Atomic Bonding and Molecules

Chapter 15

Bonding of atoms makes molecules

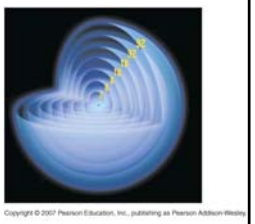
- The Formation of Ions and Ionic Bonds
- Types of bonds
  - Metallic Bonds
  - Covalent Bonds
  - Polar Covalent Bonds
- Molecular Polarity and Molecular Attractions

Causes of bonding

- Atoms bond together through their electrons
- Electrons behave as though they are contained within a series of seven concentric shells
- Outer shell electrons interact with electrons of other atoms
- These are the VALENCE electrons

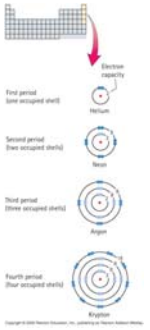
Electron Shells

- Maximum number of electrons in each shell is shown
- Inner shell fills up before next shell begins to get electrons
- Full shells are most stable



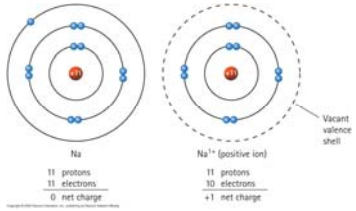
Full electron shells

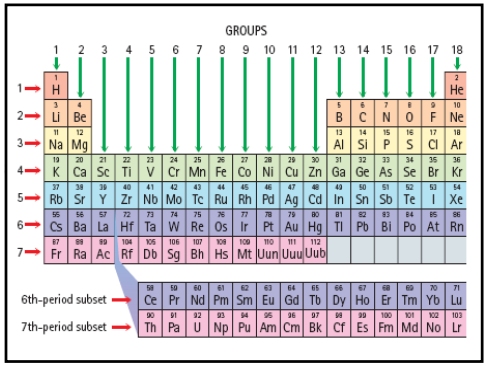
- Outer electron shells of noble gases are full



Sodium Ion Formation

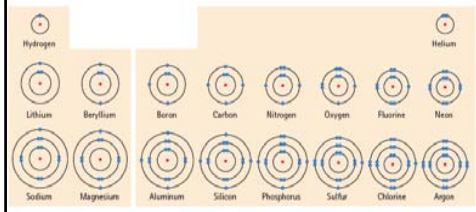
- Ion: An atom that has lost or gained one or more electrons





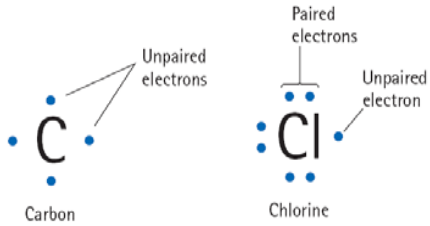
Electrons shells in periodic table

- First three periods

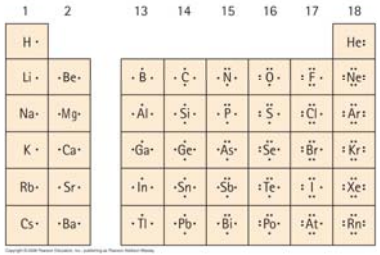


Electron Dot Structure

- A notation showing only the valence electrons surrounding the atomic symbol



Valence Electron dot structure for elements not in transition metal groups



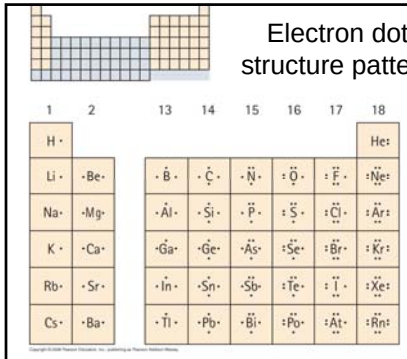
Ion

- An atom, molecule, or compound with a different number of protons and electrons
- More protons: positive CAT ION
  - THE t looks like a plus sign…
- More electrons: negative AN ION
  - Negative has an N in the prefix
- Both are all one word: anion, cation

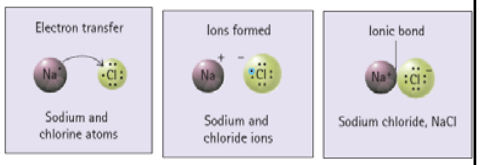
Ion formation

- Lose electrons
  - more protons than electrons
  - positive charge
- Gain electrons
  - More electrons than protons
  - Negative charge
- More than one can be lost or gained
- Determine by position in periodic table

