Solvation…

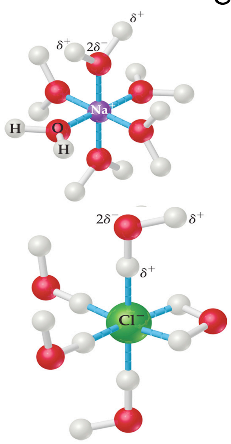
I. The act of dissolving

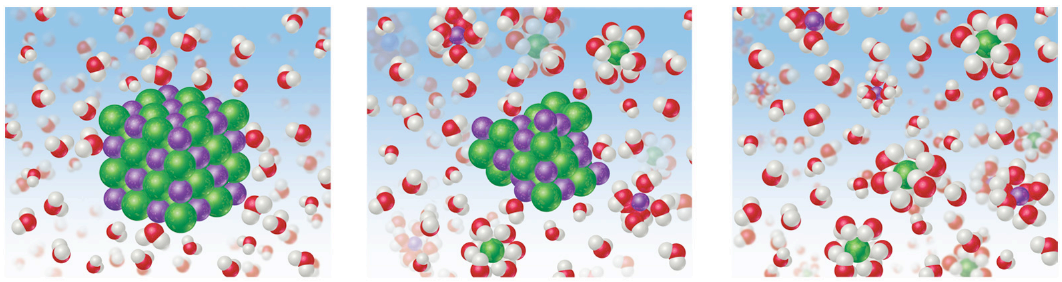
II. How it happens (given that a substance IS soluble):

A.

B.

C.

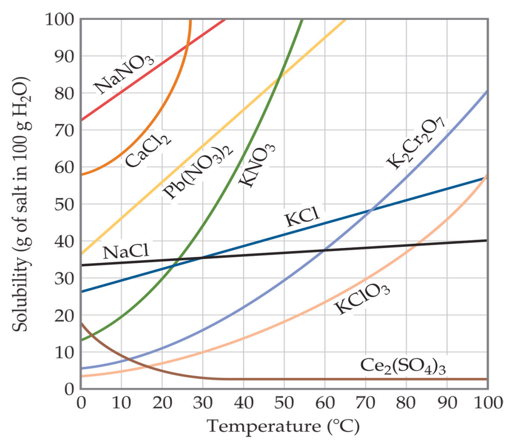




(a) (b) (c)

1.

2. Solubility:



III.

A. Polar solutes are   in polar solvents.

B. Nonpolar solutes are   in polar solvents.

IV. Solvation has to do with

A. The stronger the attraction, the

B. If the force in the solid is   solid

C. Examples:

Predict whether each of the following substances is more likely to dissolve in carbon tetrachloride (CCl_4) or in water: C_7H_{16}, Na_2SO_4, HCl, and I_2.

If You Have a Problem, I Will Drown You in the Solution! Ch. 10

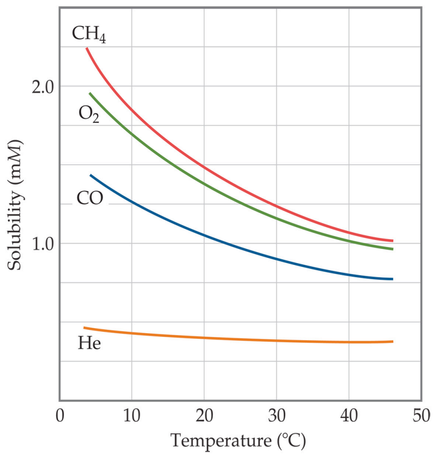
TABLE 13.3 Solubilities of Some Alcohols in Water and in Hexane*

Alcohol	Solubility in H_2O	Solubility in C_6H_{14}
CH_3OH (methanol)	∞	0.12
CH_3CH_2OH (ethanol)	∞	∞
$CH_3CH_2CH_2OH$ (propanol)	∞	∞
$CH_3CH_2CH_2CH_2OH$ (butanol)	0.11	∞
$CH_3CH_2CH_2CH_2CH_2OH$ (pentanol)	0.030	∞
$CH_3CH_2CH_2CH_2CH_2CH_2OH$ (hexanol)	0.0058	∞
$CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$ (heptanol)	0.0008	∞

