Intermolecular Forces

Coulomb's Law is used to explain IMF's. Opposite charges attract. The stronger these attractions, the stronger the IMF between molecules.

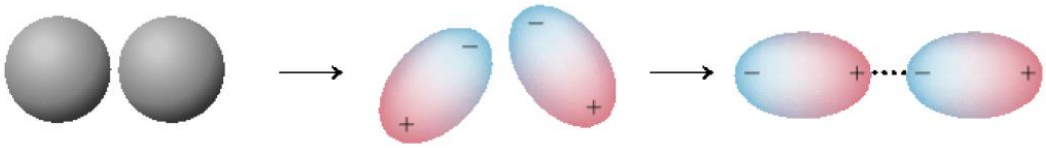
Intermolecular = Between Molecules

The stronger the IMF between molecules, the more difficult it is to separate those molecules resulting in:

- **High melting point**
- **High boiling point**
- **Decreased solubility**
- **Increased viscosity**

Type	Characteristics	Type of Substance	Relative Strength
London Dispersion (induced dipole-induced dipole)	**Attractive forces between temporary (induced) dipoles.**	**Present in all substances, but the only force in nonpolar molecules.**	**Weak Become stronger as size of e^- cloud increases (i.e. increase in molecular weight) as more e^- results in greater polarizability (easier to induce dipoles).**
Dipole-Dipole	**Positive end of a permanent dipole attracts to negative end of a permanent dipole in another molecule.**	**Polar molecules**	**Strong Coulomb's Law**
Hydrogen Bond	**Special type of dipole-dipole. H is strongly attracted to another molecule.**	**Polar molecules with H bonded to either N, O, or F**	**Strong Coulomb's Law and no shielding around H nucleus**

London Dispersion Forces



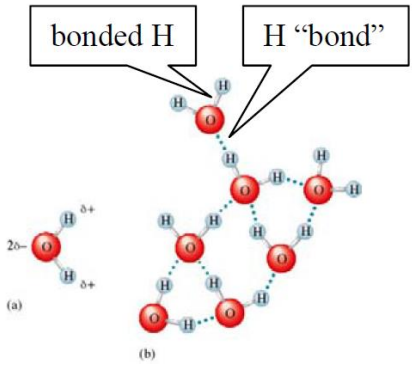
Two nonpolar atoms or molecules (Time-averaged shape is spherical)

Momentary attractions and repulsions between nuclei and electrons in neighboring molecules lead to induced dipoles.

Correlation of the electron motions between the two atoms or molecules (which are now dipolar) leads to a lower energy and stabilizes the system.

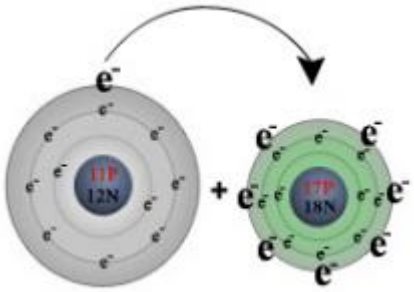
Dipole-Dipole

H-bonding



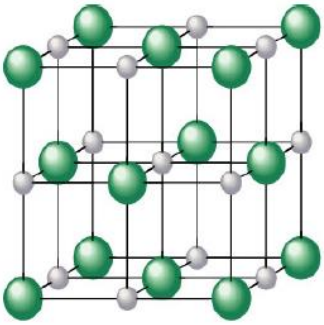
❖ **Ionic Bonds**

Positive and negative ions are attracted to one another to form a crystal lattice. Electrostatic forces (Coulomb's Law) hold the ions together. Typically formed between a metal and a nonmetal resulting from the transfer of electrons.



The strength of an ionic bond is determined by charge and size of ions.

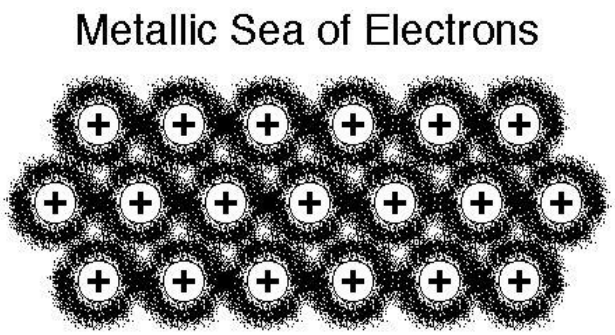
1. **Larger charges = stronger attraction between ions = stronger bond**
2. **Smaller ion = shorter distance between ions = stronger bond**



Lattice energy – energy required to separate one mole of a solid ionic compound into gaseous ions; stronger ionic bonds = higher lattice energies

❖ **Metallic Bonds**

Positive metal ions are surrounded by a sea of valence electrons.



Electrons are not bonded to any particular atom and are free to move about in the solid.

The delocalization of electrons explains why metals are good conductors of electricity, malleable, ductile, and have low volatility.