# CHEM 1305 - Chapter 09 - Handout

*Define the following terms; explain the following concepts, and answer the following questions:*

1) "A balanced equation establishes mole -to- mole relationships between each compound represented in the equation.

2) Define the terms:

   a) stoichiometry --
   Calculation of quantative relationships of reactants and products.
   (Assures that the Law of Conservation of Mass is intact for a given reaction.)

   b) limiting reactant --
   The reactant in "short supply." The amount of product that can be formed is limited by the amount of 'limiting reagent.'

   c) percent yield --

$$\left( \frac{Actual\ yield}{Theoretical\ yield} \right) 100 = \%\ Yield$$

3) The hydrocarbon methane ($CH_4$) burns according the balanced equation:

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

   a) One mole of methane will produce 1 moles of carbon dioxide.

   b) One mole of methane will produce 2 moles of water.

   c) One mole of methane reacts with 2 moles of $O_2$.

   d) Two moles of methane will produce 2 moles of carbon dioxide.

   e) Two moles of methane will produce 4 moles of water.

   f) 3.7 moles of methane will produce 7.4 moles of water.

g) 3.7 moles of $O_2$ will produce 1.9 moles of carbon dioxide.

4) The molar mass of methane is 16.04 g/mol. Considering the equation above;

a) 16.04 g of methane will produce 1 moles of carbon dioxide.

b) 16.04 g of methane will produce 2 moles of water.

c) 32.08 g of methane will produce 2 moles of carbon dioxide.

d) 32.08 g of methane will produce 4 moles of water.

e) 59.35 g of methane will produce 3.7 moles of carbon dioxide.

f) 59.35 g of methane will react with 7.4 moles of $O_2$.

g) 16.04 g of methane will produce 36 grams of water.

5) Propane combusts according to the **<u>un</u>**balanced equation:

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$

What mass of oxygen will be required to react exactly with 96.1 g of propane?

[hint 1: balance equation first.]

[hint 2: use "g --> mol --> mol --> g" framework, where the first and third arrows are executed with the help of the Periodic Chart, and the second arrow is executed using the mole-mole "conversion factors" found in the balanced equation.]

1. <u>Balance Chem Eq</u> -->$C_3H_8 + \underline{5}O_2 \rightarrow \underline{3}CO_2 + \underline{4}H_2O$

2. <u>Detn Molar Masses</u> --> using C3H8 as an example...

` 3C = 3*12 = 36
` 8H = 8*1 = 8
` ----------
` C3H8 = 44 g/mol

Similarly,
$O_2$ = 32 g/mol;
$CO_2$ = 44 g/mol;
$H_2O$ = 18 g/mol

3. <u>Calculate using dimensional analysis</u>

$$\left(\frac{96.1\ g\ C_3H_8}{1}\right)\left(\frac{1\ mol\ C_3H_8}{44\ g\ C_3H_8}\right)\left(\frac{5\ mol\ O}{1\ mol\ C_3H_8}\right)\left(\frac{32\ g\ O_2}{1\ mol\ O_2}\right) = 350\ g\ O_2$$

6) Hydrogen sulfide reacts with oxygen to produce sulfur dioxide and water:

$$2H_2S + 3O_2 \text{ --> } 2SO_2 + 2H_2O$$

a) How many moles of oxygen gas are required to react with 5.6 moles of hydrogen sulfide?

$$\left(\frac{5.6\ mol\ H_2S}{1}\right)\left(\frac{3\ mol\ O_2}{2\ mol\ H_2S}\right) = 8.4\ mol\ O_2$$

b) How many moles of sulfur dioxide gas will be produced by reacting 7.3 moles of hydrogen sulfide with excess oxygen?

$$\left(\frac{7.3\ mol\ H_2S}{1}\right)\left(\frac{2\ mol\ SO_2}{2\ mol\ H_2S}\right) = 7.3\ mol\ SO_2$$

c) How many moles of sulfur dioxide gas will be produced by reacting 7.3 moles of oxygen with excess hydrogen sulfide?

$$\left(\frac{7.3\ mol\ O_2}{1}\right)\left(\frac{2\ mol\ SO_2}{3\ mol\ O_2}\right) = 4.9\ mol\ SO_2$$

7) Consider a cake that requires two cups of flour and four eggs.
(1 cake ~ 2 cups flour ~ 4 eggs)
Considering flour and eggs to be 'reactants,' which is the *limiting reactant* if the chef has…

a) …two cups of flour and eight eggs? flour (2 cups flour requires 4 eggs)

b) …eight cups of flour and two eggs? eggs (8 cups flour requires 16 eggs)

c) …two cups of flour and two eggs? eggs (2 cups flour requires 4 eggs)

d) …six cups of flour and twelve eggs? neither (6 cups flour requires 12 eggs)

e) …one cup of flour and two eggs? neither (1 cups flour requires 2 eggs)

8) Consider again combustion of the hydrocarbon methane ($CH_4$):

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

which is the *limiting reactant* given the following amounts of reactants…

a) 1 mole of methane and 2 moles of $O_2$? neither

b) 1 mole of methane and 3 moles of $O_2$? methane

c) 2 mole of methane and 2 moles of $O_2$? oxygen

d) 16.04 grams of methane and 2 moles of $O_2$? neither
(16g methane = 1 mol methane, and 1 mole methane requires 2 mol oxygen)

e) 16.04 grams of methane and 32.08 grams of $O_2$? oxygen
(16g methane = 1 mol methane... and 32g $O_2$ = 1 mol $O_2$... and from the equation we see that 1 mole methane requires 2 mol oxygen)

9) The results for experiment yielded 1.279 g of product, whereas 1.352 g was expected. What is the percent yield?

$$\frac{1.279}{1.352} \times 100 = 94.60\ \%$$