Stoichiometry Practice #2

1. Consider the following equation:

$$3\ Ag + 4\ HNO_3 \rightarrow 3\ AgNO_3 + NO + 2\ H_2O$$

(xg; 63.02g; 6.0 mol; 18.02g)

What mass of nitric acid, HNO_3, is necessary to obtain 6.0 moles of water?

(4 : 2)

$$6.0\ mol\ H_2O \times \frac{4\ mol\ HNO_3}{2\ mol\ H_2O} \times \frac{63.02\ g\ HNO_3}{1\ mol\ HNO_3} \rightarrow 756.24 \rightarrow \boxed{760\ g\ HNO_3}$$

2. Using the equation below, answer the following questions.

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

(4.0 mol; xg; 2.02g; 18.02g; 2 : 2)

a- If 4.0 moles of H_2 gas are reacted, how many grams of water would be produced?

$$4.0\ mol\ H_2 \times \frac{2\ mol\ H_2O}{2\ mol\ H_2} \times \frac{18.02\ g\ H_2O}{1\ mol\ H_2O} = 72.08 \rightarrow \boxed{72\ g\ H_2O}$$

b- If 2.45×10^2 molecules of oxygen gas are available, how many moles of H_2 would react with it?

(x mol; 2.45×10^2 molecules)

$$2H_2 + O_2 \longrightarrow 2H_2O$$

$$2.45 \times 10^2\ molecules\ O_2 \times \frac{1\ mol\ O_2}{6.023 \times 10^{23}\ molecules\ O_2} \times \frac{2\ mol\ H_2}{1\ mol\ O_2}$$

$$8.135 \times 10^{-22} \longrightarrow \boxed{8.14 \times 10^{-22}\ mol}$$

3. a- Write a balanced equation for the combustion of methane gas (CH_4) to form carbon dioxide (CO_2) and water vapour (H_2O).

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

b- If 124.5 g of CO_2 is produced, how many moles of CH_4 must have been reacted?

(x mol; 124.5g; 16.05 g/mol; 44.01 g/mol; 1 : 1)

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

$$124.5\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01\ g\ CO_2} \times \frac{1\ mol\ CH_4}{1\ mol\ CO_2}$$

2.8289 →

$$\boxed{2.829\ mol\ CH_4}$$

4. a- Balance the equation below:

$2\,Al + 3\,F_2 \rightarrow 2\,AlF_3$

x mol : 4.5 mol

2 : 3

b- How many moles of aluminum react with 4.5 moles of fluorine?

$$4.5\ \text{mol } F_2 \times \frac{2\ \text{mol Al}}{3\ \text{mol } F_2}$$

3 mol Al

c- If 42 g of aluminum fluoride, AlF_3 are produced, what mass of aluminum is reacted with fluorine?

$2\,Al + 3\,F_2 \rightarrow 2\,AlF_3$

x g : 42 g

2×26.98 g/mol : 2×83.98 g/mol

2 : 2

$$42\text{g } AlF_3 \times \frac{1\ \text{mol } AlF_3}{83.98\text{g } AlF_3} \times \frac{2\ \text{mol Al}}{2\ \text{mol } AlF_3} \times \frac{26.98\text{g Al}}{1\ \text{mol Al}}$$

$13.493 \rightarrow$ **13g Al**

d- How many moles of fluorine will take part in the above reaction to produce 33.6 g of aluminum fluoride?

$2\,Al + 3\,F_2 \rightarrow 2\,AlF_3$

x mol : 33.6 g

3×38 g/mol : 2×83.98 g/mol

3 : 2

$$33.6\text{g } AlF_3 \times \frac{1\ \text{mol } AlF_3}{83.98\ AlF_3} \times \frac{3\ \text{mol } F_2}{2\ \text{mol } AlF_3}$$

$\rightarrow 0.6001 \rightarrow$ **0.600 mol F_2**

5. a- Write a balanced equation for the reaction of nitrogen gas (N_2) and hydrogen gas (H_2) to produce ammonia gas (NH_3).

