- A melt of NaCl is electrolysed for 35 minutes with a current of 3.50 A. Calculate the mass of sodium and volume of chlorine at 40 °C and 1.00 atm that are formed. **4**

The number of moles of electrons delivered by a current, *I*, of 3.50 A in 35 minutes is:

$$\textbf{number of moles of electrons} = \frac{It}{F} = \frac{(3.50\ \text{A})(35 \times 60\ \text{s})}{(96485\ \text{C mol}^{-1})} = 0.076\ \text{mol}$$

The overall electrolysis reaction, $NaCl(l) \rightarrow Na(s) + \frac{1}{2}Cl_2(g)$, corresponds to reduction of Na^+ and oxidation of Cl^-:

$$Na^+ + e^- \rightarrow Na \quad \text{and} \quad Cl^- \rightarrow \tfrac{1}{2}Cl_2 + e^-$$

As one mole of electrons would produce one mole of Na and half a mole of Cl_2:

number of moles of Na = 0.076 mol

number of moles of Cl_2 = ½ × 0.076 mol = 0.038 mol

The mass of Na produced is therefore:

mass of Na = number of moles × atomic mass

= (0.076 mol) × (22.99 g mol^{-1}) = 1.8 g

Using the ideal gas law, $PV = nRT$, the volume of Cl_2 produced is:

$$V = \frac{nRT}{P} = \frac{(0.038\ \text{mol})(0.08206\ \text{L atm K}^{-1}\ \text{mol}^{-1})(313\ \text{K})}{(1.00\ \text{atm})} = 0.98\ \text{L}$$