Chapter 8 – Solutions, Acids, and Bases

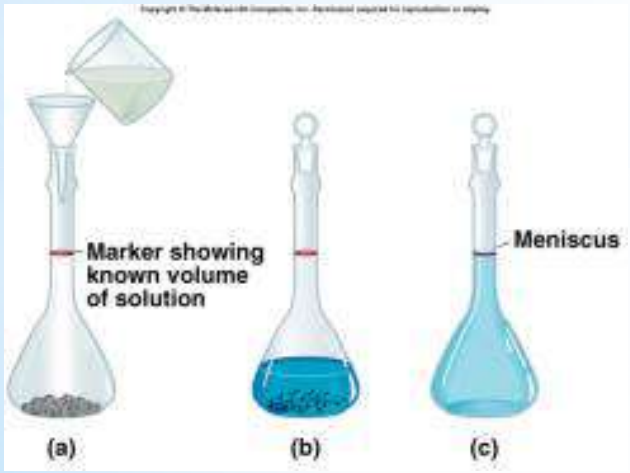
Jennie L. Borders

*Warm-Up Apr. 8

1. What is an acid?
2. What pH is neutral?
3. What is a saturated solution?

* Section 8.1 - Formation of Solutions

* Every solution has two types of components.
* A solute is a substance whose particles are dissolved in a solution.
* The substance in which the solute dissolves is called the solvent.

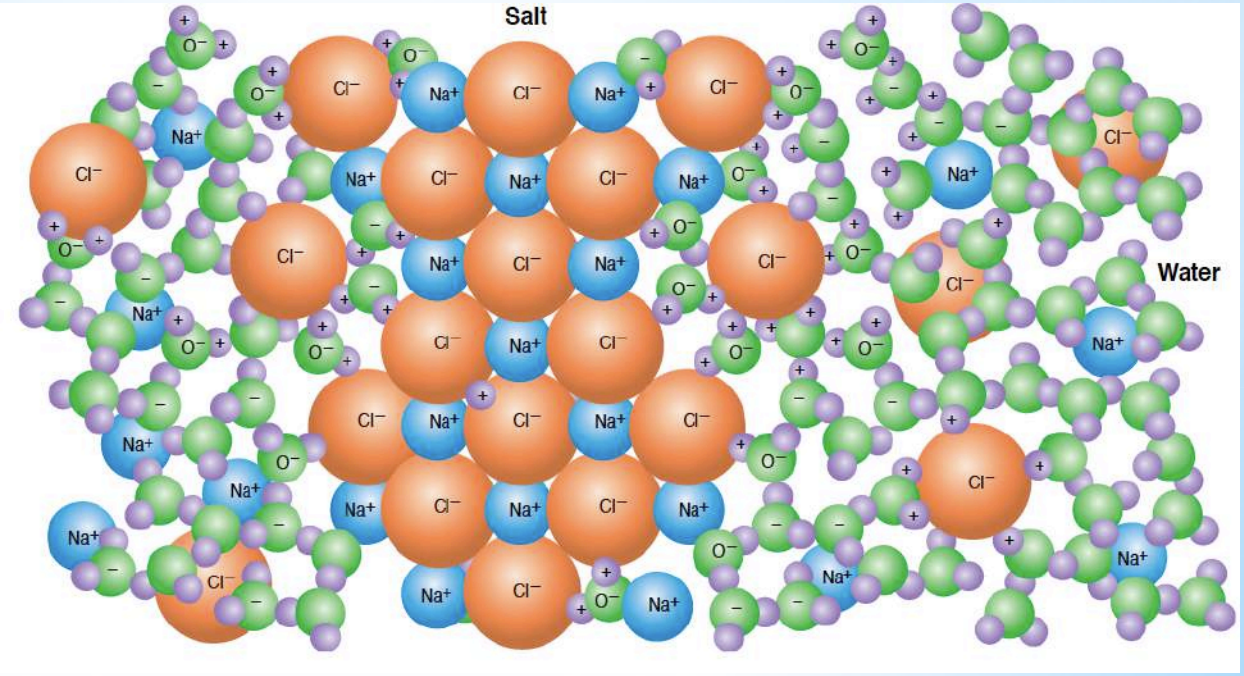


* Dissolving

*Substances can dissolve in water in three ways – by dissociation, dispersion, and ionization.

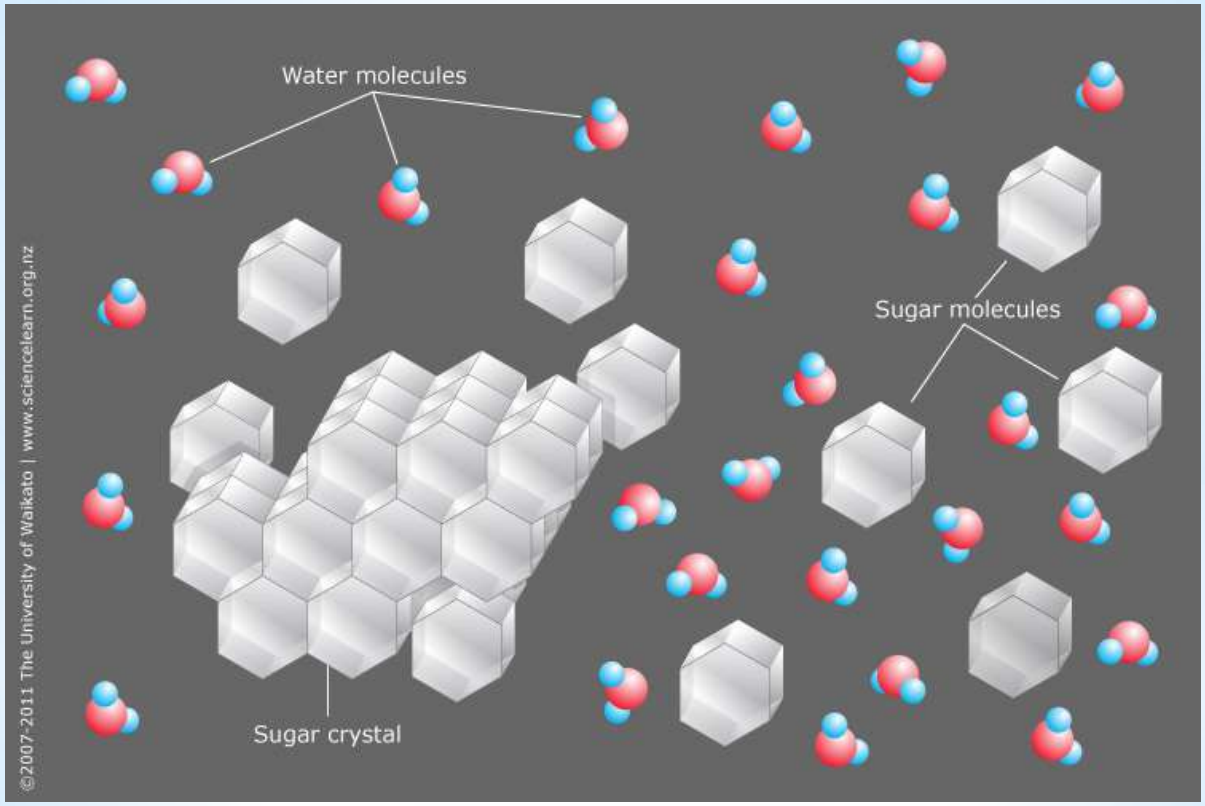
* Dissociation of Ionic Compounds

* For a solute to dissolve in water, the solute and solvent particles must attract one another.
* The process in which an ionic compound separates into ions as it dissolves is called dissociation.