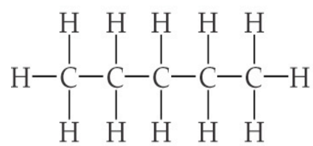
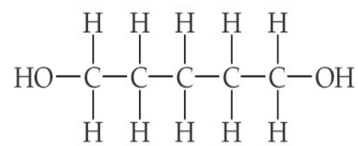
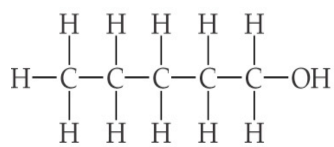
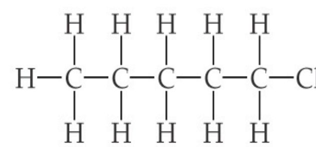
*Expressed in mol alcohol/100 g solvent at 20°C. The infinity symbol indicates that the alcohol is completely miscible with the solvent.

TABLE 13.2 Solubilities of Gases in Water at 20°C, with 1 atm Gas Pressure

Gas	Solubility (*M*)
N_2	0.69×10^{-3}
CO	1.04×10^{-3}
O_2	1.38×10^{-3}
Ar	1.50×10^{-3}
Kr	2.79×10^{-3}



Arrange the following substances in order of increasing solubility in water:

Solubility Effects

I. Look at cramsheet.

A. The higher the temperature, the

B. Pressure's effect on solubility

1. The higher the pressure,

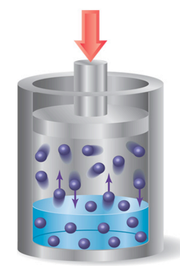
2.

3. Equation:

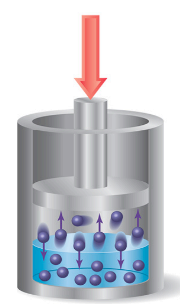
a. S_g =

b. k =

c. P_g =



(a)



(b)

C. Example: Calculate the concentration of CO_2 in a soft drink that is bottled with a partial pressure of CO_2 of 4.0 atm over the liquid at 25°C. The Henry's law constant for CO_2 in water at this temperature is 3.1×10^{-2} mol/L-atm.

Calculate the concentration of CO_2 in a soft drink after the bottle is opened and equilibrates at 25°C under a CO_2 partial pressure of 3.0×10^{-4} atm.

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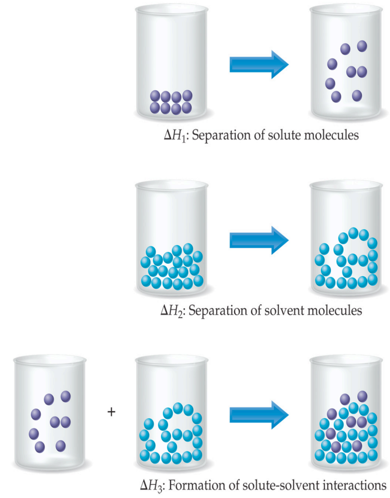


II. Energetics of solvation

   A. Three processes involved in solvation

      1.

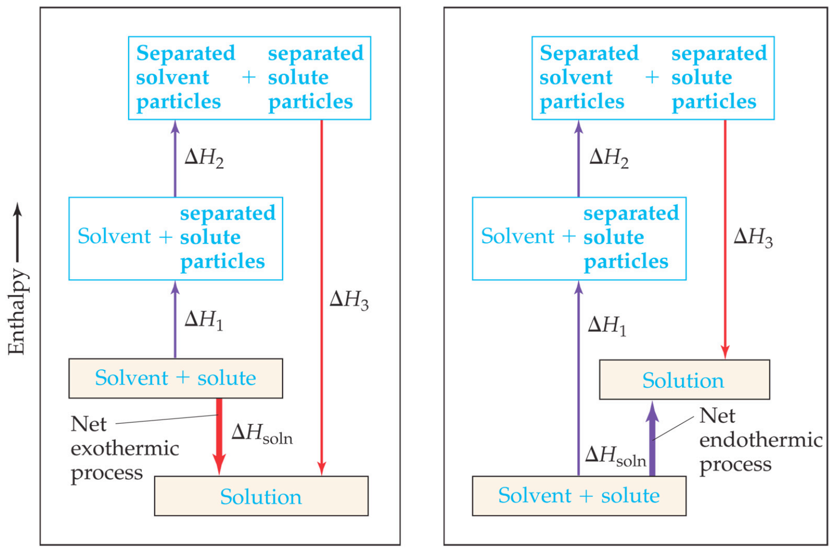
      2.

