XIII. Stoichiometry (Chapter 10)

$2Na + Cl_2 \rightarrow 2NaCl$

1. Calculate the number of moles of NaCl produced from:

   a) 3.0 moles Na   mole Na → mole NaCl

   $3.0 \text{ moles Na} \times \frac{2 \text{ mole NaCl}}{2 \text{ mole Na}} = \boxed{3.0 \text{ moles NaCl}}$

   b) .018 mole Cl_2 mole Cl_2 → mole NaCl

   $0.018 \text{ mole } Cl_2 \times \frac{2 \text{ mole NaCl}}{1 \text{ mole } Cl_2} = \boxed{0.036 \text{ mole NaCl}}$

2. How many moles of NaCl can be produced from

   a) 18 grams Na   g Na → mole Na → mole NaCl

   $18 \text{ g Na} \times \frac{1 \text{ mole Na}}{22.9898 \text{ g Na}} \times \frac{2 \text{ mole NaCl}}{2 \text{ mole Na}} = 0.78296 \text{ mole NaCl} = \boxed{0.78 \text{ mole NaCl}}$

   b) 4.8 grams Cl_2 g Cl_2 → mole Cl_2 → mole NaCl

   $4.8 \text{ g } Cl_2 \times \frac{1 \text{ mole } Cl_2}{70.906 \text{ g } Cl_2} \times \frac{2 \text{ mole NaCl}}{1 \text{ mole } Cl_2} = 0.135391 \text{ mole NaCl} = \boxed{0.14 \text{ mole NaCl}}$

3. How many grams of NaCl can be produced from

   a) 2.0 grams Na   g Na → mole Na → mole NaCl → g NaCl

   $2.0 \text{ g Na} \times \frac{1 \text{ mole Na}}{22.9898 \text{ g Na}} \times \frac{2 \text{ mole NaCl}}{2 \text{ mole Na}} \times \frac{58.4428 \text{ g NaCl}}{1 \text{ mole NaCl}} = 5.08424 \text{ g NaCl} = \boxed{5.1 \text{ g NaCl}}$

   b) 19.8 grams Cl_2 g Cl_2 → mole Cl_2 → mole NaCl → g NaCl

   $19.8 \text{ g } Cl_2 \times \frac{1 \text{ mole } Cl_2}{70.906 \text{ g } Cl_2} \times \frac{2 \text{ mole NaCl}}{1 \text{ mole } Cl_2} \times \frac{58.4428 \text{ g NaCl}}{1 \text{ mole NaCl}} = 32.63948 \text{ g NaCl} = ~~32.6~~ \boxed{32.6 \text{ g NaCl}}$

4. If 128 grams Na and 155 grams Cl_2 are mixed and allowed to react, how many grams of NaCl would be produced? Run Both and Choose Smallest Value → just like 3a & 3b

   $128 \text{ g Na} \times \frac{1 \text{ mole Na}}{22.9898 \text{ g Na}} \times \frac{2 \text{ mole NaCl}}{2 \text{ mole Na}} \times \frac{58.4428 \text{ g NaCl}}{1 \text{ mole NaCl}} = 325.3912 \text{ g NaCl}$

   $155 \text{ g } Cl_2 \times \frac{1 \text{ mole } Cl_2}{70.906 \text{ g } Cl_2} \times \frac{2 \text{ mole NaCl}}{1 \text{ mole } Cl_2} \times \frac{58.4428 \text{ g NaCl}}{1 \text{ mole NaCl}} = 255.5111 \text{ g NaCl}$ ← Smaller

