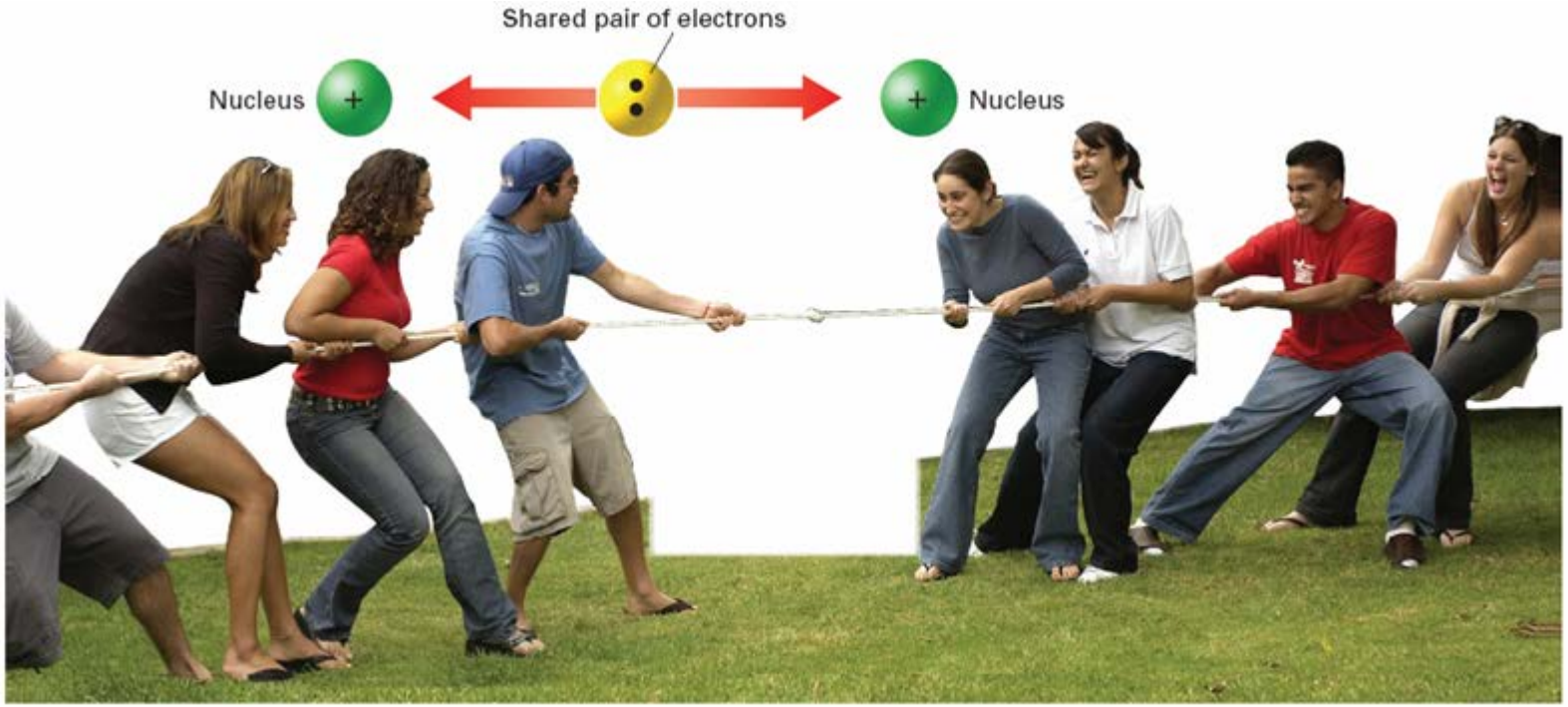
Chemistry 8.4
Polar Bonds and Molecules

- Snow covers approximately 23 percent of Earth's surface.
- Each individual snowflake is formed from as many as 100 snow crystals.
- The polar bonds in water molecules influence the distinctive geometry of snowflakes.

