

AL-Mustaqbal university college
Pharmacy department

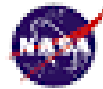


Physical pharmacy I

Lecture1

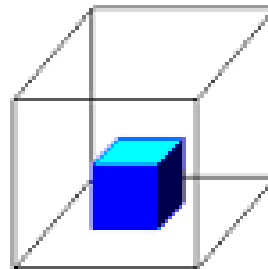
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- Learn the differences between the solid, liquid, and gas state ,and how the polarity of molecules influences those states.
- Learn the different types of intermolecular forces between molecules.



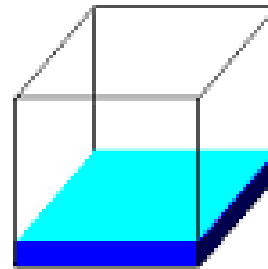
States of Matter

Glenn
Research
Center



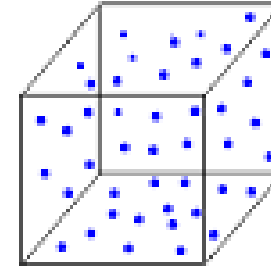
Solid

Holds Shape
Fixed Volume



Liquid

Shape of Container
Free Surface
Fixed Volume



Gas

Shape of Container
Volume of Container

States of matter

Part 1

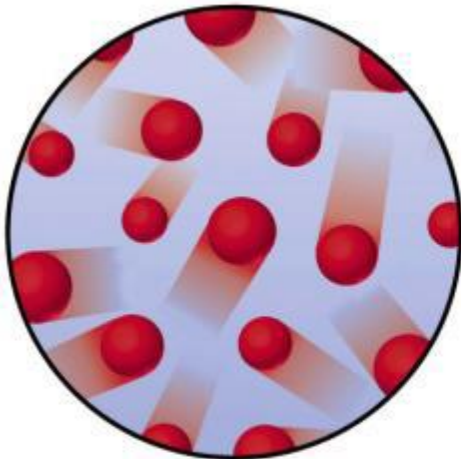
States of matter

1. Gaseous state
2. Liquid state
3. Solid and crystalline state
4. Liquid crystalline state

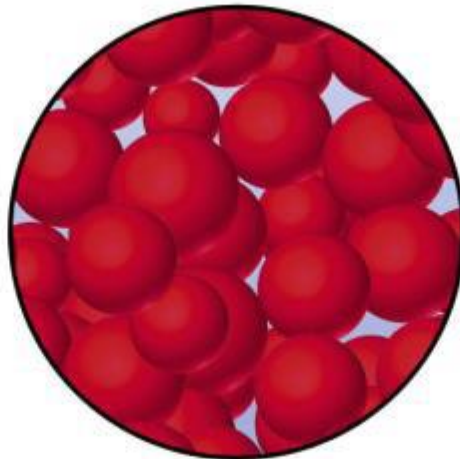


Gases vs. Liquids and Solids

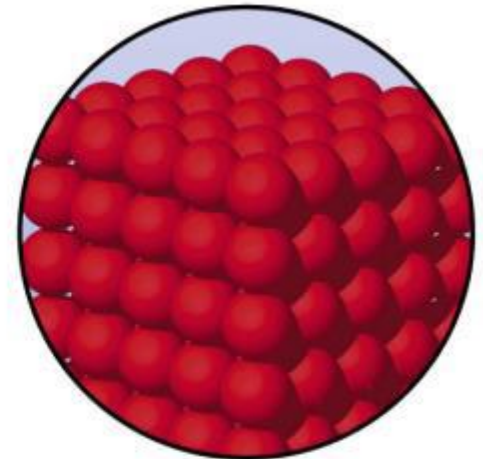
- In gases, the particles in the sample are widely separated, because the attractive forces between the particles are very weak.
- In liquids, there are strong intermolecular forces between the particles, which hold them in close contact, while still letting them slip and slide over one another.
- In solids, the intermolecular forces are so strong that the particles are held rigidly in place