   ∴ Only 256 g NaCl can be made before you run out of Cl_2

5. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 803\ kJ$

a) Calculate the number of kilojoules of energy released when 1.102×10^5 grams of oxygen react. g O_2 → moles O_2 → kJ

$$1.102\times10^5\ g\ O_2 \times \frac{1\ mole\ O_2}{31.9988\ g\ O_2} \times \frac{803\ kJ}{2\ mole\ O_2} = 1.382717\times10^6\ kJ$$

$$= \boxed{1.383\times10^6\ kJ}$$

b) How many grams of water would be produced if the above reaction results in the release of 9.2×10^7 joules of energy? joules → kJ → mole H_2O → g H_2O

$$9.2\times10^7\ joules \times \frac{1\ kilojoule}{1000\ joules} \times \frac{2\ mole\ H_2O}{803\ kJ} \times \frac{18.01528\ g\ H_2O}{1\ mole\ H_2O} = 4.12808\times10^3\ g\ H_2O$$

$$= \boxed{4.1\times10^3\ g\ H_2O}$$

c) Calculate the number of calories released from the reaction of 605 grams of methane, CH_4. 1 cal = 4.184 joules g CH_4 → Mole CH_4 → kJ → J → cal

$$605\ g\ CH_4 \times \frac{1\ mole\ CH_4}{16.04276\ g\ CH_4} \times \frac{803\ kJ}{1\ mole\ CH_4} \times \frac{1000\ J}{1\ kJ} \times \frac{1\ Cal}{4.184\ J} = 7.23769\times10^6\ Cal$$

$$= \boxed{7.24\times10^6\ cal}$$

6. $2NH_3 + 5F_2 \rightarrow N_2F_4 + 6HF$

a) The reaction of 17.3 grams of F_2 in the above reaction resulted in the collection of 4.55 grams of N_2F_4. What was the % yield in this reaction? $\%\ yield = \frac{actual}{Theoretical} \times 100$

$$\%\ Yield = \frac{4.55\ g\ N_2F_4}{\left(17.3\ g\ F_2 \times \frac{1\ mole\ F_2}{37.99680\ g\ F_2} \times \frac{1\ mole\ N_2F_4}{5\ mole\ F_2} \times \frac{104.007}{1\ mole\ N_2F_4}\right)} \times 100 = 48.04185\%$$

$$= \boxed{48.0\%}$$

b) If the above reaction runs in 63.8% yield, how many grams of HF could be collected from the reaction of 547 grams NH_3? g NH_3 → mole NH_3 → mole HF → g HF

g HF × $\frac{63.8}{100}$

$$547\,g\,NH_3 \times \frac{1\,mole\,NH_3}{17.03052\,g\,NH_3} \times \frac{6\,mole\,HF}{2\,mole\,NH_3} \times \frac{20.00634\,g\,HF}{1\,mole\,HF} \times \frac{63.8\,g\,HF\,actual}{100\,g\,HF\,Theoretical} =$$

1229.8977 g HF

= **1230 g HF** or **1.23×10^3 g HF**

7. Solution Stoichiometry. $Mg(s) + 2HNO_3(aq) \longrightarrow Mg(NO_3)_2(aq) + H_2(g)$

a) Calculate the number of mL of 4.23M HNO_3 needed to prepare 117 grams of $Mg(NO_3)_2$ from the above reaction. g $Mg(NO_3)_2$ → mole $Mg(NO_3)_2$ → mole HNO_3 → L HNO_3 → mL HNO_3

* We have not done conc. yet. Hold on these last two.

$$117\,g\,Mg(NO_3)_2 \times \frac{1\,mole\,Mg(NO_3)_2}{148.3148\,g\,Mg(NO_3)_2} \times \frac{2\,mole\,HNO_3}{1\,mole\,Mg(NO_3)_2} \times \frac{1\,L\,HNO_{3(aq)}}{4.23\,mole\,HNO_3} \times \frac{1000\,mL\,HNO_{3(aq)}}{1\,L\,HNO_{3(aq)}} =$$

372.98468 mL HNO_3

= **373 mL $HNO_{3(aq)}$**

b) How many grams of Mg are required to react with 28.4 mL of .645M HNO_3?

mL HNO_3 → L HNO_3 → mole HNO_3 → mole Mg → g Mg

$$28.4\,mL\,HNO_3 \times \frac{1\,L\,HNO_3}{1000\,mL\,HNO_3} \times \frac{0.645\,moles\,HNO_3}{1\,L\,HNO_3} \times \frac{1\,mole\,Mg}{2\,mole\,HNO_3} \times \frac{24.3050\,g\,Mg}{1\,mole\,Mg} =$$

= 0.222609495 g Mg

= **0.223 g Mg**