Chemistry I Review Unit 8 – Hydrates & Stoichiometry KEY

**Hydrates:**

-Be able to name hydrates, write the formula for a given hydrate, and determine the molar mass of hydrates.

-Be able to find the value of “n” for a hydrate.

-Be able to give the correct formula for the hydrate given either mass or %

Name the following:

1. Li2SO4 •5H2O lithium sulfate pentahydrate 2. CuI2 •6H2O copper (II) iodide hexahydrate

Write the formula and determine the molar mass for each:

3. Iron (IV) sulfate tetrahydrate 4. zinc chloride trihydrate

Formula: Fe(SO4)2 •4H2O Formula: ZnCl2•3H2O

MM: 320.05 g/mol MM: 190.35 g/mol

5. A 15.67 g sample of a hydrate of magnesium carbonate was heated, to drive off the water. The mass was reduced to 7.58 g. What is the formula of this hydrate? MgCO3 • *n* H2O

15.67 g sample $7.58 g MgCO\_{3}\* \frac{1 mol MgCO\_{3}}{84.31g MgCO\_{3}}=0.09 mol MgCO\_{3}$

-7.58 g salt $8.90 g H\_{2}O\* \frac{1 mol H\_{2}O}{18.02 g H\_{2}O}=0.49 molH\_{2}O$ $n= \frac{mol H2O}{mol Salt}= \frac{0.49 mol}{0.09 mol}=5.44=5$

8.90 g water

  **MgCO3 • *5* H2O**

6. Magnesium sulfate hydrate, MgSO4  ***n*** H2O, contains 51.1% water and 48.9% magnesium sulfate. Calculate the value of “*n.*”

$48.9 g MgSO\_{4}\* \frac{1 mol MgSO\_{4}}{120.37 g MgSO\_{4}}=0.41 mol MgSO\_{4}$

$51.1 g H\_{2}O\* \frac{1 mol H\_{2}O}{18.02 g H\_{2}O}=2.84 molH\_{2}O$

$$n= \frac{mol H2O}{mol Salt}= \frac{2.84 mol}{0.41mol}=6.9=7$$

**Percent (%) Composition:**

-Be able to calculate % of both salt and water in a given hydrate.

-Be able to use the % composition to find out what part of salt or water is in a given sample.

7. A 7.5 gram sample of a hydrate of BaCl2 was heated, and only 2.2 grams of the anhydrous salt remained. What % of water was in the hydrate?

7.5 g sample % water = $\frac{5.3g water}{7.5g sample} x 100=70.67\%$

-2.2 g salt

5.3 g water

8. If 405 grams of magnesium sulfate heptahydrate is completely dehydrated, how many grams of anhydrate magnesium sulfate salt will remain? MgSO4 • *7* H2O

$$\% salt=\frac{molar mass of salt}{whole molar mass of hydrate sample}= \frac{120.37}{246.51}x 100=48.83 \% MgSO\_{4} salt$$

(% in decimal form)(total mass of the sample) 🡪 (0.4883)(405) = **197.76 g MgSO4 salt is in the sample!**

Stoichiometry is based on the ***law of conservation of mass,*** which says that matter CANNOT be created nor destroyed!

**STOICHIOMETRIC CALCULATIONS**

**1) Write out reactants and products—use only the charges of each atom to put together the appropriate molecules.**

**2) Balance Equation!**

**3) Only mol-mol conversions using ratios from a balanced equation will work!**

9. The reaction between silver nitrate and sodium bromide produces silver bromide and sodium nitrate. If you have 2.60 mol of sodium bromide, how many moles of silver nitrate are required? Make sure to write your reaction and balance it!

AgNO3 + NaBr 🡪 AgBr + NaNO3

$$2.60 mol NaBr\*\frac{1 mol AgNO\_{3}}{1 mol NaBr}=2.60 mol AgNO\_{3} $$

**If necessary,**

**Convert any masses (grams) to moles by using the molar mass (grams/mol) of the substance given, OR**

**Convert any volumes of gases (liters) to moles by using 22.4 (liters/mol).**

**Convert any particles to moles using Avogadro’s number 6.02 x 1023 = 1 mol**

**4) Multiply by the molar ratio (placing the coefficient—from the BALANCED equation—of the moles you are given in the denominator, and the coefficient of the substance desired in the numerator).**

10. Hydrofluoric acid, HF, is never sold in glass bottles because glass is composed of silicon dioxide which will react with hydrofluoric acid. If 375 g of hydrofluoric acid was placed into a glass bottle, how many grams of water will be created? SiO2 + 4HF 🡪 SiF4 + 2 H2O.

