I apologize for the spraeling messiness of this packet. It is a combination of 1) things to know 2) unsolved problems 3) solved problems. It is a broad survey meant to be a starting point that jogs your memory.

Review for the June 2014 Chemistry Final Exam

(The exam covers only second semester, from Jan 27 to June 6th)

Disclaimer: Studying this packet is a great start but is not a substitute for actually studying all 80 days of material. Hopefully time spent with this packet will help you find what parts of the semester you need to go back and study in depth, either from your notes or from http://genest.weebly.com

Of the 80 days we have been together this semester, the things in this packet are the ones that came up over and over.

About a third of what you need to know are specific facts. Get these from your notes.

Two thirds of what you need to know are skills. Get these by doing, redoing, and redoing one more time, all of the old homework problems that you learned to solve this semester.

UNIT 6 PERCENT YIELD, STOICHIOMETERY

VOCABULARY

Vocabulary to know: –

diatomic – the wacky 7 all form diatomic molecules: H_2, F_2, N_2, O_2, Cl_2, Br_2, I_2

isotopes

ionic bond – forms between metal & nonmetal

covalent bond – forms between nonmetal & nonmetal

metal – elements from the left side of the table

nonmetal – elements from the right side of the table

coefficient – the big number, like the 5 in $5H_2O$

atomic number is how many protons an atom has

mass number is protons plus neutrons

FORMULAS

$$\% \text{ yield} = \frac{\text{actual yield}^*}{\text{theoretical yield}^{**}}$$

*actual yield is sometimes called "experimental yield"

**sometimes called "calculated yield"

MOST OF THE PROBLEMS IN THIS CHAPTER HAVE NO FORMULA. INSTEAD SOLVE THEM USING UNIT CONVERSION AND DIMENSIONAL ANALYSIS:

$$\text{grams HCl} \times \left(\frac{\text{mol HCl}}{\text{grams HCl}}\right) \times \left(\frac{\text{mol } NH_3}{\text{mol HCl}}\right) \times \left(\frac{\text{grams } NH_3}{\text{mol } NH_3}\right) = \text{grams } NH_3$$

1. Balance the following reaction and answer the other questions:

a. __2__ $C_2H_{6(g)}$ + __5__ $O_{2(g)}$ → __4__ $CO_{2(g)}$ + __6__ $H_2O_{(g)}$

b. Write five possible mole ratios.

c. If 3.00 moles of $C_2H_{6(g)}$ are burned, how many moles of $CO_{2(g)}$ are produced?

$$3.00 \text{ moles } C_2H_6 \times \left(\frac{4 \text{ mol } CO_2}{2 \text{ mol } C_2H_6}\right) = 6.00 \text{ mol } CO_2$$

d. If 2.34 grams of $C_2H_{6(g)}$ are burned, how many grams of $H_2O_{(g)}$ are produced?

$$\frac{2.34 \text{ g } C_2H_6}{1} \times \left(\frac{1 \text{ mol } C_2H_6}{30.08 \text{ g } C_2H_6}\right) \times \left(\frac{6 \text{ mol } H_2O}{2 \text{ mol } C_2H_6}\right) \times \left(\frac{18.02 \text{ grams } H_2O}{1 \text{ mol } H_2O}\right) = 4.21 \text{ g } H_2O$$

e. If 2.56 grams of $CO_{2(g)}$ are produced, how many liters of $H_2O_{(g)}$ are made at the same time if at STP?

$$2.56 \text{ g } CO_2 \times \left(\frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2}\right) \times \left(\frac{6 \text{ mol } H_2O}{4 \text{ mol } CO_2}\right) \times \left(\frac{22.4 \text{ L } H_2O}{1 \text{ mol } H_2O}\right) = 1.95 \text{ L } H_2O$$

2. Balance the following reaction and answer the questions:

a. __2__ $H_2O_{(l)}$ + __2__ $SO_{2(g)}$ + __1__ $O_{2(g)}$ → __2__ $H_2SO_{4(l)}$

b. How many moles of $H_2O_{(l)}$ are needed to completely react 3.7 grams of $SO_{2(g)}$?

$$3.7 \text{ g } SO_2 \times \frac{1 \text{ mol } SO_2}{64.07 \text{ g } SO_2} \times \frac{2 \text{ mol } H_2O}{2 \text{ mol } SO_2} = 0.058 \text{ mol } H_2O$$

c. How many moles of $O_{2(g)}$ are needed to use up 13.7 moles of $SO_{2(g)}$?

$$13.7 \text{ mol } SO_2 \times \left(\frac{1 \text{ mol } O_2}{2 \text{ mol } SO_2}\right) = 6.85 \text{ mol } O_2$$

d. How many moles of $H_2SO_{4(l)}$ will be produced if 13.7 moles of $SO_{2(g)}$ are used up?

$$13.7 \text{ mol } SO_2 \times \left(\frac{2 \text{ mol } H_2SO_4}{2 \text{ mol } SO_2}\right) = 13.7 \text{ mol } H_2SO_4$$

3. How many grams of $H_{2(g)}$ are made when 3.45 moles of Na react according to the following equation?

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

$$3.45 \text{ mol Na} \times \left(\frac{1 \text{ mol } H_2}{2 \text{ mol Na}}\right) \times \left(\frac{2.02 \text{ grams } H_2}{1 \text{ mol } H_2}\right) = 3.48 \text{ g } H_2$$

4. Imagine that 100. grams of aluminum and 100 grams of chlorine gas (remember: wacky 7 formula for the chlorine molecule…) react according to the following stoichiometery

$$2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$$

Which reagent will be the limiting reagent? How many grams of $AlCl_{3(s)}$ will form?

