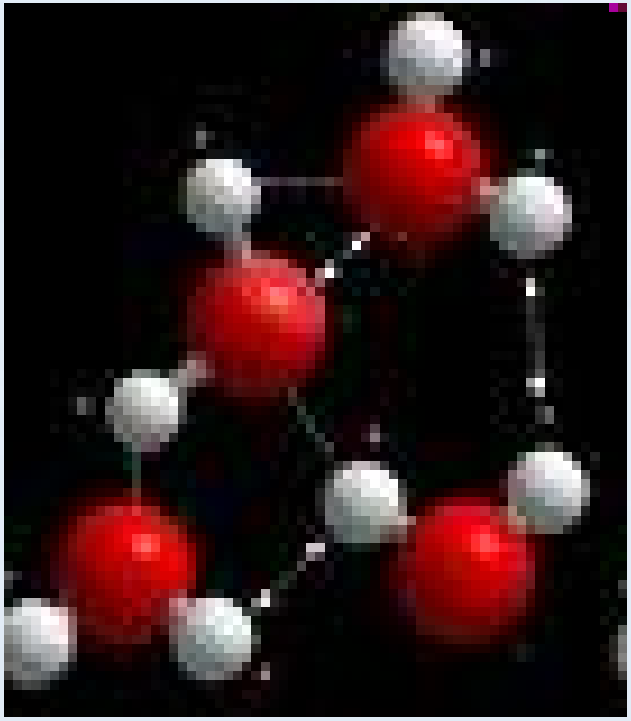
Types of Bonding

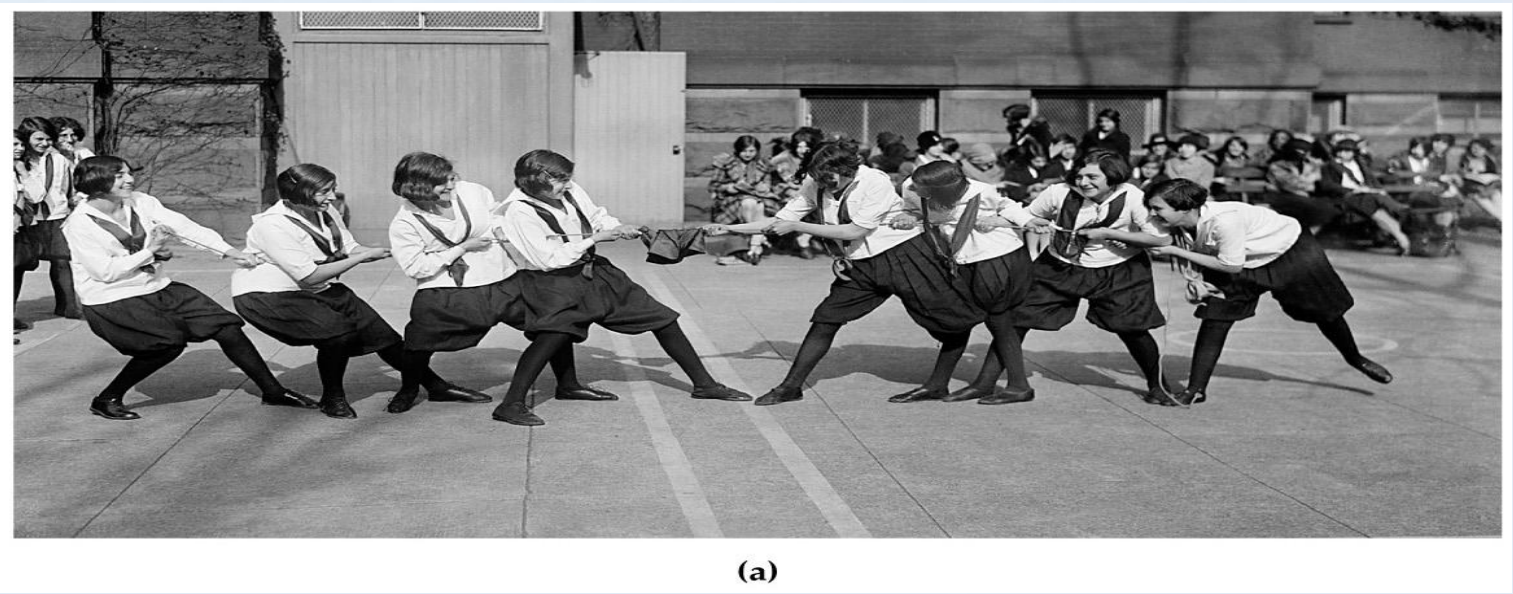


Definitions

- **Bond:** a type of interaction between atoms that makes them stay close together.

- **Molecule:** two or more atoms held together by a bond.

- **Electronegativity:** the measure of an atom's ability to attract electrons in a chemical bond.



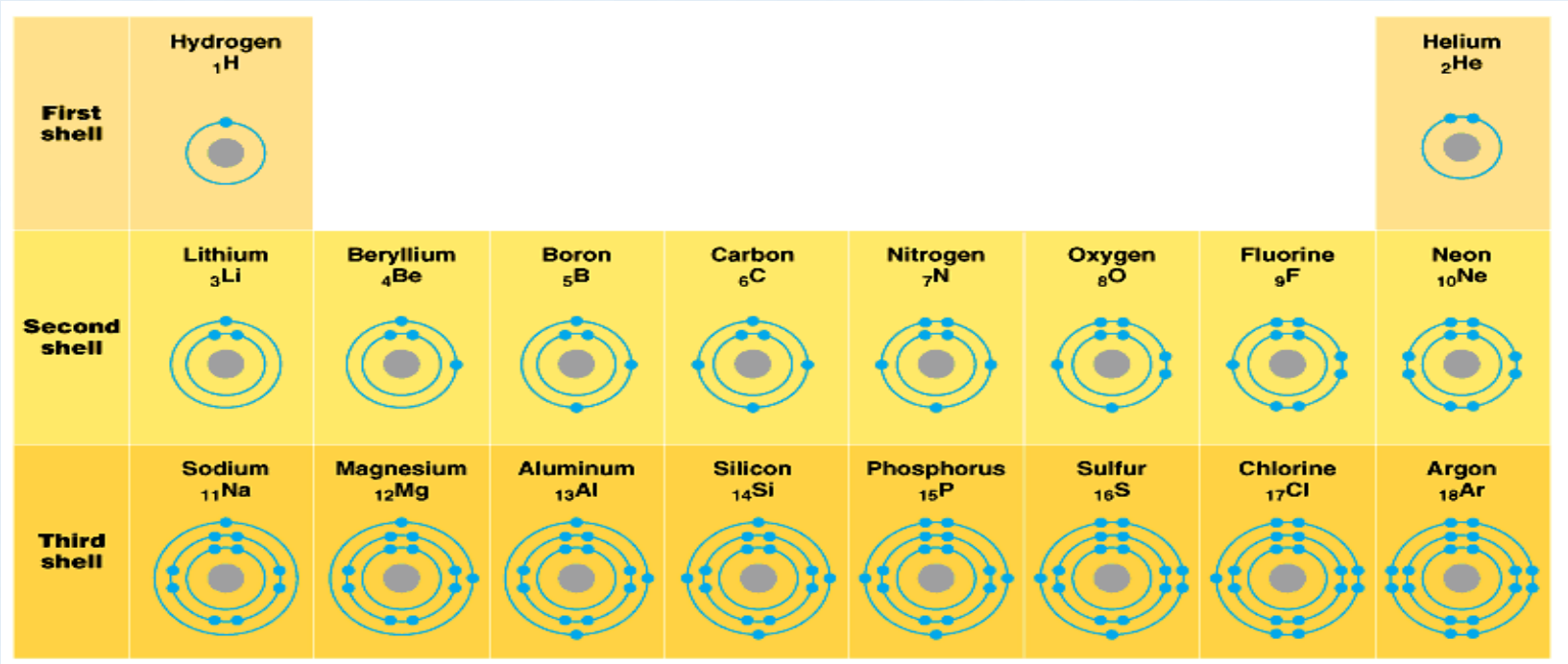
(a)

