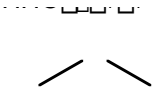
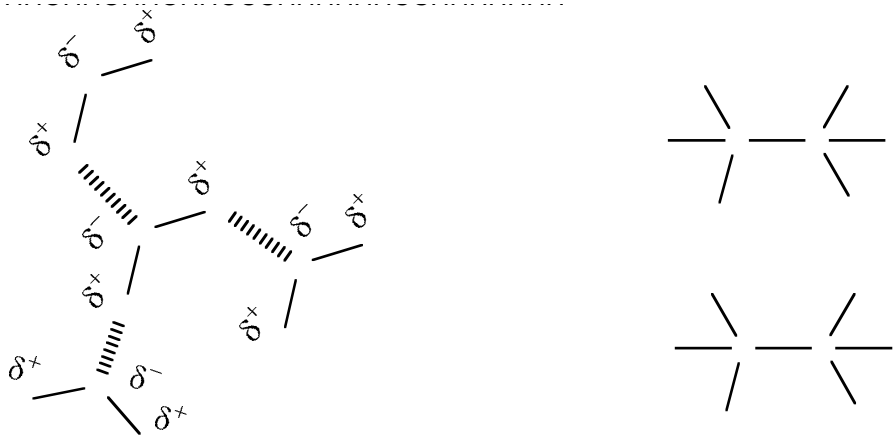
Chapter 8

Solutions:

1. Water.
   a) Properties
      1. Polar- dissolves polar substances.



      2. Hydrogen-bonding. must have a H directly attached to O,N, or F sometimes S.



Weaker than a covalent or ionic bond.

H bonds important in DNA and enzymes.

b. Physical properties of water.

1. High B.P.
2. High heat of vap.
3. High surface tension- water molecules are attracted to each other.

2. Solution – one substance dissolves in another, homogeneous. Dispersed evenly.

solid ---- liquid liquid ------ liquid gas ---- liquid

Solute –is dispersed evenly in solvent solvent – one in larger amount.

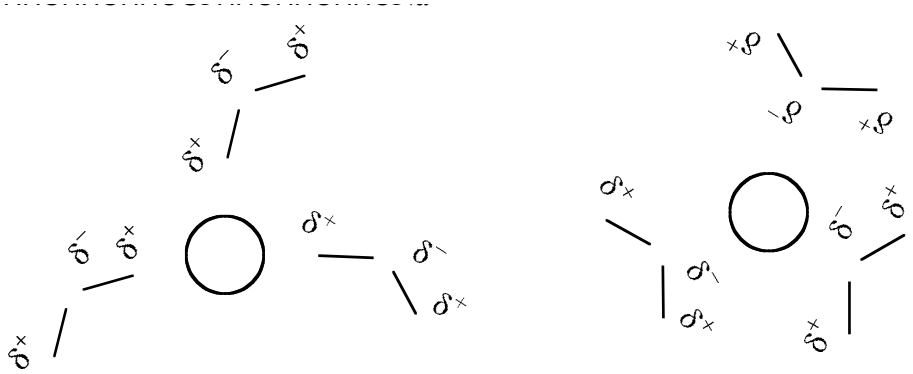
a. Likes dissolve likes- Like means polarity.

Ethanol --- water ammonia---- water sugar ----- water

polar polar polar polar polar polar

C_5H_{12} ----- water C_5H_{12} ----- CF_4

non-polar polar non-polar non-polar



Solvent Cage- effective radius of ion is larger.

4. Rate of solvation.
    1. Solute is crushed- increase surface area.
    2. Mixture is stirred- increase dispersion.
    3. Mixture is heated- more solvent collisions.

Electrolytes- ion source.

ions conduct electricity.

Strength of current is directly related to ion concentration.

Ion formation (ionic bond)

$XY(s) \rightarrow X^{+}(aq) + Y^{-}(aq)$

a) Strong electrolytes- exist only as ions, usually ionic.

$HCl(s) \rightarrow H^{+}(aq) + Cl^{-}(aq)$ 100% dissociation

0% 100%

$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2Cl^{-}(aq)$ 100% dissociation

$Na_3PO_4(s) \rightarrow 3Na^{+}(aq) + PO_4^{3-}(aq)$ 100% dissociation

b) Weak electrolytes- usually polar covalent molecule- part ionization.

Reverse direction is favored

c) Non-electrolytes- covalent polar molecule – no ions formed.

$CH_3OH(l) \rightarrow CH_3OH(aq)$ 0% dissociation methanol.

3. Solubility- amount of solute that can dissolve in a given amount of solvent.
   g solute/ 100 solvent

   a. Saturated- maximum amount of solute that can dissolve at a certain temp. solids are usually more soluble in liquids at higher temp. (opposite of gasses)
      Add anymore solute goes to bottom of solution.

   b. unsaturated – not maximum amount of solute that can dissolve at a certain temp.

   c. Soluble and Insoluble salts.
      Some ionic compounds are soluble and some are not. To be soluble most dissociate into individual ions. If not, insoluble.

