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# Solubility & Concentration

## I. Expressing Concentration

PHet Simulation - Diffusion

1. **Define the term concentration.**

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

Food Coloring Demo

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?**

Saltwater Aquariums

(1.) Mass of Solution = 3.6 g ($NaCl$) + 100.0 g ($H_2O$) = 103.6 g

(2.) Percent By Mass = $\frac{3.6\text{ g } (NaCl)}{103.6\text{ g}} \times 100 =$ 3.5 %

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 ($C_2H_5OH$) in a solution that contains 35 mL of ethanol dissolved in 155 mL of water?**

Biodiesel
- 80% petroleum blend
- Little to no modifications
- Biodegradable
- Non-toxic
- No sulfur

(1.) Volume of Solution = 35 mL ($C_2H_5OH$) + 155 mL ($H_2O$) = 190 mL

(2.) Percent By Volume = $\frac{35\text{ mL } (C_2H_5OH)}{190\text{ mL}} \times 100 =$ 18 %

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

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

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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. $5.10\ g\ C_6H_{12}O_6 \times \left(\frac{1\ mol\ C_6H_{12}O_6}{180.16\ g\ C_6H_{12}O_6}\right) = 0.0283\ mol\ C_6H_{12}O_6$

2. $100.5\ mL \times \left(\frac{1\ L}{1000\ mL}\right) = 0.1005\ L$

3. $Molarity = \frac{moles\ solute}{liters\ solution} = \frac{0.0283\ mol}{0.1005\ L} = 0.282\ M$

9. **How much copper (II) sulfate CuSO4 * 5H2O would be needed to make 100 mL of 1.5 M solution?**

1. $\frac{1.50\ mol\ CuSO_4}{1\ L} \times \frac{249.7\ g\ CuSO_4}{1\ mol\ CuSO_4} = \frac{375\ g\ CuSO_4 \cdot 5H_2O}{1\ L}$

2. $\frac{375\ g\ CuSO_4}{1\ L} \times 100\ mL \times \frac{1\ L}{1000\ mL} = 37.5\ g\ CuSO_4 \cdot 5H_2O$

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

$M_1V_1 = M_2V_2$

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 millimeters, 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?**

$M_1V_1 = M_2V_2$

$V_1 = V_2\left(\frac{M_2}{M_1}\right)$

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

13. **Write the equation to determine <u>Molality</u> of a solution concentration.**

Value does not change with temperature

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

14. **The <u>volume</u> of a solution changes with temperature, but <u>mass</u> does not change with temperature.**

<u>Circle One</u> : (True) False

Used to determine boiling points (melting points too)

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. $4.5\ g\ NaCl \times \frac{1\ mol\ NaCl}{58.44\ g\ NaCl} = 0.077\ mol\ NaCl$

2. $100.0\ g\ H_2O \times \frac{1\ kg\ H_2O}{1000\ g\ H_2O} = 0.1000\ kg\ H_2O$

$m = \frac{0.077\ mol\ NaCl}{0.1000\ kg\ H_2O} = 0.77\ mol/kg$