## Stoichiometry Worksheet #1

Aluminum chloride, AlCl<sub>3</sub>, is used as a catalyst in various industrial reactions. It is prepared from hydrogen chloride gas and aluminum metal shavings.
 2Al(s) + 6HCl(g) → 2AlCl<sub>2</sub>(s) + 3H<sub>2</sub>(g)

1A. How many moles of AlCl<sub>3</sub> can be prepared from 3.5 moles of hydrogen chloride gas with an excess of aluminum?

$$3.5 \text{ mol HCl x } \frac{2 \text{ mol AlCl}_3}{6 \text{ mol HCl}} = 1.2 \text{ mol AlCl}_3$$

Ans: 1.2 mol AICI<sub>3</sub>

1B. How many moles of hydrogen gas would be produced from the use of 8.5 moles of aluminum with an excess of hydrogen chloride?
Ans: 13 mol H<sub>2</sub>

8.5 mol Al x 
$$\frac{3 \text{ mol H}_2}{2 \text{ mol Al}} = 13 \text{ mol H}_2$$

When dinitrogen pentoxide, N<sub>2</sub>O<sub>3</sub>, a white solid, is heated, it decomposes to nitrogen dioxide and oxygen.

$$2N_2O_5(s) \xrightarrow{\Delta} 4NO_2(g) + O_2(g)$$

2A. How many moles of nitrogen dioxide can be formed from the decomposition of 1.25 g of N<sub>2</sub>O<sub>5</sub>?

1.25 g N<sub>2</sub>O<sub>5</sub> x 
$$\frac{1 \text{ mol N}_2\text{O}_5}{108.02 \text{ g N}_2\text{O}_5}$$
 x  $\frac{4 \text{ mol NO}_2}{2 \text{ mol N}_2\text{O}_5} = 0.0.231 \text{ mol NO}_2$ 

Ans: 0.0231 mol NO<sub>2</sub>

2B. How many grams of oxygen can be formed from the decomposition of 2.3 g of N<sub>2</sub>O<sub>5</sub>?

$$2.3 \text{ g N}_2\text{O}_3 \times \frac{1 \text{ mol N}_2\text{O}_3}{108.02 \text{ g N}_2\text{O}_3} \times \frac{1 \text{ mol O}_2}{2 \text{ mol N}_2\text{O}_3} \times \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = 0.34 \text{ g O}_2$$

Ans: 0.34 g O<sub>2</sub>

3. Chlorine is prepared from sodium chloride by electrochemical decomposition. Formerly chlorine was produced by heating hydrochloric acid with pyrolusite [manganese dioxide or manganese(IV) oxide, MnO<sub>2</sub>], a common manganese ore. Small amounts of chlorine may be prepared in the laboratory by the same reaction.

$$4HCl(aq) + MnO_2(s) \rightarrow 2H_2O(l) + MnCl_2(aq) + Cl_2(g)$$

3A. How many grams of HCl react with 5.00 g of MnO<sub>2</sub>, according to the equation?

$$5.00 \text{ g MnO}_2 \times \frac{1 \text{ mol MnO}_2}{86.94 \text{ g MnO}_2} \times \frac{4 \text{ mol HCl}}{1 \text{ mol MnO}_2} \times \frac{36.46 \text{ g HCl}}{1 \text{ mol HCl}} = 8.39 \text{ g HCl}$$

Ans: 8.39 g HCl

3B. If a chemist wanted to prepare 100. g of chlorine, how many grams of MnO<sub>2</sub> are needed, assuming there is more than enough hydrochloric acid?
Ans: 123 g MnO<sub>2</sub>

100. g Cl<sub>2</sub> x 
$$\frac{1 \text{ mol Cl}_2}{70.90 \text{ g Cl}_1}$$
 x  $\frac{1 \text{ mol MnO}_2}{1 \text{ mol Cl}_1}$  x  $\frac{86.94 \text{ g MnO}_2}{1 \text{ mol MnO}_2} = 123 \text{ g MnO}_2$ 

3C. How many molecules of water are produced from the reaction of 5.0 g of HCI?

$$5.0 \text{ g HCl x } \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} \text{ x } \frac{2 \text{ mol H}_2\text{O}}{4 \text{ mol HCl}} \text{ x } \frac{6.02 \text{ x } 10^{29} \text{ molecules H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 4.1 \text{ x } 10^{29} \text{ molecules H}_2\text{O}$$

4. Sodium is a soft, reactive metal that instantly reacts with water to give hydrogen gas and a solution of sodium hydroxide,

### $_{NaOH.}$ $2Na(s) + 2H_2O(l) \rightarrow H_2(g) + 2NaOH(aq)$

4A. How many grams of sodium metal are needed to give 7.81 g of hydrogen by this reaction? Ans: 178 g Na

$$7.81 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2.02 \text{ g H}_2} \times \frac{2 \text{ mol Na}}{1 \text{ mol H}_2} \times \frac{22.99 \text{ g Na}}{1 \text{ mol Na}} = 178 \text{ g Na}$$

4B. How many sodium atoms are needed to react with 1.25 x 10<sup>24</sup> molecules of water? Ans: 1.25 x 10<sup>24</sup> atoms Na

$$1.25 \times 10^{34} \text{ molecules H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{6.02 \times 10^{23} \text{ molecules H}_2\text{O}} \times \frac{2 \text{ mol Na}}{2 \text{ mol H}_2\text{O}} \times \frac{6.02 \times 10^{23} \text{ atoms Na}}{1 \text{ mol Na}} = \frac{1.25 \times 10^{24} \text{ mol Na}}{1 \text{ mol Na}} = \frac{1.25 \times 10^{24$$

# **Modern Chemistry Stoichiometry Section 1 Review Answers**

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 ${\bf Modern\ Chemistry\ Stoichiometry\ Section\ 1\ Review\ Answers:}$ 

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