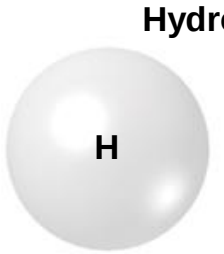
2.1 Atoms, Ions, and Molecules

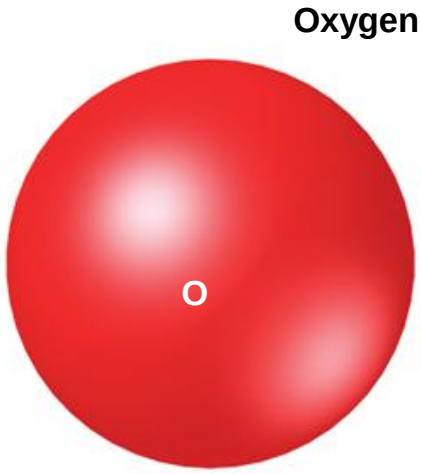
KEY CONCEPT

All living things are based on atoms and their interactions.

2.1 Atoms, Ions, and Molecules

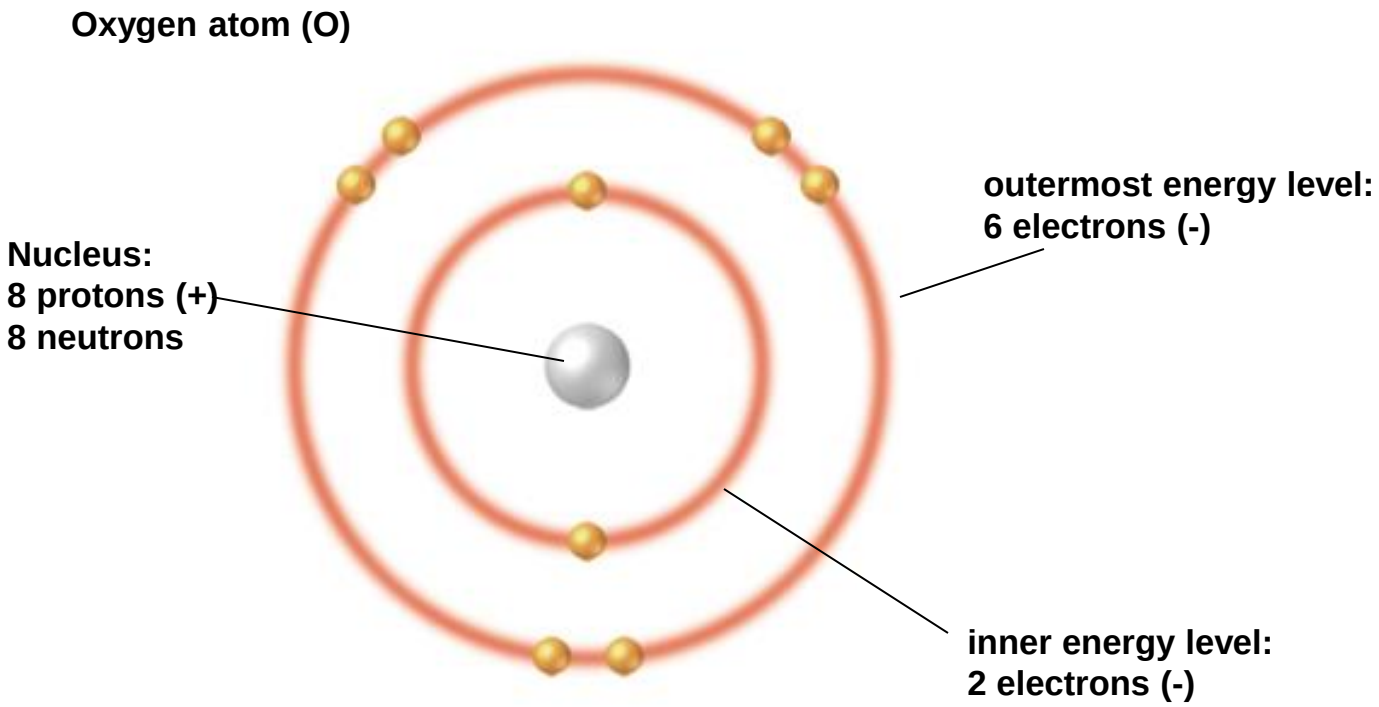
- **Living things consist of atoms of different elements.**
  - An atom is the smallest basic unit of matter.
  - An element is one type of atom.





