Question	Answer	Marks
1 (a)	charge = current × time base unit for charge = base unit for current (A) × base unit for time (s) Therefore, the base unit for charge is A s	1 1
1 (b) (i)	Anticlockwise direction.	1
1 (b) (ii)	charge flow in 1 s = 20×10^{-3} C number of electrons per second = $\frac{20 \times 10^{-3}}{1.60 \times 10^{-19}}$ number of electrons per second = $1.25 \times 10^{20}\ \text{s}^{-1}$	1 1 1
1 (b) (iii)	According to Kirchhoff's first law, the current in a series circuit is the same. Hence, the current in the lamp is also 20 mA.	1 1
2 (a) (i)	ions	1
2 (a) (ii)	positive ions	1
2 (a) (iii)	electrons	1
3 (a)	From right to left	1
3 (b) (i)	charge $\Delta Q = 1.88 \times 10^{20} \times 1.60 \times 10^{-19}$ $\Delta Q = 30$ C	1 1
3 (b) (ii)	$I = \frac{\Delta Q}{\Delta t} = \frac{30}{2.0 \times 60}$ $I = 0.25$ A	1 1
3 (c)	The current is **constant** in the resistor along its length. The value of the current is shown on the current axis as a straight line at 0.25 A.	1 1
4 (a)	$\Delta Q = I\Delta t = 15 \times 10^{-3} \times 30$ $\Delta Q = 0.45$ C	1 1
4 (b)	number of electrons = $\frac{0.45}{1.60 \times 10^{-19}}$ number of electrons = 2.8×10^{18}	1 1
4 (c)	According to Kirchhoff's first law, current in **C** = 50 – 15 = 35 mA.	1
5 (a)	The sum of the currents entering a point in a circuit is equal to the sum of the currents leaving that point. According to this law, charge is conserved.	1 1
5 (b) (i)	current at **A** = 10 + 20 = 30 mA current at **C** = 30 – 5 = 25 mA current at **B** = 20 – 5 = 15 mA	1 1 1
5 (b) (ii)	The direction of the current is 'up'.	1
6 (a)	The free electrons make collisions with the metal ions and this gives them a random velocity. The free electrons drift towards the positive end of the supply along the length of the wire. The distance travelled per unit time along the length of the wire is called the mean drift velocity of the electrons.	1 1 1
6 (b) (i)	$I = Anev$ $v = \frac{I}{Ane} = \frac{2.0 \times 10^{-3}}{4.2 \times 10^{-10} \times 8.0 \times 10^{27} \times 1.60 \times 10^{-19}}$ $v = 3.7 \times 10^{-3}\ \text{m s}^{-1}$	1 1 1
6 (b) (ii)	time taken = $\frac{8.0 \times 10^{-3}}{3.7 \times 10^{-3}} = 2.2$ s	1
7 (a)	Direction of current shown from building to the cloud.	1

Question	Answer	Marks
7 (b) (i)	$Q = It = 8200 \times 0.120$ (= 984 C) number of electrons = $\frac{984}{1.60 \times 10^{-19}}$ number of electrons = 6.15×10^{21}	1 1 1
7 (b) (ii)	Assuming the current is constant, then charge $\propto$ time. A straight line graph drawn. The graph passes through the origin.	1 1 1
8 (a)	Electric current is the rate of flow of charge. (Allow: Current is the flow of charge or charged particles.)	1
8 (b)	$Q = It$; therefore charge has the unit A s.	1
8 (c)	time = $\frac{\text{charge}}{\text{current}}$ $t = \frac{5.4 \times 10^{-9}}{0.20 \times 10^{-12}} = 2.7 \times 10^{4}$ s $t \approx 7.5$ h	1 1 1
9 (a)	The average distance travelled by the electrons per unit time along the length of the wire. The direction of the electron flow is towards the positive end of the external supply.	1 1
9 (b)	A and B are connected in series, therefore the current in A and B is the same. $I = Anev$, therefore v in inversely proportional to the cross-sectional area A. The electrons have a smaller mean drift velocity in B compared with A.	1 1 1
9 (c)	$v = \frac{I}{Ane}$ $v = \frac{0.30}{\pi \times (2.5 \times 10^{-5})^2 \times 3.4 \times 10^{28} \times 1.60 \times 10^{-19}}$ $v = 2.81 \times 10^{-2}$ m s^{-1}	1 1 1