Dipole (polar): a molecule that has two poles (one end with δ+, other end with δ-) due to the difference in electronegativity between the two atoms or its asymmetrical molecular shape

** not an ionic compound!

No ions!

Atomic Size



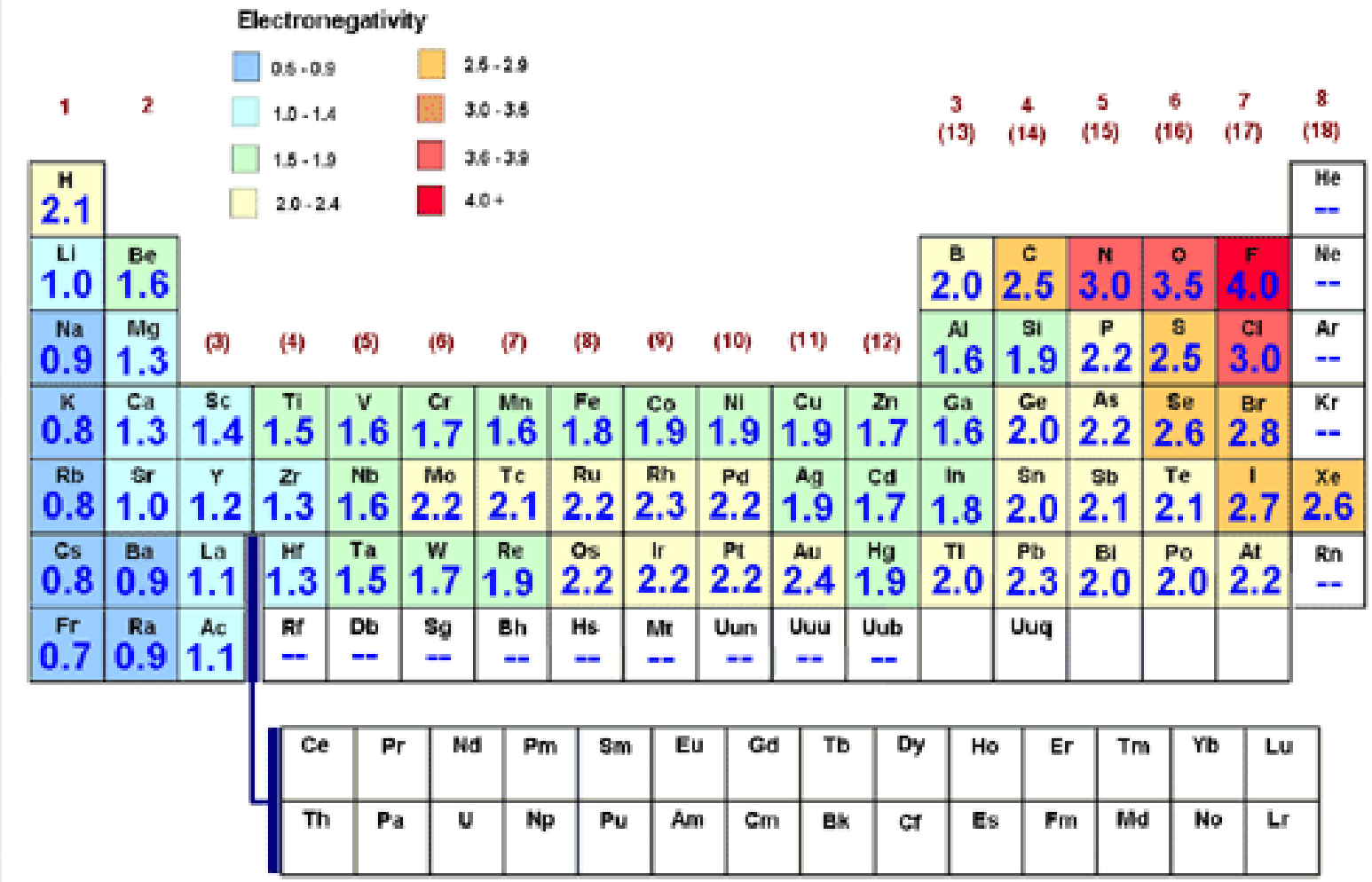
- **Decreases to the right** (same # shells but more protons → nucleus pulls electrons closer)
- Increases as you go down (# shells increase)

