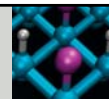


## OWL Homework and Quiz 1



- Chapter 3 HW assigned in OWL.....Due **September 20 at 11:55 PM**
- Quiz 1 – **Due Today at 11:59 PM**
  - ✓ Available in canvas (Go to your class in Canvas and Click quizzes in Canvas navigation bar, Then you will direct to Quiz 1)
  - ✓ Duration 15 minutes, 6 MCQs, covers chapters 1 and 2, and two attempts
  - ✓ No extensions

55

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

### (Q.10)



Which sample has more molecules?

- 1) 341 g  $\text{SO}_3$
- 2) 10.2 g  $\text{H}_2\text{O}$
- 3) 207 g  $\text{NaCl}$

Answer: 341 g  $\text{SO}_3$

56

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

## Elemental Analysis: Determining Empirical and Molecular Formulas



- **Empirical formulas** can be determined from **an elemental analysis**
  - An **elemental analysis** measures the mass percentage of each element in a compound

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

57

### Example Problem

- Nitroaniline had been observed in experiments on biomass from pine needles and can be used as a precursor for pharmaceuticals
  - It contains 52.17% carbon, 4.38% hydrogen, 20.28% nitrogen, and 23.17% oxygen by mass

Determine the empirical formula of nitroaniline

Consider a 100 g sample of nitroaniline. Convert each of the masses to moles

$$52.17 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} = 4.344 \text{ mol C in 100 g nitroaniline}$$

$$4.38 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 4.35 \text{ mol H in 100 g nitroaniline}$$

$$20.28 \text{ g N} \times \frac{1 \text{ mol N}}{14.007 \text{ g N}} = 1.448 \text{ mol N in 100 g nitroaniline}$$

$$23.17 \text{ g O} \times \frac{1 \text{ mol O}}{15.999 \text{ g O}} = 1.448 \text{ mol O in 100 g nitroaniline}$$

- Divide all four numbers by 1.448 to obtain small whole number ratio

$$\frac{4.344 \text{ mol C}}{1.448} = 3.00$$

$$\frac{4.35 \text{ mol H}}{1.448} = 3.00$$

$$\frac{1.448 \text{ mol N}}{1.448} = 1$$

$$\frac{1.448 \text{ mol O}}{1.448} = 1$$

The result is a small whole number ratio: 3 moles C: 3 moles H:  
1 mole N: 1 mole O

So the empirical formula =  $\text{C}_3\text{H}_3\text{NO}$

### Determining Molecular Formula

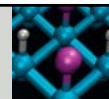
- A molecular formula is a **whole number multiple of the empirical formula**
  - Molar mass for the molecular formula is a whole number multiple of the molar mass for the empirical formula

(Q. 1) If the empirical formula of a compound is  $\text{CH}_2$  and its molar mass is 42 g/mol, what is its molecular formula?

$$n = \frac{\text{Molar mass}}{\text{Empirical formula mass}} = \frac{42 \text{ g/mol}}{14.027 \text{ g/mol}} = 3.0$$

Therefore, **Molecular formula** =  $(\text{CH}_2)_3 = \text{C}_3\text{H}_6$

## Molarity



- **Molarity** or **molar concentration**,  $M$ , is the number of moles of solute per liter of solution

$$\text{Molarity } (M) = \frac{\text{moles of solute}}{\text{liter of solution}}$$

- If we know any two of these quantities, we can determine the third one

$$n = M \times V$$

$n$  = Number of solute moles,  $M$  = Molarity, and  $V$  = volume in liters

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

61

## Example Problem

1. A solution is prepared by dissolving 45.0 g of  $\text{NaClO}$  in enough water to produce exactly 750 mL of solution. What is the molarity of this solution?

First, we compute the moles of solute:

$$45.0 \text{ g NaClO} \times \frac{1.00 \text{ mol NaClO}}{74.44 \text{ g NaClO}} = 0.605 \text{ mol NaClO}$$

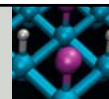
Then, convert the solution volume from mL to L:

$$750 \text{ mL} \times \frac{1.00 \text{ L}}{1000 \text{ mL}} = 0.750 \text{ L}$$

Finally, calculate the molarity:

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}} = \frac{0.605 \text{ mol}}{0.750 \text{ L}} = 0.806 \text{ M NaClO}$$

## Dilution



- Dilution** is the process in which solvent is added to a solution to decrease the concentration of the solute
  - The number of moles of solute is the same before and after dilution

$$M_i \times V_i = M_f \times V_f$$

Units: M = mol/L, V = L

The subscripts denote: i = Initial, and f = final

Copyright ©2019 Cengage Learning. All Rights Reserved. May not be scanned, copied or duplicated, or posted to a publicly accessible website, in whole or in part.

63

## Example Problem

- A chemist requires 1.5 M hydrochloric acid, HCl, for a series of reactions. The only solution available is 6.0 M HCl. What volume of 6.0 M HCl must be diluted to obtain 5.0 L of 1.5 M HCl?

Initial concentration of HCl:  $M_i = 6.0 \text{ M}$

Final concentration of HCl:  $M_f = 1.5 \text{ M}$

Final volume of solution:  $V_f = 5.0 \text{ L}$

The unknown is the initial volume,  $V_i$ . Rearranging Equation

$$V_i = \frac{M_f \times V_f}{M_i}$$

Inserting the known quantities on the right-hand side,

$$V_i = \frac{1.5 \text{ M} \times 5.0 \text{ L}}{6.0 \text{ M}} = 1.3 \text{ L}$$

To obtain the desired quantity of diluted HCl, the chemist should begin with 1.3 L of the concentrated solution and add enough water to bring the volume up to 5.0 L.