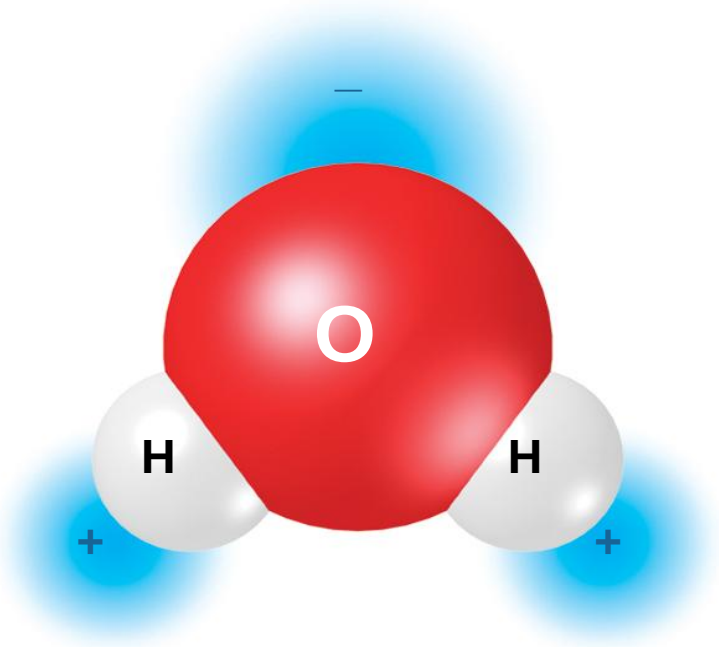
2.1 Atoms, Ions, and Molecules

- An atom has a nucleus and electrons.
  - The nucleus has protons and neutrons.
  - Electrons are in energy levels outside nucleus.



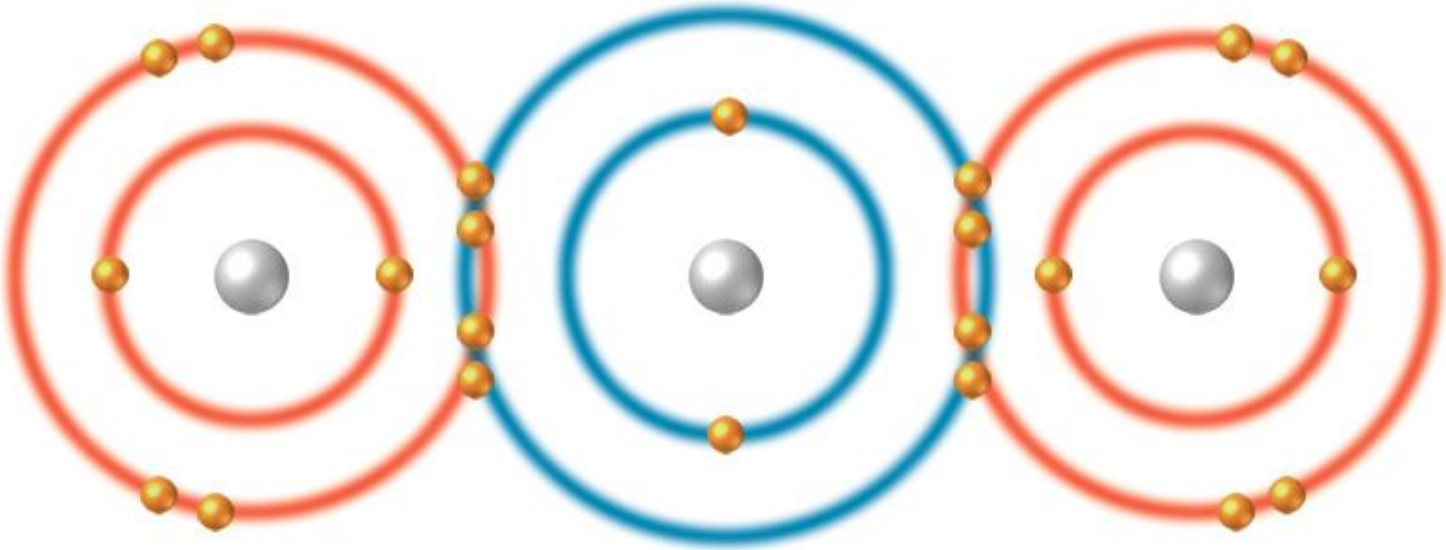
2.1 Atoms, Ions, and Molecules

- A compound is made of atoms of different elements bonded together.
  - water (H_2O)



2.1 Atoms, Ions, and Molecules

- A compound is made of atoms of different elements bonded together.
  - water (H_2O)
  - carbon dioxide (CO_2)



