Stoichiometry Practice – Complete Answers

1) 2 $Al_{(s)}$ + 6 $HCl_{(aq)}$ → 2 $AlCl_{3(aq)}$ + 3 $H_{2(g)}$

a. $11.5\text{ g} \times \frac{1\text{ mol Al}}{26.982\text{ g}} \times \frac{2\text{ mol } AlCl_3}{2\text{ mol Al}} \times \frac{133.341\text{ g}}{1\text{ mol}} = 56.8\text{ g}$

b. $\%\text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$

$= (55.0 / 56.83) \times 100$

$= 96.8\%$

2) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

5.0 g 5.0 g

Amount of product given each reactant:

$5.0\text{ g } N_2 \times \frac{1\text{ mol } N_2}{28.014\text{ g } N_2} \times \frac{2\text{ mol } NH_3}{1\text{ mol } N_2} \times \frac{17.031\text{ g } NH_3}{1\text{ mol } NH_3} = 6.079\text{ g } NH_3$

$5.0\text{ g } H_2 \times \frac{1\text{ mol } H_2}{2.016\text{ g } H_2} \times \frac{2\text{ mol } NH_3}{3\text{ mol } H_2} \times \frac{17.031\text{ g } NH_3}{1\text{ mol } NH_3} = 28.160\text{ g } NH_3$

a. Hydrogen is the excess reactant. TRUE – more NH_3 is made given the amount of hydrogen.

b. Nitrogen is the limiting reactant. TRUE – less NH_3 is made given the amount of nitrogen.

c. 2.8 grams of hydrogen are left over. FALSE –

$5.0\text{ g } N_2 \times \frac{1\text{ mol } N_2}{28.014\text{ g } N_2} \times \frac{3\text{ mol } H_2}{1\text{ mol } N_2} \times \frac{2.016\text{ g } H_2}{1\text{ mol } H_2} = 1.079\text{ g } H_2$ needed.

Given 5.0 g – 1.079 = 3.9 g left over.

d. The theoretical yield of ammonia is 6.1 g. TRUE – see calculations above.

3) $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$

45.0 g 60%

Theoretical yield:

$45.0\text{ g } NO_2 \times \frac{1\text{ mol } NO_2}{46.007\text{ g}} \times \frac{2\text{ mol } HNO_3}{3\text{ mol } NO_2} \times \frac{63.012\text{ g}}{1\text{ mol } HNO_3} = 41.089\text{g}$

$60\% = \frac{x}{41.089\text{g}} \times 100$

$= 24.7\text{ g}$

4) $C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(l)$

10.0g 7.50L

Theoretical

$$10.0\text{ g} \times \frac{1\text{ mol glucose}}{180.156\text{ g}} \times \frac{6\text{ mol } CO_2}{1\text{ mol glucose}} \times \frac{44.009\text{ g}}{1\text{ mol}} = 14.657\text{ g } CO_2$$

Actual

$$7.50\text{ L} \times \frac{1.26\text{ g } CO_2}{1\text{ L}} = 9.576\text{ g}$$

% yield = (9.576 g / 14.657 g) x 100

65.3%

5) $CS_2\ (g) + 3\ Cl_2\ (g) \rightarrow CCl_4\ (l) + S_2Cl_2\ (l)$

$$6.00\text{ g } CS_2 \times \frac{1\text{ mol } CS_2}{76.143\text{ g}} \times \frac{3\text{ mol } Cl_2}{1\text{ mol } CS_2} = 0.23639\text{ mol } Cl_2 \text{ reacts with } 6.0\text{ g } CS_2$$

= 0.0788 mol

$$10.0\text{ g } Cl_2 \times \frac{1\text{ mol } Cl_2}{70.906\text{ g}} = 0.1410\text{ mol } Cl_2 \text{ available.}$$

$Cl_2(g)$ is the limiting reactant because more moles of Cl_2 (0.236 mol) are needed to react with the available moles of CS_2 than what is available (0.141 mol).

$$0.1410\text{ mol } Cl_2 \times \frac{1\text{ mol } CS_2}{3\text{ mole } Cl_2} \times \frac{76.143\text{ g } CS_2}{1\text{ mol } CS_2} = 3.578\text{ g reacted } CS_2$$

6.0 g - 3.578 g = 2.42 g

6) $2N_2H_4(l) + N_2O_4(l) \rightarrow 3N_2(g) + 4H_2O(g)$

Determine how many moles of one of the products (ex. water) are produced using the initial amounts of each reactant.

a. $$1.40\text{ kg } N_2H_4 \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1\text{ mol } N_2H_4}{32.046\text{ g } N_2H_4} \times \frac{4\text{ mol } H_2O}{2\text{ mol } N_2H_4} = 87.374\text{ mol } H_20$$

b. Using the # of moles of dinitrogen tetraoxide, N_2O_4:
   i. $$2.80\text{ kg } N_2O_4 \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1\text{ mol } N_2O_4}{92.01\text{ g } N_2O_4} \times \frac{4\text{ mol } H_2O}{1\text{ mol } N_2O_4} = 121.7\text{ mol } H_20$$

c. Since hydrazine (N_2H_4) produces fewer moles of water, it is the limiting reagent.