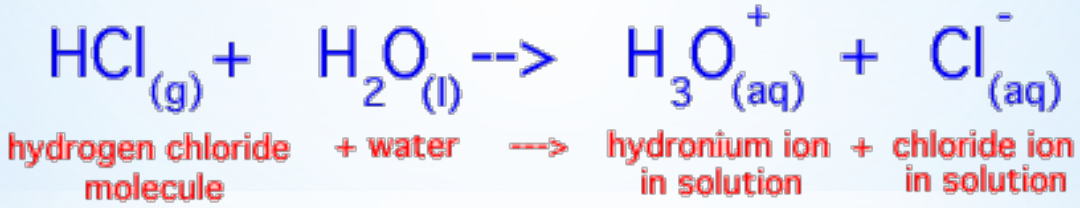
* Dispersion of Molecular Compounds

* Sugar dissolves in water by dispersion, or breaking into small pieces that spread throughout the water.



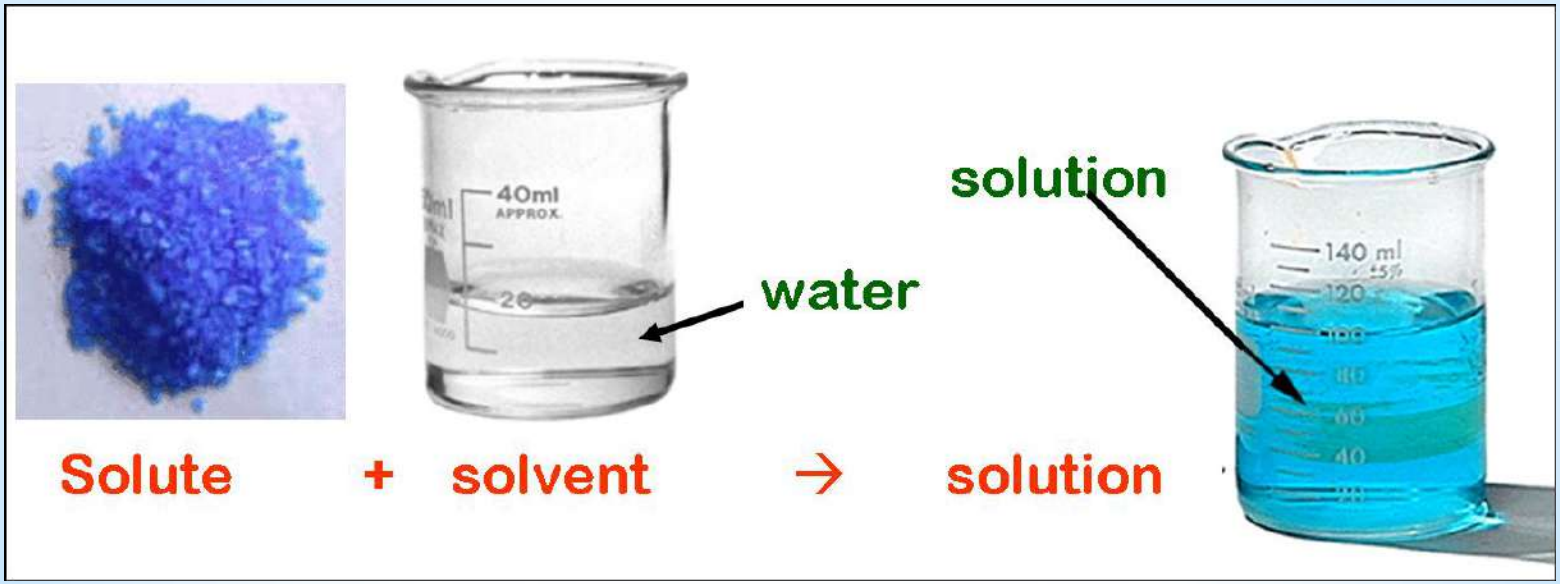
* Ionization of Molecular Compounds

* The process in which neutral molecules gain or lose electrons is known as ionization.
* Unlike dissociation and dispersion, which are physical changes, dissolving by ionization is a chemical change.



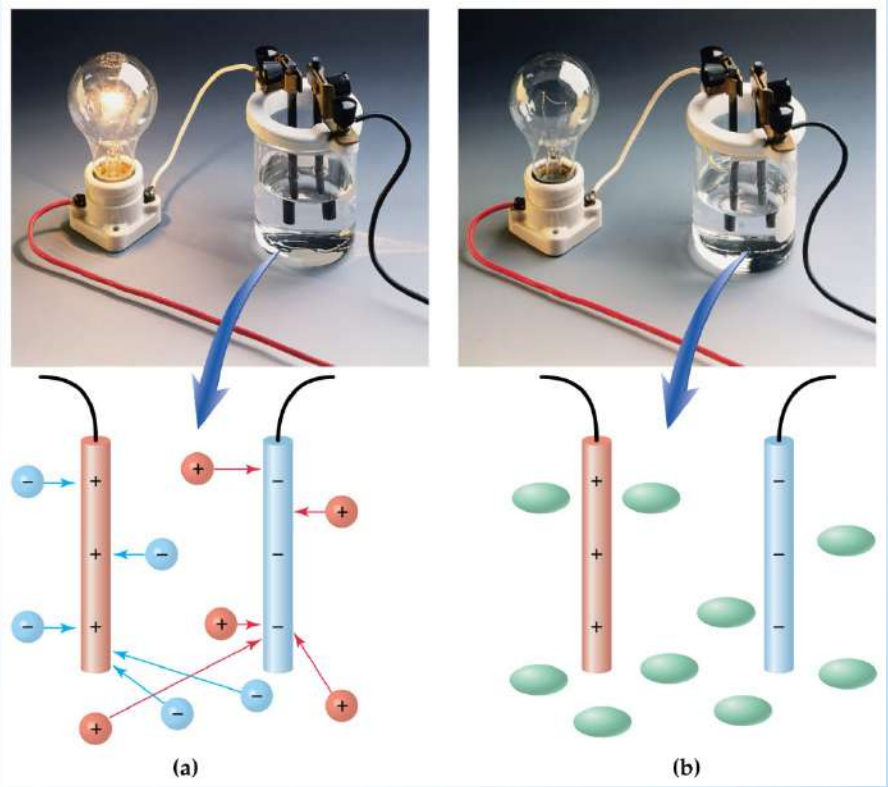
* Properties of Liquid Solutions

* Three physical properties of a solution that can differ from those of its solute and solvent are conductivity, freezing point, and boiling point.