$N_2 + 3\,H_2 \rightarrow 2\,NH_3$

x molecules : 212.5 g

3×2.02 g/mol : 2×17.04 g/mol

3 : 2

b-If 212.5 g of ammonia gas is produced, how many molecules of hydrogen gas must have reacted with the nitrogen?

$$212.5\text{g } NH_3 \times \frac{1\ \text{mol } NH_3}{17.04\text{g } NH_3} \times \frac{3\ \text{mol } H_2}{2\ \text{mol } NH_3} \times \frac{6.023 \times 10^{23}\ \text{molecules } H_2}{1\ \text{mol } H_2}$$

$1.12666 \times 10^{25} \rightarrow$ **1.127×10^{25} molecules H_2**

6. Solid copper can be prepared from copper oxide by reacting with ammonia, according to the following unbalanced equation:

$3\,CuO + 2\,NH_3 \rightarrow N_2 + 3\,Cu + 3\,H_2O$

x mol : 9.0 mol

How many moles of ammonia (NH_3) are needed to obtain 9.0 moles of copper (Cu)?

$$9.0\ \text{mol Cu} \times \frac{2\ \text{mol } NH_3}{3\ \text{mol Cu}}$$

6.0 mol NH_3

7. Iron (Fe) and carbon monoxide (CO) are produced when iron oxide (Fe_2O_3) reacts with carbon (C).
You would like to produce 50 mol if iron, what mass of iron oxide is required?

$$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$$

(xg : 159.70 : 1 ; 50 mol : 55.85 : 2)

$$50\ mol\ Fe \times \frac{1\ mol\ Fe_2O_3}{2\ mol\ Fe} \times \frac{159.70\ g\ Fe_2O_3}{1\ mol\ Fe_2O_3} = 3992.5\ g \rightarrow \boxed{4000\ g\ Fe_2O_3}$$

8. 200.0 mL of NaI whose concentration is 2.0 M are reacted with $Pb(NO_3)_2$ in order to obtain the precipitate PbI_2 according to the equation below. Calculate the mass of PbI_2 obtained.

(200.0 mL, 2.0 M) (xg)

$$2\ NaI + Pb(NO_3)_2 \rightarrow PbI_2 + 2\ Na(NO_3)$$

(149.89 g/mol : 2 ; 461 g/mol : 1)

(1) $\frac{2.0\ mol}{1000\ mL} : \frac{x\ mol}{200.0\ mL} \rightarrow 0.4\ mol$

(2) $0.4\ mol\ NaI \times \frac{1\ mol\ PbI_2}{2\ mol\ NaI} \times \frac{461\ g\ PbI_2}{1\ mol\ PbI_2} \quad 92.2 \rightarrow \boxed{92\ g\ PbI_2}$

9. When a solution of aluminum hydroxide, $Al(OH)_3$, reacts with a solution of sulfuric acid, H_2SO_4, the result is a salt, aluminum sulphate, $Al_2(SO_4)_3$ and water, H_2O.
The reaction is seen by the following balanced equation:

(xg) (100 g)

$$2\ Al(OH)_3 + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6\ H_2O$$

(78.01 g/mol : 2 ; 342.17 : 1)

What mass of aluminum hydroxide is required to produce 100.0 g of aluminum sulphate?

$$100.0\ g\ Al_2(SO_4)_3 \times \frac{1\ mol\ Al_2(SO_4)_3}{342.17\ g\ Al_2(SO_4)_3} \times \frac{2\ mol\ Al(OH)_3}{1\ mol\ Al_2(SO_4)_3} \times \frac{78.01\ g\ Al(OH)_3}{1\ mol\ Al(OH)_3}$$

$$45.5972 \longrightarrow \boxed{45.60\ g\ Al(OH)_3}$$

10. Sandy neutralizes 200mL of HCL at a concentration of 1.5mol/L using $Ca(OH)_2$ according to the following equation:

200mL 1.5 mol/L x g

$$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$$

36.46g/mol 40.08 + 2(35.45) = 110.98 g/mol

2 : 1

After the neutralization, she allows the water from the beaker to evaporate. What is the mass of the $CaCl_2$ that will be left in the beaker?

① $\frac{1.5\ mol}{1000\ mL} : \frac{x\ mol}{200\ mL}$ 0.3 mol HCl

② $0.3\ mol\ HCl \times \frac{1\ mol\ CaCl_2}{2\ mol\ HCl} \times \frac{110.98\ g\ CaCl_2}{1\ mol\ CaCl_2}$ 16.647 ↓ **20 g $CaCl_2$**

11. When 200mL of HCl is mixed with $NaHCO_3$, 22.01g of CO_2 is produced. What was the concentration of the HCl solution used to produce this much gas?

200.mL 22.01g

$$HCl_{(aq)} + NaHCO_{3(s)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

36.46g 12.01 + 2(16.00) = 44.01 g

① $22.01\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01\ g\ CO_2} \times \frac{1\ mol\ HCl}{1\ mol\ CO_2}$ 0.5001 → 0.5001 mol HCl

② $\frac{0.5001\ mol\ HCl}{200\ mL} : \frac{x\ mol}{1000\ mL}$ 2.5006 ↓ **3 mol/L HCl**