Unit #8
Chemical Compositions

Looking at different ways to write or figure out formulas

N29 – PERCENT COMPOSITION AND EMPERICAL FORMULAS

Target:

I can calculate percent composition and empirical formulas for various compounds

Please write the target in RED PEN at the top of your notes, under the title

Percent Composition

Determining how much of a molecule's mass is from each element

$$\frac{\text{Part}}{\text{Whole}} \times 100 = \%$$

$$\frac{\text{Element's Mass}}{\text{Molecule's Mass}} \times 100 = \%\ \text{Composition}$$

% Composition Steps

1) Find the molar mass of the molecule

2) Divide each element's atomic mass by the molar mass of the molecule

3) Multiply by 100 to put answer in terms of an actual %

note *If you add up the % for each element it should add up to 100%...but rounding answers may make it not quite add up to 100%. That's ok.*

Example

$$\frac{\text{Element's Mass}}{\text{Molecule's Mass}} \times 100 = \%\ \text{Composition}$$

Calculate the % composition of Magnesium Carbonate

Molar Mass of Molecule 24.31 + 12.01 + 3(16.00) = 84.32 g/mol

$$Mg = \left(\frac{24.31}{84.32}\right) \bullet 100 = 28.83\%$$

$$C = \left(\frac{12.01}{84.32}\right) \bullet 100 = 14.24\%$$

3 x 16 because there are 3 oxygens!

$$O = \left(\frac{48.00}{84.32}\right) \bullet 100 = 56.93\%$$

Check that it adds up to 100% !!!

Empirical Formula

The simplest, reduced version of a formula.

Smallest whole number ratios possible.

Molecular Formula

The real version of the formula – may or may not be in the simplest most reduced form, just depends on the specific formula.

Example

Molecular: C_6H_6

Empirical: CH

Ionic Formulas

Are always empirical! NaCl, $MgCl_2$, $Al_2(SO_4)_3$

Covalent Formulas

Sometimes empirical, sometimes not.

Molecular:	H_2O	$C_6H_{12}O_6$	$C_{12}H_{22}O_{11}$
	↓	↓	↓
Empirical:	H_2O	CH_2O	$C_{12}H_{22}O_{11}$

Determining Empirical Formula

1) Given: % composition

2) Assume you have 100g sample to make #s easy

3) Use the poem!

Percent to mass
Mass to moles
Divide by small
Multiply by whole

Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula of adipic acid?

1. **Percent to mass** – 49.32g C, 43.84g O, 6.85g H
2. **Mass to mole**

$$49.32\,g\,carbon \left| \frac{1\,mol\,carbon}{12.01\,g\,carbon} = 4.107\,mol\,carbon \right.$$

$$6.85\,g\,hydrogen \left| \frac{1\,mol\,hydrogen}{1.01\,g\,hydrogen} = 6.78\,mol\,hydrogen \right.$$

$$43.84\,g\,oxygen \left| \frac{1\,mol\,oxygen}{16.00\,g\,oxygen} = 2.74\,mol\,oxygen \right.$$

3. **Divide by small** – divide the mole values by the smallest mole value found… gets you the simplest ratios!

Carbon: $\frac{4.107 mol\, carbon}{2.74 mol} = 1.50$

Hydrogen: $\frac{6.78 mol\, hydrogen}{2.74 mol} = 2.47$

Oxygen: $\frac{2.74 mol\, oxygen}{2.74 mol} = 1.00$

4. **Multiply till whole** – If necessary, multiply the values found until they are whole numbers. The numbers may not be perfect, might have to round a little bit!
YOU HAVE TO MULTIPLY THEM ALL BY THE SAME # !

Hydrogen: 2.47 →

Carbon: 1.50
x 2
3

2.50
x 2
5

Oxygen: 1.00
x 2
2

Empirical formula: $C_3H_5O_2$

Determining Molecular Formula

1) Find molar mass of the empirical formula

2) Divide molecular formula mass by empirical formula mass

3) Multiply empirical formula subscripts by the multiplier # found in step 2

No cute rhyme this time…sorry! ☺

The empirical formula for adipic acid is $C_3H_5O_2$. The molecular mass of adipic acid is 146 g/mol. What is the molecular formula of adipic acid?

1. **Molar mass of empirical formula**

   3(12.01 g) + 5(1.01) + 2(16.00) = 73.08 g/mol

2. **Divide molecular by empirical masses**

   $\frac{146}{73.08}$ = 1.997 → 2 **you will usually have to round a bit**

3. **Multiply empirical by multiplier found in step 2**

$$(C_3H_5O_2) \times 2 = \mathbf{C_6H_{10}O_4}$$