Electronegativity

- **EN increases as the atomic size decreases (EN increases to right)**

- **noble gases do not have EN because they do not participate in bonding.**

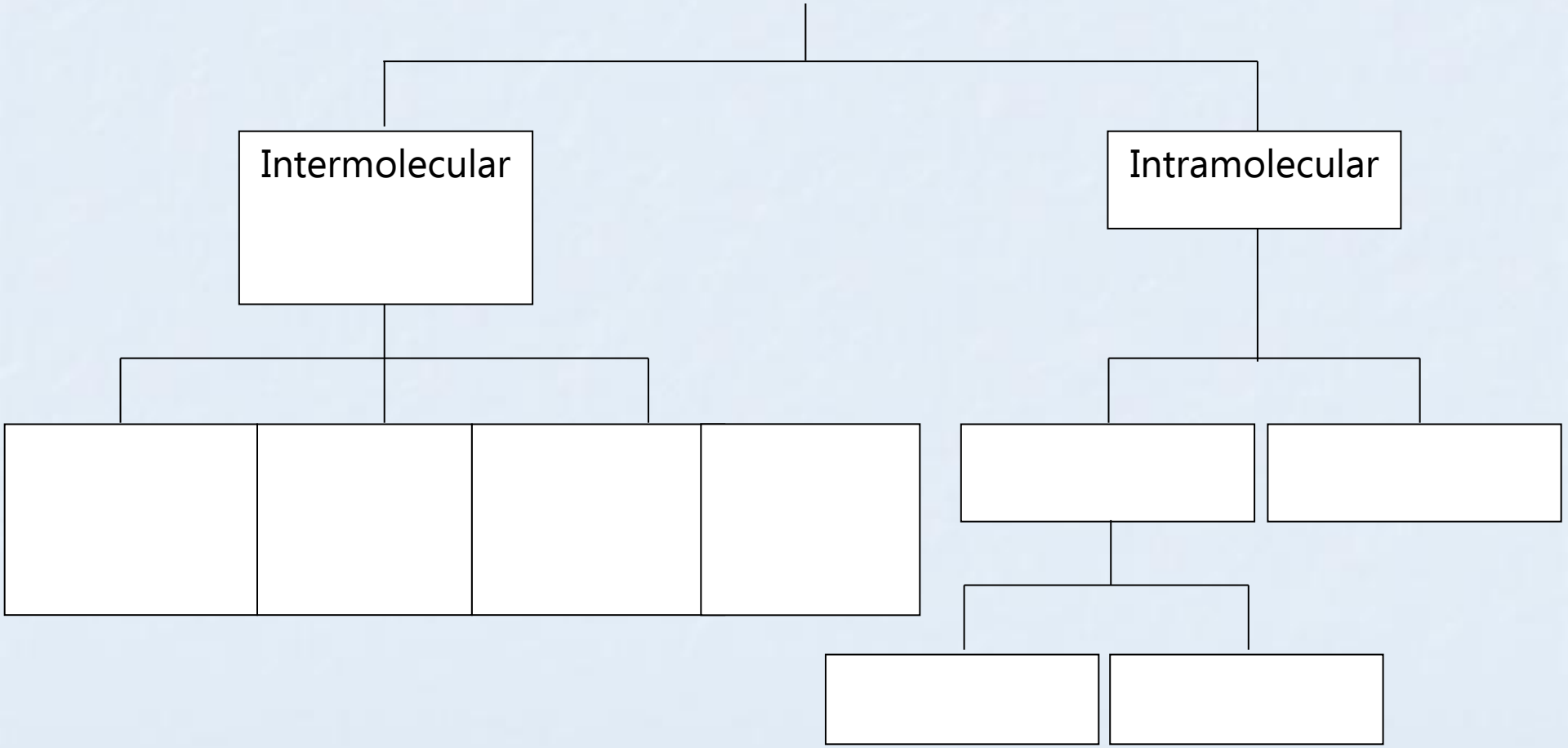
- **EN decreases as you go down, because the atomic size is increasing.**



F, O, N – have the highest electronegativity.

These three elements participate in hydrogen bonding.

