Chapter 13 part 2:
Concentration and Dilution

SAME HOMEWORK AS ELECTROLYTES:
Read: BLB 4.1, 4.5; 13.4
HW: BLB 4:3, 15, 37, 61, 72, 73; 13:39, 47

Know:
- different expressions of concentration
- concentration of a transferred solution
- concentration of a diluted solution
- concentration/moles of ions in solution

### Expressing Concentration

1. mass fraction $= \frac{\text{mass of component}}{\text{total mass}}$
2. weight % $= \text{mass fraction} \times 100\%$
3. mole fraction $= \frac{\text{moles of component}}{\text{total moles}}$ $X_i$
4. parts per million $= X_i \times 10^6 \ ppm$
   $= \text{mass fraction} \times 10^6 \ ppm$
   parts per billion $X_i \times 10^9 \ ppb$
   parts per trillion $X_i \times 10^{12} \ ppt$
5. molarity $= \frac{\text{moles of solute}}{\text{liters of solution}}$ $M$
6. molality $= \frac{\text{moles of solute}}{\text{mass (kg) of solvent}}$ $m$
Joe makes a solution by adding 1.25 g NaCl to 2.50 \times 10^2 \text{ mL} of water and stirring until the salt is dissolved.

What is the molarity of the solution?

What is the molality of the solution? (T=4°C)

Based on the mass of NaCl, how many ppm of NaCl? (T=4°C)

What is the mole fraction of NaCl?

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**Dilution of Solutions**

**DEFINE DILUTION:**

➢ Does adding solvent change the number of moles of solute?

\[
\text{Moles of solute} = n = M V
\]

\[
M = \text{concentration (molarity) of solution}
\]

\[
V = \text{volume of solution (L)}
\]

SO...

\[
\text{moles}_{\text{init}} = \text{moles}_{\text{final}}
\]

\[
n_i = n_f
\]

\[
M_{\text{init}} V_{\text{init}} = M_{\text{final}} V_{\text{final}}
\]

Example: 50 mL of a 0.25 M stock solution was diluted to 200 mL. What is the final concentration?
**Concentration of an Electrolyte**

Relative concentrations of each ion in the solution depends on the chemical formula.

\[
\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^- \\
2M
\]

\[
\text{AlCl}_3 \rightarrow \text{Al}^{3+} + 3\text{Cl}^- \\
2M
\]

\[
\text{Na}_2\text{SO}_4 \rightarrow 2\text{Na}^+ + \text{SO}_4^{2-} \\
2M
\]

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**Concentration Problem-Solving Steps**

1. Draw **pictures**!

2. **Organize** information below pictures

3. Write the **chemical process** or reaction

4. Solve for **unknowns**
   - Is it **transfer or dilution**?

5. Decide if **unnecessary information** is included

6. Answer the **question** that was asked!
**Example:** A 10 mL sample of a solution of Li$_2$S was diluted with water to 100 mL. A 50 mL sample of the dilute solution was found to contain 0.5 M Li$^+$. What was the concentration of Li$_2$S in the original undiluted solution?

**The millimole shortcut:**
1 mole = 1000 millimoles = 1000 mmol

**Example:** When 10.0 mL of a solution containing 2.25 M Na$_3$PO$_4$ is diluted to 40.0 mL, a dilute solution is formed. How many moles of Na$^+$ ions are contained in 20.0 mL of the dilute solution?
Example:

How many mL of a 85.0 mL stock solution of 1.50 M Na₃PO₄ must be used to make 63.0 mL of a solution that has a concentration of 0.750 M Na⁺?

Example:

A 7.00 mL sample is taken from an 80.0 mL stock solution that is 0.060 M Na₂S₂O₃. The sample is diluted to 200.0 mL. What is the S₂O₃²⁻ concentration of the dilute solution?
Example:

What is the molality of KBr in a solution made by dissolving 2.21g of KBr in 897 g of water?