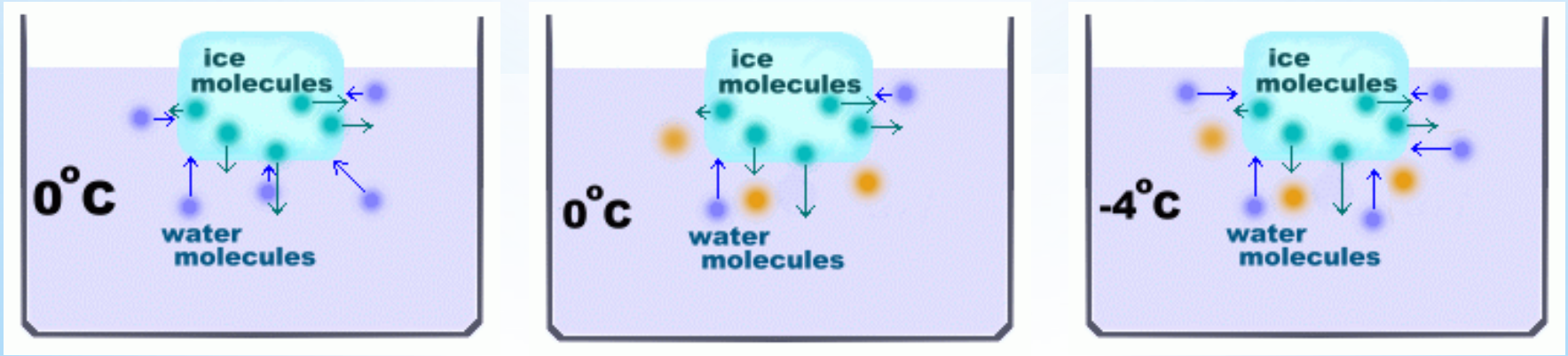
Conductivity

* Solid ionic compounds do not conduct electricity because the ions cannot move.
* When an ionic compound is dissolved in water, the ions break apart and can move. This allows the solution to conduct electricity.



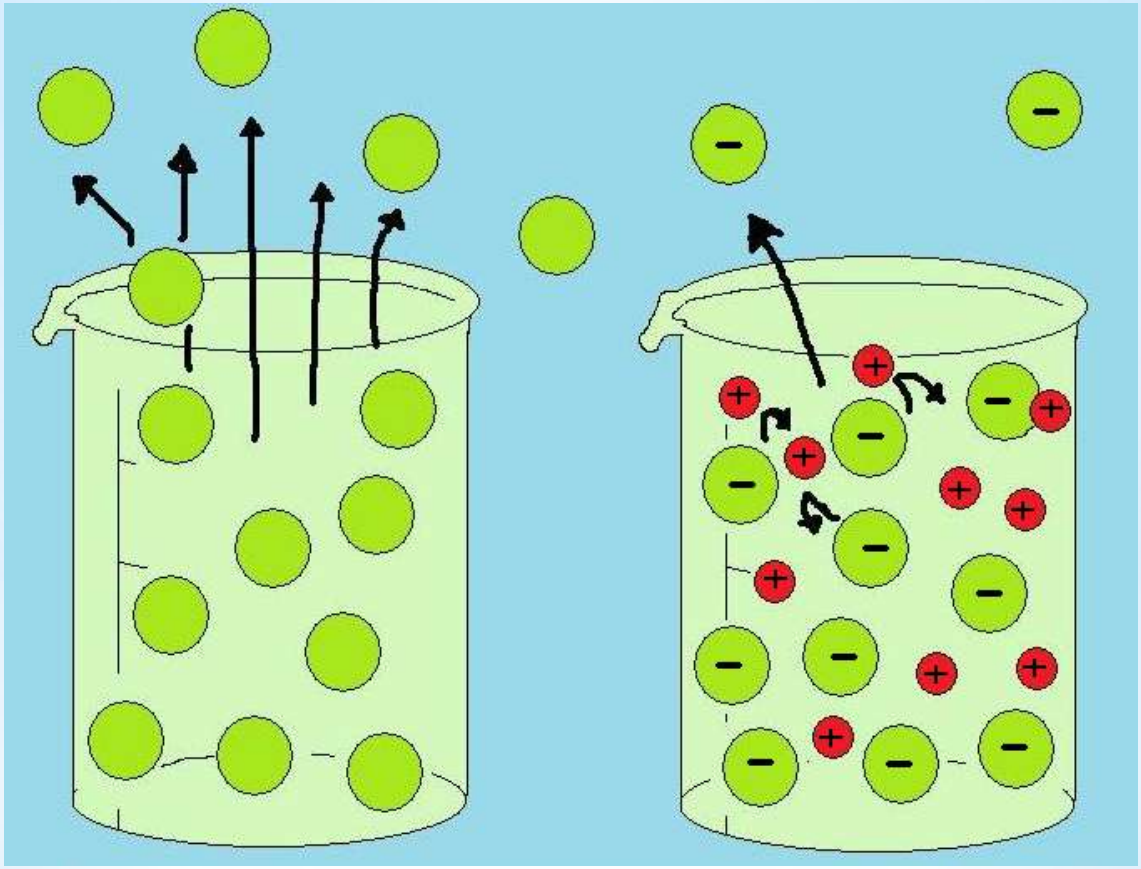
* Freezing Point

* Ice forms when water molecules are able to arrange themselves in a rigid, honeycomb-like structure.
* The presence of other solute ions, which are attracted to the water molecules, interferes with the freezing point.
* A solute will lower the freezing point of a solvent.



* Boiling Point

* A solute can also raise the boiling point of a solvent.



* Heat of Solution

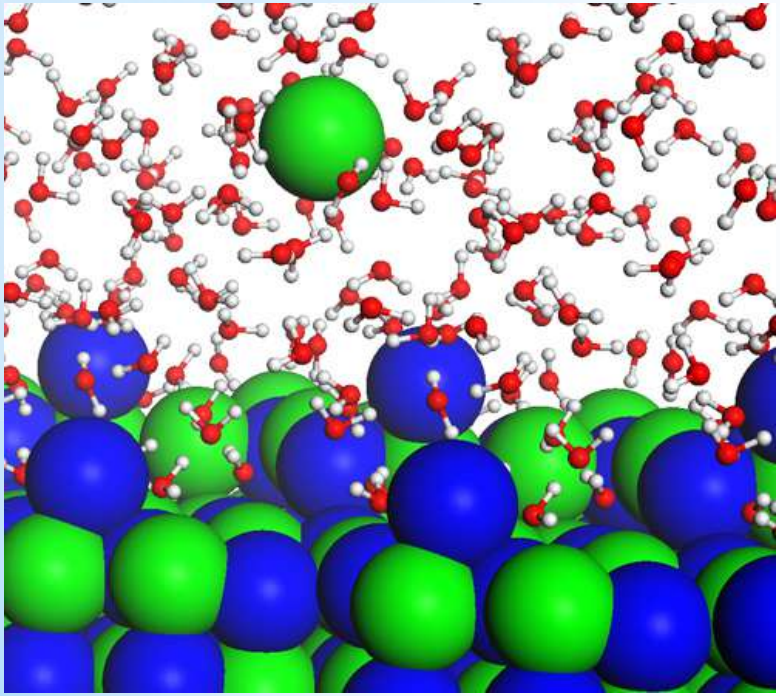
* During the formation of a solution, energy is either released or absorbed.
* The solution process can be described as exothermic or endothermic.

Factors Affecting the Rate of Dissolving

* The rate of dissolving depends on the number of collisions between the particles of the solute and solvent.
* Factors that affect the rate of dissolving include surface area, stirring, and temperature.

* Surface Area

* The greater the surface area, the more frequent to collisions are between the solute and solvent particles.



* Stirring

* Stirring moves dissolved particles away from the surface of the solid and allows more collisions between solute and solvent particles.

* Temperature

* Increasing the temperature of a solvent causes the particles to move faster. As a result, both the number of collisions and the energy of the collisions with solute particles increase.

