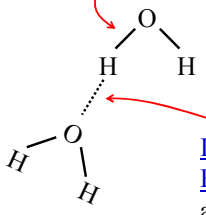
Intermolecular Forces 5.1

Types of intermolecular forces
Determining relative boiling points

Intramolecular vs. Intermolecular Forces

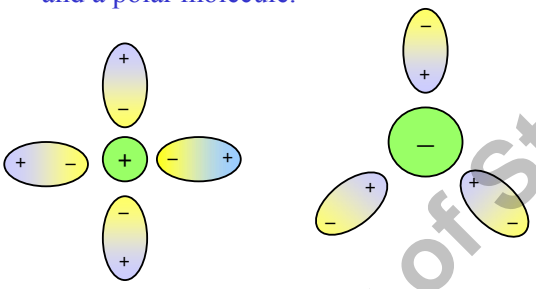
Intramolecular Forces are bonds.



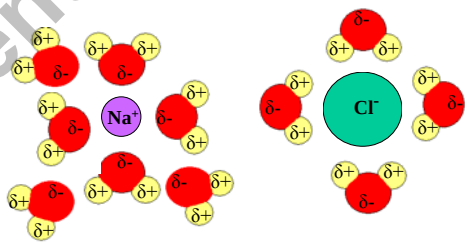
Intermolecular Forces are forces of attraction between molecules.

Ion-Dipole

- The forces of attraction between an ion and a polar molecule.

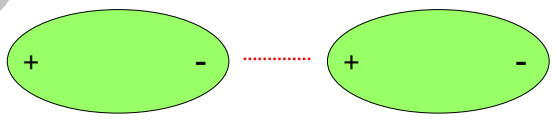


$Na^+_{(aq)}$ and $Cl^-_{(aq)}$



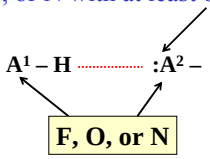
Dipole - Dipole

The attractive forces between the negative end of one polar molecule and the positive end of another polar molecule.



Hydrogen Bonds
A type of Dipole - Dipole

- Occurs between a Hydrogen that is covalently bonded to Fluorine, Oxygen, or Nitrogen and another F, O, or N with at least one lone pair



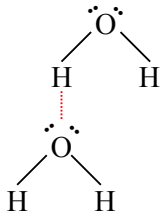
- Five to ten times stronger than other dipole-dipole attractions

Hydrogen Bonds

Why are H-Bonds so strong?

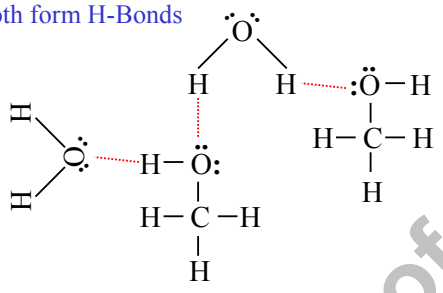
1) F – H, O – H, and N – H bonds are very polar.
2) These atoms are very small, so the partial charges caused by the difference in electronegativity is highly concentrated.
3) The lone pair(s) on F, O, or N increases the already partially negative charge on these atoms, thereby creating a stronger attraction for the slightly positive hydrogen.

Hydrogen Bonds Between Water Molecules



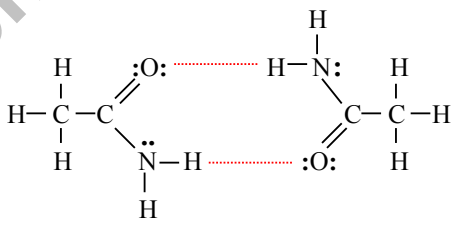
Hydrogen Bonds Between Water and Methanol

Both form H-Bonds



Hydrogen Bonds in Acetamide

Forms two H-Bonds with itself



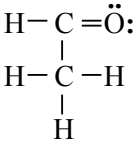
Boiling Point (221°C)

Ethanal does not form Hydrogen Bonds

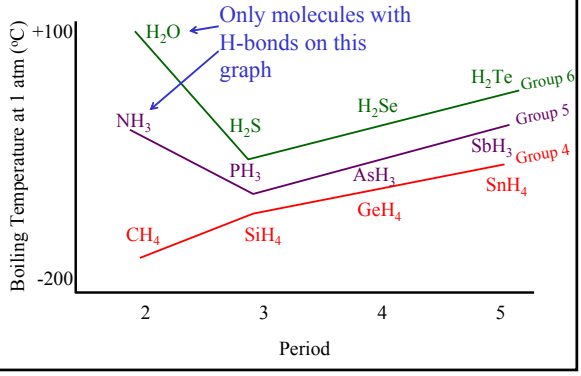
This structure does not form H-Bonds.

Hydrogen is bonded to Carbon.