Gas



Liquid



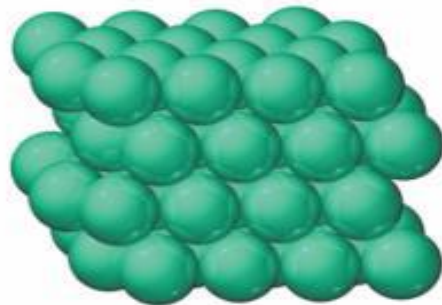
Solid

The Physical States of Matter

•Solids

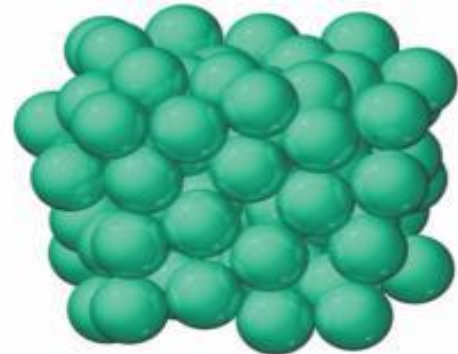
- have strong intermolecular forces.
- have high **densities** in comparison to gases.
- are rigid (have a definite shape) and incompressible (have a definite volume).
- may be crystalline (ordered) [e.g. table salt] or amorphous (disordered) [e.g., plastics].

