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C3 Charge Carriers II

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 Al³⁺ 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} Cu²⁺ ions in a solution? Assume these ions are the only charged particles moving.
- C3.6 In an MgSO₄ solution, a current of 36 µA flows. Work out how many SO₄²⁻ ions pass a point in 15 seconds. [Hint: assume that the Mg²⁺ ions and SO₄²⁻ 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.