

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 quantitative relationships of reactants and products.

(Assures that the Law of Conservation of Mass is intact for a given reaction.)

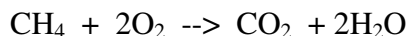
b) limiting reactant --

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

c) percent yield --

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

3) The hydrocarbon methane (CH₄) burns according to the balanced equation:



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 O₂.

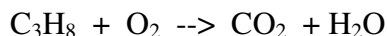
d) Two moles of methane will produce 2 moles of carbon dioxide.

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 unbalanced equation:



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. Balance Chem Eq → $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$

2. Detn Molar Masses → using C_3H_8 as an example...

$$\begin{array}{r} \text{`} \quad 3\text{C} = 3 \cdot 12 = 36 \\ \text{`} \quad 8\text{H} = 8 \cdot 1 = 8 \\ \text{`} \quad \text{-----} \\ \text{`} \quad \text{C}_3\text{H}_8 = 44 \text{ g/mol} \end{array}$$

Similarly,

$$\text{O}_2 = 32 \text{ g/mol};$$

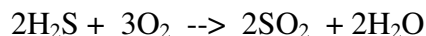
$$\text{CO}_2 = 44 \text{ g/mol};$$

$$\text{H}_2\text{O} = 18 \text{ g/mol}$$

3. Calculate using dimensional analysis

$$\left(\frac{96.1 \text{ g } \text{C}_3\text{H}_8}{1} \right) \left(\frac{1 \text{ mol } \text{C}_3\text{H}_8}{44 \text{ g } \text{C}_3\text{H}_8} \right) \left(\frac{5 \text{ mol } \text{O}}{1 \text{ mol } \text{C}_3\text{H}_8} \right) \left(\frac{32 \text{ g } \text{O}_2}{1 \text{ mol } \text{O}_2} \right) = 350 \text{ g } \text{O}_2$$

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



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

$$\left(\frac{5.6 \text{ mol } \text{H}_2\text{S}}{1} \right) \left(\frac{3 \text{ mol } \text{O}_2}{2 \text{ mol } \text{H}_2\text{S}} \right) = 8.4 \text{ mol } \text{O}_2$$

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

$$\left(\frac{7.3 \text{ mol } \text{H}_2\text{S}}{1} \right) \left(\frac{2 \text{ mol } \text{SO}_2}{2 \text{ mol } \text{H}_2\text{S}} \right) = 7.3 \text{ mol } \text{SO}_2$$

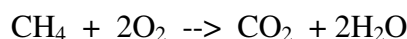
c) How many moles of sulfur dioxide gas will be produced by reacting 7.3 moles of oxygen with excess hydrogen sulfide?

$$\left(\frac{7.3 \text{ mol } \text{O}_2}{1} \right) \left(\frac{2 \text{ mol } \text{SO}_2}{3 \text{ mol } \text{O}_2} \right) = 4.9 \text{ mol } \text{SO}_2$$

- 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 (CH₄):



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

- a) 1 mole of methane and 2 moles of O₂? neither
 - b) 1 mole of methane and 3 moles of O₂? methane
 - c) 2 mole of methane and 2 moles of O₂? oxygen
 - d) 16.04 grams of methane and 2 moles of O₂? 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 O₂? oxygen
(16g methane = 1 mol methane... and 32g O₂ = 1 mol O₂... 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?

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