Regular ordered structure



Crystalline solid

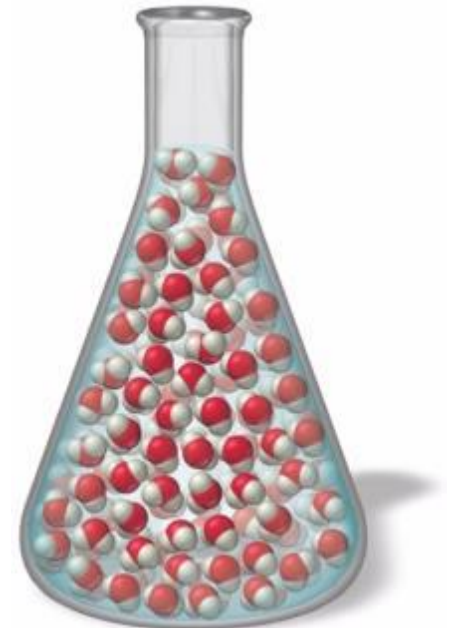
No long-range order



Amorphous solid

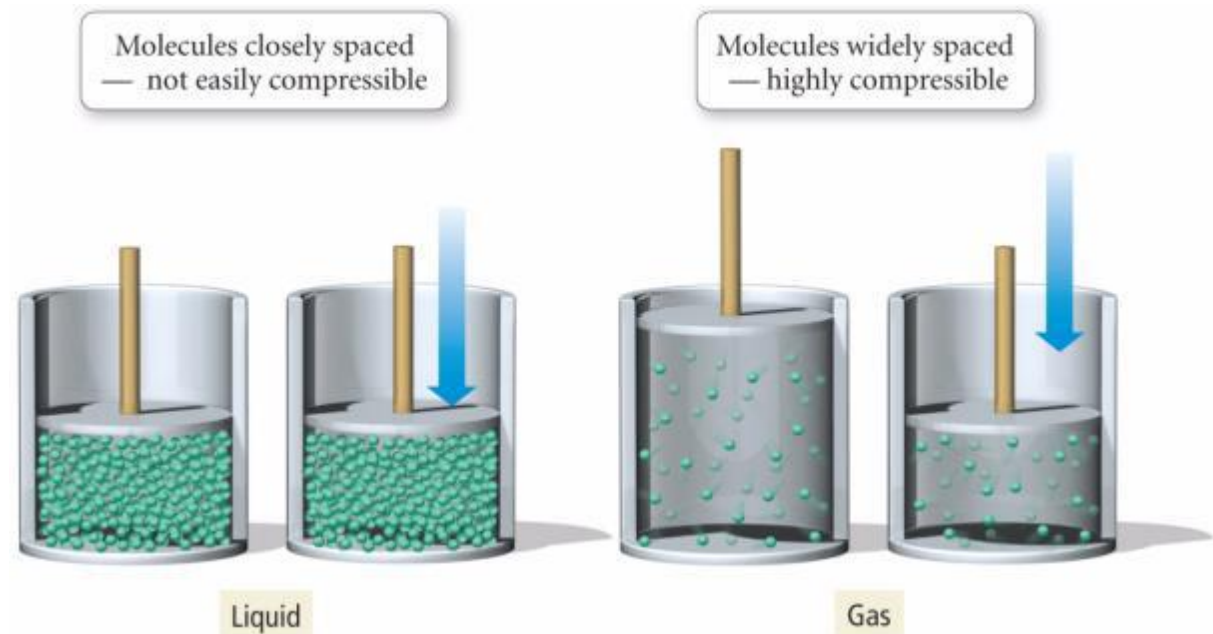
Liquids

- have moderate intermolecular forces.
- have high densities in comparison to gases.
- are fluid (they flow, and have an indefinite shape) and incompressible (have a definite volume); they conform to the shape of their containers (they form surfaces).



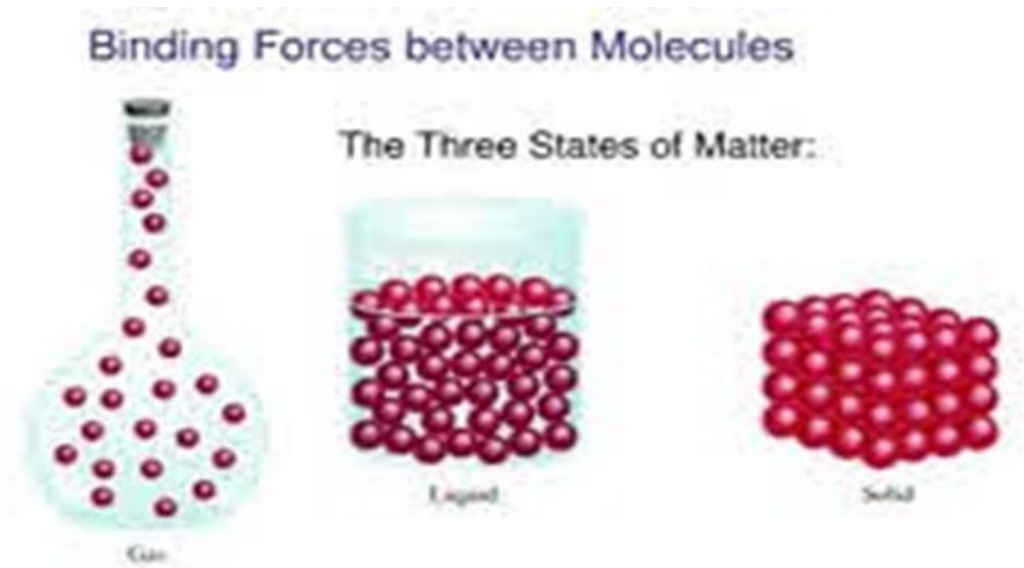
Gases

- have weak intermolecular forces.
- have low densities
- are fluid and compressible; they have no definite shape or volume, and conform to the container shape, but fill the entire volume (i.e., they do not form surfaces).



Binding Forces Between Molecules

- Repulsive and attractive forces
- Intramolecular forces
- Intermolecular forces
- Bond energy

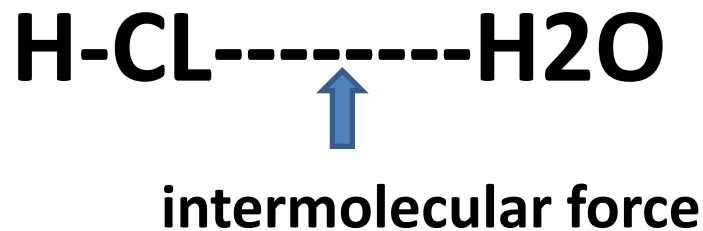


In order for molecules to exist in aggregates in **gases, liquids** and **solids** Intermolecular forces must exist