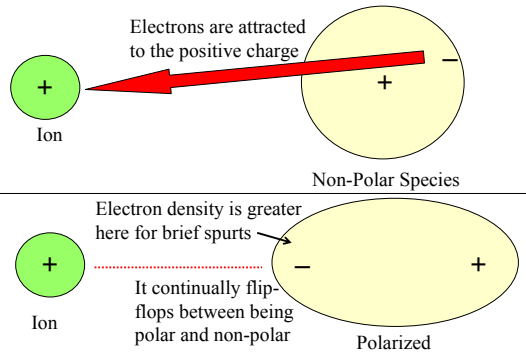
Hydrogen needs to bond with F, O, or N to form an H-bond.



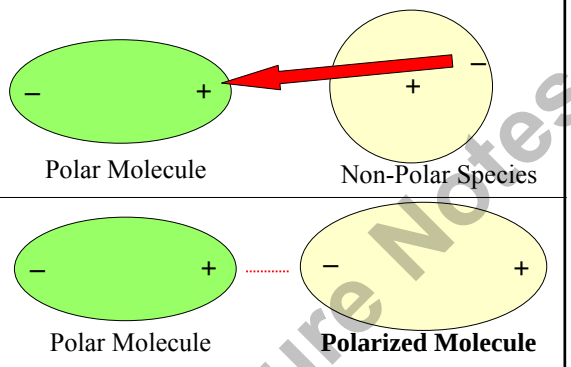
Hydrogen Bonds



Ion Induced Dipole



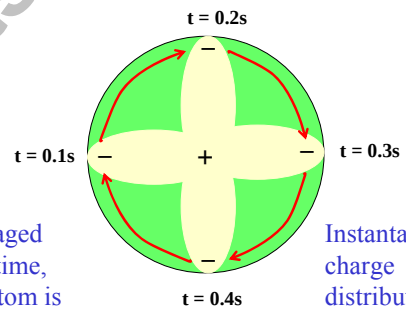
Dipole Induced Dipole



London Dispersion Forces

- These forces exist between all species: atoms, ions, non-polar and polar molecules.
  - Contribute to the overall force of attraction between all particles.
- London Dispersion Forces are the only intermolecular forces that keep assemblages of non-polar species together.

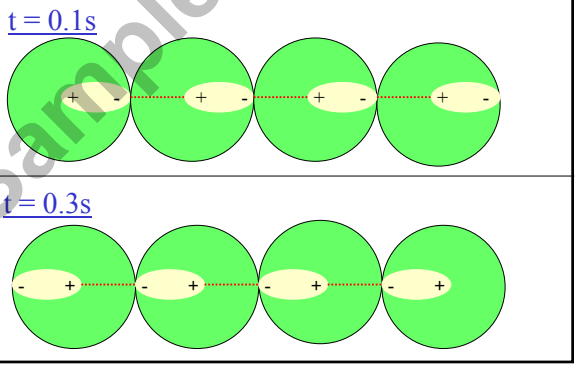
London Dispersion Forces



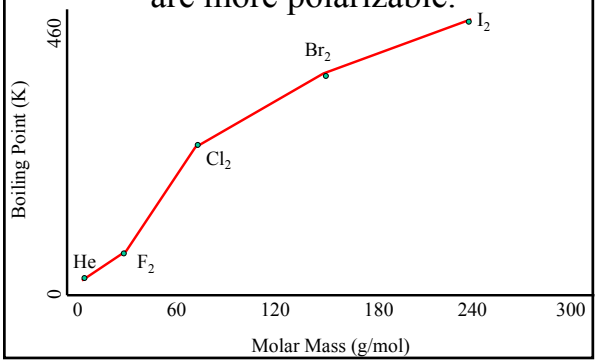
Averaged over time, this atom is non-polar.

Instantaneous charge distributions are polar.

London Dispersion Forces



Larger species with more electrons are more polarizable.



Larger species with more electrons are more polarizable.

- They have a weaker hold on their outer electrons.
- When moving down a group, or constructing molecules with more atoms, the resulting species has more electrons and is larger.
  - The more electrons a species has, the more polarizable it is.
    - This is not always true when moving from left to right across a period, as atomic radius decreases.

Intermolecular Forces of Attraction

ion-ion
ion-dipole
H-bonds
dipole-dipole
ion-induced dipole
dipole-induced dipole
London dispersion

Ex1)Which species has the higher boiling point?
Identify the intermolecular forces acting on each.

C_2H_6 or C_3H_8

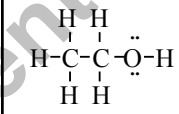
Both are Non-Polar

The larger molecule has the higher BP, as larger molecules are more polarizable.

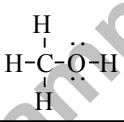
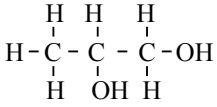
Only London dispersion forces act on these molecules.

$BP_{C_2H_6}$ = - 89°C $BP_{C_3H_8}$ = - 42°C

Ex2)Which species has the higher boiling point?
Identify the intermolecular forces acting on each.

	C_3H_8

Ex3)Which species has the higher boiling point?
Identify the intermolecular forces acting on each.

Ex4)Which has the higher **melting** point?
Identify the intermolecular forces acting on each.

CH_4	CI_4

Ex5)Which species has the higher boiling point? Identify the intermolecular forces acting on each.	
NaCl	H_2O