Electron dot structure pattern



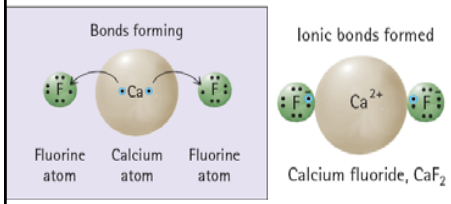
Ionic Bonds



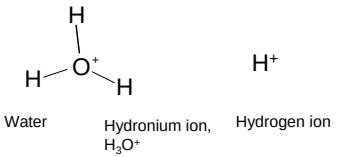
- Electrical force of attraction between oppositely charged ions

Ionic Bond Ratios

- Compounds form in ratios to neutralize charges



Molecular Ions



- Typically formed by the loss or gain of a hydrogen ion, H^+

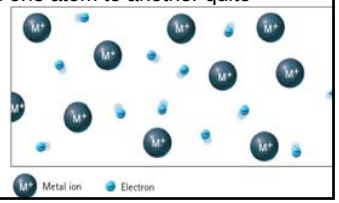
Groups of atoms forming ions

- Molecular ions
- Bonds within group are covalent

Hydronium ion	H_3O^+
Ammonium ion	NH_4^+
Bicarbonate ion	HCO_3^-
Nitrate ion	NO_3^-
Hydroxide ion	OH^-
Carbonate ion	CO_3^{2-}
Sulfate ion	SO_4^{2-}
Phosphate ion	PO_4^{3-}

Metallic Bonds

- Nucleus of metal atoms only weakly hold outer electrons
- Weak attraction allows the electrons to move from one atom to another quite freely



Metallic Properties

Mobility of electrons results in many properties of metals

- Conductive—electrons move freely
- Shiny—electrons vibrate and reflect light
- Malleable—can move with respect to one another without breaking because electrons in constant motion
- Alloys—electrons shared between unlike types of metal atoms

Metallic Alloys

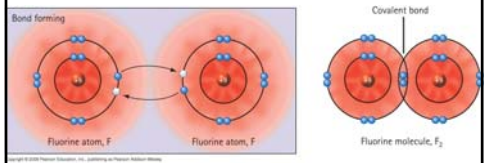
- An alloy is a mixture of metallic elements.

Metal Ores

- Few metals naturally occur as elements
  - Gold, copper, mercury
- Most occur as oxides and sulfides
  - Ionic compounds
  - Concentrations of these are ORE

Covalent Bonds

- Atoms are held together by their mutual attraction for shared electrons



- There are two electrons within a single covalent bond

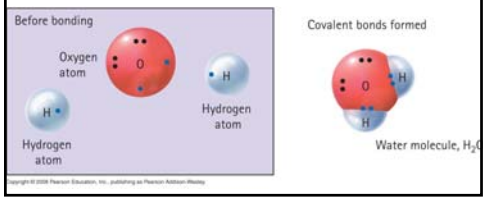
Covalent Bond Diagrams

- The covalent bond is represented using a straight line

F — F

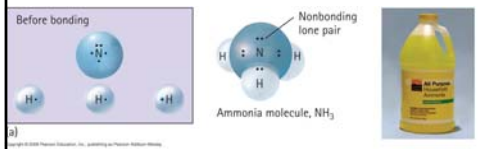
Covalent Water

- The number of covalent bonds an atom can form equals its number of unpaired valence electrons



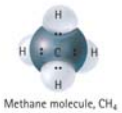
Covalent Ammonia

- The number of covalent bonds an atom can form equals its number of unpaired valence electrons



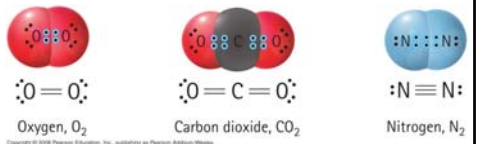
Covalent Methane

- The number of covalent bonds an atom can form equals its number of unpaired valence electrons



Multiple covalent bonds

- are possible if atom has more than one unpaired valence electron



Nonpolar Covalent Bonds

- Electrons are shared evenly when the two atoms are the same element

Polar Covalent Bonds

- Shared *unevenly* when the bonded atoms are different elements

Polar covalent bonds

- Closer together on the periodic table, less polar bond
- Further apart on the periodic table, more polar bond
- Molecules are called ‘dipoles’
- Ionic bonds are extremely polar—but not covalent