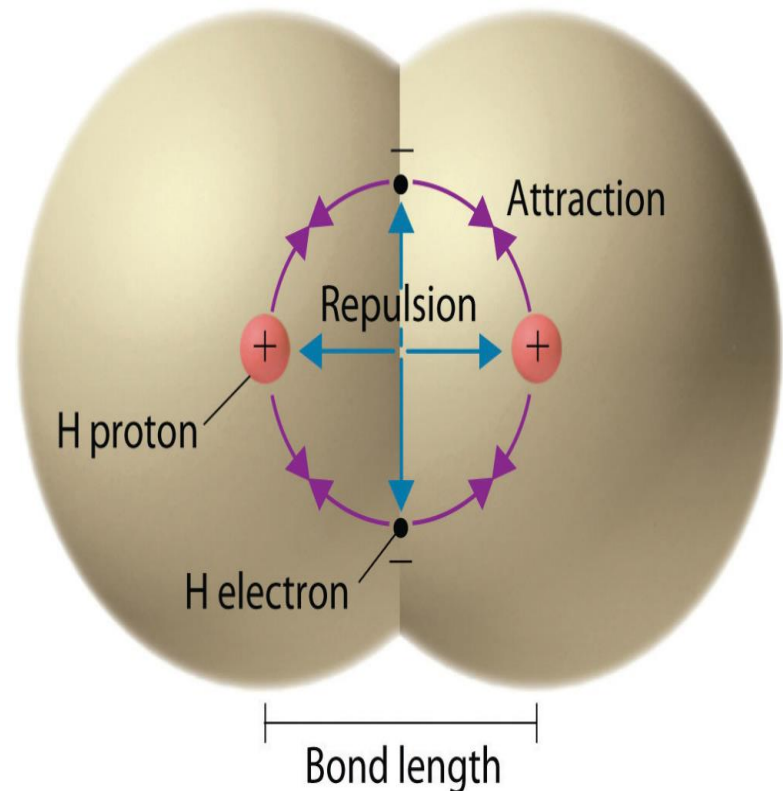
➤ Repulsive and Attractive Forces

For molecules to exist as aggregates in gases ,liquids ,and solids ,**inter**molecular forces must exist

These intermolecular forces involve both attractive and repulsive forces. These forces must be balanced in an energetically favored arrangement for the molecules to interact.



When two atoms or molecules are brought closer together, the **opposite** charges and binding forces in the two molecules are closer together than the **similar** charges and forces, causing the molecules to attract one another.



