Chem 101 2017 Discussion #5 Chapter 5

Your name: _____ TF's name:_____ Discussion Day/Time: _____

Things you should know when you leave Discussion today:

1. Molar calculations
2. Dimensional analysis.
3. Unit Conversions
4. Calculations using limiting reactants.
5. Theoretical yield and Percent yield
6. Balancing reactions by inspection.

1. Octanitrocubane (ONC) is a powerful explosive that, like TNT, is shock-insensitive (not readily detonated by shock). First synthesized by Philip Eaton and Mao-Xi Zhang in 1999 (Angewandte Chemie International Edition 39 (2): 401–404.), ONC is the most explosive chemical compound ever made (only nuclear weapons are more powerful). It detonates through the (unbalanced) reaction below.

$$C_8(NO_2)_8\ (s) \rightarrow \quad CO_2\ (g) + \quad N_2\ (g)$$

   a. Write the balanced chemical reaction for the detonation of ONC.

   b. If we wanted to synthesize ONC from carbon dioxide and nitrogen gas (i.e. reverse the reaction) and we had 56.0 g of nitrogen gas and as much carbon dioxide as we wanted (it's "in excess"), how many moles ONC could you make if all nitrogen gas was used assuming 100% yield? (Hint: write balance chemical reaction for making ONC.)

   c. If we wanted to synthesize ONC from carbon dioxide and nitrogen gas (i.e. reverse the reaction) and we had 88.0 g of carbon dioxide and as much nitrogen gas as we wanted, how many moles ONC could you make assuming 100% yield? [Note the difference from part b!]

   d. If we wanted to synthesize ONC from carbon dioxide and nitrogen gas (i.e. reverse the reaction) and we had 88.0 g of carbon dioxide and 56.0 g nitrogen gas, how many grams ONC could you make assuming 100% yield?

   e. How many moles of the non-limiting reagent are left in excess?

f. If we synthesized ONC from carbon dioxide and nitrogen gas using the amounts in part (d) and our yield was 87 grams, calculate the percent yield.

g. What mass of a non-limiting reagent was used assuming percent yield from part **f**?(Assume that no additional reactions take place)

h. What mass of a limiting reagent was used assuming percent yield from part **f**?(Assume that no additional reactions take place)

i. Using the information in questions (a-h) fill in the following table. **What is conserved during reaction? Number of grams? or Number of moles?**

	CO_2 (g)	N_2 (g)	$C_8(NO_2)_8$ (s)
Starting amount in grams			
Starting amount in moles			
Change in moles (Assuming 100% yield.)			
Final amount in moles (Assuming 100% yield.)			
Change in grams (Assuming 100% yield.)			
Final amount in grams (Assuming 100% yield.)			
Change in grams (Assuming 75% yield.)			
Final amount in grams (Assuming 75% yield.)			

2. Consider a reaction where two reactants (A and B) become two products (C and D). Using the three experimental observations below determine the stoichiometric coefficients and put them in the spaces below.

$$\_\_\_\ A + \_\_\_\ B \rightarrow \_\_\_\ C + \_\_\_\ D$$

Experiment 1: If 4 moles of A react with excess B, then 2 moles of C are formed.

Experiment 2: When 12 moles of B are completely used up, 6 moles of A are used.

Experiment 3: When 4 moles of B react with excess A, 1 mole of D is formed.

3. Consider a gas cylinder filled with 2.1 grams of $N_2(g)$ and 0.60 grams of $H_2(g)$. When reaction proceeds it forms ammonia.

   a. Write balanced chemical reaction:

   b. How many moles of reaction are in 2.1grams of $N_2(g)$?

   c. How many moles of reaction are in 0.60 grams of $H_2(g)$?

   d. If the reaction goes to completion, how many grams of NH_3 are produced?(Answer:2.6g)

   e. What is the mass of the cylinder contents after the reaction goes to completion? (Is the mass of the cylinder change throughout the reaction?)

   f. If only 62% of the product formed in the reaction, what was the actual yield of the product?(Answer:1.6g)

4. Ammonia (NH_3, M_{NH3} = 17.0 g/mol) can be synthesized from the decomposition of urea, $(NH_2)_2CO$ (M_{urea} = 60.0 g/mol), according to the reaction below. If the yield of the reaction is 55.0%, what mass (in g) of urea is required to form 8.50 g of ammonia? (Hint: always check if reaction is balanced)(Answer: 109g)

$$(NH_2)_2CO(s) \rightarrow NH_2CONHCONH_2(s) + NH_3(g).$$

5. A mixture of 152 g of CS_2 and 67.2 L of Cl_2 is passed through a hot reaction tube, where the following reaction takes place (Note: 1 mole of any gas occupies 22.4 L):
   a. Balance the chemical reaction:

$$CS_2\ (g) + Cl_2(g) \rightarrow CCl_4(l) + S_2Cl_2\ (l)$$

   b. How much in grams of the non-limiting reagent is left in excess to one significant figure?

   c. How many grams of CCl_4 can be made?(Answer:154g)

   d. You did an experiment and you made 119g grams of CCl_4 what is percentage yield to one significant figure?(Answer:77.3%)

6. Sodium hydroxide reacts with carbon dioxide as follows, Suppose 400. g of NaOH is allowed to react with 308. g of CO_2 (g). (Hint: always check if reaction is balanced)

$$NaOH(s) + CO_2\ (g) \rightarrow Na_2CO_3\ (s) + H_2O\ (l)$$

   a. What is the limiting reactant?

   b. What mass of sodium carbonate can be produced? (Answer:530.g)

   c. What mass of excess reactant remains after the limiting reactant has been consumed completely? (Answer:88.0g)

7. During plant respiration, glucose ($C_6H_{12}O_6$) and oxygen react to form carbon dioxide and water.

   a. Write balanced chemical reaction:

   b. What mass (in g) of O_2 is needed to fully react with 36.0 grams of glucose (M = 180 g/mol) assuming 100% yield.(Answer:38.4)

   c. How many grams of CO_2 will be formed assuming 100% yield?(Answer:52.8g)

   d. How many grams of water forms assuming 100% yield? (Answer:21.6g)

   e. What is the total mass of reactants? How does that compare to the total mass of products?

   f. What is the sum of the moles of reactants? How does that compare to the total moles of products?

g. How many grams of CO_2 will be formed assuming 58% yield?(Answer:30.6g)

h. What mass (in g) of O_2 is needed to react with 36.0 grams of glucose (M = 180 g/mol) with 58% yield. (Answer:22.3g)

i. How many grams of water forms assuming 79% yield?(Answer:17.1g)

8. An iron bar weighed **533 g**. After the bar had been standing in moist air for a month, exactly **one-eighth** of the iron turned to **rust** (**Fe_2O_3**). Calculate the final **total mass**: of the **iron bar + rust**. (Answer: 562g) **(Road map**: Calculate the mass of Fe_2O_3 that can be made from $1/8^{th}$ of the mass of the original iron and add this to the mass of $7/8^{th}$ of the mass of the original iron.)

   a. Write balanced chemical reaction

Fe(s) + ☐ → **Fe_2O_3 (s)**

9. If 4.88 g of 'barium chloride hydrate' is treated with sulfuric acid, it gives 4.66 g of anhydrous barium sulfate. How many water molecules were attached to the original barium chloride molecule? (Answer:2)