Name: ______________________________ Date: ________________ CHEM 1A

Monday, October 7, 2019 – Stoichiometry Part 1 (Chapter 3)

I. **Warm-Up –** Compound X_2Y is 60% X by mass. Calculate the percent Y by mass of the compound XY_3?

Assume 100g of X_2Y, therefore 60g in X_2Y and 40g of Y. If one unit of X is 30g, and one unit of Y is 40g in X_2Y, then the percent of Y in XY_3 is given by $\frac{40+40+40}{30+40+40+40} \times 100\% = 80\%\ Y\ in\ XY_3$.

II. What is a mole? A mole is a number; it is 6.022 x 10^{23} of something.

(Hint: You will need your periodic table for these problems.)

Molar Mass/Atomic Mass = The mass of a mole of objects (g/mol = amu)
1 mole of C weighs 12.011 grams

Average Atomic Mass = The sum of the masses of an atoms isotopes, each multiplied by its natural abundance

Percent by mass = mass X/total Mass

1. How many moles in 5.23×10^{23} atoms?

$$5.23 \times 10^{23} atoms \left(\frac{1\ mol}{6.0224 \times 10^{23} atoms}\right) = 0.868\ mol$$

2. How many moles of copper in 3.20 g?

$$3.20\ g\ Cu \left(\frac{1\ mol\ Cu}{63.55\ g\ Cu}\right) = 0.0504\ mol\ Cu$$

3. How many moles of O in 3.4 mol of $CuSO_4$?

$$3.4\ g\ CuSO_4 \left(\frac{4\ mol\ O}{1\ mol\ CuSO_4}\right) = 14\ mol\ O$$

4. **Average Atomic Mass Values -** Three naturally occurring isotopes of potassium are ^{39}K, 38.963707 amu, ^{40}K, 39.963999 amu, and ^{41}K. The natural abundances of ^{39}K and ^{41}K are 93.2581% and 6.7302%, respectively. Determine the atomic mass of ^{41}K.

^{39}K ⇒ 93.2581% ⇒ 38.963707 amu

^{40}K ⇒ 100% - 93.2581% - 6.7302% = 0.0117% ⇒ 39.963999 amu

^{41}K ⇒ 6.7302% ⇒ ? amu

Average Atomic Mass = (fraction of isotope A)(mass of isotope A) + (fraction of isotope B)(mass of isotope B) + etc.

39.098 amu = (0.932581)(38.963707 amu) + (0.000117)(39.963999 amu) + (0.067302)(X amu)

Atomic Mass of ^{41}K ⇒ 40.957 amu

5. In a sample of 200 chlorine atoms, it is found that 151 are ^{35}Cl (34.969 amu), and 49 are another isotope. What is the other naturally occurring isotope of chlorine?

Average Atomic Mass = (fraction of Cl-35)(mass of Cl-35) + (fraction of Cl-X)(mass of isotope Cl-X) + etc.
35.453 amu = (151/200)(34.969 amu) + (49/200)(mass of Cl-X)
Mass of Cl-X) = 36.945 amu
Therefore the other isotope is Cl-37

6. For which of the following compounds does 1.00 g represent 3.32×10^{-2} mol?

a. NO_2 b. H_2O c. C_2H_6 d. NH_3 e. CO

1.00g /3.32×10^{-2} mol = 30.12 g/mol = molar mass of ethane

7. A single atom of an element weighs $5.81x10^{-23}$ g. Identify the isotope.

$\frac{5.81 \text{ x } 10^{-23} g}{1 \text{ atom}} \text{ x } \frac{6.022 \text{ x } 10^{-23} \text{atoms}}{1 \text{ mol}} =$ 34.9 g/mol ⇒ ^{35}Cl

8. How many hydrogen atoms are in 6.3 mg sample of methane? (Methane is CH_4).

$6.3 \; mg \; CH_4 \; x \; \frac{1 \; g}{1000 \; mg} \; x \; \frac{1 \; mole \; CH_4}{16.042 \; g} \; x \; \frac{4 \; mole \; H}{1 \; mole \; CH_4} \; x \; \frac{6.022 \; x \; 10^{23} atoms}{1 \; mole \; H} = 9.5 \; x \; 10^{20} atoms$

Chemical Equations

9. Balance the following equations:

(a) _2__Fe + _3__Cl_2 → _2__$FeCl_3$

(b) _4__Fe + _3__O_2 → _2__Fe_2O_3

(c) _2__$FeBr_3$ + _3__H_2SO_4 → ___$Fe_2(SO_4)_3$ + _6__HBr

(d) ___$C_4H_6O_3$ + ___H_2O → __2_$C_2H_4O_2$

(e) ___C_2H_4 + __3_O_2 → __2_CO_2 + __2_H_2O

(f) _14__H_2SiCl_2 + _4__H_2O → ___$H_8Si_4O_4$ + _28_HCl

(g) __C_7H_9 + _3_HNO_3 → __$C_7H_6(NO_2)_3$ + _3_H_2O

(h) __$C_5H_8O_2$ + _2_ NaH+ _2_HCl → __$C_5H_{12}O_2$ + _2_NaCl

Methodology for Reaction Stoichiometry Problems

1. Write a balanced chemical reaction
2. Convert given value(s) into moles (you may have to ID the limiting reagent)
3. Use reaction coefficients as a molar ratio
4. Convert moles of your unknown into the desired units

Limiting Reagent ⇒ Limits the amount of product that is produced due to running out 1st - The limiting reagent is used to determine the maximum yield of product/s aka the theoretical yield and the maximum consumption of reactants aka the theoretical consumption

Identifying Limiting Reagents:
1. Convert all given values of reactants into moles
2. Divide each mole value by the coefficient
3. The smallest number identifies the LR