Cold water Hot water

* Section 8.1 Assessment

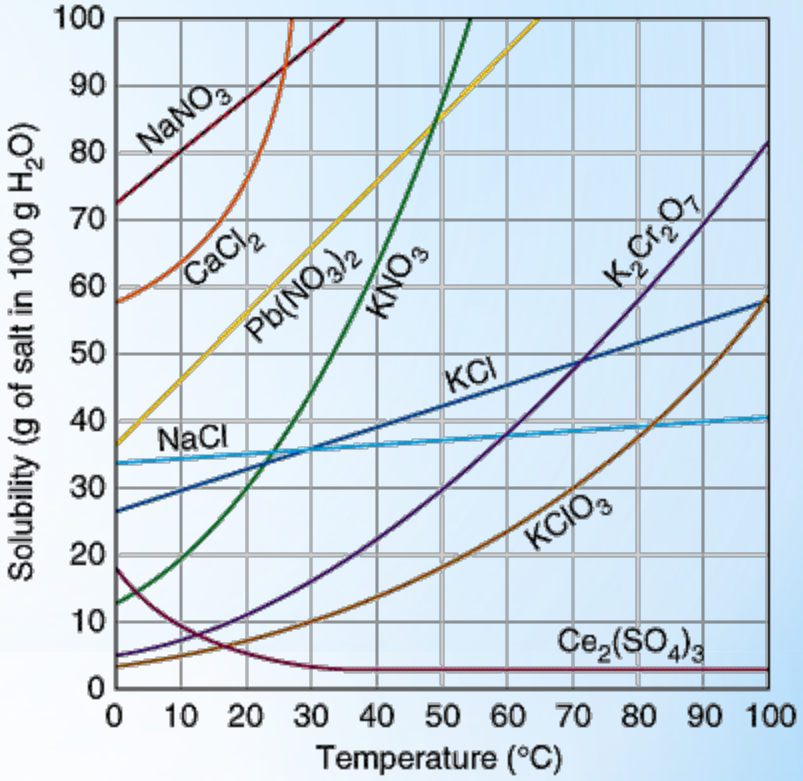
1. What are three ways that substances can dissolve in water?
2. What physical properties of a solution differ from those of its solutes and solvent?
3. How does the formation of a solution involve energy?
4. What factors affect dissolving rates?

* Section 8.1 Assessment

5. Suppose you put equal amounts of pure water and salt water into separate ice cube trays of the same size and shape. When you put both trays in the freezer, what would you expect to happen?

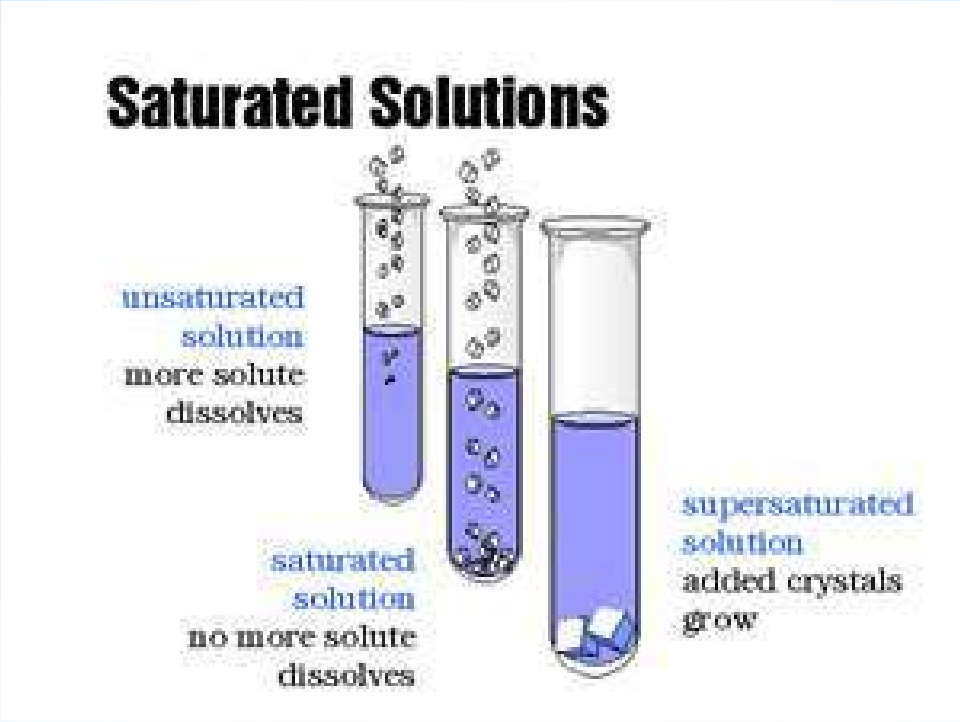
* Section 8.2 - Solubility and Concentration

* The maximum amount of solute that dissolve in a given amount of solvent at a constant temperature is called solubility.
* Solubility is usually expressed in grams of solute per 100g of solvent at a specified temperature.



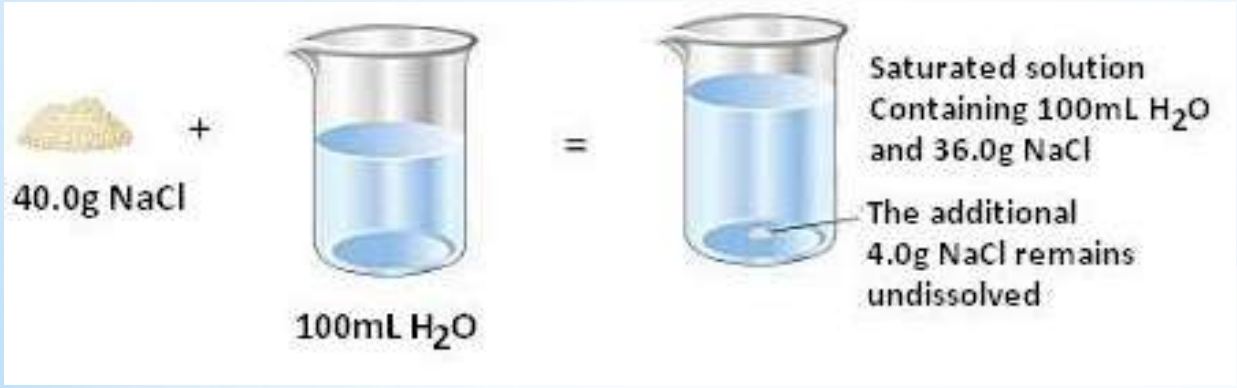
* Solubility

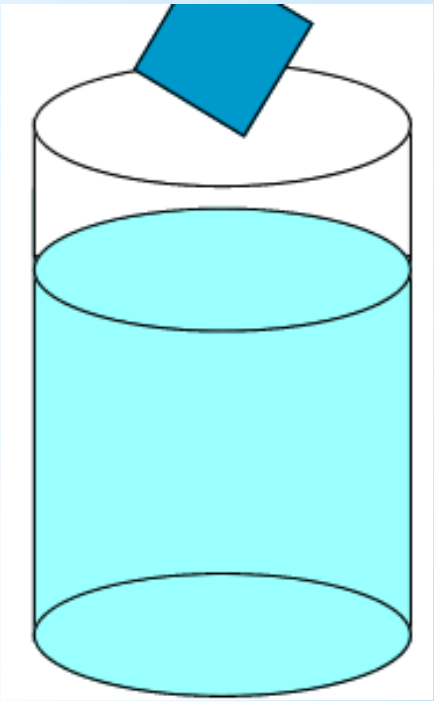
* Solutions are described as saturated, unsaturated, or supersaturated, depending on the amount of solute in solution.