Types of Bonding

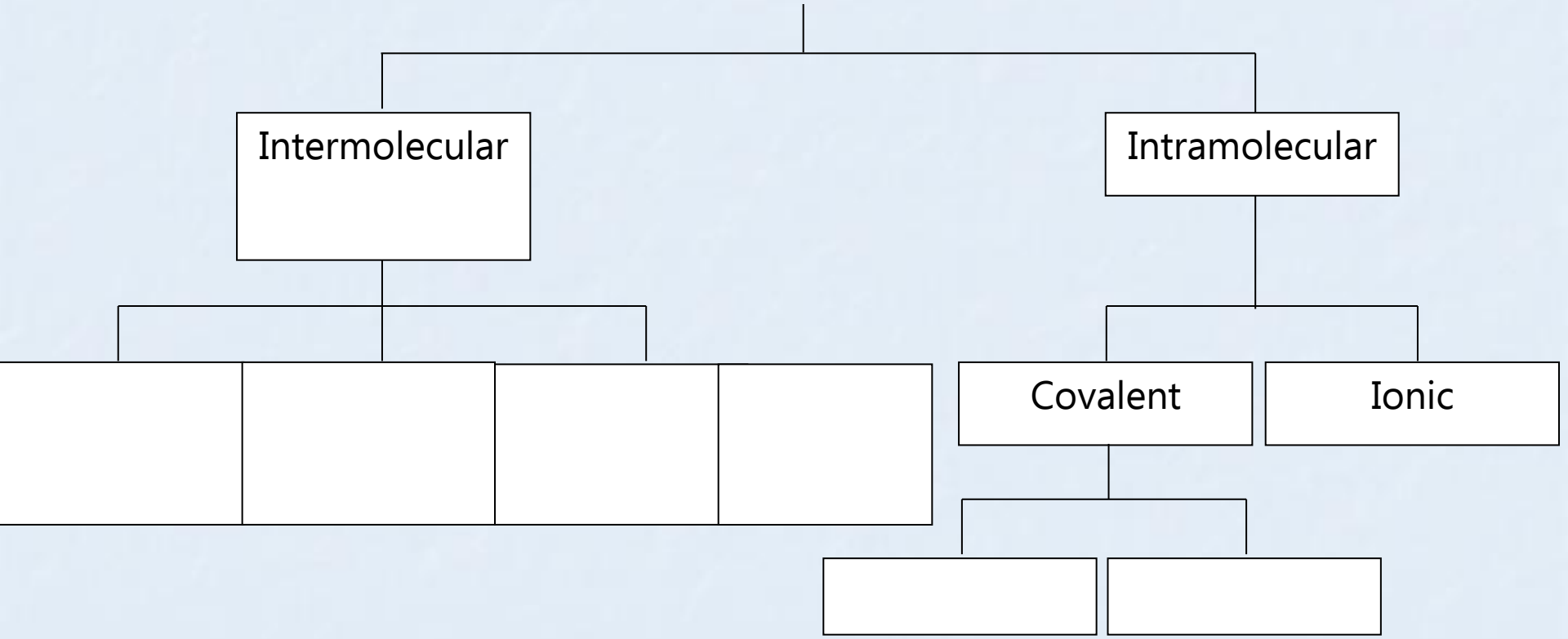


Forces of Attraction

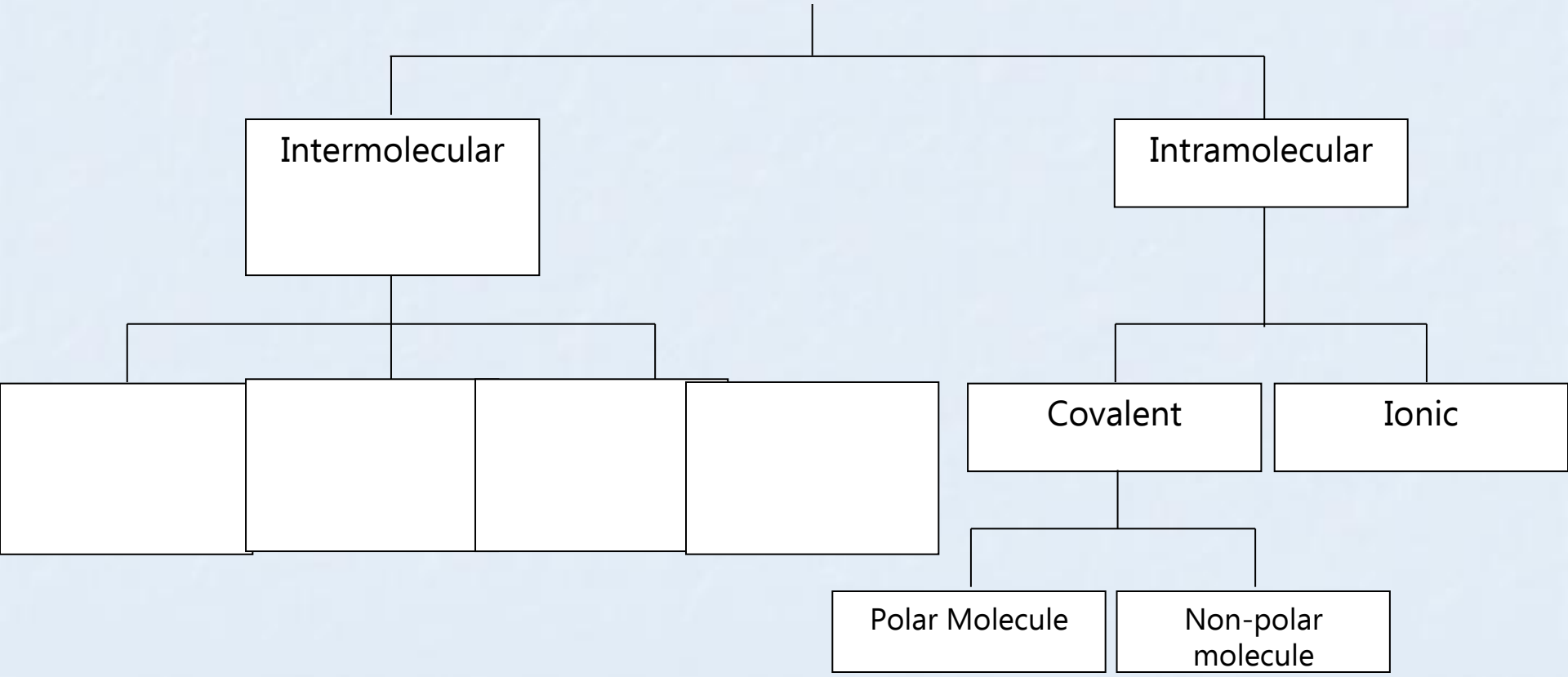
- Intramolecular: bonding between atoms within a molecule

- Intermolecular: bonding between molecules

Types of Bonding



Types of Bonding



Intramolecular: Ionic

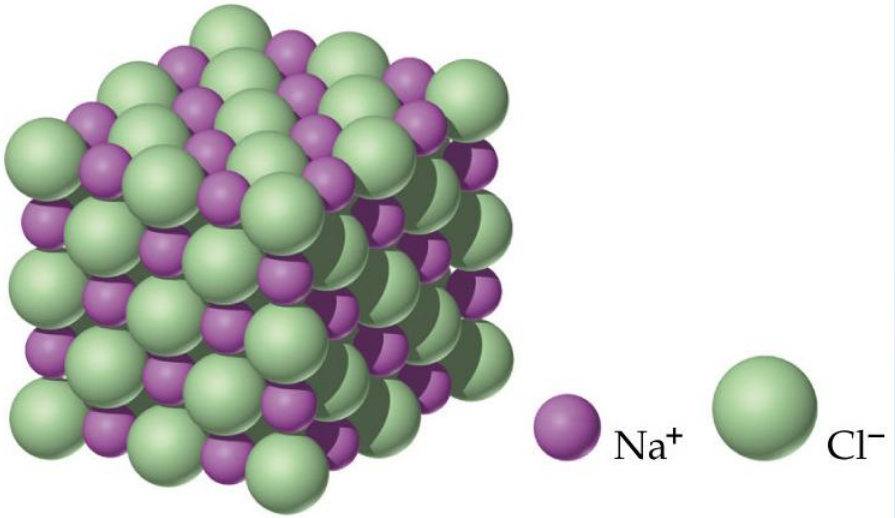
- **Between 2 atoms with very large differences in electronegativity → one takes away an electron (s) from the other**

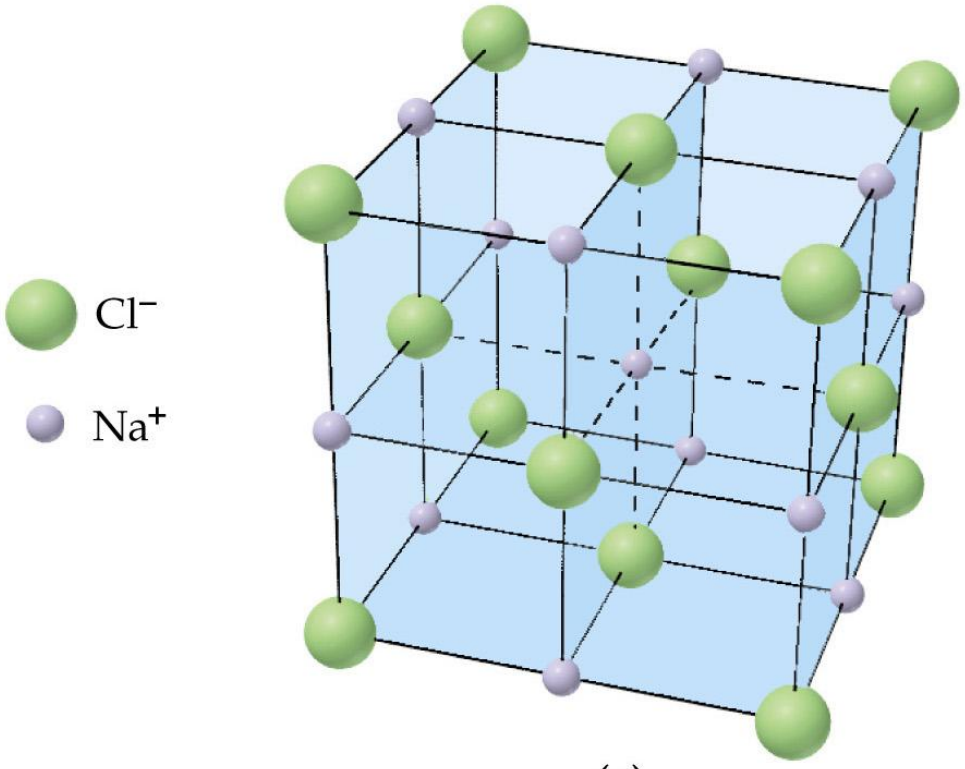
- **Acceptor becomes (-) charged (anion = negative ion)**
- **Donor becomes (+) charged (cation = positive ion)**