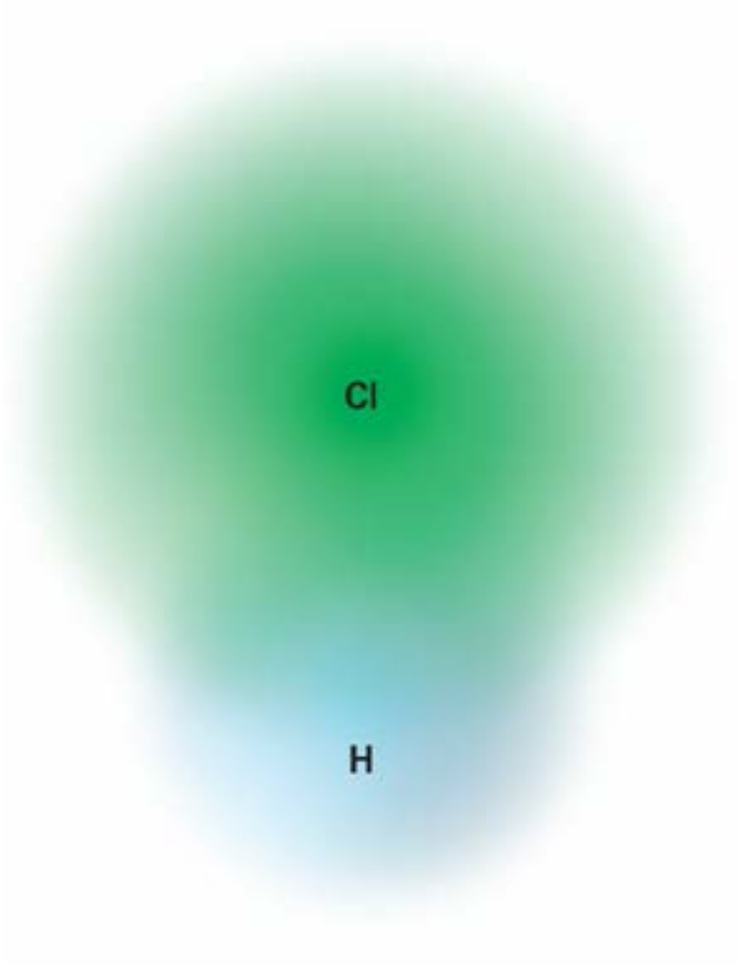
- Bond Polarity
  - How do electronegativity values determine the charge distribution in a polar bond?

- **nonpolar covalent bond**
  - When the atoms in a bond pull equally
    - as occurs when identical atoms are bonded
  - bonding electrons are shared equally

- The bonding pairs of electrons in covalent bonds are pulled by the nuclei.



- The chlorine atom attracts the electron cloud more than the hydrogen atom does.



- **polar covalent bond**
  - known also as a polar bond
  - a covalent bond between atoms in which the electrons are shared unequally.
  - The more electronegative atom attracts electrons more strongly
    - gains a slightly negative charge
  - The less electronegative atom has a slightly positive charge

Table 8.3

Electronegativity Differences and Bond Types

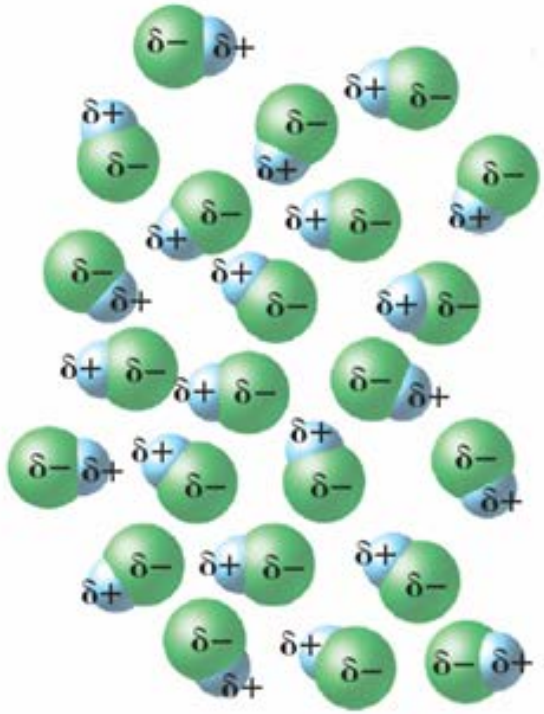
Electronegativity difference range	Most probable type of bond	Example
0.0–0.4	Nonpolar covalent	H—H (0.0)
0.4–1.0	Moderately polar covalent	$\overset{\delta+}{\text{H}}-\overset{\delta-}{\text{Cl}}$ (0.9)
1.0–2.0	Very polar covalent	$\overset{\delta+}{\text{H}}-\overset{\delta-}{\text{F}}$ (1.9)
≥ 2.0	Ionic	Na^+Cl^- (2.1)