$$375 g HF\*\frac{1 mol HF}{20.01 g HF}\* \frac{2 mol H\_{2}O}{4 mol HF}\* \frac{18.02 g H\_{2}O}{1 mol H\_{2}O}=168.85 g H\_{2}O$$

11. Ammonia, NH3, is made in the direct reaction between nitrogen and hydrogen. If 280. L of nitrogen are used, how many grams of hydrogen are also used? N2 + 3H2 🡪 2NH3

$$280. L N\_{2}\*\frac{1 mol N\_{2}}{22.4 L N\_{2}}\* \frac{3 mol H\_{2}}{ 1 mol N\_{2}}\* \frac{2.02 g H\_{2}}{1 mol H\_{2}}=75.75 g H\_{2}$$

12. Laughing gas, N2O, is made by the decomposition of ammonium nitrate. If you begin with 155 g of ammonium nitrate, how many molecules laughing gas can you make? NH4NO3 🡪 N2O + 2 H2O

$$155 g NH\_{4}NO\_{3}\*\frac{1 mol NH\_{4}NO\_{3}}{80.04 g NH\_{4}NO\_{3}}\* \frac{1 mol N\_{2}O}{1 mol NH\_{4}NO\_{3}}\* \frac{ 6.02 x 10^{23}molecule N\_{2}O}{1 mol N\_{2}O}=1.17 x 10^{23}molecule N\_{2}O$$

**LIMITING REACTANTS**

**If more than 1 reactant is given, convert both givens to the proper units using the mole ratios and choose the smallest answer. The limiting reactant is the reactant that produces the least amount of product.**

**Know the difference between limiting vs excess reactants.**

13. Methyl alcohol, CH3OH, can be produced in a synthesis reaction between carbon monoxide and hydrogen. If you start with 12.0 liters of hydrogen and 74.5 g of carbon monoxide, how many grams of methyl alcohol are produced?

CO + 2H2 🡪 CH3OH

$12.0 L H\_{2} \*\frac{1 mol H\_{2}}{22.4 L H\_{2}}\* \frac{1 mol CH\_{3}OH}{2 mol H\_{2}}\* \frac{32.05 g CH\_{3}OH}{1 mol CH\_{3}OH}=8.58 g CH\_{3}OH$ **Limiting Reactant, max product that can be made**

$$74.5 g CO\*\frac{1 mol CO}{28.01 g CO}\* \frac{1 mol CH\_{3}OH}{1 mol CO}\* \frac{32.05 g CH\_{3}OH}{1 mol CH\_{3}OH}=85.25 g H\_{2}O$$

**PERCENT YIELD**

**Only products (quantities that apply to the right side of a balanced equation) can be placed into the Yield Formula, and both actual and theoretical yields must have the same units (and molecule!) If reactants are given, you'll probably be using them to compute a theoretical yield. All calculated quantities are ‘theoretical-yields'.**

**REVIEW actual vs. theoretical yield.**

**% Yield = Actual Yield x 100%**

 **Theoretical Yield**

14. Disulfur dichloride is a golden yellow liquid with a revolting smell. It is used industrially in the vulcanization of rubber and is prepared by the following reaction below. If you begin with 5.23 g of sulfur dichoride and isolated 1.19 g of disulfur dichloride, what is your percent yield? (Actual)

 **3SCl2 + 4NaF 🡪 SF4 + S2Cl2 + 4NaCl**

$5.23 g SCl\_{2}\*\frac{1 mol SCl\_{2}}{102.97 g SCl\_{2}}\* \frac{1 mol S\_{2}Cl\_{2}}{2 mol SCl\_{2}}\* \frac{135.04 S\_{2}Cl\_{2}}{1 mol S\_{2}Cl\_{2}}=3.43 g S\_{2}Cl\_{2}$🡨 Theoretical yield

% yield = $\frac{actual}{theoretical} x 100=\frac{1.19 g}{3.43 g} x 100=$ **34.69%**

15. Zinc will react directly with chorine in a synthesis reaction. If you begin with 13.5 g of zinc and actually produced only 2.44 g of zinc chloride in a reaction, what is the percent yield? (Actual)

 **Zn + Cl2 🡪 ZnCl2**

$13.5 g Zn\*\frac{1 mol Zn}{65.38 g Zn}\* \frac{1 mol ZnCl\_{2}}{1 mol Zn}\* \frac{136.27 g ZnCl\_{2}}{1 mol ZnCl\_{2}}=28.14 g ZnCl\_{2}$🡨 Theoretical yield

% yield = $\frac{actual}{theoretical} x 100=\frac{2.44 g}{28.14 g} x 100=$ **8.67 %**