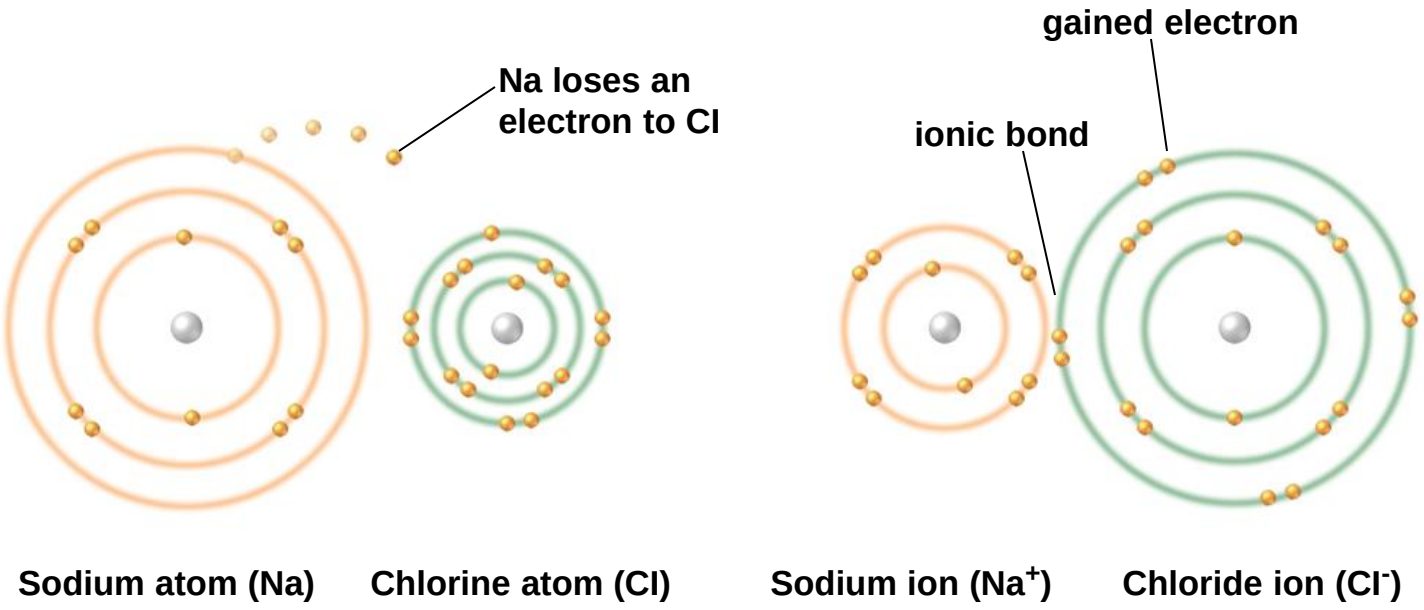
2.1 Atoms, Ions, and Molecules

- A compound is made of atoms of different elements bonded together.
  - water (H_2O)
  - carbon dioxide (CO_2)
  - many other carbon-based compounds in living things

2.1 Atoms, Ions, and Molecules

Ions form when atoms gain or lose electrons.