- Polar Molecules
  - What happens to polar molecules between a pair of oppositely charged metal plates?

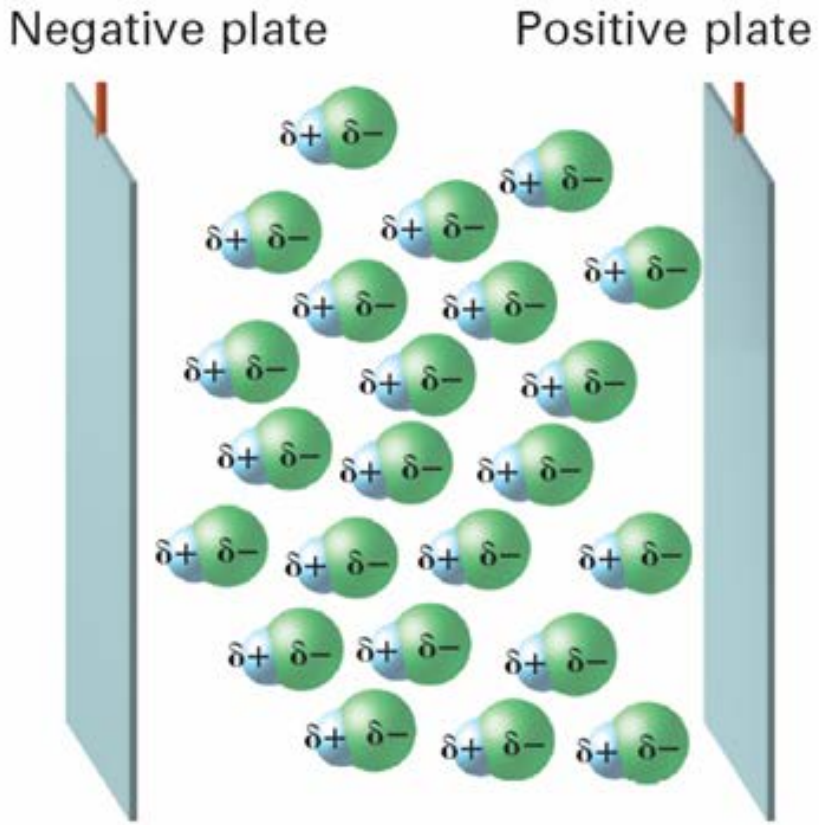
- **polar molecule**
  - one end of the molecule is slightly negative and the other end is slightly positive.
- **Dipole**
  - A molecule that has two poles
  - also called a dipolar molecule

– When polar molecules are placed between oppositely charged plates, they tend to become oriented with respect to the positive and negative plates.

- A hydrogen chloride molecule is a dipole.



Electric field absent.
Polar molecules orient randomly.



Electric field on.
Polar molecules line up.

