Empirical Formulas:

1. A compound is formed from 0.1010 g hydrogen and 2.004 g calcium. What is the empirical formula?

2. What is the empirical formula for a compound with 1.6 g calcium and some oxygen in a 2.243 g sample?

3. What is the empirical formula for a compound containing phosphorus and oxygen when a 3.299 g sample of the compound contains 1.859 g phosphorus?

4. A 0.6409 g sample of a compound containing nitrogen and hydrogen contains 0.5309 g ofnitrogen determine the empirical formula.

5. A compound is 46 % sulfur and 54 % fluorine, what is the empirical formula?

Empirical and Molecular Formulas Worksheet

Objectives:

- be able to calculate empirical and molecular formulas

Empirical Formula

1) What is the empirical formula of a compound that contains 0.783g of Carbon, 0.196g of Hydrogen and 0.521g of Oxygen?

2) What is empirical formula of a compound which consists of 89.14% Au and 10.80% of O?

3) What is empirical formula if compound consists of 21.2%N, 6.1%H, 24.2%S and 48.5%O?

Molecular Formula

4) Empirical formula of a substance is CH_2O. Molar mass is 180. What is the molecular formula?

5) Sample (3.585g) contains 1.388g of C, 0.345g of H, 1.850g O and its molar mass is 62g. What is molecular formula of this substance?

Determining the Formula of a Hydrate

Name KEY

Chem Worksheet 11-6

A **hydrate** is an ionic compound that contains water molecules in its structure. To determine the formula of a hydrate experimentally, we must calculate the mole: mole ratio of the water portion compared to the anhydrate portion. An **anhydrate** is the substance that remains after the water is removed from a hydrate. When a hydrate is heated the water molecules are driven off as steam, leaving behind the water-free anhydrate.

The first step to finding the formula for a hydrate is to record the mass of the hydrate. After heating the hydrate, the mass is determined for the anhydrate that remains. The mass of the water that was present is calculated by finding the difference between the mass of the hydrate and the mass of the anhydrate. The mass of the water and the mass of the anhydrate are each converted to moles using their respective molar masses. From this a whole number ratio can be determined (see example).

Data Table

Mass of hydrate ($CaCl_2 \cdot xH_2O$)	4.72 g
Mass of anhydrate ($CaCl_2$)	3.56 g
Mass of water	1.18 g

Example

A calcium chloride hydrate has a mass of 4.72 g. After heating for several minutes the mass of the anhydrate is found to be 3.56 g. Use this information to determine the formula for the hydrate.

- find the mass of the water driven off: mass of hydrate – mass of anhydrate = mass of water
  $4.72\text{ g} - 3.56\text{ g} = 1.18\text{ g}$

- convert the mass of anhydrate to moles:
  $$\frac{3.56\text{ g } CaCl_2}{1} \times \frac{1\text{ mol } CaCl_2}{110.98\text{ g } CaCl_2} = 0.0321\text{ mol } CaCl_2$$

- convert the mass of water to moles:
  $$\frac{1.18\text{ g } H_2O}{1} \times \frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O} = 0.0655\text{ mol } H_2O$$

- find the mole H_2O to mole $CaCl_2$ ratio:
  $$\frac{0.0655\text{ mol } H_2O}{0.0321\text{ mol } CaCl_2} = \frac{2\text{ mol } H_2O}{1\text{ mol } CaCl_2}$$

Since the compound contains 2 moles of water for every 1 mole of anhydrate the formula is **$CaCl_2 \cdot \underline{2}\ H_2O$**

Solve the following problems. Show work to support your answer.

$MgSO_4 \cdot 7H_2O$ 1. A hydrate of magnesium sulfate has a mass of 13.52 g. This sample is heated until no water remains. The $MgSO_4$ anhydrate has a mass of 6.60 g. Find the formula and name of the hydrate.

$CuSO_4 \cdot 5H_2O$ 2. A sample of copper (II) sulfate hydrate has a mass of 3.97 g. After heating, the $CuSO_4$ that remains has a mass of 2.54 g. Determine the correct formula and name of the hydrate.

$FeCl_3 \cdot 6H_2O$ 3. When 5.00 g of $FeCl_3 \cdot xH_2O$ are heated, 2.00 g of H_2O are driven off. Find the chemical formula and the name of the hydrate.

$NaCO_3 \cdot H_2O$ 4. A sample of the hydrate of sodium carbonate has a mass of 8.85 g. It loses 1.28 g when heated. Find the formula and the name of the hydrate.

