Name: ____________________________

STOICHIOMETRY
HONORS CHEMISTRY
TEXTBOOK PGS 102–115, 133–139

1. Given an equation

$$2C_2H_6(g) + 7O_2(g) \xrightarrow{\Delta} 4CO_2(g) + 6H_2O(g)$$

How many mol of CO_2 will be formed by the complete combustion of 6.6 mol C_2H_6? 0.0410 mol C_2H_6?

$$\mathbf{6.6\ mol\ C_2H_6\left(\frac{4\ mol\ CO_2}{2\ mol\ C_2H_6}\right) = 13\ mol\ CO_2}$$

$$\mathbf{.0410\ mol\ C_2H_6\left(\frac{4\ mol\ CO_2}{2\ mol\ C_2H_6}\right) = 0.0820\ mol\ CO_2}$$

2. In the reaction,

$$2C_2H_6(g) + 7O_2(g) \xrightarrow{\Delta} 4CO_2(g) + 6H_2O(g)$$

Determine the moles of CO_2 and H_2O formed when 2.00 moles of ethane are reacted with 10.0 moles of oxygen.

In the reaction the initial set of conditions is 2.00 moles of C_2H_6 and 10.0 moles of O_2.

	$2C_2H_6(g)$	$+\ 7O_2(g)$	$\xrightarrow{\Delta}\ 4CO_2(g)$	$+\ 6H_2O(g)$
Initial	**2.00 mol**	**10.0 mol**	**0 mol**	**0 mol**

Next, the following table is completed

$(mol\ C_2H_6)_o$	**$(mol\ O_2)_{required}$**	**$(mol\ O_2)_o$**	**Conclusion**
2.00		**10.0 mol**	

To answer the next entry, $(mol\ O_2)_{required}$, the number of moles of O_2 which would completely react with 2.00 mol of C_2H_6 are calculated.

$$\mathbf{2.00\ mol\ C_2H_6\left(\frac{7\ mol\ O_2}{2\ mol\ C_2H_6}\right) = 7.00\ mol\ O_2}$$ **required to react with 2.00 mol of C_2H_6.**

The next entry can now be made

$(mol\ C_2H_6)_o$	**$(mol\ O_2)_{required}$**	**$(mol\ O_2)_o$**	**Conclusion**
2.00	**7.00**	**10.0 mol**	

But 10.0 mol of O_2 are available.

3. Suppose in another example 15.0 mol of O_2 are combined with 5.00 mol of C_2H_6. Determine the moles of products formed and the moles of excess reactant remaining.

$$2C_2H_{6}(g) + 7O_{2}(g) \xrightarrow{\Delta} 4CO_{2}(g) + 6H_2O(g)$$

Initial 5.00 mol 15.0 mol 0 mol 0 mol

$(\text{mol } C_2H_6)_o$	$(\text{mol } O_2)_{required}$	$(\text{mol } O_2)_o$	Conclusion
5.00		**15.0 mol**	

$$5.00 \text{ mol } C_2H_6 \left(\frac{7 \text{ mol } O_2}{2 \text{ mol } C_2H_6}\right) = 17.5 \text{ mol } O_2$$

$(\text{mol } C_2H_6)_o$	$(\text{mol } O_2)_{required}$	$(\text{mol } O_2)_o$	Conclusion
5.00	**17.5 mol**	**15.0 mol** **C_2H_6 excess**	**O_2 limiting,**

In this case 5.00 moles of C_2H_6 require 17.5 mol of O_2 for complete reaction, however, only 15.0 moles of O_2 were available initially. There is not enough O_2 for complete reaction. The amount of O_2 is limiting. The second calculation determines the correct amount of CO_2 and H_2O formed.

$$15.0 \text{ mol } O_2 \left(\frac{4 \text{ mol } CO_2}{7 \text{ mol } O_2}\right) = 8.57 \text{ mol } CO_2$$

$$15.0 \text{ mol } O_2 \left(\frac{6 \text{ mol } H_2O}{7 \text{ mol } O_2}\right) = 12.9 \text{ mol } H_2O$$

$$15.0 \text{ mol } O_2 \left(\frac{2 \text{ mol } C_2H_6}{7 \text{ mol } O_2}\right) = 4.29 \text{ mol } C_2H_6$$

5.00 mol - 4.29 mol = 0.71 moles of C_2H_6 remain unreacted.