  → Ionic bond forms from an attraction between an anion and a cation

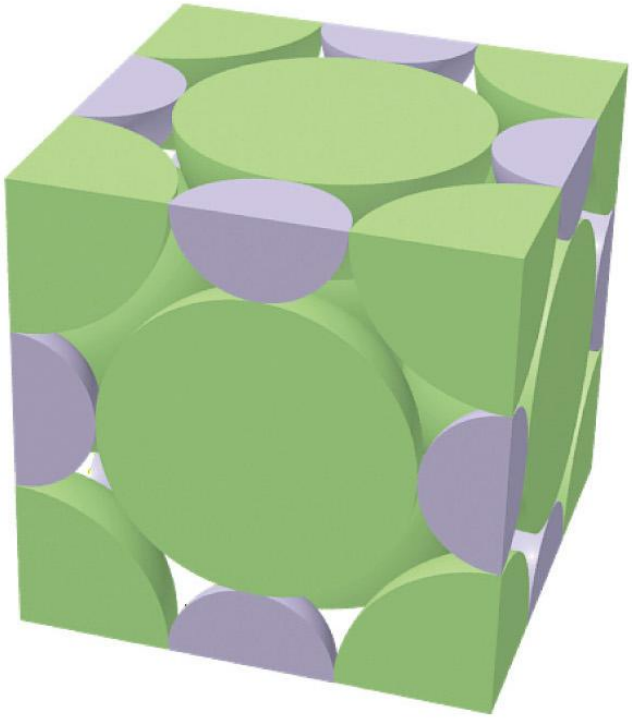
  → forms an ionic compound eg. NaCl

- **Salt crystals have a 3D lattice because of +/-attractions**





(a)



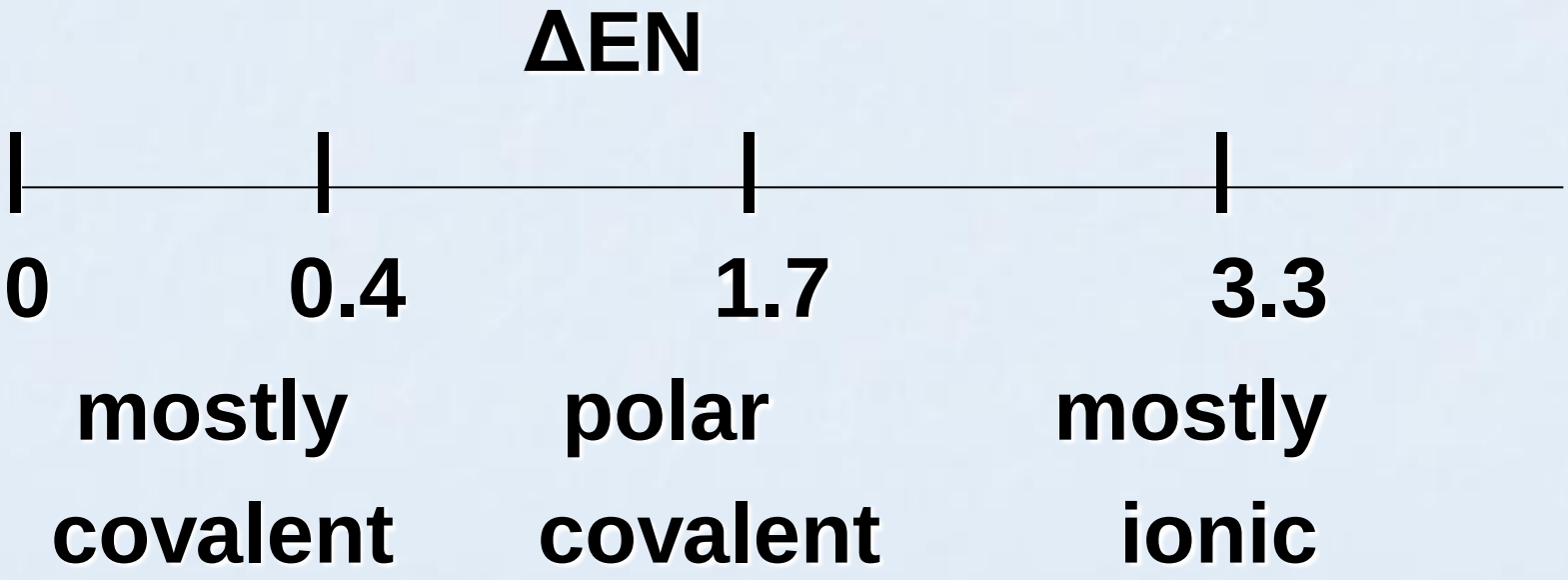
(b)

Intramolecular: Covalent

- **Covalent bonds = sharing of electrons between non-metals (ex. H_2O)**
  - **Non-polar (equal sharing of electrons)**
  - **Polar (unequal sharing of electrons →there is a (+) charged end and (-) charged end in a molecule)**

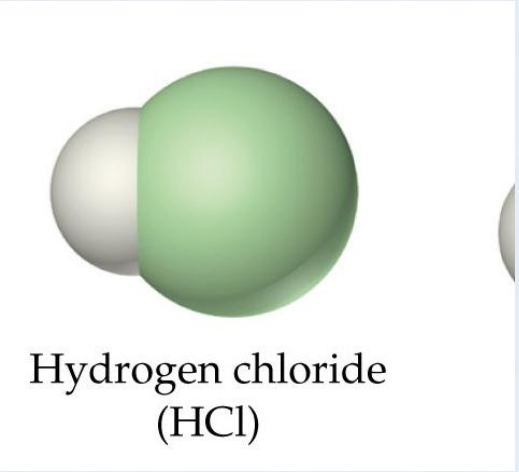
Polar or Non-polar? That is the Question!

Look at the difference in electronegativity between two atoms of that molecule.



Exercise: Ionic, Polar Covalent or Nonpolar Covalent?

- **1) HCl:**
- **2) Cl_2:**
- **3) MgO:**
- **4) CH_4:**
- **5) CO_2:**

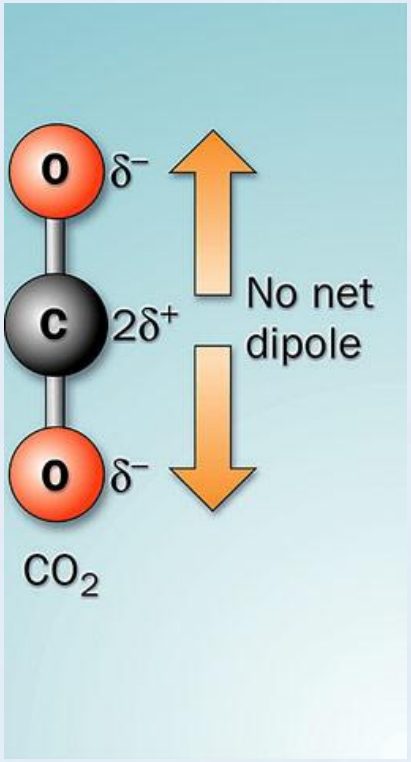


Hydrogen chloride
(HCl)

Exercise: Ionic, Polar Covalent or Non-polar Covalent?