$XY(s) \rightarrow$ XY(s) insoluble

$XY(s) \rightarrow X^+(aq) + Y^-(aq)$ soluble, electrolyte

Ex $AgNO_3(s) \rightarrow Ag^+(aq) + NO_3^-(aq)$

$CaSO_4(s) \rightarrow CaSO_4(s)$

Mixture: $Pb(NO_3)_2(s) + NaCl(s)$

$Pb(NO_3)_2(s) \rightarrow Pb^{2+}(aq) + 2NO_3^-(aq)$

$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

Formation of $PbCl_2(s)$

Net ionic $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$ only ions reacting.

$NaPO_4(s) + AgNO_3$ (s)

$NaPO_4(s) + AgNO_3(s) \rightarrow Ag_3PO_4(s) + NaNO_3(aq)$

Formation of $Ag_3PO_4(s)$

Net ionic $3Ag^+(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s)$only ions reacting.

4. Concentration- amount of solute dissolved in a certain amount of solution.

   concentration = amount of solute / amount of solution

   amount of solution = solute + solvent

   a. Percent concentration-

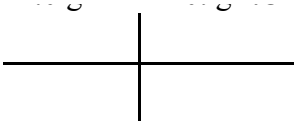
      1. Mass percent-

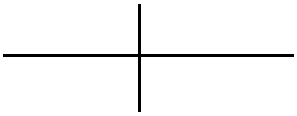
         mass/mass = (m/m)% = g solute/g solution x 100

         g solution = g solute + g solvent

         Ex. 8-1. Mix 110. mL of water and 10. mL of ethyl alcohol. Calculate the (m/m)%. Density of water = 1.0 g/mL

         ethyl alcohol = 0.79 g/mL





2. Volume Percent

   volume/volume = (v/v)% = volume solute/volume solution x 100

   Ex. 8-2. Calculate from ex. 8-1.

   Ex. 8-3. Wine is 12% alcohol. How much alcohol is there if there is 120. mL of water.

   120. mL solvent

   12solute + 1440 = 100 solute

   1440 = 88solute

   16.4 mL = solute

3. mass/ volume (%m/v)
   mass/volume = (g/v)% = grams solute/mL solution x 100

   Ex. 8-4. Take 10. g of NaCl and mix with 119 mL of water to give a resulting solution of 120. mL. Calculate the (% m/v).

4. Conversion Factor.

   10%(m/m) = 10 g solute/ 100 g solution or
   100 g solution/10 g solute

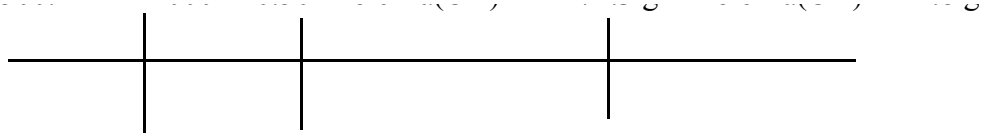
   Ex. 8-5. Antifreeze is 15% (v/v) solution.Calculate the volume of solution if you have 60.0 mL of ethylene glycol.

2. **Molarity (M)**

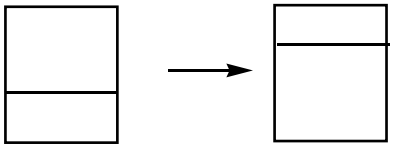
   a) (M) molarity = moles of solute/ 1L of solution

   Ex. 8-6. What is the molarity of 8.3 g of $Ba(OH)_2$ in a 250. mL solution.

Ex. 8-7. Calculate how many grams of barium hydroxide are in 500. mL of a o.50 M solution.



3. **Dilution** – addition of more solvent.



$$M_2 = M_1V_1/V_2 = (5.0\ mL)(2.0\ M)/\ 10.0\ mL = 1.0\ M$$

Ex. 8-8 If you add 1.5 L of water to a 500. mL of a 2.0 M solution of barium hydroxide what is the new molarity?

$$M_2 = M_1V_1/V_2 = (0.500\ mL)(2.0\ M)/\ 2.0\ L = 0.50\ M$$

Ex. 8-9. If you want to mix up 100. mL of a 0.50 M solution how would this be accomplished by using a stock solution of 2.0 M NaOH in a 300. mL beaker?

$M_2V_2 = M_1V_1$ $V_1 = M_2V_2 / M_1 = (0.50\ M)(100.\ mL)/ 2.0\ M = 25\ mL$

Take 25 mL of the stock solution and dilute with 75 mL of water.

4. **Osmosis and Dialysis** -

A) Osmosis- solvent water moves through a semi-permeable membrane from low to high concentration of solute. Generates osmotic pressure.

semi-permeable membrane- lets through small particles (water) but not larger molecules.

Isotonic solution – equal concentration on the outside and inside.
hypotonic solution – greater concentration inside.
hypertonic solution – greater concentration outside.

B) Dialysis- Movement lets small molecules like ions and glucose pass through a semi-permeable membrane. Starches and proteins do not pass through.