

Solutions

Homogeneous mixture of two or more substances in a single physical state

(If you're not a part of the solution, you're a part of the precipitate.)

Solute

II Substance that is dissolved

II Originally in a different physical state or present in smaller amount



Solvent

- ⊃ Substance that does the dissolving
- ⊃ Does not change physical state or present in greater quantity than solute



Like Dissolves Like

Soluble vs Insoluble

- A substance that dissolves in another substance is soluble. If it will not dissolve it is called insoluble.
- Examples: salt is soluble in water, but insoluble in acetone. Oil is insoluble in water

Solutions occur between all states of matter

<u>Solute</u>	<u>Solvent</u>	<u>Example</u>
Gas	Gas	Air
Gas	Liquid	Carbonated drink
Liquid	Liquid	Antifreeze
Solid	Liquid	Ocean
Gas	Solid	Charcoal filter
Liquid	Solid	Dental filling
Solid	Solid	Brass (alloy)

- Did you hear about the company, who after years of problems with employee absenteeism, finally hired a guy who shows up every day? He's completely made of brass. They corporate officials are very happy with this working solution.

Aqueous Solutions



◆ Solutions in which water is the solvent

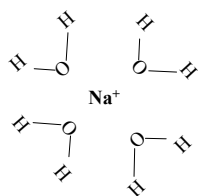
◆ Something to ponder? Salt is an ionic compound; water is a molecular compound. Their properties couldn't be more different, yet somehow they always manage to dissolve their differences.

Electrolyte

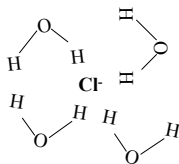
- ✗ Substance that will conduct an electrical current when dissolved in water (all ionic compounds)

Nonelectrolyte

- Substance that will not conduct an electrical current when dissolved in water (molecular compounds)



Solvation of NaCl, and ionic compound



Concentration

- The amount of solute in a given amount of solvent or solution

Concentration

1. Molarity(M)
2. Molality(m)
3. Mole Fraction



Molarity, M

- Molarity = $\frac{\text{moles of solute}}{\text{L of solution}}$

Divide the number of moles by the total liters of solution.

Use factor label method with mol/L when needed.

MOST common way of expressing aqueous solution concentration.

Molality, m

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

Divide the number of moles by the mass of solvent.

Use factor label method with mol/kg when needed.

Used in fp depression and bp elevation calculations

Mole Fraction, X

- Mole Fraction = $\frac{\text{moles of component}}{\text{total moles of solution}}$

$$X_{\text{solute}} + X_{\text{solvent}} = 1$$

Solubility

- The amount of a solute that will dissolve in a specific solvent under given conditions
- See charts on p. 457.

- Did you hear about the homeless sucrose molecule who got help at the Solvation Army? (He's lucky he got in because that place is usually saturated.)

Saturated
Unsaturated
Supersaturated

The Effects of Temperature Upon Solubility

- ◆ For solid in liquid-(generally) as temperature increases, solubility increases
- ◆ For gas in liquid-as temperature increases, solubility decreases

Pressure only affects the solubility of gas in liquids

- As pressure increases, the solubility of a gas in a liquid increases

Factors Affecting Rate of Dissolving

- ✓ Stirring-add energy
- ✓ Heating-add energy
- ✓ Crushing-increase surface area

Colligative Properties

- Any property that depends only upon the number of solute particles present (concentration) rather than their identity.

Colligative Properties

- ① Vapor pressure reduction
- ② Boiling point elevation
- ③ Freezing point depression
- ④ Osmotic pressure

Colligative Properties

Colligative property	As amt. of solute increases...	Why?
Vapor pressure reduction	Vapor pressure decreases	Solute particles in the way
Boiling point elevation	Boiling point goes up	Directly related to vapor pressure
Freezing point depression	Freezing point goes down	Directly related to vapor pressure
Osmotic pressure	Goes up	More solvent wants to flow

Applications: fp depression and bp elevation:

- $\Delta T_b = K_b m$
- $\Delta T_f = K_f m$
- K_b on p. 472, and K_f on p. 474
- For H_2O ,
- $K_b = 0.52 \text{ C/m}$, $K_f = 1.86 \text{ C/m}$

Special case with ionic compounds

- **Ionic**
- **Metal + nonmetal**
- **Ions separate (dissociate) in solution**
- **1 mole of NaCl is really 1 mole of Na^+ and 1 mole of Cl^-**
- **Total of 2 moles of particles**
- $\Delta T_b = K_b m_i$
- $\Delta T_f = K_f m_i$
- **Molecular**
- **Nonmetals only, forming a molecule**
- **Molecules stay together in solution**
- $\Delta T_b = K_b m$
- $\Delta T_f = K_f m$

Raoult's Law

- The magnitude of vapor pressure reduction is proportional to solute concentration
- The more solute you add to a solution, the more the VP decreases, resulting in a higher BP.

Osmotic Pressure, Π

- The pressure required to prevent osmosis
- Many applications in biology