- **1) HCl: ΔEN = 0.9 → polar covalent**
- **2) Cl_2: ΔEN = 0 →non-polar covalent**
- **3) MgO: ΔEN = 2.3 →ionic**
- **4) CH_4: ΔEN = 0.4 → non-polar covalent**
- **5) CO_2: ΔEN = 1.0 → should be polar covalent but it's not! Why?**

Why Non-polar?



Think of physics. Vectors cancel out.

-valence electrons in C are attracted to both O's

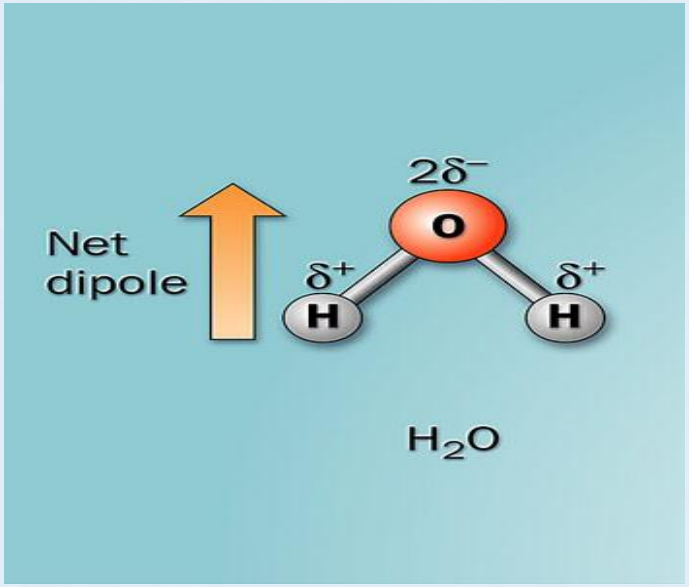
→ the attractive forces cancel out b/c the molecule is symmetrical

- neither positive nor negative pole

- It contains polar bonds but overall it is non-polar.

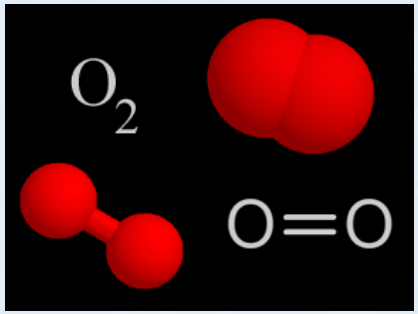
Water: Polar or Non-polar?

- **ΔEN =?**
- **Symmetrical?**
  Asymmetrical?



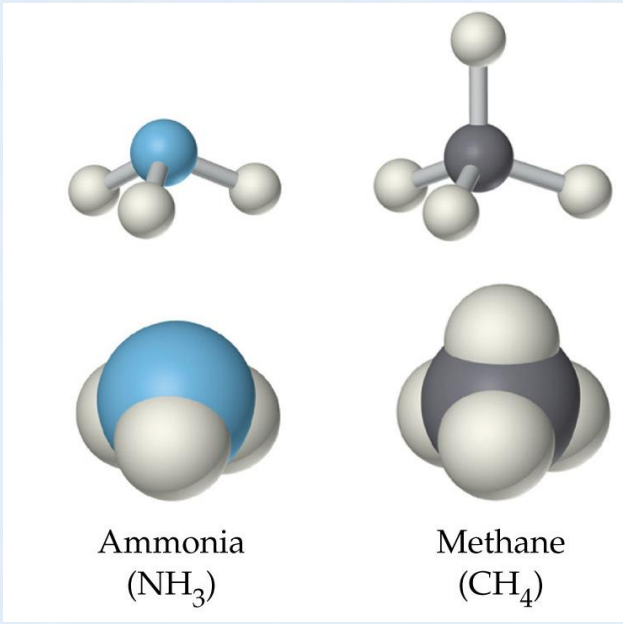
Ionic, Polar or Nonpolar?

1) SiF_4:

2) 

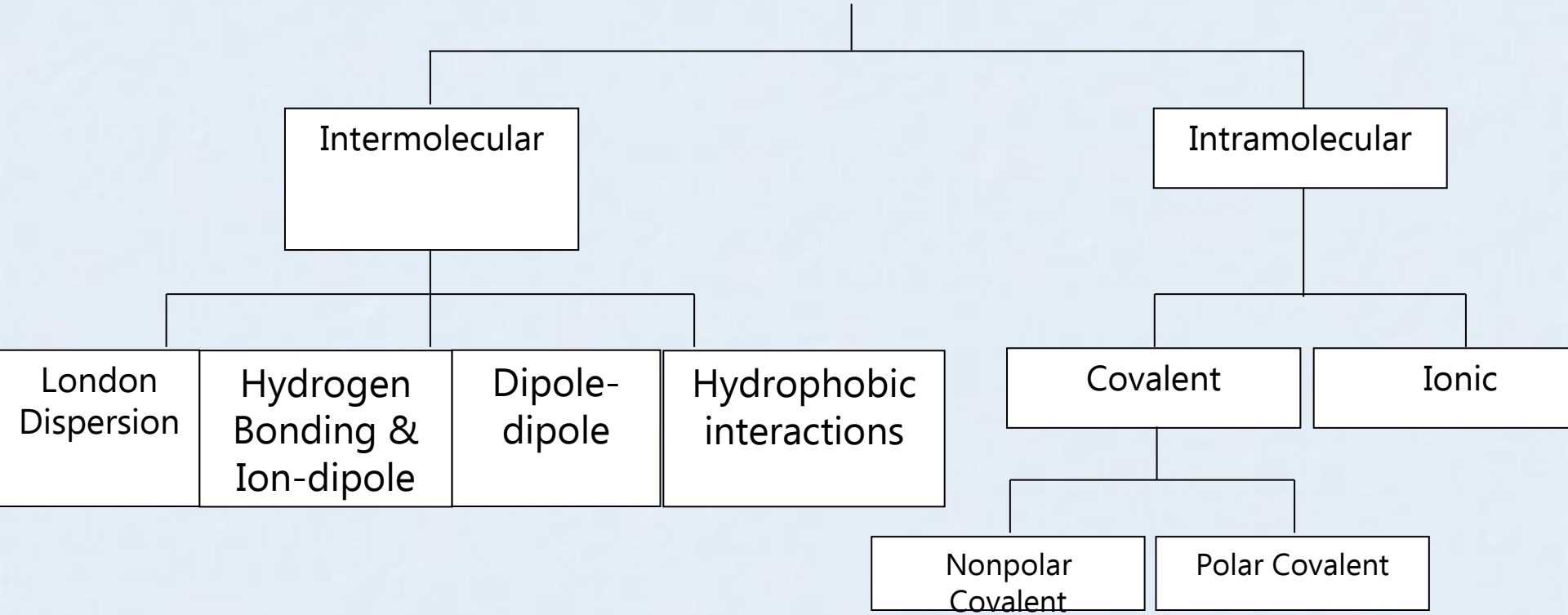
3)

4)



5) CF_4:

Types of Bonding



Hydrogen Bonding

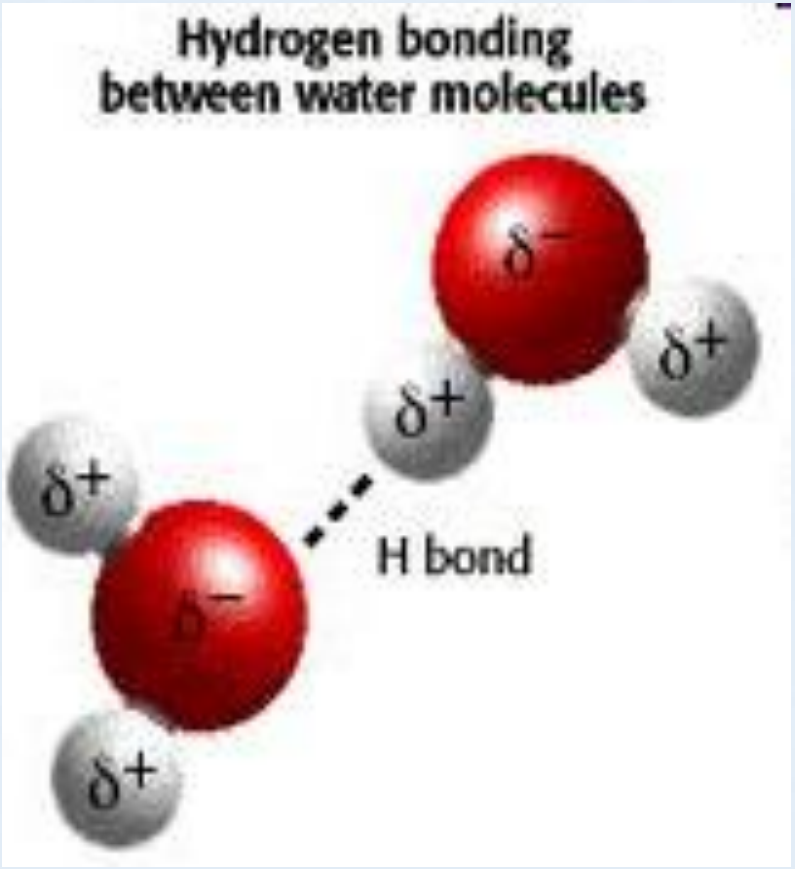
- represented by dots in-between molecules

- between **hydrogen atom** (that is covalently bonded to a very electronegative atom like F, O, N)

  and

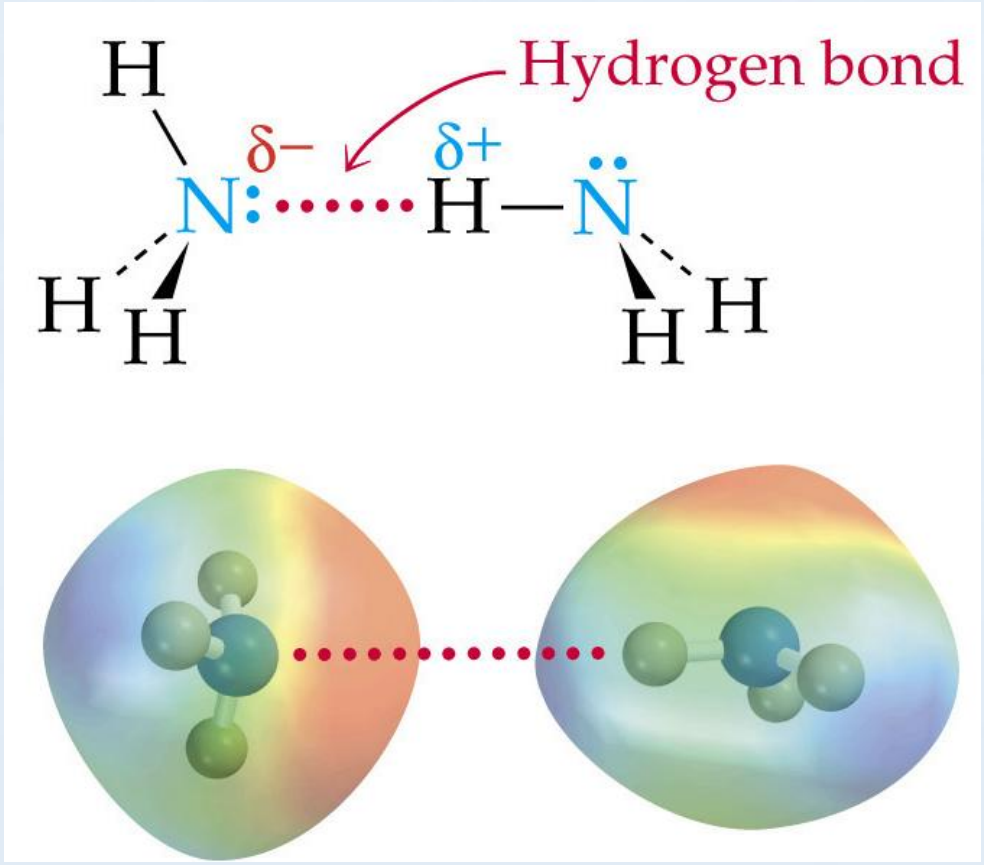
  an electronegative atom (F, O, N) in another polar molecule