4. Calculate the mass of calcium nitride formed when 50.0 g of calcium react with 50.0 g of nitrogen according to the reaction.

$$3Ca_{(s)} + N_{2(g)} \rightarrow Ca_3N_{2(s)}$$

Solution:

$$\textbf{50 g Ca}\left(\frac{\textbf{1 mol Ca}}{\textbf{40.1 g}}\right) = \textbf{1.25 mol Ca}$$

$$\textbf{50 g N}_2\left(\frac{\textbf{1 mol N}_2}{\textbf{28.0 g}}\right) = \textbf{1.79 mol N}_2$$

	$3Ca(s)$ +	$N_2(g)$ →	$Ca_3N_2(s)$
initial	**1.25 mol**	**1.79 mol**	**0 mol**

(mol Ca)$_o$	**(mol N_2)$_{required}$**	**(mol N_2)$_o$**	**Conclusion**
1.25	**0.417 mol**	**1.79 mol Ca limiting**	**N_2 excess,**

$$\textbf{1.25 mol Ca}\left(\frac{\textbf{1 mol N}_2}{\textbf{3 mol Ca}}\right) = \textbf{0.417 mol N}_2$$

$$\textbf{1.25 mol Ca}\left(\frac{\textbf{1 mol Ca}_3\textbf{N}_2}{\textbf{3 mol Ca}}\right) = \textbf{0.417 mol Ca}_3\textbf{N}_2$$

$$\textbf{0.417 mol Ca}_3\textbf{N}_2\left(\frac{\textbf{148 g Ca}_3\textbf{N}_2}{\textbf{1 mol Ca}_3\textbf{N}_2}\right) = \textbf{61.7 g Ca}_3\textbf{N}_2\textbf{ formed}$$

5. How many moles of C_2H_6, assuming excess oxygen, are required to form 3.7 mol H_2O?

$$\textbf{3.7 mol H}_2\textbf{O}\left(\frac{\textbf{2 mol C}_2\textbf{H}_6}{\textbf{6 mol H}_2\textbf{O}}\right) = \textbf{1.2 mol C}_2\textbf{H}_6$$

6. .Define the terms *concentration* and *molarity*.

Concentration is a measure of the relative amount of solute per unit amount of solution.

Molarity is one expression of concentration. It is defined as the quotient of moles of solute and volume of solution.

$$\textbf{molarity} = \frac{\textbf{moles solute}}{\textbf{Liter solution}}$$

7. Calculate the molarity of a solution contain 0.875 mole NaCl in 1 liter? in 500 ml; in 100 ml; in 6 liters?

Solution:

The definition of molarity is $\frac{\text{moles solute}}{\text{Liter solution}}$, to calculate the molarity of these solutions, substitute the appropriate numbers.

$$\frac{0.875 \text{ moles NaCl}}{1 \text{ Liter solution}} = 0.875 \text{ M NaCl}$$

$$\frac{0.875 \text{ moles NaCl}}{0.5 \text{ Liter solution}} = 1.75 \text{ M NaCl}$$

$$\frac{0.875 \text{ moles NaCl}}{0.1 \text{ Liter solution}} = 8.75 \text{ M NaCl}$$

$$\frac{0.875 \text{ moles NaCl}}{6 \text{ Liter solution}} = 0.146 \text{ M NaCl}$$

8. Calculate the volume of 0.500 M $Cu(NO_3)_2$ needed to prepare 250 mLs of a 0.0400 M $Cu(NO_3)_2$ solution.

$$M_cV_c = M_dV_d$$

$$V_c = \frac{M_dV_d}{M_c}$$

$$V_c = \frac{0.0400 \text{ M} \cdot 250 \text{ mLs}}{0.500 \text{ M}}$$

$$V_c = 20.0 \text{ mLs of concentrated solution}$$

9. How many mLs of 0.450 M HCl are required to completely react with 2.50 g of Zn?

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

$$2.50 \text{ g Zn} \left(\frac{1 \text{ mol}}{65.4 \text{ g}}\right) = 0.0382 \text{ mol Zn}$$

$$0.0382 \text{ mol Zn} \left(\frac{2 \text{ mol HCl}}{1 \text{ mol Zn}}\right) = 0.0764 \text{ mol HCl}$$

A solution of 0.450 M HCl contains $\frac{0.450 \text{ mol HCl}}{1 \text{ L solution}}$, therefore

$$0.0764 \text{ mol HCl} \left(\frac{1 \text{ L solution}}{0.450 \text{ mol HCl}}\right) = 0.170 \text{ L or 170. mLs of the HCl solution}$$

10. Calculate the molarity of sulfuric acid in a 20.00 mL sample which is neutralized by 18.50 mLs of 0.750 M NaOH.

The important reaction is

$$\mathbf{H_2SO_4}\textit{(aq)} + \mathbf{2NaOH}\textit{(aq)} \rightarrow \mathbf{Na_2SO_4}\textit{(aq)} + \mathbf{H_2O}\textit{(l)}$$

$$0.01850\ \text{L}\left(\frac{0.750\ \text{mol}}{1\ \text{L}}\right) = 0.0139\ \text{mol NaOH}$$

$$0.0139\ \text{mol NaOH}\left(\frac{1\ \text{mol}\ H_2SO_4}{2\ \text{mol NaOH}}\right) = 0.00695\ \text{mol}\ H_2SO_4$$

$$\frac{0.00695\ \text{mol}\ H_2SO_4}{0.020\ \text{L}} = 0.347\ \text{M}\ H_2SO_4$$