$CaSO_4 \cdot 2H_2O$ 5. A 16.4 g sample of hydrated calcium sulfate is heated until all the water is driven off. The calcium sulfate that remains has a mass of 13.0 g. Find the formula and the chemical name of the hydrate.

$Pb(C_2H_3O_2)_2 \cdot 3H_2O$ 6. When 8.00 g of $Pb(C_2H_3O_2)_2 \cdot xH_2O$ are heated, 1.14 g of H_2O are driven off. Find the chemical formula and the name of the hydrate.

$CoCl_2 \cdot 6H_2O$ 7. A hydrate is determined to be 45.43% water and 54.57% $CoCl_2$. Find the chemical formula and name for this hydrate. (*Hint – assume that there is 100 g total of hydrate compound.)

Name Key Block _____

Chapter 10 – Review for Test (show all work on this sheet or on a separate sheet of paper)

143 1. Calculate the formula mass of copper I oxide.

Cu_2O = (143.2 g/mol)

2. Calculate the formula mass of potassium permanganate.

$KMnO_4$ = 158 g/mol

3. What is the percent carbon in Acetic Acid?

$HC_2H_3O_2$ = 76 g/mol = ~~31.6%~~ 40%

78% 4. What is the percent barium in barium fluoride?

BaF_2 = 175.3 78.3%

5. Determine the empirical formula and name for a compound where the sample contains 32.8 % Cr and 67.2 % Cl.

32.8g Cr → .630 mol → 67.2 = 1.89 mol

$CrCl_3$ Chromium (III) Chloride

$AlCl_3O_{12}$ 6. Determine the empirical formula and name for a compound where the sample contains 8.29 % Al, 32.7 % Cl. and 59.0 % O.

8.29g Al → .307 mol 32.7g → .921 mol 59g O → 3.69 mol

$AlCl_3O_{12}$ $Al(ClO_4)_3$ Aluminum Chlorate

7. Determine the molecular formula for a compound that has a molar mass of 78 g/mol and is 92.3 % C and 7.70 % H.

7.69 mol 7.7 mol → CH → C_6H_6

$P_6N_6Cl_{12}$ 8. Determine the molecular formula for a compound that has a molar mass of 695 g/mol is 26.7 % P, 12.1 % N, and 61.2 % Cl.

.86 mol .864 mol 1.72 mol

1 1 2

6 ($PNCl_2$) → 116 g/mol

$P_6N_6Cl_{12}$

$SrC_2O_4 \cdot H_2O$ 9. What is the formula for a hydrate of strontium oxalate: mass of hydrate is 100.00 grams, the mass of the anhydrous salt is 90.70 g.

9.3g H_2O → .517 mol H_2O 90.70g SrC_2O_4 → .516

$SrC_2O_4 \cdot H_2O$

$SrC_2O_4 \cdot xH_2O$: 174.6 g/mol

10. What is the density of fluorine gas at STP? Looking for... g/L

F_2 → 38 g/mol | 1 mol / 22.4L = 1.70 g/L

11. What is the molar mass of a gas that has a density of 3.57 g/L at STP?

3.57 g / L | 22.4 L / 1 mol = 79.9 or 80.0 g/mol

Molecular (True) Formula

Practice Problems (Level 1)

1. A compound has the following percentage composition: 26.7% carbon; 2.2% hydrogen; 71.1% oxygen. The molecular weight of this compound is 90. What is the compound's true formula?

2. A certain compound was analyzed and found to have the following composition: 54.6% carbon; 9.0% hydrogen; 36.4% oxygen. The true molecular weight for the compound is 176. What is the molecular formula of the compound?

3. The percentage composition of ethane gas is 80.0% carbon and 20.0% hydrogen. The molecular weight for ethane is 30. What is the correct formula for this compound?

4. Analysis of a compound shows that it consists of 24.3% carbon, 4.1% hydrogen, and 71.6% chlorine. The molecular weight of the compound is determined to be 99.8. What molecular formula corresponds to these data?

5. An unknown compound is analyzed and found to consist of 49.0% carbon, 2.7% hydrogen, and 48.2% chlorine. Boiling point data suggest that the molecular weight of the compound is about 150. What molecular formula would you predict for this compound?

6. A gaseous compound is found to have the following composition: 30.5% nitrogen and 69.5% oxygen. The molecular weight of the gas is found to be 91.8. What molecular formula corresponds to these data?