Food coloring: conc vs. dilute

Section 12.3 Notes - Concentrations of Solutions

There are many ways to express concentration. Concentration is a measure of the amount of solute dissolved in a given quantity of solvent. You can express concentration qualitatively by using the words dilute versus concentrated. However, these words do not describe an amount. They can only be used to compare one solution to another. You can express concentration quantitatively using molarity, molality, mole fractions, and mass percentage which more accurately describe the amounts involved.

Molarity

solute & solvent

Molarity (M): the number of moles of solute in one liter of solution

$$\text{Molarity} = \frac{\text{\# moles of solute}}{\text{\# of liters of solution}}$$

Units: mol/L or M

Example 1) How many grams of KCl are dissolved in a 1.5 M solution that contains 2.0 liters of solution?

$M = \frac{mol}{L}$ $1.5\,M = \frac{X}{2.0\,L}$ $X = 3.0\,mol$ $\frac{3.0\,mol}{1} \times \frac{74.6\,g\,KCl}{1\,mol}$

$\frac{2.0\,L}{1} \times \frac{1.5\,mol}{1\,L} \times \frac{74.6\,g}{1\,mol}$ show dimensional analysis $= 223.8\,g\,KCl$

Molality

Molality (m): the number of moles of solute in one kilogram of solvent

$$\text{Molality} = \frac{\text{\# moles of solute}}{\text{\# of kg of solvent}}$$

Units: mol/kg or m

Example 2) Calculate the molality of a solution containing 72.6 grams of KCl (solute) dissolved in 1500 grams of water (solvent).

$m = \frac{mol}{kg} = \frac{.974\,mol}{1.5\,kg} = .65\,m$

$\frac{72.6\,g\,KCl}{1} \times \frac{1\,mol}{74.6\,g} = .973$

Mole Fractions

Mole Fractions: ratio of the moles of solute or solvent to the total number of moles of solvent and solute

$$\text{Mole Fraction} = \frac{\text{\# moles of solute (or solvent)}}{\text{\# of solvent + solute}}$$

Units: NONE!

Example 3) A mixture contains 1.2 mol of oxygen gas and 17 grams of nitrogen gas. Calculate the mole fraction of each component.

$\frac{17\,g\,N_2}{1} \times \frac{1\,mol}{28\,g} = .61$

$X_{O_2} = \frac{1.2}{1.2 + .61} = .66$

$X_{N_2} = 1 - .66 = .34$

Rubbing alcohol

Percent Solutions

Use the units of percent solution ***by volume*** *when both the solute and solvent are liquids.*

$$\% \text{ by volume} = \frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$$

Use the units of percent solution ***by mass*** *when a solid solute is dissolved in a liquid solvent.*

$$\% \text{ by mass} = \frac{\text{mass of solute (g)}}{\text{volume of solution (mL)}} \times 100\%$$

Example 4) How many grams of salt would you need to prepare 2.0 L of 8.0% (m/v) solution?

$$8\% = \frac{x}{2000\text{mL}}$$

X= 160g NaCl

Making Dilutions

We sometimes need to make a solution less concentrated. We do this by adding more solvent to dilute the solution.

To perform a dilution calculation you need to know three pieces of information:

1. the molarity of the stock (original, concentrated) solution 12.0M
2. the molarity of the new (diluted) solution you are trying to make 1.0M
3. how much of the new (diluted) solution you need to make 250mL

get out 12M HCl & 250mL volumetric flask

You will be solving for two pieces of information:

1. the amount of the stock solution you will need
2. how much solvent you will need to add to the stock solution to make it dilute

The formula you will use is $\mathbf{M_1 \times V_1 = M_2 \times V_2}$

Example 5) How do I prepare 250 mL (V1) of 1.0 M (M1) hydrochloric acid if I have 12.0 M (M2) HCl available? $V_2 = ?$

$$M_1V_1 = M_2V_2$$

$$\frac{1.0M \times 250mL}{12.0M} = \frac{12.0M \times V_2}{12.0M}$$

V_2 = 20.83 mL of 12.0M HCl (Stock Solution)

added to 229.17 mL water

(250 − 20.83)