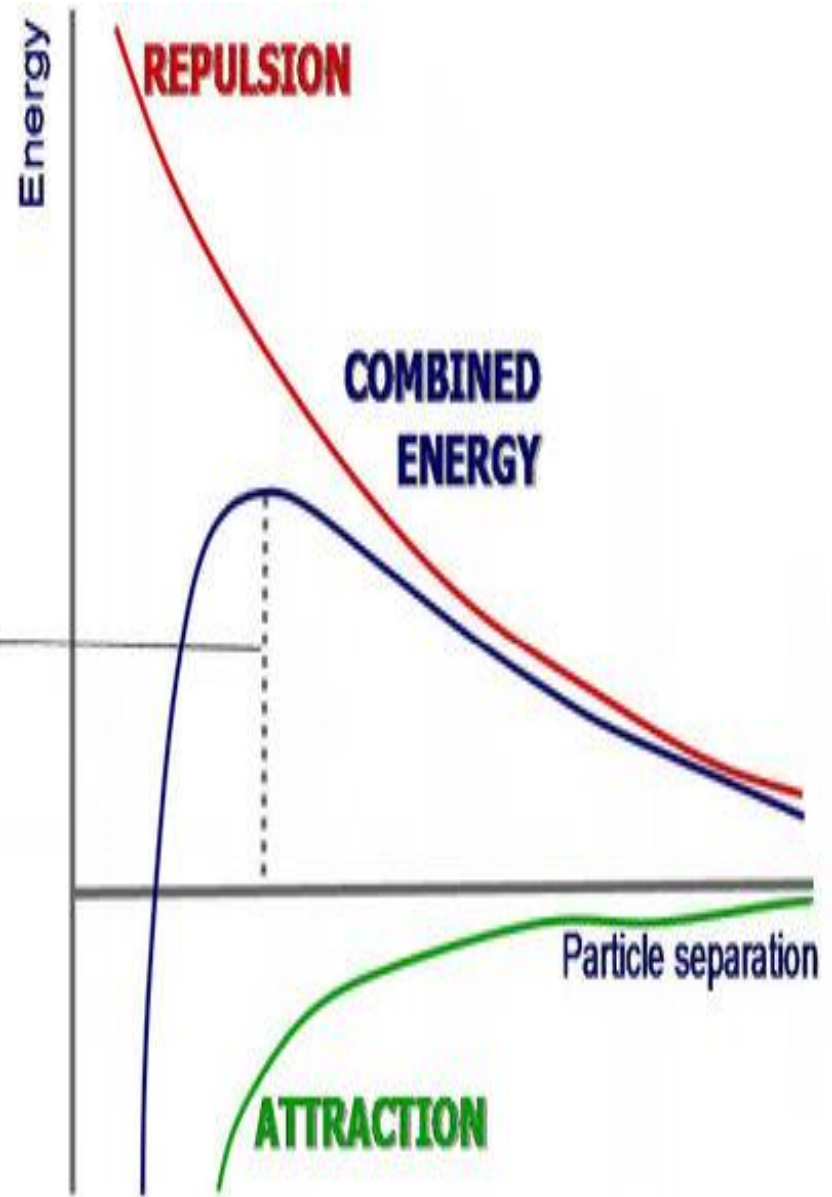


LONG RANGE ELECTROSTATIC
(DOUBLE LAYER)



SHORT RANGE
VAN DER WAALS

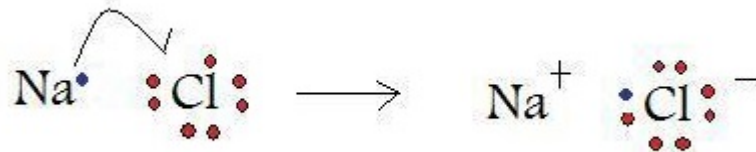
Energy
barrier



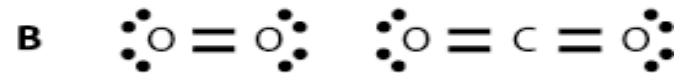
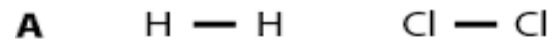
➤ Intramolecular forces

Types of intramolecular forces of attraction

1-Ionic bond: This bond is formed by the complete transfer of valence electron(s) between atoms.

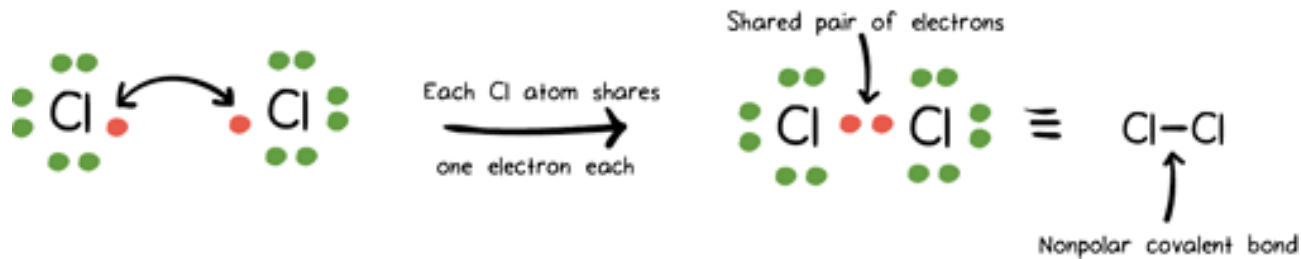


2-Covalent bond: This bond is formed between atoms that have similar electro negativities—the affinity or desire for electrons. they share electrons in order to achieve octet configuration and become more stable ; (three type single ,double &triple bond)



