

# Solubility & Concentration

## I. Expressing Concentration

### 1. Define the term concentration.

Concentration - measure of how much solute is dissolved in a specific amount of solvent or solution  
 (Concentrated vs. Dilute)

### 2. List four quantitative descriptions of solution concentrations.

1. Percent By Mass
2. Percent By Volume
3. Molarity (moles/L)
4. Molality (moles/kg)

### 3. Write the equation to determine Percent By Mass of a solution concentration.

$$\text{Percent By Mass} = \frac{\text{Mass of Solute}}{\text{Mass of Solution}} \times 100$$

### 4. In order to maintain a sodium chloride (NaCl) concentration similar to ocean water, an aquarium must contain 3.6 g NaCl per 100.0 g of water. What is the percent by mass of NaCl in the solution?

$$\begin{aligned} \textcircled{1} \quad \text{Mass of Solution} &= 3.6 \text{ g (NaCl)} + 100.0 \text{ g (H}_2\text{O)} = 103.6 \text{ g} \\ \textcircled{2} \quad \text{Percent By Mass} &= \frac{3.6 \text{ g (NaCl)}}{103.6 \text{ g}} \times 100 = \textcircled{3.5 \%} \end{aligned}$$

### 5. Write the equation to determine Percent By Volume of a solution concentration.

$$\text{Percent By Volume} = \frac{\text{Volume of Solute}}{\text{Volume of Solution}} \times 100$$

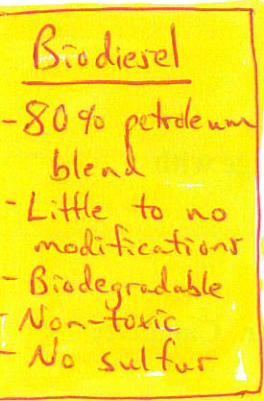
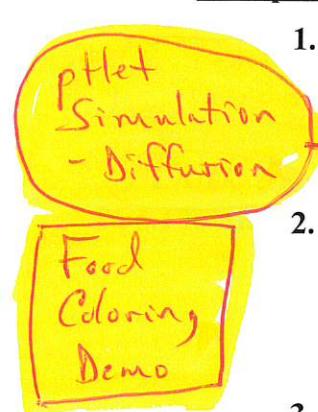
### 6. What is the percent by volume of ethanol (C<sub>2</sub>H<sub>5</sub>OH) in a solution that contains 35 mL of ethanol dissolved in 155 mL of water?

$$\begin{aligned} \textcircled{1} \quad \text{Volume of Solution} &= 35 \text{ mL (C}_2\text{H}_5\text{OH)} + 155 \text{ mL (H}_2\text{O)} \\ &= 190 \text{ mL} \end{aligned}$$

$$\textcircled{2} \quad \text{Percent By Volume} = \frac{35 \text{ mL (C}_2\text{H}_5\text{OH)}}{190 \text{ mL}} \times 100 = \textcircled{18 \%}$$

### 7. Write the equation to determine Molarity of a solution concentration.

$$\text{Molarity (M)} = \frac{\text{Moles of Solute}}{\text{Liters of Solution}}$$



8. A 100.5 mL intravenous (IV) solution contains 5.10 g of glucose ( $C_6H_{12}O_6$ ). What is the molarity of this solution? The molar mass of glucose is 180.16 g/mol.

*Saline Solution  
0.9% NaCl  
(similar to blood, tears)*

- ①  $5.10 \text{ g } C_6H_{12}O_6 \times \left( \frac{1 \text{ mol } C_6H_{12}O_6}{180.16 \text{ g/mol}} \right) = 0.0283 \text{ mol } C_6H_{12}O_6$
- ②  $100.5 \text{ mL} \times \left( \frac{1 \text{ L}}{1000 \text{ mL}} \right) = 0.1005 \text{ L}$
- ③ Molarity =  $\frac{\text{mole solute}}{\text{liters solution}}$   
 $= \frac{0.0283 \text{ mol}}{0.1005 \text{ L}}$   
 $= 0.282 \text{ M}$

9. How much copper (II) sulfate  $CuSO_4 \cdot 5H_2O$  would be needed to make 100 mL of 1.5 M solution?

- ①  $\frac{1.50 \text{ mol } CuSO_4}{1 \text{ L}} \times \frac{249.7 \text{ g } CuSO_4}{1 \text{ mol } CuSO_4} = \frac{375 \text{ g } CuSO_4 \cdot 5H_2O}{1 \text{ L}}$
- ②  $\frac{375 \text{ g } CuSO_4}{1 \text{ L}} \times 100 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 37.5 \text{ g } CuSO_4 \cdot 5H_2O$

10. In order to dilute (add solvent) a concentrated stock solution, what formula is used to determine the appropriate amount of solvent required?

$$M_1 V_1 = M_2 V_2$$

M = Molarity

V = Volume

11. If you want to know the concentration and volume of the solution you want to prepare, you can calculate the volume of stock solution you will need. What volume, in milliliters, of 2.00 M calcium chloride ( $CaCl_2$ ) stock solution would you use to make 0.50 L of 0.300 M calcium chloride solution?

$$\begin{aligned} M_1 V_1 &= M_2 V_2 \\ \downarrow \\ V_1 &= V_2 \left( \frac{M_2}{M_1} \right) \end{aligned}$$

$$V_1 = (0.50 \text{ L}) \left( \frac{0.300 \text{ M}}{2.00 \text{ M}} \right) = 0.075 \text{ L} \left( \frac{1000 \text{ mL}}{1 \text{ L}} \right) = 75 \text{ mL}$$

13. Write the equation to determine Molarity of a solution concentration.

Value does not change with temperature

Molarity (m) =  $\frac{\text{Moles of Solute}}{\text{kg of Solvent}}$

14. The volume of a solution changes with temperature, but mass does not change with temperature.

Used to determine boiling points

(melting points too)

Circle One :  True  False

15. In the lab, a student adds 4.5 g of sodium chloride (NaCl) to 100.0 g of water. Calculate the molality of the solution.

- ①  $4.5 \text{ g NaCl} \times \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}} = 0.077 \text{ mol NaCl}$
- ②  $100.0 \text{ g H}_2\text{O} \times \frac{1 \text{ kg H}_2\text{O}}{1000 \text{ g H}_2\text{O}} = 0.1000 \text{ kg H}_2\text{O}$

$m = \frac{0.077 \text{ mol NaCl}}{0.1000 \text{ kg H}_2\text{O}}$   
 $= (0.77 \text{ mol/kg})$