A Level OCR Physics

Chapter 10 Charge and current

Question	Answers	Extra information	Mark	AO Spec reference
1(a)(i)	ions		1	4.1.1 AO1
(ii)	electrons		1	4.1.1 AO1
(b)	$P = E/t$ $E = Pt$ or time = 2 × 60 × 60 = 7200 s E = 36 × 7200 = 2.6 × 10^4 J	any for first mark	1 1	3.3.3 AO1
(c)	$Q = It$ $P = VI$ $I = P/V$ = 36/12 = 3 A $Q = It$ = 3 × 7200 s = 21600 C or coulombs		1 1 1	4.1.1 4.2.5 AO2
2(a)	$I = \Delta Q/\Delta t$ $\Delta t = \Delta Q/I$ = 15 C / 30 000 A = 5 × 10^{-4} s		1	4.1.1 AO1
(b)	number of electrons = ΔQ/charge on 1 electron Number of electrons = 15 C / 1.6 × 10^{-19} C = 9.4 × 10^{19}		1 1	4.1.1 AO2
(c)	$W = VQ$ = 40 × 10^6 × 15 C = 6 × 10^8 J		1	4.2.2 AO2
(d)	Use of $E = mc\Delta\theta$ or $E = mL$ E = (0.58 × 830 × 1800) + (0.58 × 156000) = 9.6 × 10^5 J Yes 6 × 10^8 J >> 9.6 × 10^5 J		1 1 1	5.1.3 AO3
3(a)	e C = A s or n m^{-3} $I = nAve$ = m^{-3} m^2 m s^{-1} C = s^{-1} A s = A	mark for either correct units for n or use of $Q = It$ Must see cancelling	1 1	2.1.2 AO2
(b)	As area increases the mean drift velocity decreases		1	4.1.2 AO2

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	$I = nAve$ Since the wires are made of the same material and connected in series I, n and e are constant (wtte) $v \propto 1/A$	Must have the statement about I, n and e are constant for subsequent mark A1	M1 A1	
(c)	$n = I/Ave$ $A = \pi r^2 = \pi (0.11\times10^{-3})^2$ $n = 3/\pi (0.11\times10^{-3})^2 \times 1.6\times10^{-19} \times 4.9\times10^{-3}$ $n = 1\times10^{29}$		1 1	4.1.2 AO2
(d)	The resistance increases Max two from the following • positive ions in the lattice vibrate with greater amplitudes • free electrons have more collisions with positive ions • more energy is transferred to the lattice		1 Max 2	4.2.4 AO1
4(a)	$I = nAve$ and $A = 4\times10^{-6}$ m^2 $v = 1/nAe = 1/\ 1.4\times10^{25} \times 4\times10^{-6} \times 1.6\times10^{-19}$ $v = 2.2\times10^{-4}$ m s^{-1}		1 1	4.1.2 AO1
(b)	$R = \rho l/A$ and ρ stays the same $R \propto l$ $R \propto 1/A$ so resistance stays the same		1 1	4.2.4 AO2
(c)	Student either calculates or appreciates that I same, n same and e same $v \propto 1/A$ so if A doubled $v = 1.1\times10^{-4}$ m s^{-1}	Allow e.c.f. from 4.2 – if they think resistance has changed will be using a new current to determine the v	1 1	4.1.2 AO3
(d)	$I/ = nAve$ and I, A and e constant $v \propto I/n$ so v smaller in the connecting wires (vice versa)		1 1	4.1.2 AO3

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5(a)	$Q = It = 2 \times 4 \times 60 = 480$ C		1	4.1.1 AO1
(b)	$e = 1.6\times10^{-19}$ C n of ions = $480/1.6\times10^{-19} = 3\times10^{21}$		1 1	4.1.1 AO2
(c)	$m/ = 3\times10^{21} \times 1.79\times10^{-25}$ kg = 5.37×10^{-4} kg.		1	4.1.1 AO2
(d)	$\rho = m/V$ $V = m/\rho$ $V = dA$ $d = m/A\rho = 5.37\times10^{-4}$ kg/$(35\times10^{-4} \times 1.05\times10^{4})$ depth = 1.5×10^{-5} m	use of $\rho = m/V$ or conversion of area to m^2	1 1 1	3.2.4 AO2
6(a)	A semiconductor is a material where the number of charge carrier/resistivity/n/free electrons per unit volume/number density changes depending on the conditions.	names condition e.g. change temperature/light intensity /energy increase NOT half way between conductor and insulator	1	4.2.4 AO1
(b)	use of $R = \rho l/A$ or $A = \pi r^2 = \pi\ 0.038^2$ $R = 3000 \times 375\times10^{-6}$ m/$\pi 0.038^2 = 248\ \Omega$		1 1	4.2.4 AO2
(c)	$V = IR$ $I = V/R = 0.4/248 = 1.6\times10^{-3}$ A	e.c.f	1	4.2.3 AO1
(d)	$I = nAve$ $v = I/nAe = 1.6\times10^{-3}$ / $8.7\times10^{15} \times \pi\ 0.038^2 \times 1.6\times10^{-19}$ $v = 260$ (255) m s^{-1}		1 1	4.1.2 AO2
(e)	n would increase v would decrease		1 1	4.1.2 AO2

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7(a)	Current flowing into a junction/component is equal to the current flowing out. Law of conservation of charge		1 1	4.1.1 AO1
(b)	Either $I = 0.4 + 0.3 = 0.7$ A or $t = 10 \times 60 = 600$ s $Q = It = 600 \times 0.7 = 420$ C		1 1	4.1.1 AO2
(c)	0.6 A Current flowing out of X is 0.7 A therefore current flowing into Y must also be 0.7 A $(0.6 + 0.1) = 0.7$		1 1	4.1.1 AO2
(d)	0.3 A downwards/from top branch to bottom		1 1	4.1.1 AO2
8(a)	KE = $\frac{1}{2} mv^2$ 20 keV = 20 000 × 1.6×10^{-19} C = 3.2×10^{-15} J $\frac{1}{2} mv^2 = 3.2\times10^{-15}$ $v^2 = 2 \times 3.2\times10^{-15}/9.11\times10^{-31}$ $v = 8.4\times10^{7}$ m s^{-1}	either statement for this mark	1 1	4.2.2 AO2
(b)	$v = d/t$ and $d = 4.22\times10^{8}/t$ $t = 4.22\times10^{8} / 8.4\times10^{7} = 5.0$ s	e.c.f	1	3.1.1 AO2
(c)	$Q = It$ $ne = 3\times10^{6}$ A × 1 $n = 3\times10^{6}/1.6\times10^{-19}$ $n = 1.9\times10^{25}$		1 1	4.1.1 AO2
(d)	From Jupiter to Io		1	4.1.1 AO1