of the coil increases / the coil gets 'hotter' (Allow 'coil heats up')
The resistance / resistivity of coil increases (as its temperature increases)
The decrease in current is linked to $I = V/R$
More / frequent collisions of electrons and (vibrating) atoms / ions (as temperature / resistance increases)
The coil (eventually) reaches steady temperature / constant (higher) resistance

QWC 'Organisation' — B1

[Total : 16]

6

(a)	particle(-like) / particulate (nature) / photon ('behaviour')	B1
(b)(i)	A 'packet' of energy / radiation / A quantum of (EM) radiation / energy / light (Do <u>not</u> allow '*particle of light*')	B1
(b)(ii)	The <u>minimum</u> frequency (of the EM radiation) for emission of electrons / photoelectric effect	B1
(c)(i)	Visible (light)	B1
(c)(ii)	work function = $1.9 \times 1.6 \times 10^{-19}$ work function = 3.04×10^{-19} (J) $\approx 3.0 \times 10^{-19}$ (J)	M1 A0
(c)(iii)1.	$E = hf$ / $E = \dfrac{hc}{\lambda}$	C1
	$E = \dfrac{6.63\times10^{-34} \times 3.0\times10^{8}}{5.1\times10^{-7}}$ $E = 3.9 \times 10^{-19}$ (J)	A1
2.	$hf = \phi + KE_{(max)}$ / $hf = \phi + \frac{1}{2}mv^2$ (Allow $E = \phi + \frac{1}{2}mv^2$ if E is qualified in **(c)(iii)1.**)	C1
	$3.9 \times 10^{-19} = 3.0 \times 10^{-19} + KE_{(max)}$ / $3.9 \times 10^{-19} = 3.04 \times 10^{-19} + KE_{(max)}$	C1
	KE = 9.0×10^{-20} (J) / KE = 8.6×10^{-20} (J) (Possible ecf)	A1
(c)(iv)	No change (to maximum KE of electron) Each photon has same energy (but there are fewer photons)	B1 B1
(c)(v)	number of photons = $\dfrac{80\times10^{-3}}{3.9\times10^{-19}}$ ($\approx 2.05 \times 10^{17}$) (Possible ecf)	C1
	number of electrons = $0.07 \times \dfrac{80\times10^{-3}}{3.9\times10^{-19}}$ number of electrons = 1.44×10^{16} (s^{-1}) $\approx 1.4 \times 10^{16}$ (s^{-1})	A1
(d)	$\lambda = \dfrac{h}{mv}$ (Allow any subject)	C1
	$5.1\times10^{-7} = \dfrac{6.63\times10^{-34}}{9.11\times10^{-31} \times v}$	C1
	$v = 1.43 \times 10^{3} \approx 1.4 \times 10^{3}$ (ms^{-1})	A1

[Total : 17]