2025 Ch H2 Q8
Section: Chemistry in Society
Topic: Oxidising and Reducing Agents

Question Summary
(a) Tin is extracted from SnO2 using carbon: SnO2 + C -> Sn + CO2. Three related calculations:
(i) Mass of SnO2 needed to obtain 100 g Sn at 64% yield.
(ii) Identify excess reactant when 25.2 g SnO2 reacts with 3.0 g C, and find moles left over.
(iii) From 26.5 litres of CO2 (80 L mol^-1), calculate the mass of SnO2 that reacted.
(b) From a magnesium extraction flow diagram: (i) separate Mg(OH)2(s) from CaCl2(aq); (ii) suggest another profit maximisation besides recycling Cl2.

Worked Solution
(a)(i) Stoichiometry: 1 mol SnO2 -> 1 mol Sn.
Given GFMs: SnO2 = 150.7 g; Sn = 118.7 g.
At 100% yield, Sn mass from x g SnO2 is x * (118.7 / 150.7).
At 64% yield, actual Sn = 0.64 * [theoretical Sn]. To obtain 100 g Sn:
Theoretical Sn required = 100 / 0.64 = 156.25 g.
Corresponding SnO2 required = 156.25 * (150.7 / 118.7) = **198.4 g** (3 s.f.).

(a)(ii) Moles: n(SnO2) = 25.2 / 150.7 = 0.167 mol; n(C) = 3.0 / 12.0 = 0.250 mol.
Reaction is 1:1, so SnO2 is limiting. Excess moles of C = 0.250 - 0.167 = **0.083 mol**.
Excess reactant: **carbon**.

(a)(iii) Moles CO_2 = 26.5 L / (80 L mol^-1) = 0.33125 mol.
Mole ratio SnO_2:CO_2 is 1:1, so moles SnO_2 reacted = 0.33125 mol.
Mass SnO_2 = 0.33125 * 150.7 = **49.92 g** (2 d.p.).

(b)(i) Separate the solid $Mg(OH)_2$ from the $CaCl_2$ solution by **filtration**.
(b)(ii) Profit can also be maximised because **seawater is a free/cheap raw material** (or by **selling $CaCl_2$ as a by-product**).

Final Answers
(a)(i) 198.4 g SnO_2
(a)(ii) Excess: carbon; moles left unreacted = 0.083 mol
(a)(iii) 49.92 g SnO_2
(b)(i) Filtration
(b)(ii) Seawater is free/cheap raw material (or sell $CaCl_2$ by-product)

Revision Tips
- For percentage yield problems: required theoretical product = actual / (%yield as a decimal).
- Always compare *moles* to find the limiting reagent and excess moles.
- Gas calculations at a given molar volume: n = V / Vm, then convert to mass via GFM.
- In industrial flowsheets, look for *separation of phases* (filtration) and *valuable by■products* to boost profitability.