Covalent bond

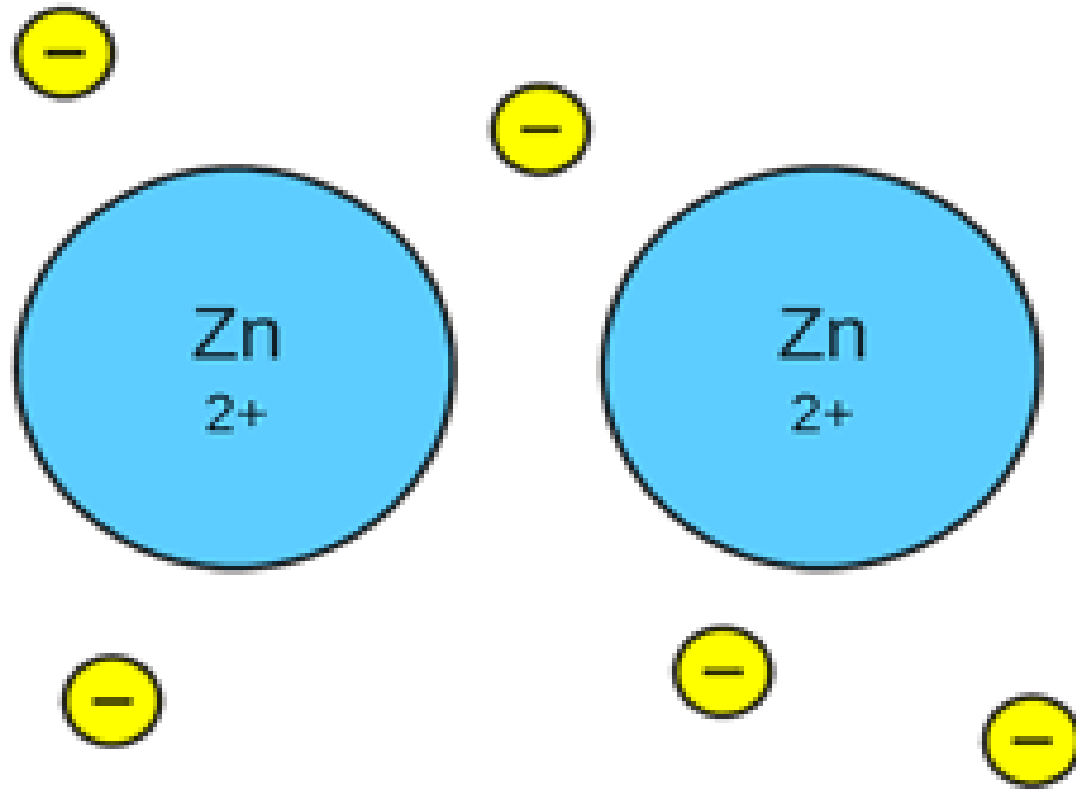
A nonpolar covalent bond is formed between same atoms or atoms with very similar electronegativities



A polar covalent bond is formed when atoms of slightly different electronegativities share electrons.