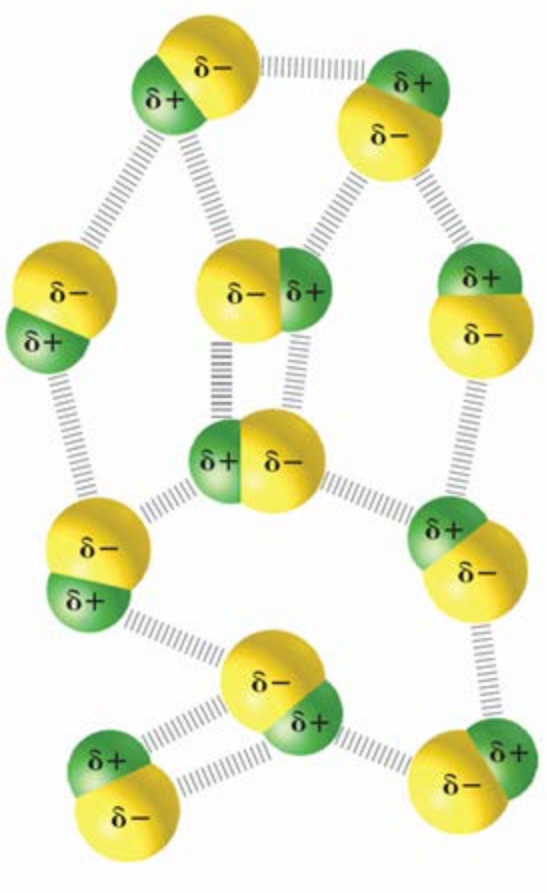
- Attractions Between Molecules
  - How do intermolecular attractions compare with ionic and covalent bonds?

- Intermolecular attractions are weaker than either ionic or covalent bonds.
  - These attractions are responsible for determining whether a molecular compound is a gas, a liquid, or a solid at a given temperature.

– Van der Waals Forces

- **van der Waals forces**
  - The two weakest attractions between molecules
  - named after the Dutch chemist Johannes van der Waals (1837–1923).

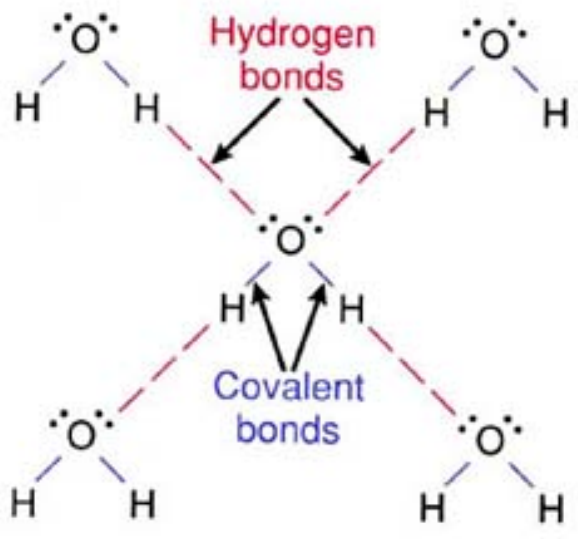
- **Dipole interactions** occur when polar molecules are attracted to one another.



- **Dispersion forces**
  - weakest of all molecular interactions
  - caused by the motion of electrons.
  - The strength of dispersion forces generally increases as the number of electrons in a molecule increases.