* Saturated Solutions

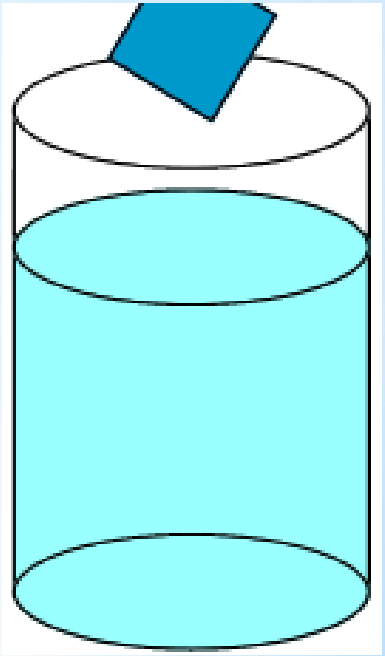
* A saturated solution is one that contains as much solute as the solvent can hold at a given temperature.





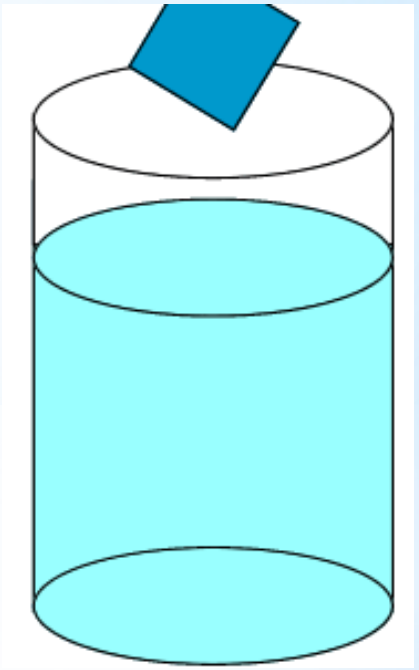
* Unsaturated Solutions

* A solution that has less than the maximum amount of solute that can be dissolved is called an unsaturated solution.



* Supersaturated Solutions

* A supersaturated solution is one that contains more solute than it can normally hold at a given temperature.
* Supersaturated solutions are very unstable.

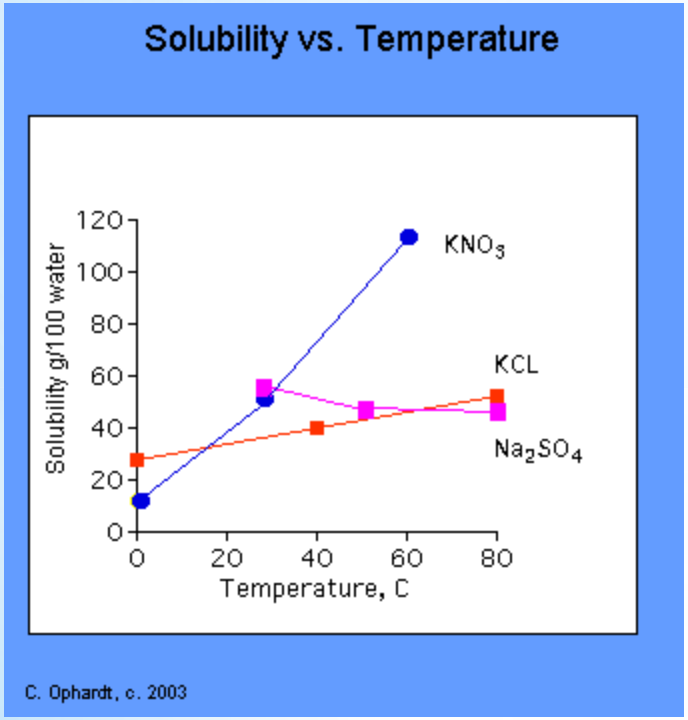


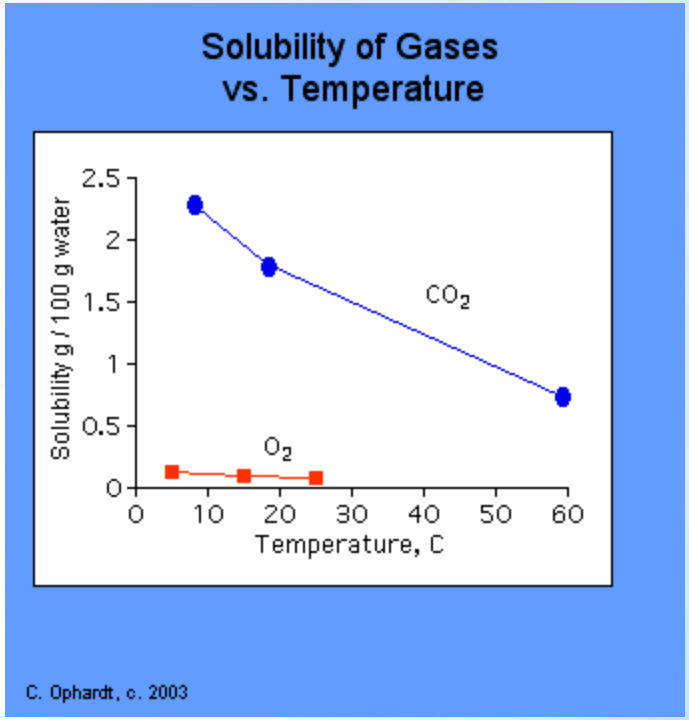
* Factors Affecting Solubility

* Three factors that affect the solubility of a solute are the polarity of the solvent, temperature, and pressure.

* Temperature

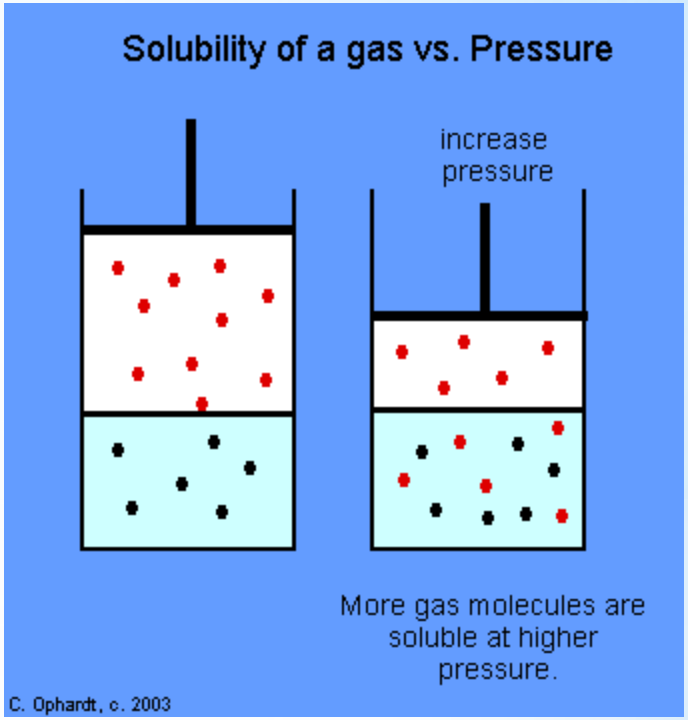
* In general, the solubility of solids increases as the solvent temperature increases.
* The solubility of gases usually decreases as the temperature of the solvent increases.