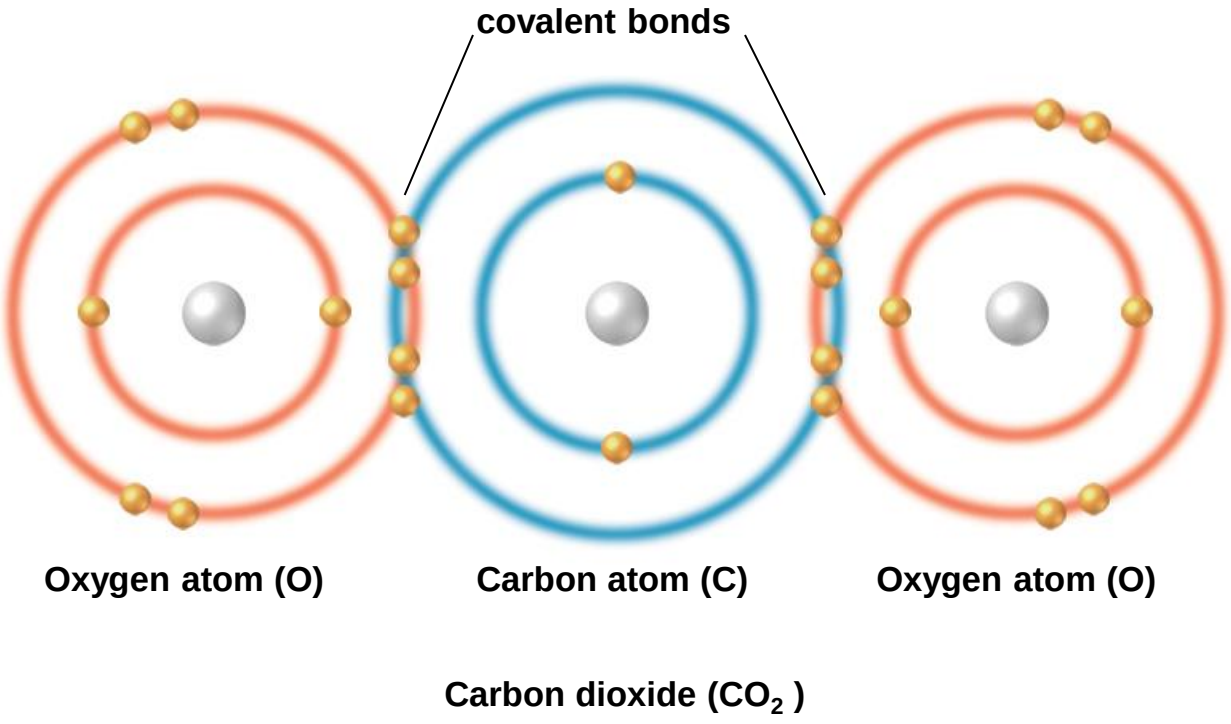
- An ion is an atom that has gained or lost one or more electrons.
  - positive ions
  - negative ions
- Ionic bonds form between oppositely charged ions.



2.1 Atoms, Ions, and Molecules

Atoms share pairs of electrons in covalent bonds.

- A covalent bond forms when atoms share a pair of electrons.
  - multiple covalent bonds
  - diatomic molecules



2.1 Atoms, Ions, and Molecules

KEY CONCEPT

Life depends on chemical reactions.

2.1 Atoms, Ions, and Molecules

- **Bonds break and form during chemical reactions.**
  - Chemical reactions change substances into different ones by breaking and forming chemical bonds.
    - Reactants are changed during a chemical reaction.
    - Products are made by a chemical reaction.

2.1 Atoms, Ions, and Molecules

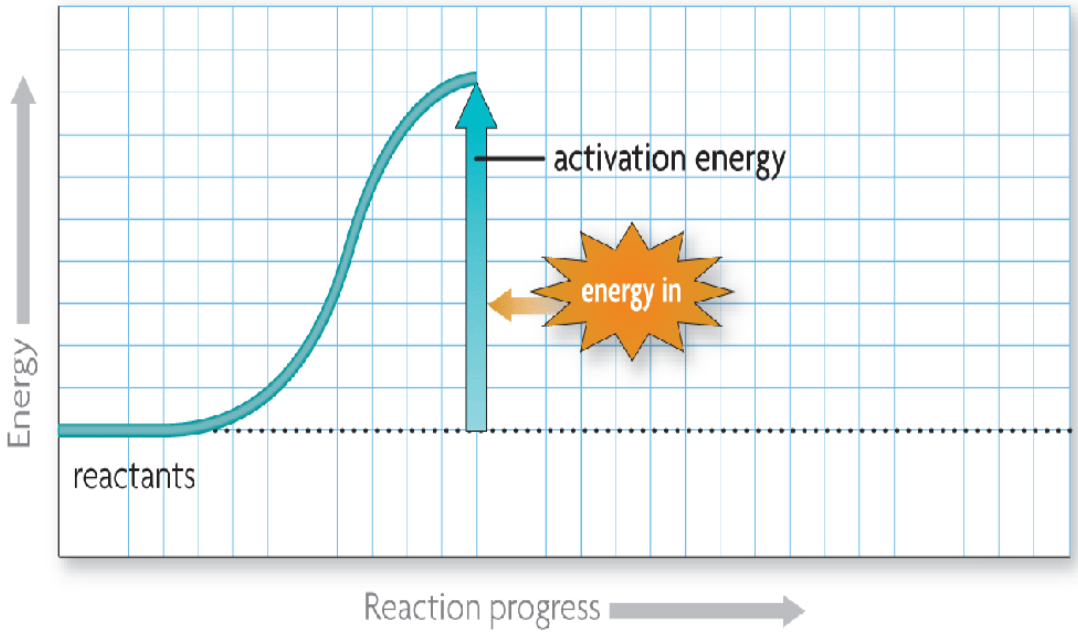
- Bond energy is the amount of energy that breaks a bond.
  - Energy is added to break bonds.
  - Energy is released when bonds form.
- A reaction is at equilibrium when reactants and products form at the same rate.

