CHE 152 Lab 1 Solution Concentration

Name

Unit of Concentration (Equations not given on exam)	Uses
$Molarity (M) = \frac{Moles \ of \ solute}{Volume \ (L) \ of \ solution}$	Stoichiometric calculations involving solutions since $V($ in $L) \times M = mol solute$ Used in osmotic pressure calculations.
$Molality (m) = \frac{Moles of solute}{Mass (kg) of solvent}$	Does not change with temperature, therefore used in boiling point elevation and freezing point depression calculations
$\frac{Mass \%}{(\% \text{ w/w or \% m/m})} = \frac{Mass \text{ of solute}}{Mass \text{ of solution}} \times 100$	Commonly used in the biological, medical and environmental sciences.
Volume % = $\frac{Volume \ of \ solute}{Volume \ of \ solution} \times 100$	Commonly have to convert these units to molarity or molality for colligative property
$\begin{array}{ll} Mass/Volume \ \% \ = \ \underbrace{Mass \ of \ solute}_{(\% \ m/v)} \ \times \ 100 \end{array}$	
$Mole \ Fraction \ (X) = \frac{Moles \ of \ solute}{Moles \ of \ solution}$	Used in Raoult's Law calculations when finding the vapor pressure of a solution

Exploring Common Ways of Expressing Concentration

Your task now is to practice applying these units of concentration. It is very important that you are able to convert from one concentration unit to another. Consider the following questions when solving problems involving conversion of concentration units:

- What are the units of concentration given in the problem?
- What are the units you are converting to?
- What is (are) the conversion factor(s) needed to get the desired unit of concentration?
- Set up the problems using dimensional analysis. Units should cancel to give the units desired.

Remember that dimensional analysis and problem solving is very much like putting a puzzle together. Just like putting a puzzle together, we look for pieces that are similar in color, or we start the puzzle at the edges. With dimensional analysis you are organizing your pieces (conversion factors) in the same manner. Working from both edges you can figure out how to connect the pieces.

Below are some useful tips and conversion factors for doing concentration dimensional analysis problems:

- If you are given a density (g/mL), you are likely going to use it as a conversion factor, particularly if you have also been provided a volume.
- If a volume is not provided, you can assume any starting amount (e.g., 1000 mL or 1L).
- If you are given the formula of a substance, you will likely have to determine the molar mass using a periodic table to convert between moles and grams.
- Remember: the mass of a solution is equal to the mass of the solvent plus the mass of the solute.

Questions

Use dimensional analysis (factor-label method) and correct significant figures to solve the following problems. <u>Write your final answer in the space provided.</u>

1. Calculate the *molarity* of a solution made by diluting 25.0mL of 6.15*M* HCl to a volume of 0.500L with water.

 $25.0 \ mL \ \times \ \frac{6.15 \ mol \ HCl}{1000 \ mL} \ \times \ \frac{1}{0.500 \ L} = 0.308 \ M \ HCl$

Molarity = _____

2. Concentrated HCl is 12.0*M* and is 36.0% HCl by mass. What is its *density*?

$$12.0 \ mol \ HCl \ \times \ \frac{36.45 \ g \ HCl}{1 \ mol \ HCl} = 437.4 \ g \ HCl$$
$$437.4 \ g \ HCl \ \times \ \frac{1}{0.360} = 1215 \ g \ soln$$
$$\frac{1215 \ g \ soln}{1000 \ mL} = 1.22 \frac{g}{mL} \ soln$$

Density = _____

3. A 1.38M solution of nitric acid in water has a density of 1.04g/mL. What is the *mole fraction* of nitric acid in the solution?

$$1.38 \ mol \ HNO_3 \times \frac{63.02 \ g \ HNO_3}{1 \ mol \ HNO_3} = 86.97 \ g \ HNO_3$$

Assume 1000 mL soln, thus mass of soln is 1040 g

Mass of solvent = 1040 g soln - 86.97 g solute = 953.03 g solvent

953.3 g solvent $\times \frac{1 \mod H_2 O}{18.02 \ g \ H_2 O} = 52.90 \mod H_2 O$

 $\frac{1.38 \text{ mol } \text{HNO}_3}{52.90 \text{ mol } \text{H}_2\text{O} + 1.38 \text{ mol } \text{HNO}_3} = 0.0254$

Mol fraction =

 Exactly 400mL of an acid solution, when acted upon by an excess of zinc metal, evolves 2.430L of hydrogen gas measured over water at 21°C and 747.5torr. What is the *molarity* of the acid? The vapor pressure of water at 21°C is 18.6torr.

Pressure of $H_2 = 747.5 \ torr - 18.6 \ torr = 728.9 \ torr \times \frac{1 \ atm}{760 \ torr} = 0.959 \ atm$

$$n = \frac{PV}{RT} = \frac{(0.959 \ atm)(2.430 \ L)}{(0.0821 \ \frac{L \cdot atm}{mol \cdot K})(294 \ K)} = 0.0965 \ mol \ H_2$$

Chemical Reaction = $Zn(s) + 2 HX(aq) \rightarrow ZnX_2(aq) + H_2(g)$

$$0.0965 \ mol \ H_2 \ \times \ \frac{2 \ mol \ HX}{1 \ mol \ H_2} \ \times \ \frac{1}{0.400 \ L} = 0.483 \ M \ HX$$

Molarity = _____