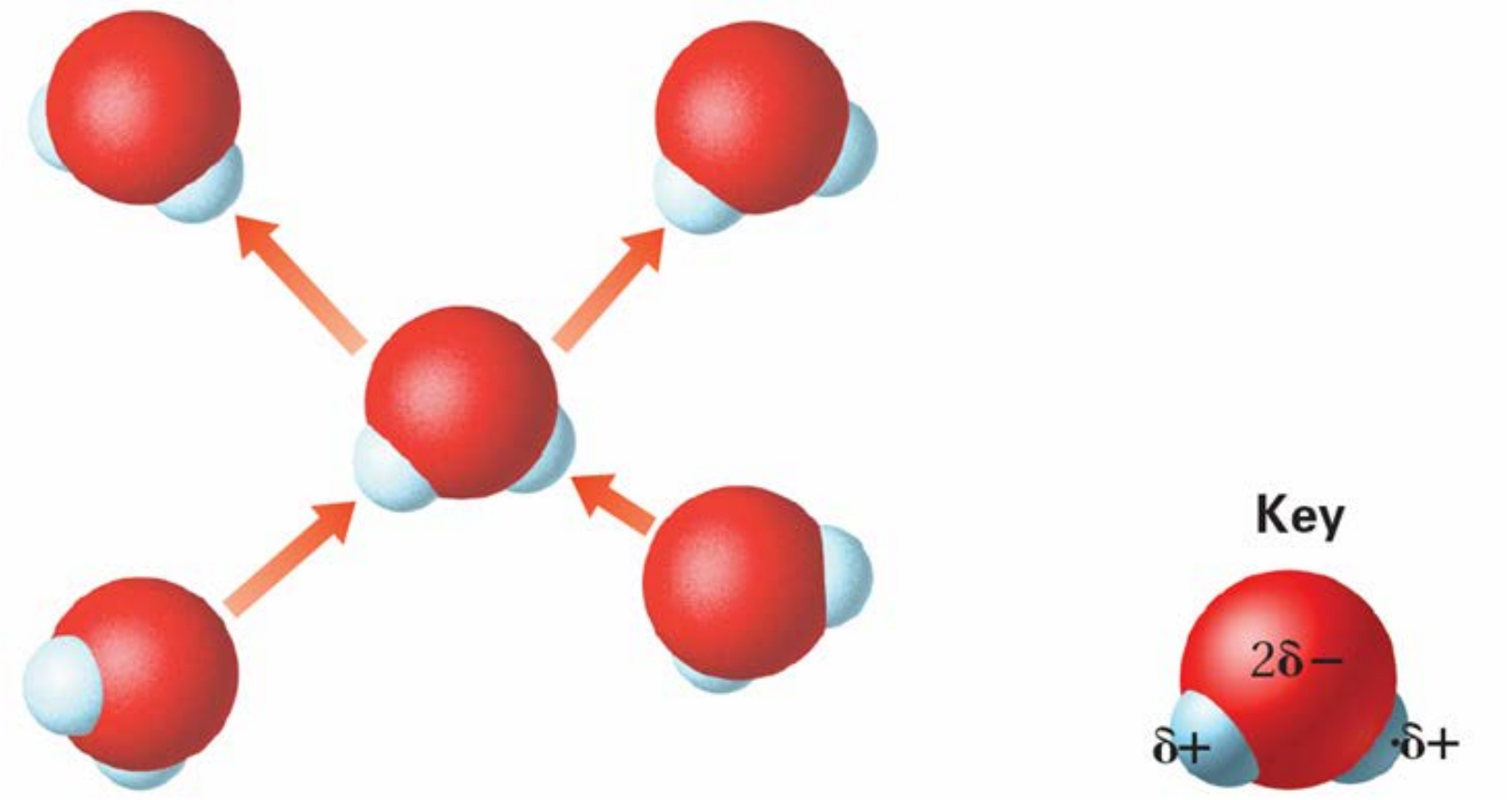
– Hydrogen Bonds

- **Hydrogen bonds**
- attractive forces in which a hydrogen covalently bonded to a very electronegative atom
- The hydrogen is also weakly bonded to an unshared electron pair of another electronegative atom.



Hydrogen bonding in water.