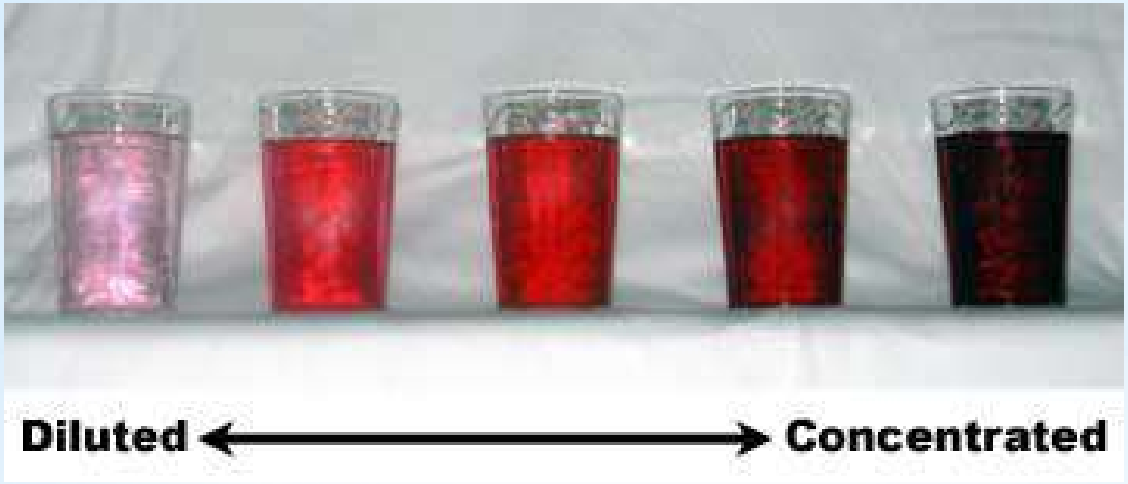
* Pressure

* Increasing the pressure of a gas increases its solubility in a liquid.



* Concentration

* The concentration of a solution is the amount of solute dissolved in a specified about of solution.



* Section 8.2 Assessment

1. What terms are used to describe solution with different amount of solute?
2. List three factors that affect solubility.
3. What are three ways to measure the concentration of a solution?
4. What is the effect of pressure on the solubility of a gas?

* Section 8.3 - Properties of Acids and Bases

* An acid is a compound that produces hydronium ions (H_3O^+) when dissolved in water.
* Some general properties of acids include sour taste, reactivity with metals, and ability to produce color changes in indicators.

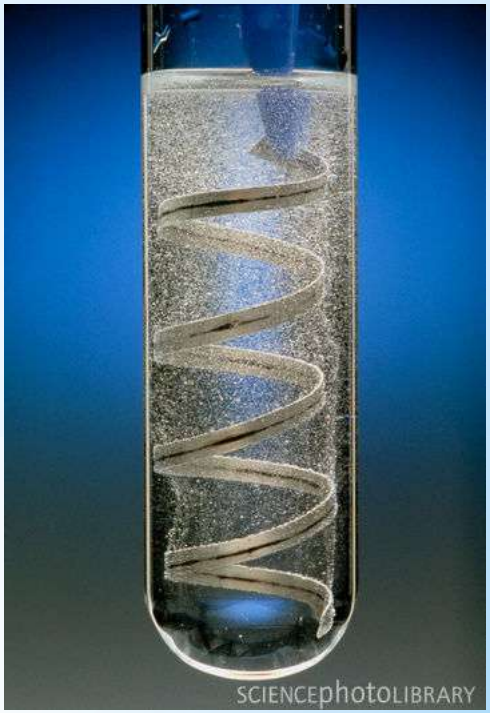
$$HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

hydrogen chloride molecule + water ---> hydronium ion in solution + chloride ion in solution

* Reactivity with Metals

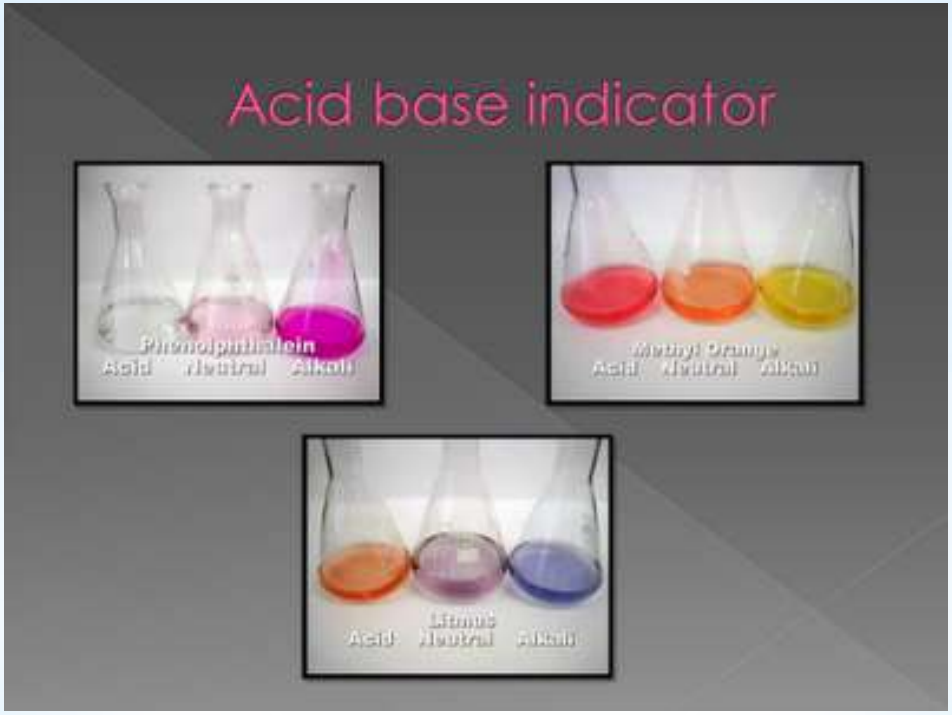
* The reaction between an acid and a metal is an example of a single-replacement reaction.

$$Zn + 2HCl \rightarrow H_2 + ZnCl_2$$



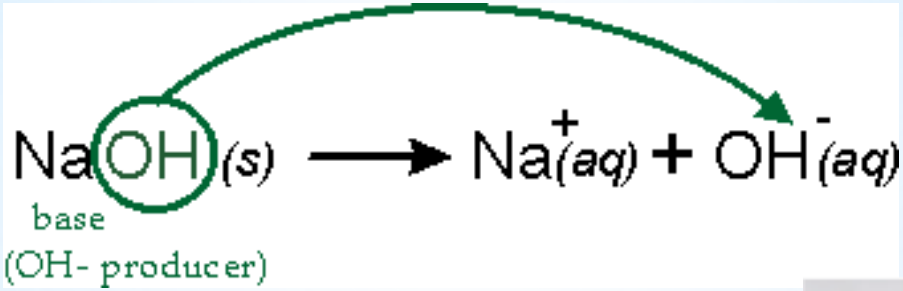
* Indicators

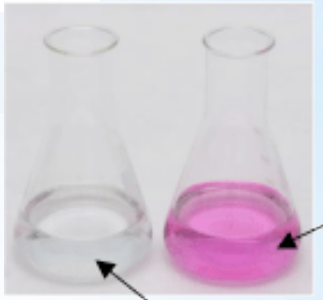
* An indicator is any substance that changes color in the presence of an acid or base.
* Phenolphthalein is an example of an acid-base indicator that is colorless in the presence of an acid and pink in the presence of a base.