      3.

   B.   is known as the

      1. Endothermic:

      2. Exothermic:



Concentration Units

I. See your cramsheet.

II.   is the most used in AP (   ).

III.   (   ) and   (   )
are next.

IV. Always be aware of   !!! Use dimensional analysis to convert between them.

Colligative Properties

I. Properties that depend

II.

   A. Adding salts   of a solvent.

   B. Since the solute particles   , molecules need
                                                                                  to
   become gaseous.

   C. Thus, there are

   D.

      1. Relates

      2. Equation:

         a. P_A =

         b. X_A =

c. $P°_A$ =

d.

3. Changing

III.

A. affect vapor pressure, changing the

B. Lowering the vapor pressure means that it takes

C. Thus, increasing

D. Equation:

1. ΔT_b =

2. K_b =

3. m =

E. Then,

F. Note:

Solvent	Normal Boiling Point (°C)	K_b (°C/m)	Normal Freezing Point (°C)	K_f (°C/m)
Water, H_2O	100.0	0.51	0.0	1.86
Benzene, C_6H_6	80.1	2.53	5.5	5.12
Ethanol, C_2H_5OH	78.4	1.2	−114.6	.99
Carbon tetrachloride, CCl_4	76.8	5.02	−22.3	29.8
Chloroform, $CHCl_3$	61.2	3.6	−63.5	.68

IV.

A. Solute-solvent attractions affect

B. Thus, increasing solute concentration

C. Equation:

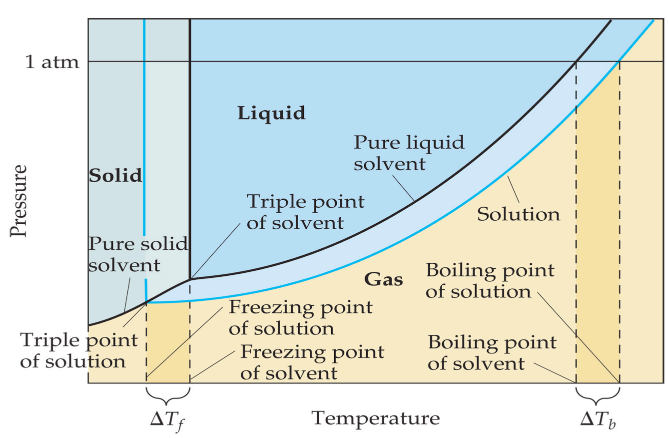
1. ΔT_f =

2. K_f =

3. m =

D. Then,

E. Note again:

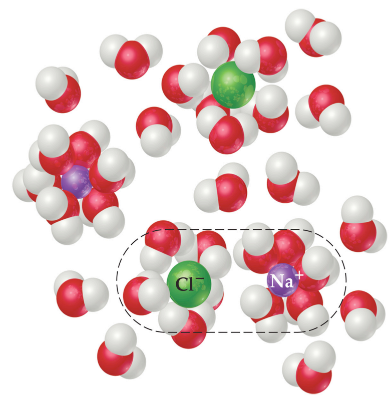


Example: Automotive antifreeze consists of ethylene glycol ($C_2H_6O_2$), a nonvolatile nonelectrolyte. Calculate the boiling point and freezing point of a 25.0 mass % solution of ethylene glycol in water.

Example: Calculate the freezing point of a solution containing 0.600 kg of $CHCl_3$ and 42.0 g of eucalyptol ($C_{10}H_{18}O$), a fragrant substance found in the leaves of eucalyptus trees.

Answer: -63.8^{o}C

List the following aqueous solutions in order of their expected freezing point: 0.050 *m* $CaCl_2$, 0.15 *m* NaCl, 0.10 *m* HCl, 0.050 *m* $HC_2H_3O_2$, 0.10 *m* $C_{12}H_{22}O_{11}$.



V. Ideal Solutions
- A. The above equations were for
- B. In reality, solute-solvent interactions are
- C. Experimentally, the
- D. For example...
- E. This is known as the
  1. One mole of NaCl
  2. Some ions temporarily with each other.
  3. Thus, the real concentration is
  4. Reassociation is more likely at
  5. Thus,

	Concentration			
Compound	**0.100 *m***	**0.0100 *m***	**0.00100 *m***	**Limiting Value**
Sucrose	1.00	1.00	1.00	1.00
NaCl	1.87	1.94	1.97	2.00
K_2SO_4	2.32	2.70	2.84	3.00
$MgSO_4$	1.21	1.53	1.82	2.00

F.
1.

2.