- **Hydrogen Bonding in Water**

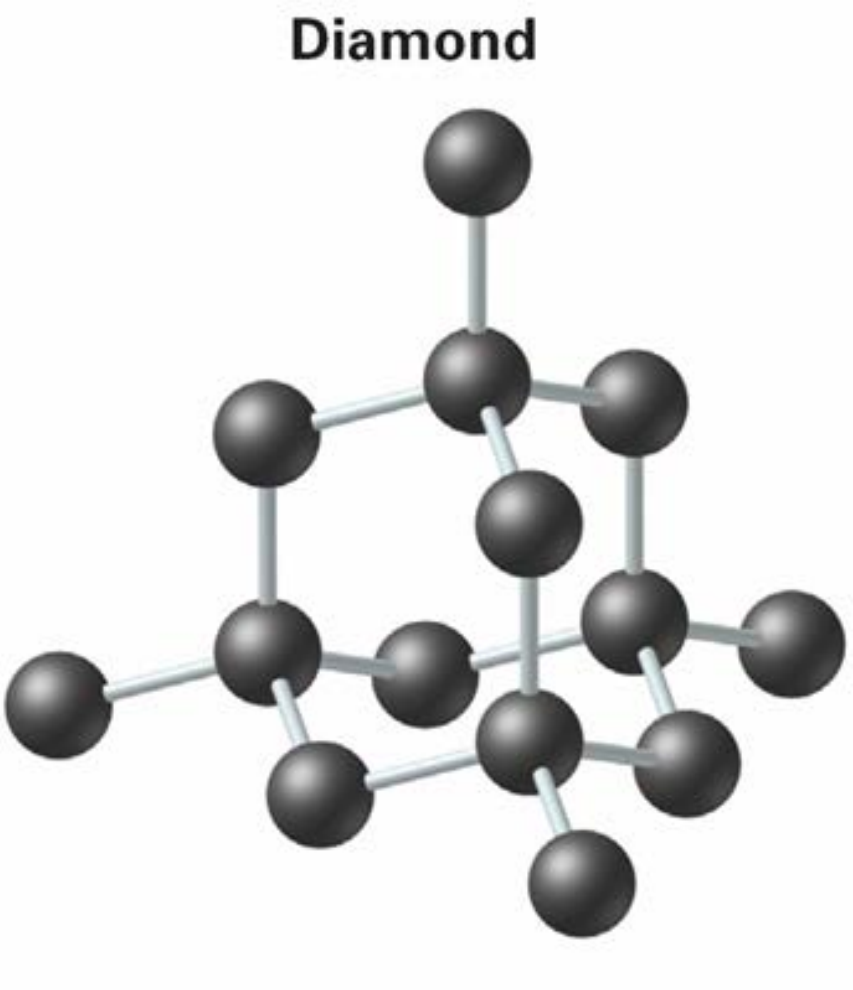


- The relatively strong attractive forces between water molecules cause the water to form small drops on a waxy surface.

- Intermolecular Attractions and Molecular Properties
  - Why do network solids have high melting points?

- **Network solids**
  - Also known as network crystals
  - solids in which all of the atoms are covalently bonded to each other.
  - consist of molecules that do not melt until the temperature reaches 1000°C or higher, or they decompose without melting at all.
  - Melting a network solid would require breaking covalent bonds throughout the solid.

- Diamond is an example of a network solid.
  - does not melt
  - vaporizes to a gas at 3500°C or above.



- Silicon Carbide is a network solid
  - has a melting point of about 2700°C.

Table 8.4

Characteristics of Ionic and Covalent Compounds

Characteristic	Ionic compound	Covalent compound
Representative unit	Formula unit	Molecule
Bond formation	Transfer of one or more electrons between atoms	Sharing of electron pairs between atoms
Type of elements	Metallic and nonmetallic	Nonmetallic
Physical state	Solid	Solid, liquid, or gas
Melting point	High (usually above 300°C)	Low (usually below 300°C)
Solubility in water	Usually high	High to low
Electrical conductivity of aqueous solution	Good conductor	Poor to nonconducting

Quiz.

1. In a molecule, the atom with the largest electronegativity value

A. repels electrons more strongly and acquires a slightly negative charge.
B. repels electrons more strongly and acquires a slightly positive charge.
C. attracts electrons more strongly and acquires a slightly positive charge.
D. attracts electrons more strongly and acquires a slightly negative charge.

2. When polar molecules are placed between oppositely charged plates, the negative

A. molecules stick to the positive plates.
B. molecules stick to the negative plates.
C. ends of the molecules turn toward the positive plates.
D. ends of the molecules turn toward the negative plates.

3. Which of the following bond types is the weakest?

A. ionic bond

B. Van der Waals force

C. covalent bond

D. hydrogen bond

END