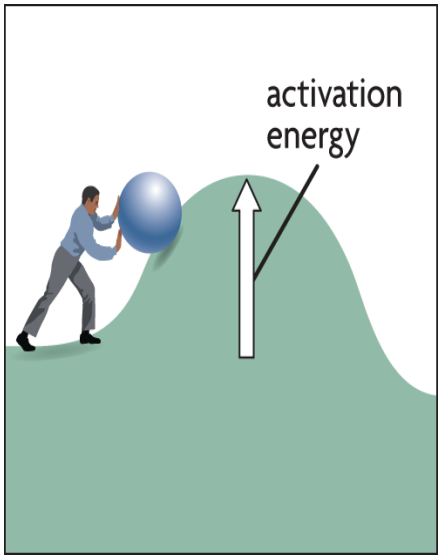
$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

2.1 Atoms, Ions, and Molecules

Chemical reactions release or absorb energy.

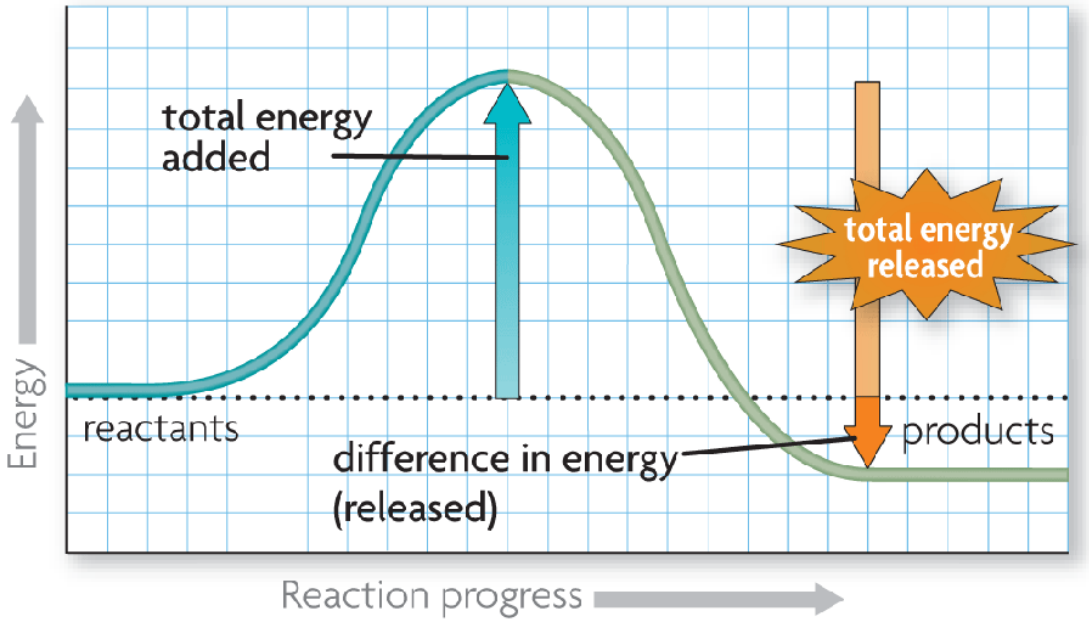
- Activation energy is the amount of energy that needs to be absorbed to start a chemical reaction.





