Unit 6C: Stoichiometry Study Guide Name: Dimensional Analysis Answer key Date:

1. Balance and determine the reaction type:
   a. 2 Mg + 1 O_2 → 2 MgO Rxn Type: Syn
   b. 1 Mg + 1 $Co(NO_3)_2$ → 1 Co + 1 $Mg(NO_3)_2$ Rxn Type: SR
   c. 1 $Sr(OH)_2$ + 2 HCl → 1 $SrCl_2$ + 2 ~~H_2O~~ HOH Rxn Type: DR/Neutralizati
   d. 2 C_2H_6 + 7 O_2 → ~~4~~ 4 CO_2 + 6 H_2O Rxn Type: combus.

2. $2\ Na + Cl_2 \rightarrow 2\ NaCl$ $\Delta H = -411.12$ kJ
   a. Is the reaction endothermic or exothermic?
   exothermic
   b. How many grams of chlorine gas is needed to produce 0.75 moles of sodium chloride?

$$0.75\text{mol NaCl} \left| \frac{1\text{ mol } Cl_2}{2\text{mol NaCl}} \right| \frac{70.90\text{g } Cl_2}{1\text{mol } Cl_2} = 26.5875$$

   27 g Cl_2 2 S.F.

   c. How many particles of NaCl will be produced when 35 grams of Na reacts with excess chlorine?

$$35\text{g Na} \left| \frac{1\text{mol Na}}{22.99\text{g Na}} \right| \frac{2\text{ mol NaCl}}{2\text{mol Na}} \left| \frac{6.02\times10^{23}\text{ particles NaCl}}{1\text{mol NaCl}} \right.$$

   9.1649 ⇒ 9.2×10^{23} particles

3. $CaCO_3 \rightarrow CaO + CO_2$ $\Delta H = +176.8$ kJ
   a. Is the reaction endothermic or exothermic?
   endothermic
   b. How many liters of carbon dioxide are produced at STP when 25.0 g of calcium carbonate decompose?

$$25.0\text{g } CaCO_3 \left| \frac{1\text{mol } CaCO_3}{100.09\text{g } CaCO_3} \right| \frac{1\text{mol } CO_2}{1\text{mol } CaCO_3} \left| \frac{22.4\text{L } CO_2}{1\text{mol } CO_2} \right.$$

   5.59 L CO_2

   c. How many grams of $CaCO_3$ are required to produce 4.11 grams of CaO?

$$4.11\text{g CaO} \left| \frac{1\text{mol CaO}}{56.08\text{g CaO}} \right| \frac{1\text{ mol } CaCO_3}{1\text{mol CaO}} \left| \frac{100.09\text{g } CaCO_3}{1\text{mol } CaCO_3} \right.$$

   7.34g $CaCO_3$

4. $C(s) + 2H_2(g) \rightarrow CH_4(g) + 74.3\ kJ$

a. Is the reaction endothermic or exothermic?

exothermic

b. How many liters of CH_4 will be produced when 31 grams of carbon react with excess hydrogen at STP?

$$31\text{g C} \left| \frac{1\text{mol C}}{12.01\text{g C}} \right| \frac{1\text{mol CH}_4}{1\text{mol C}} \left| \frac{22.4\text{ L CH}_4}{1\text{mol CH}_4} \right| = \boxed{58\text{ L CH}_4}$$

c. How many grams of carbon are required to react with 4.22×10^{24} molecules of H_2?

$$4.22\times10^{24}\text{ molecules H}_2 \left| \frac{1\text{mol H}_2}{6.02\times10^{23}\text{ molecules H}_2} \right| \frac{1\text{mol C}}{2\text{ mol H}_2} \left| \frac{12.01\text{g C}}{1\text{mol C}} \right| = \boxed{42.1\text{g C}}$$

d. 55 liters of H_2 at STP react with excess carbon. How many moles of CH_4 will be produced?

$$55\text{L H}_2 \left| \frac{1\text{mol H}_2}{22.4\text{ L H}_2} \right| \frac{1\text{mol CH}_4}{2\text{ mol H}_2} \left| \frac{\text{mol CH}_4}{\text{mol CH}_4} \right| = \boxed{1.2\text{ mol CH}_4}$$

5. $2Al + 3Cl_2 \rightarrow 2AlCl_3$

Aluminum reacts with chlorine to produce aluminum chloride according to the equation above. 4.25×10^{22} atoms of aluminum are mixed with 18.23 grams of chlorine gas and allowed to react.

a. What is the limiting reactant? Aluminum

b. What is the excess reactant? chlorine

c. How many grams of the excess reactant remain after the reaction?

d. What is the maximum mass (theoretical yield) of aluminum chloride that will be made?

e. What is the percent yield if 7.48 g of aluminum chloride is produced in lab?

Step 1: $4.25\times10^{22}\text{ atom Al} \left| \frac{1\text{mol Al}}{6.02\times10^{23}\text{ atom Al}} \right| = 0.0706\text{ mol Al}$

$18.23\text{g Cl}_2 \left| \frac{1\text{mol Cl}_2}{70.90\text{g Cl}_2} \right| = 0.257\text{ mol Cl}_2$

$2Al + 3Cl_2 \rightarrow 2AlCl_3$

B:	0.0706 mol	0.257 mol	∅
∴	−0.0706 mol	0.0706(3/2)	0.0706(2/2)
	∅	0.1059 mol	0.0706 mol

(B) (start) (used)

$0.257\text{ mol Cl}_2 - 0.1059\text{ mol} = 0.1511\text{ mol Cl}_2$ excess

$0.1511\text{ mol Cl}_2 \left| \frac{70.90\text{g}}{1\text{mol Cl}_2} \right| =$

10.7g Cl_2 excess

(C) $0.0706\text{ mol Al} \left| \frac{133.33\text{g AlCl}_3}{1\text{mol AlCl}_3} \right|$

9.41g AlCl_3

(d) % yield: $\left(\frac{A}{T}\right)\times100 = \left(\frac{7.48\text{g}}{9.41\text{g}}\right)\times100 = 79.5\%$