Concentration

Sections 8.4-8.5

Concentration

- Because a solution is made up of a solute and a solvent, we often wish to refer to one amount compared to another

- **Concentration**: how much solute is dissolved in a given amount of solvent

- Several ways to report this measurement
  - Some are percentages
  - Some are ratios

Mass/Mass Percent

- (m/m%)
- Compares mass of solute to mass of solution
- Mass of solution = mass of solute + mass of solvent
- Usually in grams
- Make sure you LABEL!

$$\frac{solute(g)}{solution(g)} \times 100$$

Volume/Volume Percent

- (v/v%)
- Compares volume of solute to volume of solution
- Volume of solution = volume of solute + volume of solvent
- Usually in mL
- Make sure you LABEL!

$$\frac{solute(mL)}{solution(mL)} \times 100$$

Mass/Volume Percent

- (m/v%)
- Also known as weight/volume percent (w/v%)
- Compares mass of solute to volume of solution
- Usually in g/mL
- Make sure you LABEL!
- Similar to density, but not a pure substance

$$\frac{solute(g)}{solution(mL)} \times 100$$

Example #1

Determine the concentration of each solution:

a. 2.5g NaCl dissolved in water to give 109g of solution (m/m%)

b. 32mL of hexane in 524mL of octane (%v/v)

c. 4.9g K_2SO_4 in 87 mL of solution (m/v%)

Example #1 Solved

a. 2.5g NaCl dissolved in water to give 109g of solution (m/m%)

$$\frac{solute(g)}{solution(g)} \times 100$$

$$\frac{2.5 g NaCl}{109 g sol'n} \times 100 = 2.3\% NaCl$$

Example #1 Solved

b. 32mL of hexane in 524mL of octane (%v/v)

$$\frac{solute(mL)}{solution(mL)} \times 100$$

Solution (mL) = hexane (mL) + octane (mL)

$$\frac{32mLhexane}{556mLsol'n} \times 100 = 5.8\%hexane$$

Example #1 Solved

c. 4.9g K_2SO_4 in 87 mL of solution (m/v%)

$$\frac{solute(g)}{solution(mL)} \times 100$$

$$\frac{4.9 g K_2SO_4}{87 mL sol'n} \times 100 = 5.6\% K_2SO_4$$

Conversion Factors

- The percent concentrations can be used as conversion factors between solute and solution
- This is why labeling becomes VERY IMPORTANT!!
- Can assume 100 g or mL of solution given a percent concentration

Example #2

A drink sold in a health food store contains 0.50% (m/v) of vitamin C. What volume would you have to ingest to obtain 1,000. mg of vitamin C?

Example #2 Solved

0.50% (m/v) = 0.50 g vitamin C in 100 mL solution

$$\frac{0.50\,g}{100\,mL} \qquad \frac{100\,mL}{0.50\,g}$$

1,000. mg = 1.000 g

$$1.000\,gC \times \frac{100\,mLsol'n}{0.50\,gC} = 200\,mLsol'n$$

Molarity

- Another expression of concentration
- Relates **moles of solute to liters of solution**
- Units: mol/L, new symbol: M
- For use in stoichiometric calculations because it contains moles

$$\frac{solute(mol)}{solution(L)}$$

Example #3

Calculate the molarity of each aqueous solution with the given amount of NaCl (molar mass: 58.44 g/mol) and final volume.

a. 2.0 mol in 250 mL

b. 12.0 g in 2.0 L

Example #3 Solved

a. 2.0 mol in 250 mL

$$250 mL \times \frac{1 L}{1000 mL} = 0.250 L$$

$$\frac{solute(mol)}{solution(L)} \quad \frac{2.0 mol}{0.250 L} = 8.0 M NaCl$$

b. 12.0 g in 2.0 L

$$12.0 g NaCl \times \frac{1 mol NaCl}{58.44 g NaCl} = 0.205 mol NaCl$$

$$\frac{solute(mol)}{solution(L)} \quad \frac{0.205 mol NaCl}{2.0 L} = 0.103 M NaCl$$

Example #4

A commercial mouthwash contains 4.3 g of ethanol and 0.021 g of antiseptic in each 30. mL portion. Calculate the mass/volume percent concentration of each component.

(This sample is looking at two different solutes in a solution)

Example #5

How many moles of NaCl are contained in each volume of aqueous NaCl solution?

a. 2.5L of a 0.25M solution

b. 25 mL of a 2.0M solution

c. 250 mL of a 0.25M solution