Diploma of Health Sciences
Diploma of Science
SLE155 Chemistry for the Professional Sciences

Q1 Chemical reactions and stoichiometry **[3 + 3 = 6 marks]**

a) For the following balanced equations write a **net ionic equation**.
Make sure that you include **states**.

1 mark each, deduct ½ mark for each mistake or omission [3 × 1 = 3 marks]

$2\ Fe(NO_3)_3(aq) + 3\ Na_2CO_3(aq) \rightarrow Fe_2(CO_3)_3(s) + 6\ NaNO_3(aq)$

$2\ Fe^{3+}(aq) + 3\ CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$

$2\ FeCl_3(aq) + SnCl_2(aq) \rightarrow 2\ FeCl_2(aq) + SnCl_4(aq)$

$2\ Fe^{3+}(aq) + Sn^{2+}(aq) \rightarrow 2\ Fe^{2+}(aq) + Sn^{4+}(aq)$

$2\ KI(aq) + Cl_2(l) \rightarrow 2\ KCl(aq) + I_2(g)$

$2\ I^-(aq) + Cl_2(l) \rightarrow 2\ Cl^-(aq) + I_2(s)$

b) Calculate the volume of 0.300 M $FeCl_3(aq)$ solution needed to react completely with 20.0 mL of 0.0450 M $AgNO_3(aq)$ solution to give a precipitate of AgCl.
The net ionic equation is:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

[3 marks]

Concentration $Cl^-(aq)$ ions is 0.900 M because 3 mole Cl^- ions for every one mole $FeCl_3(aq)$ **1 mark**

Molarity = $\frac{\text{amount of solute}}{\text{volume of solution in litres}}$

. amount $Ag^+(aq)$ ions = 0.0450 × 0.0200 = 0.000900 mol **½ mark**

1 mole Ag^+ requires 1 mole Cl^- (from chemical equation)

. amount $Cl^-(aq)$ required is 0.000900 mol **½ mark**

. volume $Cl^-(aq)$ is $\frac{0.000900}{0.900}$ (from volume of solution = $\frac{\text{amount}}{\text{molarity}}$)

. volume 0.300 M $FeCl_3$ required is 0.00100 L
= 1.00 mL to 3 significant figures **1 mark**

Answer can be in mL or L but should be 3 significant figures.

c) Sodium hydroxide, NaOH reacts with phosphoric acid, H_3PO_4 to form sodium phosphate, Na_3PO_4, used in food processing, and water.

$$3\ NaOH(aq) + H_3PO_4(aq) \rightarrow Na_3PO_4(aq) + 3\ H_2O(l)$$

Data: $M_r\ Na_3PO_4 = 163.94\ g\ mol^{-1}$ $M_r\ H_3PO_4 = 97.994\ g\ mol^{-1}$
$M_r\ NaOH = 39.997\ g\ mol^{-1}$ $M_r\ H_2O = 18.015\ g\ mol^{-1}$

i) Determine the limiting reagent if 35.60 g of NaOH is reacted with 30.80 g of H_3PO_4.

[3 marks]

Using amount sodium hydroxide = $\frac{\text{mass}}{\text{molar mass}}$,
Amount sodium hydroxide = 35.60 / 39.997
= 0.8901 mol **1 mark**

Amount phosphoric acid = 30.80 / 97.994
= 0.3143 mol **1 mark**

One mol phosphoric acid requires 3 mol sodium hydroxide, so 0.3143 mol phosphoric acid requires 3 × 0.3143 mol = 0.9429 mol NaOH .
Limiting reagent is NaOH. **1 mark**

ii) Calculate the theoretical yield in grams of Na_3PO_4 when 35.60 g of NaOH is reacted with 30.80 g of H_3PO_4.

[2 marks]

Using balanced equation above, 0.8901 mol of NaOH will produce ⅓ × 0.8901 mol
= 0.2967 mol of Na_3PO_4 **1 mark**

Using amount substance = $\frac{\text{mass}}{\text{molar mass}}$,
Mass Na_3PO_4 = 0.2967 mol × 163.94 g mol^{-1}
= 48.63918 g
= 48.63 g (4 significant figures) **1 mark**

iii) Calculate the percentage yield of Na_3PO_4 if only 28.50 g Na_3PO_4 is obtained from the reaction.

[1 mark]

Percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

= $\frac{28.50}{48.63} \times 100$

= 58.59% (4 significant figures) **1 mark**

If answer to part ii) above was incorrect, give ½ mark if percentage yield was calculated correctly using an incorrect answer from above but not if answer is >100%!.