Stoichiometry

① a) $\frac{2 \text{ mol } C_4H_{10}}{13 \text{ mol } O_2}$

b) $\frac{13 \text{ mol } O_2}{8 \text{ mol } CO_2}$

c) $\frac{13 \text{ mol } O_2}{10 \text{ mol } H_2O}$

d) $\frac{2 \text{ mol } C_4H_{10}}{8 \text{ mol } CO_2}$

e) $\frac{2 \text{ mol } C_4H_{10}}{10 \text{ mol } H_2O}$

② $12 \text{ mol } KClO_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } KClO_3} = \boxed{18 \text{ mol } O_2}$

③ a) $\frac{2.5 \text{ g } K}{39.1 \text{ g/mol}} = 0.0639 \text{ mol } K$

$0.0639 \text{ mol } K \times \frac{2 \text{ mol } KCl}{2 \text{ mol } K} = 0.0639 \text{ mol } KCl$

$0.0639 \text{ mol } KCl \times 74.6 \text{ g/mol} = \boxed{4.77 \text{ g } KCl}$

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b) $\frac{1 \text{ g } Cl_2}{71 \text{ g/mol}} = 0.0141 \text{ mol } Cl_2$

$0.0141 \text{ mol } Cl_2 \times \frac{2 \text{ mol } KCl}{1 \text{ mol } Cl_2} = 0.0282 \text{ mol } KCl$

③ b) $0.0282 \text{ mol KCl} \times 74.6 \text{ g/mol} = \boxed{2.10 \text{ g KCl}}$

④ $\frac{120 \text{ g } Na_2O}{62 \text{ g/mol}} = 1.935 \text{ mol } Na_2O$

$1.935 \text{ mol } Na_2O \times \frac{2 \text{ mol NaOH}}{1 \text{ mol } Na_2O} = 3.87 \text{ mol NaOH}$

$3.87 \text{ mol NaOH} \times 40 \text{ g/mol} = \boxed{154.8 \text{ g NaOH}}$

$\frac{160 \text{ g NaOH}}{40 \text{ g/mol}} = 4 \text{ mol NaOH}$

$4 \text{ mol NaOH} \times \frac{1 \text{ mol } Na_2O}{2 \text{ mol NaOH}} = 2 \text{ mol } Na_2O$

$2 \text{ mol } Na_2O \times 62 \text{ g/mol} = \boxed{124 \text{ g } Na_2O}$

⑤ $\frac{16 \text{ g } S_8}{256.8 \text{ g/mol}} = 0.0623 \text{ mol } S_8$

$0.0623 \text{ mol } S_8 \times \frac{8 \text{ mol Fe}}{1 \text{ mol } S_8} = 0.498 \text{ mol Fe}$

$0.498 \text{ mol Fe} \times 55.8 \text{ g/mol} = \boxed{27.8 \text{ g Fe}}$

$0.0623 \text{ mol } S_8 \times \frac{8 \text{ mol FeS}}{1 \text{ mol } S_8} = 0.498 \text{ mol FeS}$

$0.498 \text{ mol FeS} \times 87.9 \text{ g/mol} = \boxed{43.8 \text{ g FeS}}$

⑥ $12 \text{ mol } NaClO_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } NaClO_3} = 18 \text{ mol } O_2$

$18 \text{ mol } O_2 \times 32 \text{ g/mol} = \boxed{576 \text{ g } O_2}$

$\frac{80 \text{ g } O_2}{32 \text{ g/mol}} = 2.5 \text{ mol } O_2$

$2.5 \text{ mol } O_2 \times \frac{2 \text{ mol } NaCl}{3 \text{ mol } O_2} = 1.667 \text{ mol } NaCl$

$1.667 \text{ mol } NaCl \times 58.5 \text{ g/mol} = \boxed{97.5 \text{ g } NaCl}$

⑦ $3.5 \text{ mol } AgNO_3 \times \frac{1 \text{ mol } Cu}{2 \text{ mol } AgNO_3} = \boxed{1.75 \text{ mol } Cu}$

$\frac{89.5 \text{ g } Ag}{109.9 \text{ g/mol}} = 0.829 \text{ mol } Ag$

$0.829 \text{ mol } Ag \times \frac{1 \text{ mol } Cu}{2 \text{ mol } Ag} = 0.415 \text{ mol } Cu$

$0.415 \text{ mol } Cu \times 63.5 \text{ g/mol} = \boxed{26.4 \text{ g } Cu}$

⑧ $\frac{25\,000\ g\ Fe_2O_3}{159.6\ g/mol} = 156.6\ mol\ Fe_2O_3$

$156.6\ mol\ Fe_2O_3 \times \frac{2\ mol\ Fe}{1\ mol\ Fe_2O_3} = 313.2\ mol\ Fe$

$313.2\ mol\ Fe \times 55.8\ g/mol = 17\,476.6\ g$

$= \boxed{17.5\ kg\ Fe}$

⑨ $\frac{120\ g\ C_6H_{12}O_6}{180\ g/mol} = 0.667\ mol\ C_6H_{12}O_6$

$0.667\ mol\ C_6H_{12}O_6 \times \frac{6\ mol\ CO_2}{1\ mol\ C_6H_{12}O_6} = 4\ mol\ CO_2$