- Special type of dipole – dipole



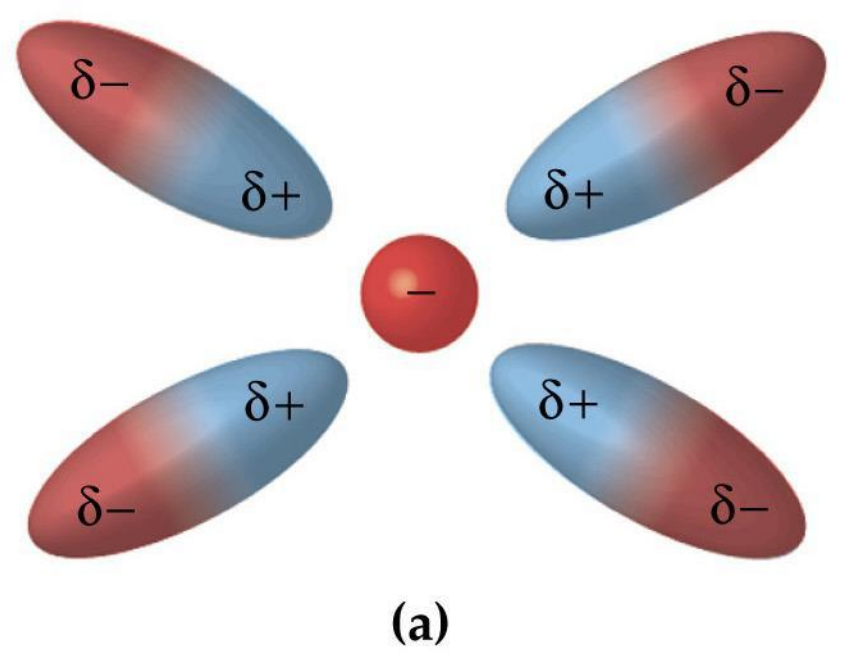
Hydrogen Bonding

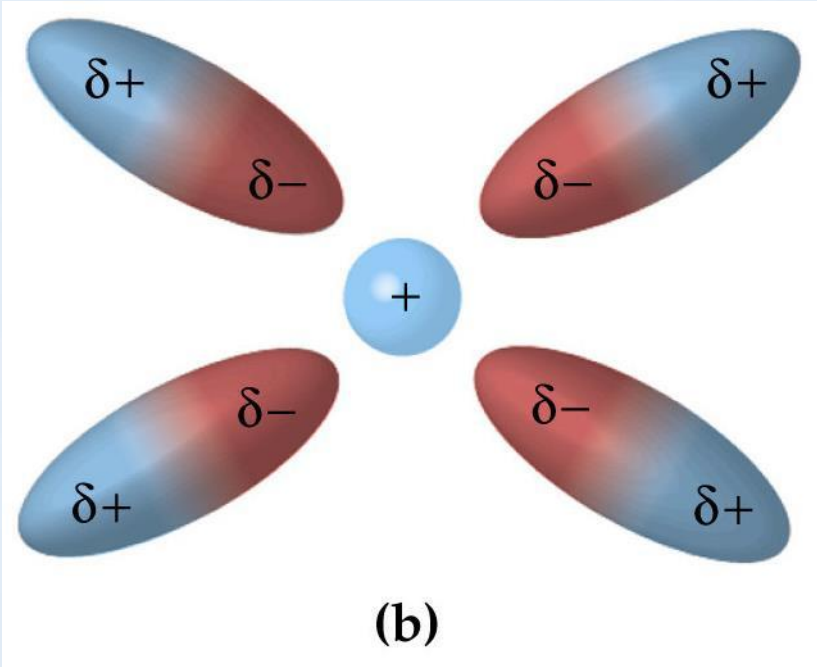
- **Interaction between two NH_3 molecules?**



Ion - Dipole

- Dipole is attracted to an oppositely charged ion
- When ionic compounds dissolve in water, water molecules surround the ion and remove it from the crystal lattice structure (hydration shell)


δ–
δ+
δ–
δ+
–
δ+
δ+
δ–
δ–
(a)

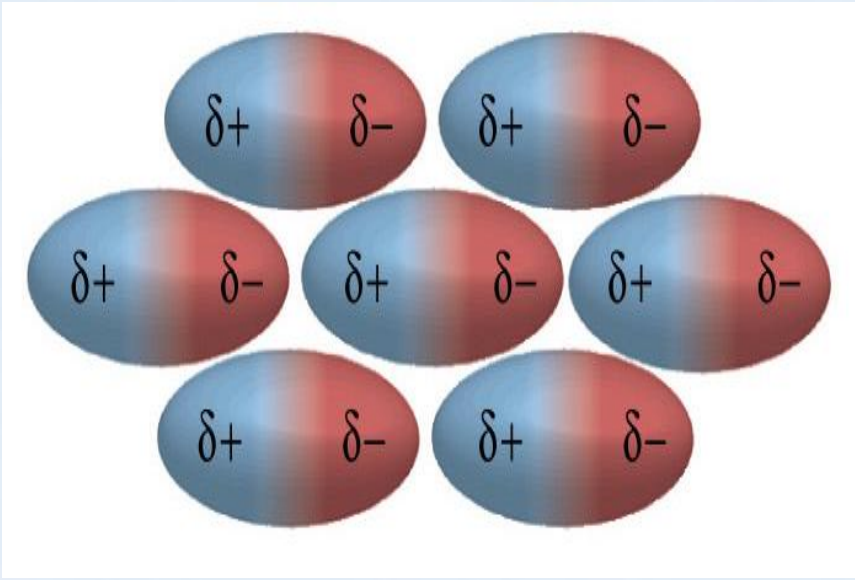

δ+
δ–
δ+
δ–
+
δ–
δ–
δ+
δ+
(b)

Dipole-dipole

- **between polar molecules**

- **More permanent (compared to London dispersion) hold of molecules**

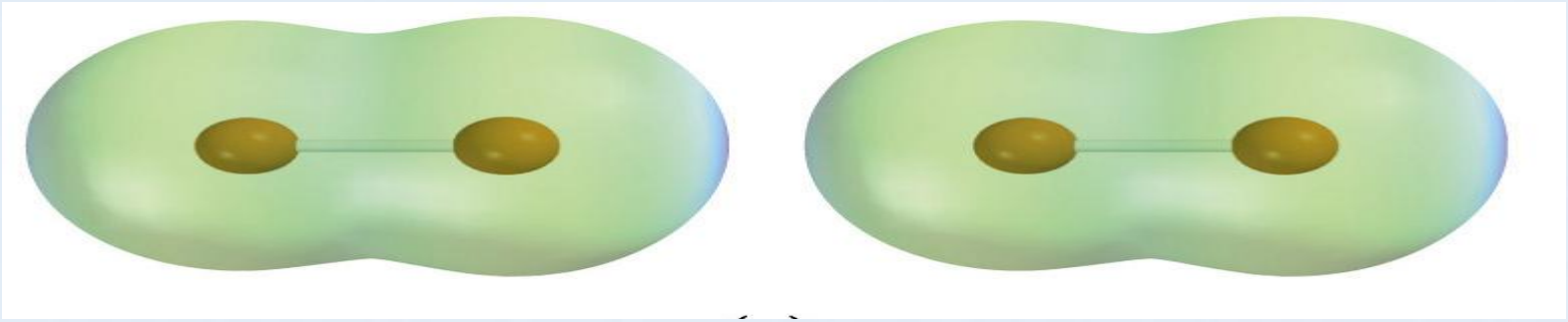
  due to the alignment of + and – ends.



- **Soluble in polar solvent like water**

- **Ex. Between HCl molecules**

London Dispersion



- **between non-polar molecules**. **Overall non-polar molecule has no charge.**
- **Once in awhile electrons will gather in one place momentarily and have a charge. That charge would quickly and briefly attract other molecules.**
- **Not permanent becausecof weak attractive forces.**
- **Ex. Oil molecules, gases (oxygen, nitrogen gas)**

Hydrophobic Interactions

- Nonpolar molecules are excluded from mixing with polar molecules by associating wi th each other
- Minimizes the surface contact between non-polar molecules and polar molecules.

- Can occur spontaneously without the nee d for energy
- Attraction between LIKE molecules
- Example: oil molecules spontaneously ass ociate excluding water

How strong are the intermolecular bonds?

Polar	Non-polar
Molecules stick to each other →High melting point, high boiling point	Molecules do not stick to each other →Low melting point low boiling point Eg. many are gases (like CO2) at room temperature London dispersion force forms the weakest bond →low boiling point