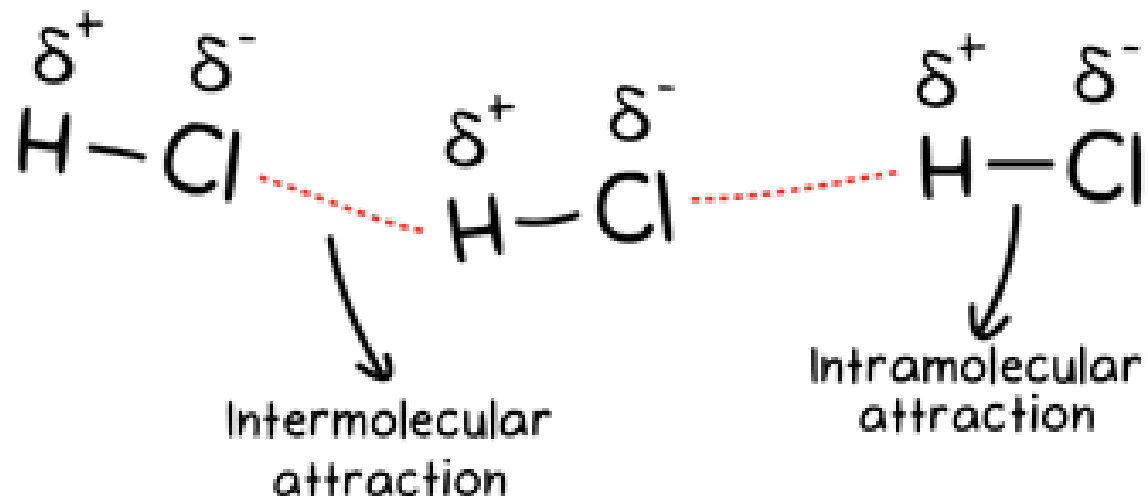
3-Metallic bonding: This type of covalent bonding specifically occurs between atoms of metals



➤ Intermolecular forces

Intermolecular forces occur between molecules . It can be divided in to:

- 1.Vanderwaals forces
- 2.Ion–dipole interaction
- 3.Ion–induced dipole interaction
- 4.Hydrogen bonds



