Solutions and Their Behavior

What is a solution?

Quantitative descriptions of solutions:

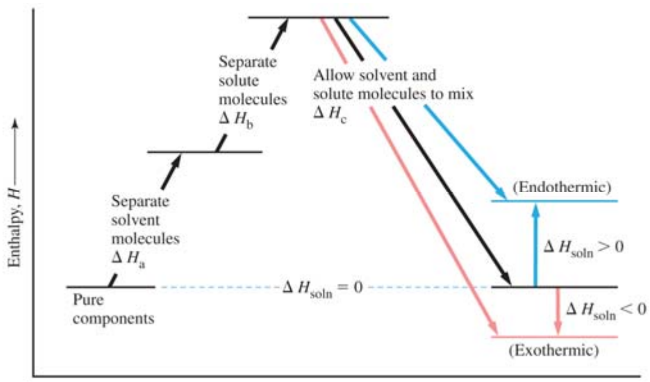
- Molarity (M):
- Molality (m):
- Mole Fraction (X):
- Weight Percent:
- Parts per (thousand/million/billion/trillion…):

1

A Closer Look at Dissolution:

Largely a thermodynamic process

- Combination of Enthalpy (ΔH) and Entropy (ΔS)
- Energy "cost" for the process must not be too high
- Look at energy cost of IM forces disrupted compared to energy return of IM forces produced



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A Closer Look at Dissolution: "*like dissolves like*"…usually

Example: Ethylene Glycol and Hexane in Water

	Strongest IM force in pure compound	Strongest IM force in solution w/ water
OH OH $H_2C—CH_2$		
$CH_3CH_2CH_2CH_2CH_2CH_3$		
H_2O		

Remember, the ***tendency*** for any process indicated by its Free Energy (Gibbs Energy, ΔG), which has enthalpy (ΔH) and entropy (ΔS) components! ($\Delta G = \Delta H - T\Delta S$)

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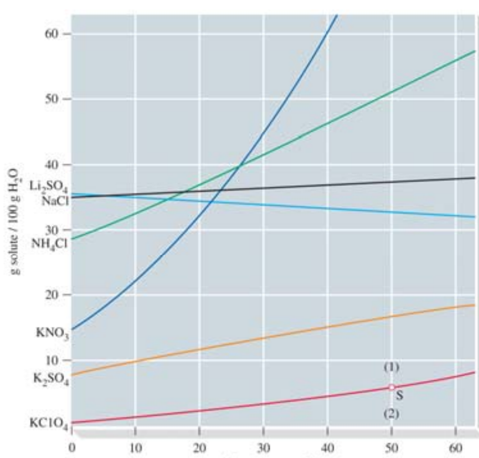
Manipulating the Solution Process

Often ***equilibrium*** based.

Solubility and Temperature:

- Because of enthalpy and entropy components, we can use head to drive dissolution
  - Impact depends on size of ΔH and ΔS parts.
- Consider heat as a reactant or product in the solubility process. What happens when we add (or remove) heat?
  - Le Chatelier's Principle:



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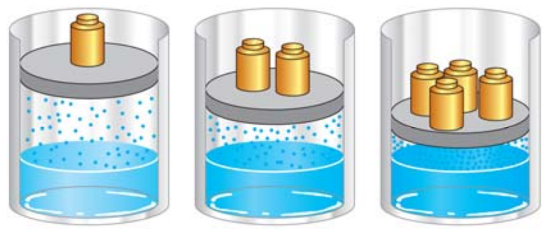
Manipulating the Solution Process

Gas solubility and pressure: ↑ Pressure → ↑ Solubility

- WHY?



- Henry's Law: $S_g = k_H P_g$

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Consequences of Forming Solutions

Colligative Properties: depend on # solute particles relative to # of solvent particles

1. **Vapor Pressure Decrease**
   - Described by Raoult's Law: $P_{solvent} = X_{solvent} P^o_{solvent}$
   - WHY?
2. **Boiling Point Increase**

   $$\Delta t_{bp} = K_{bp}\, m_{solute}$$

   - K_{bp} values are tabulated by solvent
   - WHY?
3. **Freezing Point Depression**

   $$\Delta t_{fp} = K_{fp}\, m_{solute}$$

   - K_{fp} values are tabulated by solvent
   - WHY?

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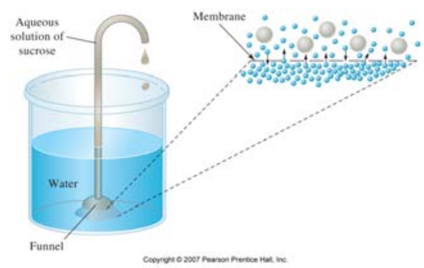
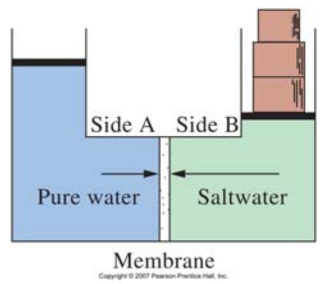
Odds and Ends

1. **Osmosis and Osmotic Pressure**
   - Attempt to reach a uniform concentration on both sides of semipermeable membrane.
   - Results in change in pressure: $\Pi = M \times RT$





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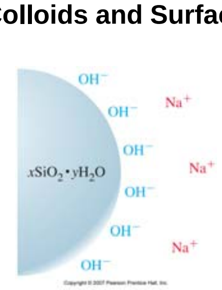
Odds and Ends

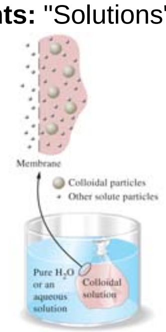
2. **Electrolytes:** need to account for dissociation – Van't Hoff Factor (i)

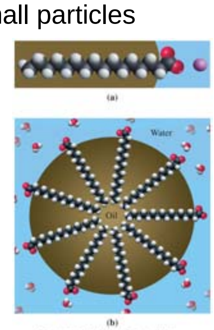
TABLE 13.3 Variation of the van't Hoff Factor, *i*, with Solution Molality

	Molality, *m*					
Solute	1.0	0.10	0.010	0.0010	...	Inf. dil.[a]
NaCl	1.81	1.87	1.94	1.97	...	2
$MgSO_4$	1.09	1.21	1.53	1.82	...	2
$Pb(NO_3)_2$	1.31	2.13	2.63	2.89	...	3

3. **Colloids and Surfactants:** "Solutions" of small particles







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