C3 Charge Carriers II

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Data: Magnitude of the charge on an electron = 1.60×10^{-19} C
Free electron density of copper [Cu] = 10^{29} m^{-3}
Free electron density of germanium [Ge] = 10^{20} m^{-3}

C3.1 If 0.035 pC of charge is transferred via the movement of Al^{3+} ions, how many of these must have been transferred in total?

C3.2 If a 50 μA current is flowing then find out how many electrons pass a point each minute.

C3.3 In a bolt of lightning, 45 nC flows to ground in 25 ms. Work out the average number of charge carriers flowing past per second.

C3.4 If 56×10^{16} electrons flow to the ground in 0.035 μs, work out the average current.

C3.5 How long does it take for a current of 6.0 A to deliver 1.5×10^{17} Cu^{2+} ions in a solution? Assume these ions are the only charged particles moving.

C3.6 In an $MgSO_4$ solution, a current of 36 μA flows. Work out how many SO_4^{2-} ions pass a point in 15 seconds. [Hint: assume that the Mg^{2+} ions and SO_4^{2-} ions move at the same speed in opposite directions and the movement of each type of ion is responsible for half the current]

C3.7 Complete the questions in the table. In all cases, free electrons are travelling in a wire of circular cross section, area A, diameter D.

D /mm	A /mm^2	Material	Current /A	Drift Velocity
	3.8	Ge	7.0	(a)
2.5		Cu	4.0	(b)
1.0		Ge	(c)	0.0050 m s^{-1}
	(d)	Cu	6.0	40 mm s^{-1}
(e)		Ge	2.0	75 mm s^{-1}

C3.8 A copper wire with diameter 0.90 cm has a current of 3.0 A flowing through it. It is connected in series to another wire, identical except that it has radius of 0.15 cm. Work out the ratio of the drift velocity in the thick wire to the drift velocity in the thin wire.