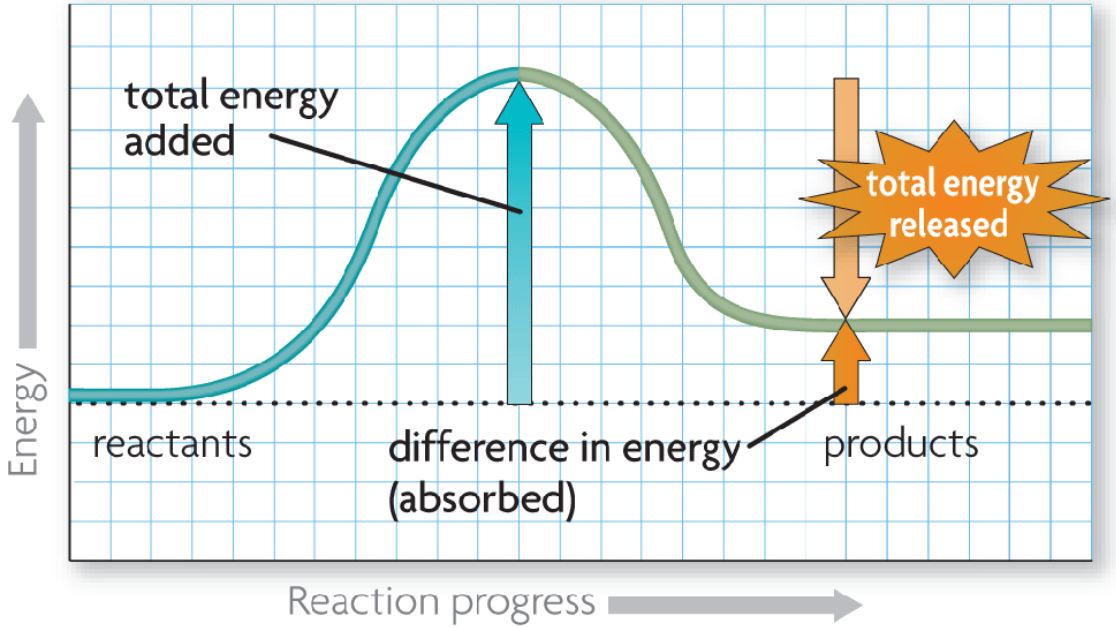
2.1 Atoms, Ions, and Molecules

- Exothermic reactions release more energy than they absorb.
  - Reactants have higher bond energies than products.
  - Excess energy is released by the reaction.



2.1 Atoms, Ions, and Molecules

- Endothermic reactions absorb more energy than they release.
  - Reactants have lower bond energies than products.
  - Energy is absorbed by the reaction to make up the difference.



2.1 Atoms, Ions, and Molecules

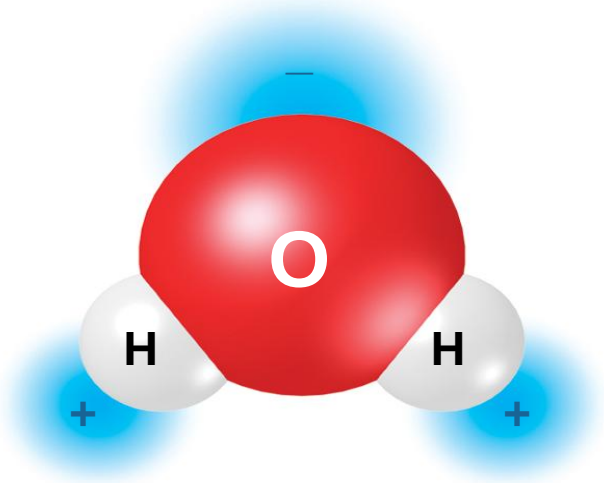
KEY CONCEPT

Water's unique properties allow life to exist on Earth.

2.1 Atoms, Ions, and Molecules

Life depends on hydrogen bonds in water.

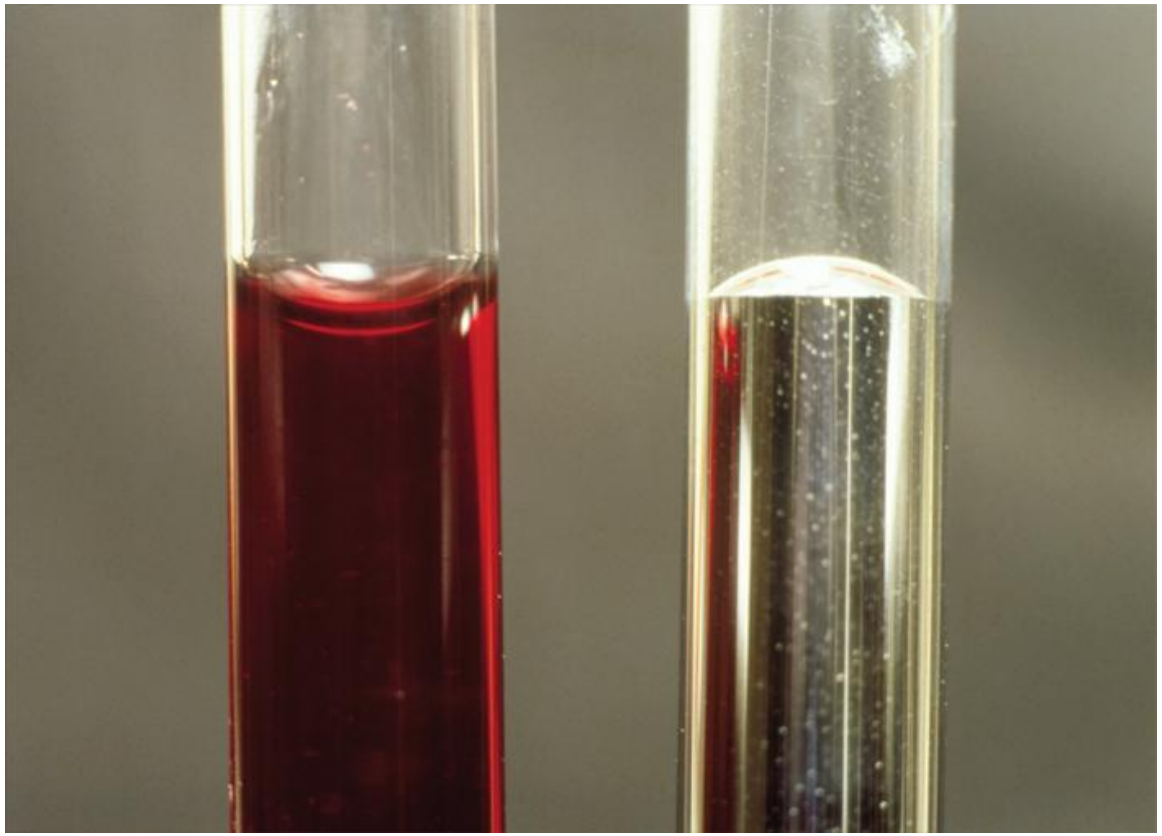
- Water is a polar molecule.
  - Polar molecules have slightly charged regions.