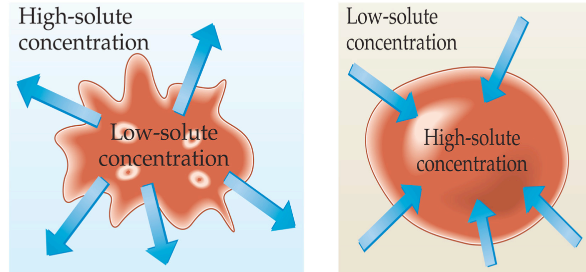
3. i =

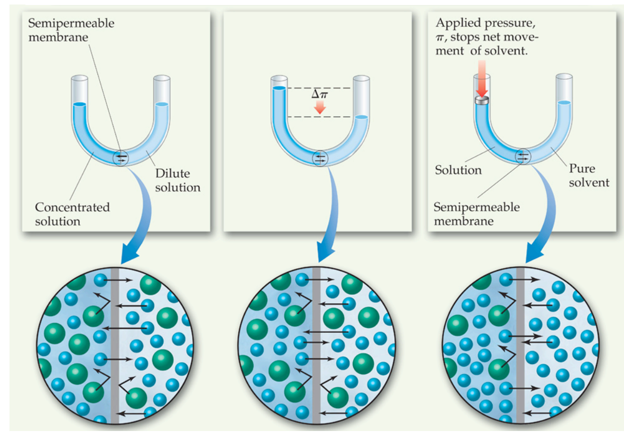
4. Depends on the

VI.
A. Osmosis:

B. =

C. Equation:
1. π =
2. M =
3. R =
4. T =





Example: The average osmotic pressure of blood is 7.7 atm at 25°C. What concentration of glucose ($C_6H_{12}O_6$) will be isotonic with blood?

Example: What is the osmotic pressure at 20°C of a 0.0020 *M* sucrose ($C_{12}H_{22}O_{11}$) solution? (Ans: 0.048atm or 37 torr)

Colligative Properties and Molar Mass

I. You can find from all colligative properties.
II. You will be given Using the data given, you can solve for the
III. Use to find molarity or molality.
IV. Use the given to find moles.
V.

Example: A solution of an unknown nonvolatile electrolyte was prepared by dissolving 0.250 g of the substance in 40.0 g of CCl_4. The boiling point of the resultant solution was 0.357°C higher than that of the pure solvent. Calculate the molar mass of the solute.

Example: Camphor ($C_{10}H_{16}O$) melts at 179.8°C, and it has a particularly large freezing-point-depression constant, K_f = 40.0°C/*m*. When 0.186 g of an organic substance of unknown molar mass is dissolved in 22.01 g of liquid camphor, the freezing point of the mixture is found to be 176.7°C. What is the molar mass of the solute? (Ans: 110 g/mol)

Example: The osmotic pressure of an aqueous solution of a certain protein was measured in order to determine the protein's molar mass. The solution contained 3.50 mg of protein dissolved in sufficient water to form 5.00 mL of solution. The osmotic pressure of the solution at 25°C was found to be 1.54 torr. Calculate the molar mass of the protein.

Example: A sample of 2.05 g of polystyrene of uniform polymer chain length was dissolved in enough toluene to form 0.100 L of solution. The osmotic pressure of this solution was found to be 1.21 kPa at 25°C. Calculate the molar mass of the polystyrene. (Ans: 4.2 x 10^4 g/mol)

Beer's Law

I. Relates

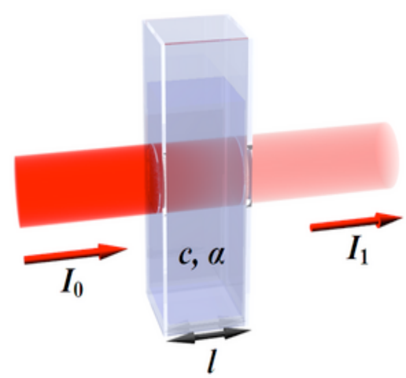
II. Some definitions:

A.

B. Line Equation: Based on

This will be used to

C. Blank: solution with



III. Equation:

A. A=

B. a=

C. b=

D. c=

IV. Beer's Law concepts.

A. The solution measured

B. If the points

C. The colorimeter must be set to