$4\ mol\ CO_2 \times 44\ g/mol = \boxed{176\ g\ CO_2}$

⑩ $1.2\ mol\ NH_3 \times \frac{4\ mol\ NO}{4\ mol\ NH_3} = 1.2\ mol\ NO$

$1.2\ mol\ NH_3 \times \frac{6\ mol\ H_2O}{4\ mol\ NH_3} = 1.8\ mol\ H_2O$

$1.2 + 1.8 = 3\ mol\ total$ $\boxed{(d)}$

Limiting Reactants

① $Cl_2(g) + 3F_2(g) \longrightarrow 2ClF_3(g)$

$$1.75 \text{ mol } Cl_2 \times \frac{2 \text{ mol } ClF_3}{1 \text{ mol } Cl_2} = 3.5 \text{ mol } ClF_3$$

$$3.68 \text{ mol } F_2 \times \frac{2 \text{ mol } ClF_3}{3 \text{ mol } F_2} = 2.453 \text{ mol } ClF_3$$

F_2 is limiting; Cl_2 is excess.
2.453 mol ClF_3 are produced.

$$2.453 \text{ mol } ClF_3 \times \frac{1 \text{ mol } Cl_2}{2 \text{ mol } ClF_3} = 1.227 \text{ mol } Cl_2$$

$1.75 \text{ mol} - 1.227 \text{ mol} =$ 0.523 mol Cl_2 excess

② $H_2(g) + Cl_2(g) \rightarrow 2\,HCl(g)$

$$7.5 \text{ mol } H_2 \times \frac{2 \text{ mol } HCl}{1 \text{ mol } H_2} = 15 \text{ mol } HCl$$

$$9.0 \text{ mol } Cl_2 \times \frac{2 \text{ mol } HCl}{1 \text{ mol } Cl_2} = 18 \text{ mol } HCl$$

H_2 is limiting; Cl_2 is excess.
15 mol HCl are produced.

$$15 \text{ mol } HCl \times \frac{1 \text{ mol } Cl_2}{2 \text{ mol } HCl} = 7.5 \text{ mol } Cl_2$$

$9.0 - 7.5 =$ 1.5 mol excess Cl_2

③ $Al + NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + NO + H_2O$

④ $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$

$$175\ g\ C_2H_2 \times \frac{1\ mol}{26\ g} = 6.731\ mol\ C_2H_2$$

$$6.731\ mol\ C_2H_2 \times \frac{4\ mol\ CO_2}{2\ mol\ C_2H_2} = 13.462\ mol\ CO_2$$

$$175\ g\ O_2 \times \frac{1\ mol}{32\ g} = 5.469\ mol\ O_2$$

$$5.469\ mol\ O_2 \times \frac{4\ mol\ CO_2}{5\ mol\ O_2} = 4.375\ mol\ CO_2$$

O_2 is limiting; C_2H_2 is excess.

$$4.375\ mol\ CO_2 \times \frac{2\ mol\ C_2H_2}{4\ mol\ CO_2} = 2.188\ mol\ C_2H_2$$

$6.731 - 2.188 = 4.543$ mol excess C_2H_2

$$4.543\ mol\ C_2H_2 \times 26\ g/mol = \boxed{118.1\ g\ \text{excess}\ C_2H_2}$$

Theoretical Yield of CO_2 is 4.375 mol (192.5 g)

Actual Yield = $48.2\ L \times 1.79\ g/L = 86.3\ g$

$$\%\ = \frac{86.3}{192.5} \times 100 = \boxed{44.8\%}$$

Percent Yield Worksheet

1) Write the equation for the reaction of iron (III) phosphate with sodium sulfate to make iron (III) sulfate and sodium phosphate.

$$2\ FePO_4 + 3\ Na_2SO_4 \rightarrow 1\ Fe_2(SO_4)_3 + 2\ Na_3PO_4$$

2) If I perform this reaction with 25 grams of iron (III) phosphate and an excess of sodium sulfate, how many grams of iron (III) sulfate can I make?

33 grams

3) If 18.5 grams of iron (III) sulfate are actually made when I do this reaction, what is my percent yield?

(18.5 / 33) x 100% = 56%

4) Is the answer from problem #3 reasonable? Explain.

Yes. Any yield under 100% is reasonable under the law of conservation of mass.

5) If I do this reaction with 15 grams of sodium sulfate and get a 65.0% yield, how many grams of sodium phosphate will I make?

According to the stoichiometry, the theoretical yield is 11.5 grams. Multiplying this by 0.650, you get 7.48 grams.