  - Nonpolar molecules do not have charged regions.
  - Hydrogen bonds form between slightly positive hydrogen atoms and slightly negative atoms.

2.1 Atoms, Ions, and Molecules

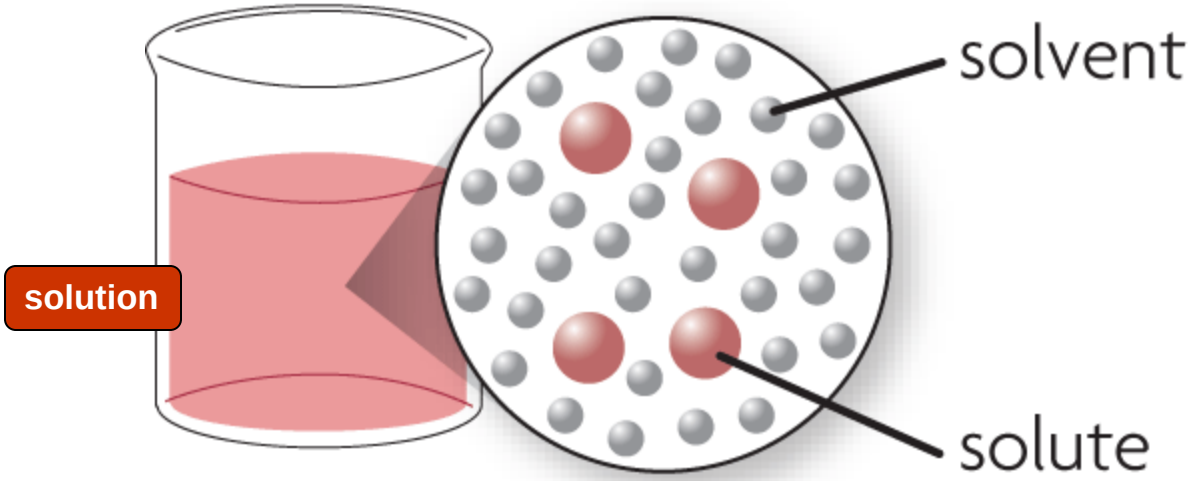
- Hydrogen bonds are responsible for three important properties of water.
  - high specific heat
  - cohesion
  - adhesion



2.1 Atoms, Ions, and Molecules

Many compounds dissolve in water.

- A solution is formed when one substance dissolves in another.
  - A solution is a homogeneous mixture.
  - Solvents dissolve other substances.
  - Solutes dissolve in a solvent.