* Bases

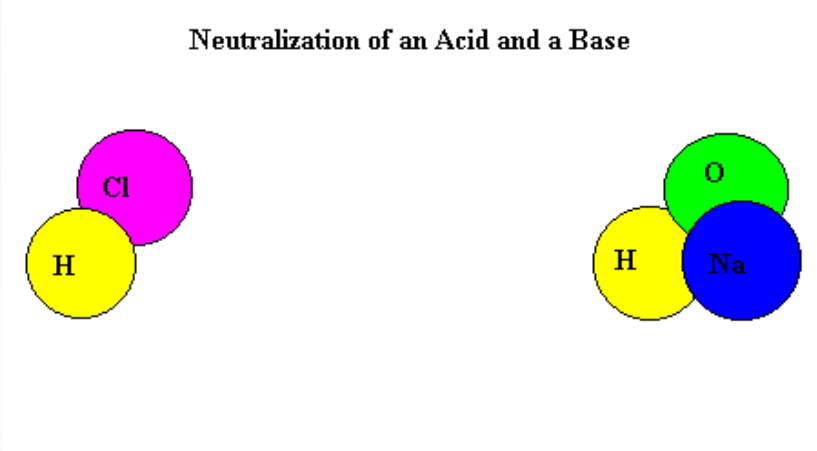
* A base is a compound that produces hydroxide ions (OH^-) when dissolved in water.
* Some general properties of bases include bitter taste, slippery feel, and ability to produce color changes in indicators.





* Neutralization Reactions

* A reaction between an acid and a base is called neutralization.
* The products of a neutralization reaction are water and a salt.



Neutralization Reactions						
Acid		Base		Water		Salt
HCl	+	$NaOH$	→	H_2O	+	$NaCl$
H_2SO_4	+	$2KOH$	→	$2H_2O$	+	K_2SO_4
$2HNO_3$	+	$Ca(OH)_2$	→	$2H_2O$	+	$Ca(NO_3)_2$

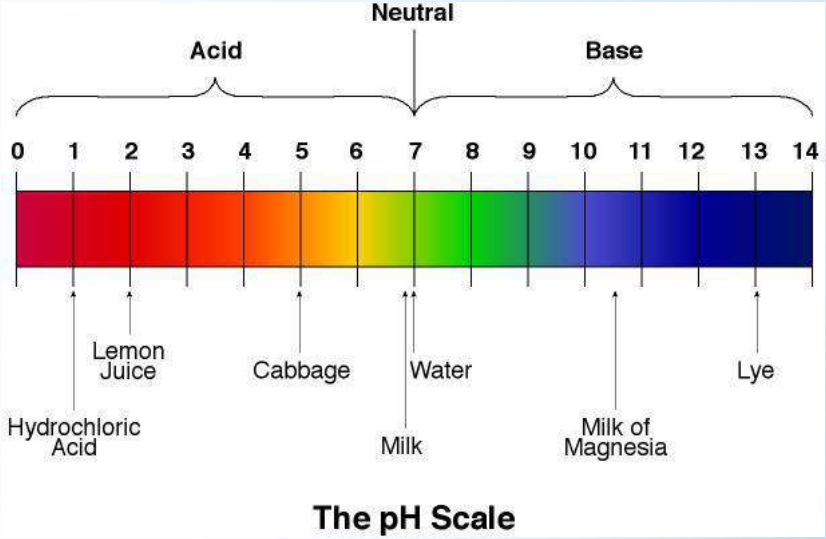
* Section 8.3 Assessment

1. List three general properties of acids.
2. List three general properties of bases.
3. What are the two products of a neutralization reaction?
4. What ion is present in all common acid solutions?

* Section 8.4 - Strength of Acids and Bases

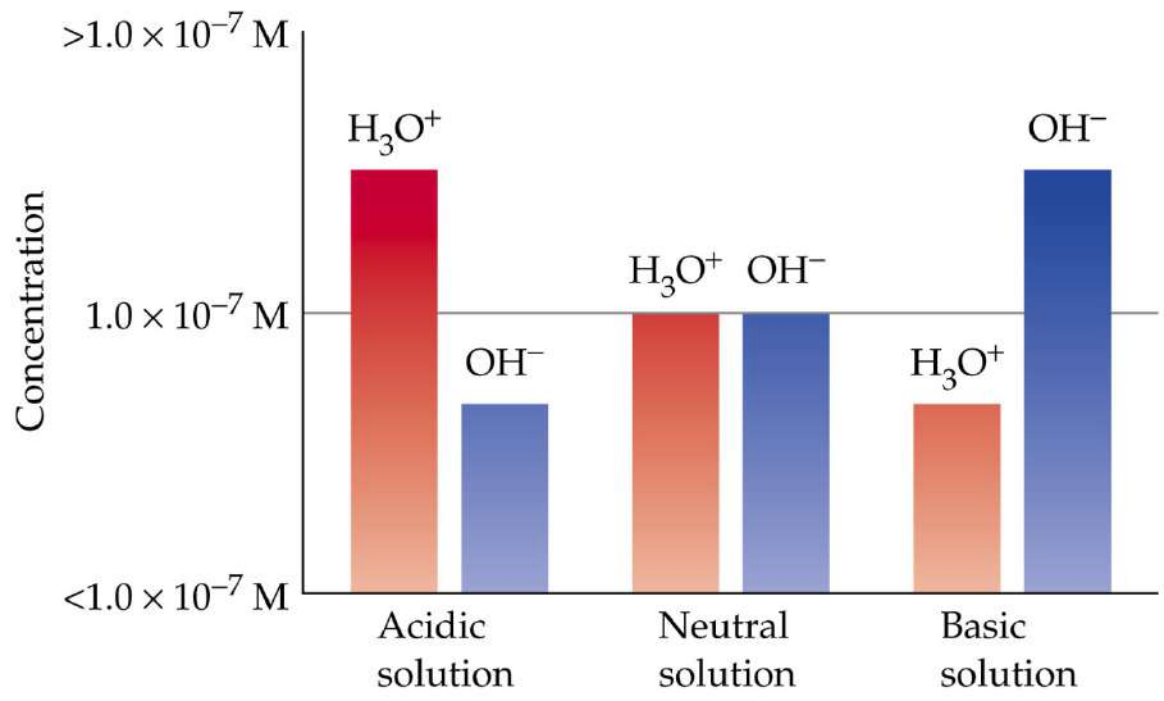
* Chemists use a number scale called the pH scale that ranges from 0 to 14 to describe the concentration of hydronium ions (H_3O^+) in a solution.

