Chemistry Name: _____

Section _____ % COMPOSITION KEY Date: _____

% Composition and Empirical Formulas

Percent Composition

Write the formula for percent composition by mass:

$$\%\ \text{composition} = \frac{\text{mass of part}}{\text{mass of whole}} \times 100$$

Example: Find the percent composition by mass of sulfur in calcium thiosulfate, CaS_2O_3.

Find the mass of S and the formula mass of CaS_2O_3:

Ca = 40.08 u

S_2 = 2 (32.065 u)

O_3 = 3 (15.9994 u)

} total = 152.20 u and S_2 = 64.130 u

Make substitutions into the formula:

$$\%\ \text{composition} = \frac{2\,(32.065\ \text{u})}{40.08\ \text{u} + 2(32.065\ \text{u}) + 3(15.9994\ \text{u})} \times 100 \quad \text{or} \quad \frac{64.130\ \text{u}}{152.20\ \text{u}} \times 100$$

Remember to solve only if the problem says to solve

Empirical and Molecular Formulas

Empirical formula: the simplest whole-number ratio of atoms of the elements in a compound.

Molecular formula: the actual ratio of atoms in a molecule of that compound.

Examples:	Molecular	÷ GCF =	Empirical
glucose	$C_6H_{12}O_6$	÷ 6 =	CH_2O
butane	C_4H_{10}	÷ 2 =	C_2H_5
oxalic acid	$H_2C_2O_4$	÷ 2 =	CHO_2
ethanol	C_2H_5OH	÷ 1 =	C_2H_6O

Go on to the next page.

Molecular Formula from Empirical Formula and Molecular Mass

Example: Find the molecular formula for a molecule with a molecular mass of 42.0 u and an empirical formula of CH_2.

Find the formula mass of CH_2:

C = 12.011 u

H_2 = 2 (1.00794 u)

} total = 14.027 u or 14.0 u

Divide (molecular mass / empirical mass) to find the ratio:

$$\frac{42.0\text{ u}}{14.0\text{ u}} = 3.00$$

Distribute the ratio across the empirical formula: $3 \times CH_2 = C_3H_6$

Empirical Formula from Data

Example: Find the empirical formula for a compound which, when analyzed by mass, is 22.85% Na, 21.49% B, and the remainder O.

The steps for this process are:

1. If data is not mass, then change percentages to grams
2. Convert mass to moles using atomic mass
3. Normalize or divide all the numbers by the smallest value
4. Clear all fractions

O = 100% – (22.85% + 21.49%) = 55.66%

Na $22.85\text{ g} \times \frac{1\text{ mol}}{22.99\text{ g}} = 0.9939\text{ mol} \div 0.9939\text{ mol} = 1 \times 2 = 2$

B $21.49\text{ g} \times \frac{1\text{ mol}}{10.81\text{ g}} = 1.988\text{ mol} \div 0.9939\text{ mol} = 2 \times 2 = 4$

O $55.66\text{ g} \times \frac{1\text{ mol}}{16.00\text{ g}} = 3.479\text{ mol} \div 0.9939\text{ mol} = 3.5 \times 2 = 7$

$Na_2B_4O_7$

This is the last page.