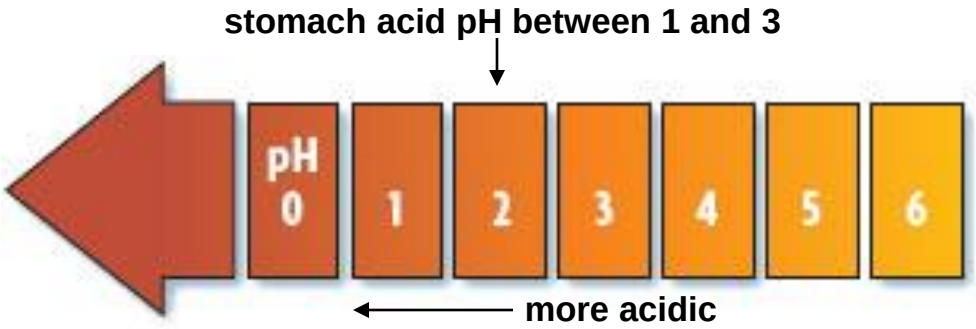
2.1 Atoms, Ions, and Molecules

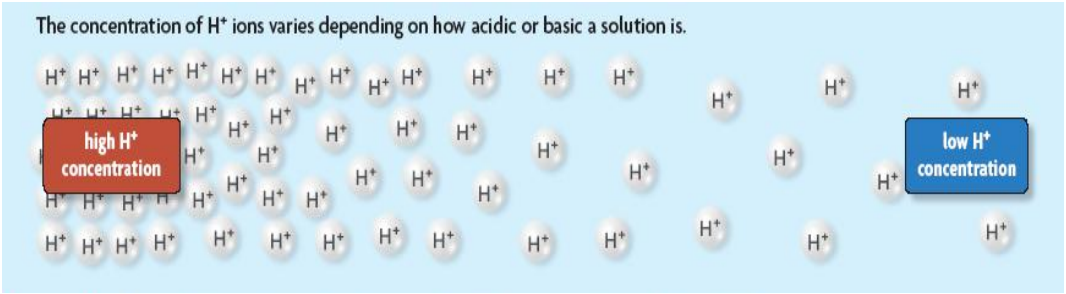
- “Like dissolves like.”
  - Polar solvents dissolve polar solutes.
  - Nonpolar solvents dissolve nonpolar solutes.
  - Polar substances and nonpolar substances generally remain separate.

2.1 Atoms, Ions, and Molecules

Some compounds form acids or bases.

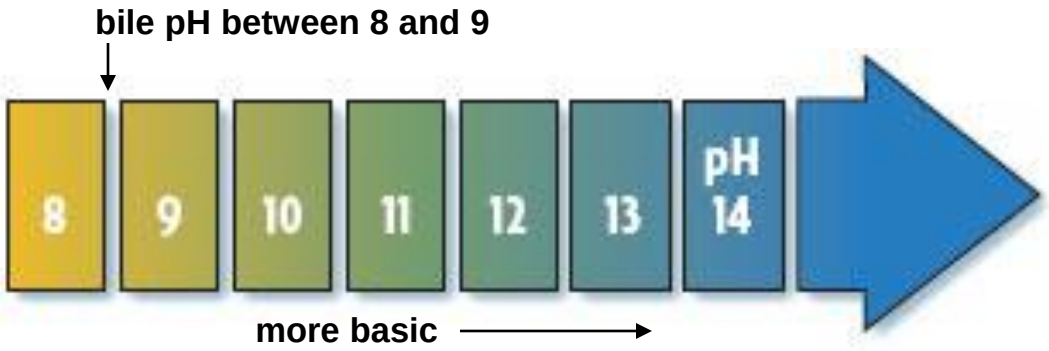
- An acid releases a hydrogen ion when it dissolves in water.
  - high H^+ concentration
  - pH less than 7

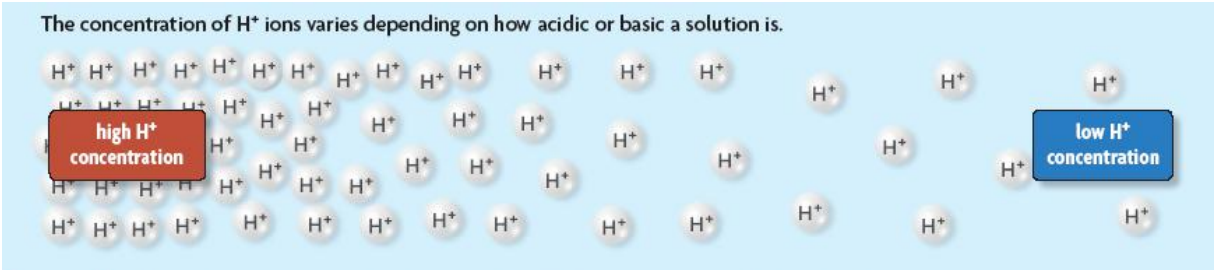




2.1 Atoms, Ions, and Molecules

- A base removes hydrogen ions from a solution.
  - low H^+ concentration
  - pH greater than 7





2.1 Atoms, Ions, and Molecules

- A neutral solution has a pH of 7.