solution	pH number
acid	less than 7
neutral	7
base	greater than 7



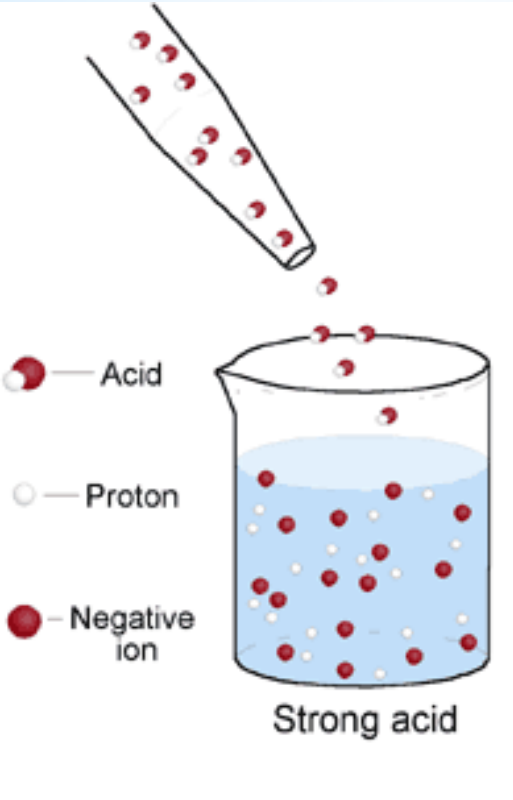
* pH Scale

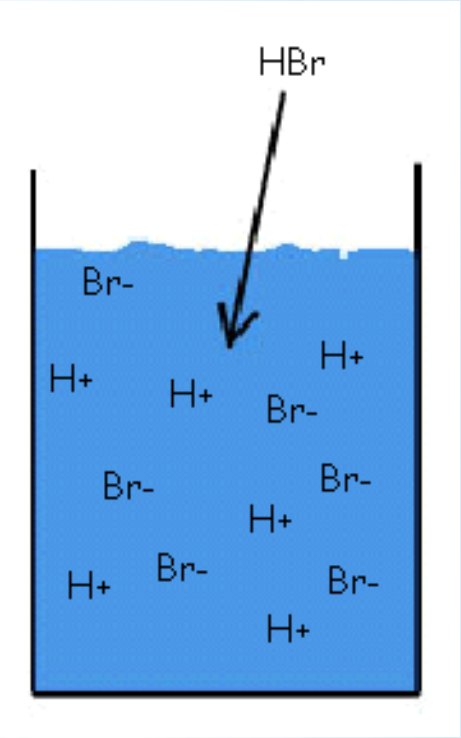
* The lower the pH value, the greater the H_3O^+ ion concentration in solution is.
* The higher the pH value, the lower the H_3O^+ ion concentration is.



* Strong Acids and Bases

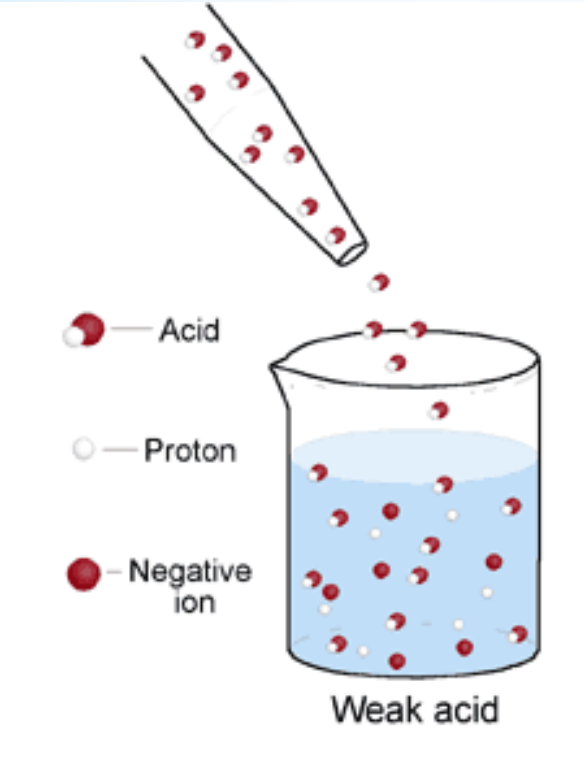
* When strong acids dissolve in water, they ionize almost completely.
* Strong bases dissociate almost completely in water.

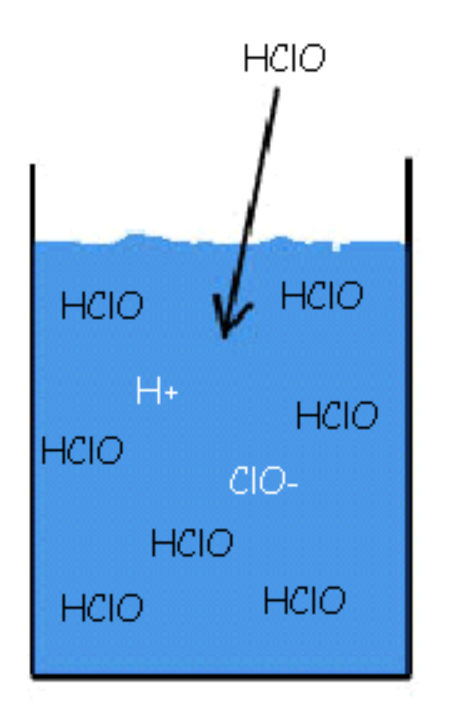




* Weak Acids and Bases

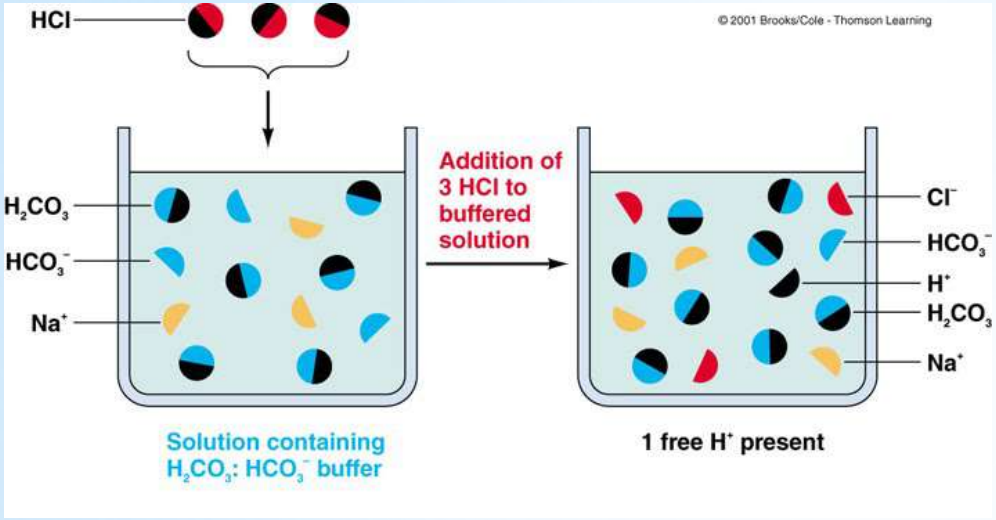
* Strength refers to the solute's tendency to form ions in water.
* Weak acids and bases only partially dissociate in water.

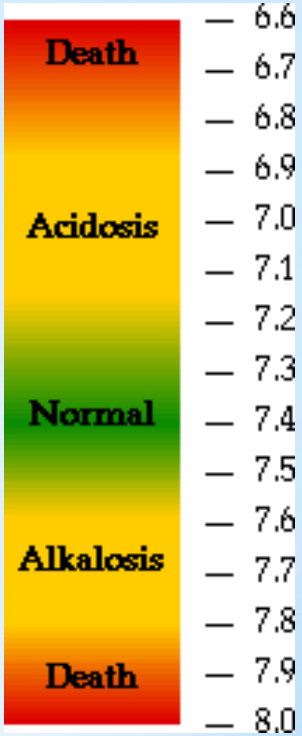




* Buffers

* A buffer is a solution that is resistant to large changes in pH.





* Section 8.4 Assessment

1. How is pH related to the concentration of hydronium ions in solution?
2. What determines the degree to which an acid is weak or strong?
3. Why is pure water neutral?
4. What is a buffer?