Step 1) Convert the mass of each reactant into moles of product

#1 $100.\text{ grams Al} \times \left(\frac{1 \text{ mol Al}}{26.98 \text{ g Al}}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{2 \text{ mol Al}}\right) = 3.71 \text{ mol } AlCl_3$

#2 $100.\text{ grams } Cl_2 \times \left(\frac{1 \text{ mol } Cl_2}{70.90 \text{ g } Cl_2}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{3 \text{ mol } Cl_2}\right) = 0.940 \text{ mol } AlCl_3$

Step 2) Both of your statements in Step 1 can't be right. The one that will actually happen is the one that makes the least moles of product. Below this box write "The limiting reactant

The limiting reactant is chlorine because it makes the least product.

Step 3) Calculate the mass of product produced

Because we just found that 0.940 mol $AlCl_3$ can form, we use that in our calculation:

$\frac{0.940 \text{ mol } AlCl_3}{1} \times \left(\frac{133.33 \text{ grams } AlCl_3}{1 \text{ mol } AlCl_3}\right) = 125 \text{ grams } AlCl_3$

5. Use the same three steps you used on the example from class. Imagine that 67.00 grams of aluminum and 60.50 grams grams of chlorine gas react according to the following stoichiometery

$$2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$$

Which reagent will be the limiting reagent? How many grams of $AlCl_{3(s)}$ will form?

#1 $\frac{67.00 \text{ grams Al}}{1} \times \left(\frac{1 \text{ mol Al}}{26.98 \text{ g Al}}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{2 \text{ mol Al}}\right) = 2.48 \text{ mol } AlCl_3$ would form

#2 $60.50 \text{ g } Cl_2 \times \left(\frac{1 \text{ mol} Cl_2}{70.90 \text{ g } Cl_2}\right) \times \left(\frac{2 \text{ mol } AlCl_3}{3 \text{ mol } Cl_2}\right) = 0.569 \text{ mol } AlCl_3$ would form

Both can't be right; Cl_2 will run out first. Cl_2 is the "LIMITING REAGENT"

$\frac{0.569 \text{ mol } AlCl_3 \text{ (FROM ABOVE answer)}}{1} \times \left(\frac{133.33 \text{ grams } AlCl_3}{1 \text{ mol } AlCl_3}\right) = 75.9 \text{ grams } AlCl_3$ will form

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4. 0.092 moles of iron filings are placed into a solution containing 0.158 mol of $CuSO_4$. Assuming that they react according to the balanced equation below, what is the limiting reactant? How many moles of Cu will be formed?

$$3\ CuSO_4\ (aq) + 2\ Fe\ (s) \rightarrow 3\ Cu\ (s) + Fe_2(SO_4)_3\ (aq)$$

#1 $\frac{0.158 \text{ mol } CuSO_4}{} \times \left(\frac{3 \text{ mol Cu}}{3 \text{ mol } CuSO_4}\right) = 0.158 \text{ mol Cu}$

#2 $\frac{0.092 \text{ mol Fe}}{} \times \left(\frac{3 \text{ mol Cu}}{2 \text{ mol Fe}}\right) = 0.138 \text{ mol Cu}$

5. One industrial process for making nitric acid begins with the reaction below. If 2.90 mol NH_3 and 3.75 mol O_2 are available, how many moles of each product are formed?

$$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$$

FIND THE LIMITING REACTANT

$2.90 \text{ mol } NH_3 \times \frac{4 \text{ mol NO}}{4 \text{ mol } NH_3} = 2.90 \text{ mol NO}$ * so NH_3 is limiting

$3.75 \text{ mol } O_2 \times \frac{4 \text{ mol NO}}{5 \text{ mol } O_2} = 3.00 \text{ mol NO}$

Now just calculate the other product, based on NH_3 being limiting

$\frac{2.90 \text{ mol } NH_3}{1} \times \left(\frac{6 \text{ mol } H_2O}{4 \text{ mol } NH_3}\right) = 4.35 \text{ mol } H_2O$

1. Write the formula we usually use for calculating percent yield:

2. Which value are we most likely to obtain by weighing a product on the electronic scale? (circle only one answer)
   a. actual yield
   b. theoretical yield

3. If a chemist runs a reaction where her theoretical yield of binaphthalene was 1.51×10^{-8} grams but only 7.50×10^{-9} grams formed, what was her percent yield?

4. For the reaction of $SiO_{2(s)}$ + 4 HF → $SiF_{4(g)}$ + 2 $H_2O_{(L)}$ suppose there are 7.00 grams of $SiO_{2(s)}$ and 1.100 grams of HF present in the test tube, show by calculation which reactant is limiting.

5. A chemist reacts bromine gas with hydrogen gas to form HBr gas.
   a. Write a balanced equation to describe this reaction. Remember some molecules may be diatomic.

   b. If he starts with 13.1 moles of Br_2, calculate the theoretical yield of HBr in moles.

6. If 830. g of F_2 and 12.0 g of O_2 are reacted, they react as $2\ F_{2(g)} + O_{2(g)} \rightarrow 2\ F_2O_{(g)}$
   a. Assuming that oxygen is the limiting reactant, calculate the theoretical yield of F_2O in grams.

   b. For this reaction, find the volume (in liters) of $F_2O_{(g)}$ that would be expected to form. (Assume the gas is at standard temperature and pressure.)