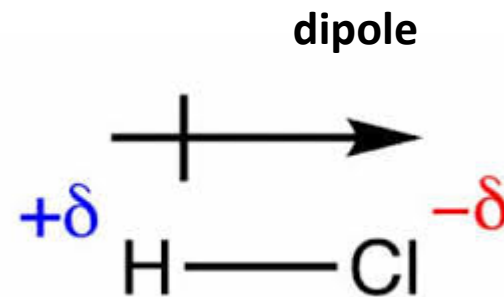
Intermolecular forces

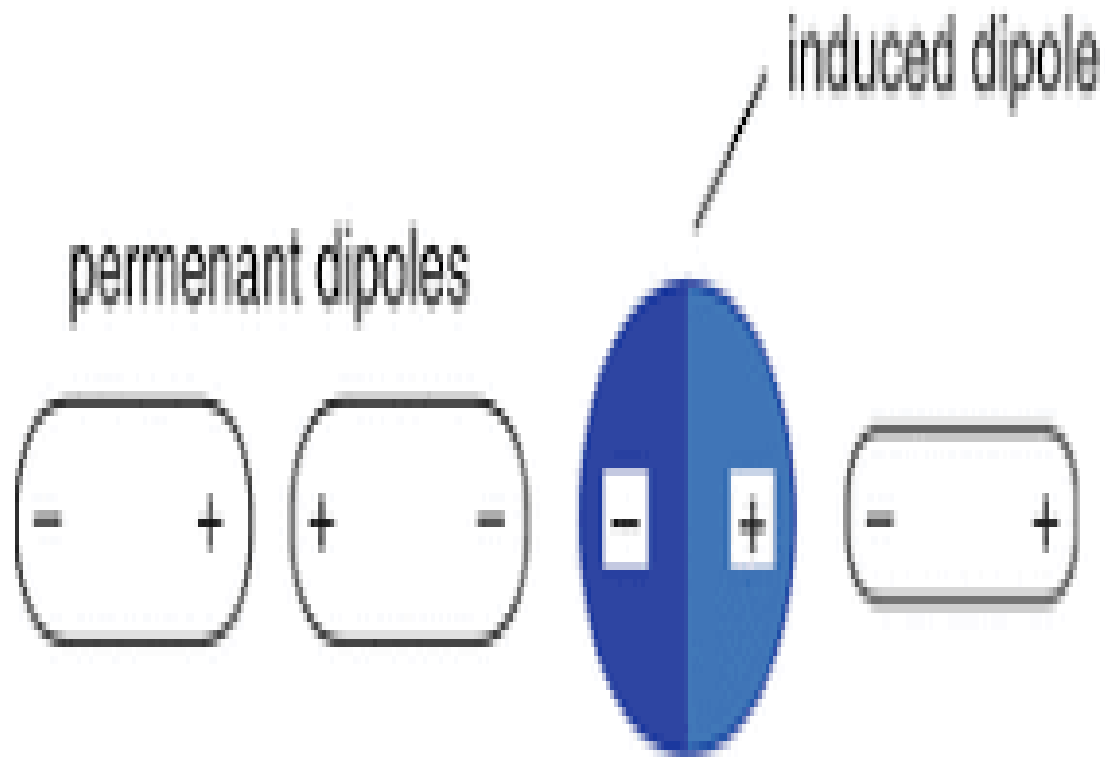
1-VanderWaals Forces

VanderWaal interactions are weak forces that involve the dispersion of charge across a molecule called a dipole.

VanderWaal interactions can be classified into:

- A. Dipole–dipole interaction ,orientation effect ,or **Keesom force**
- B. Dipole-induced dipole interaction ,induction effect ,or **Debye force**
- C. Induced dipole induced dipole interaction ,dispersion effect ,or **London force**

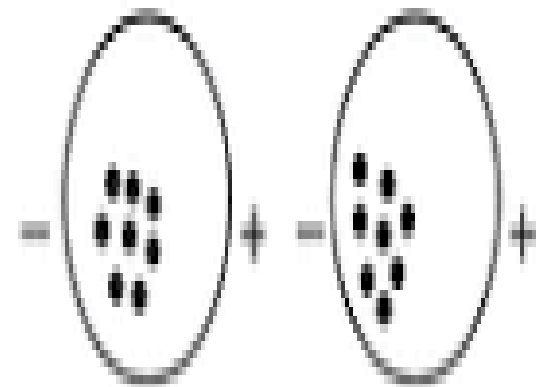




Keesom force

Debye force

temporary fluctuating dipoles



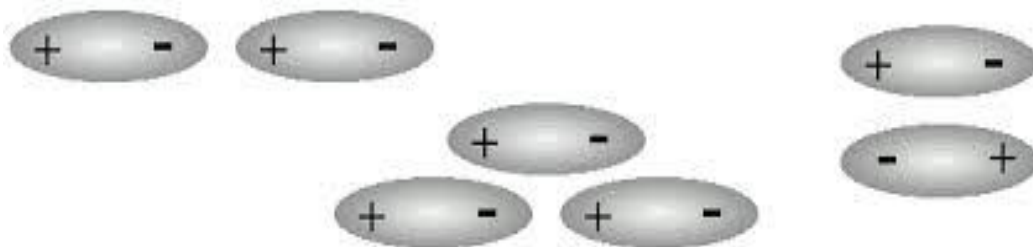
Dispersion force

Keesom forces

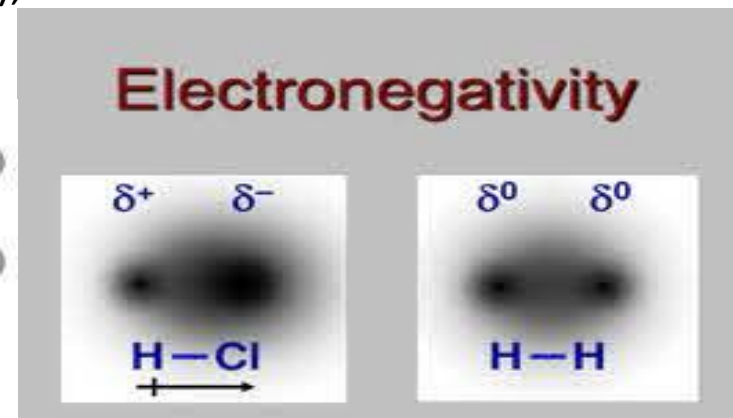
Keesom forces occur between polar molecules in which the permanent dipoles interact with one another (**dipole-dipole interactions**) or (**orientation effect**).

Polar molecules have polar covalent bonds which are unevenly distributed in space due to the difference in the electronegativity of the atoms forming the bond .e.g. HCl.

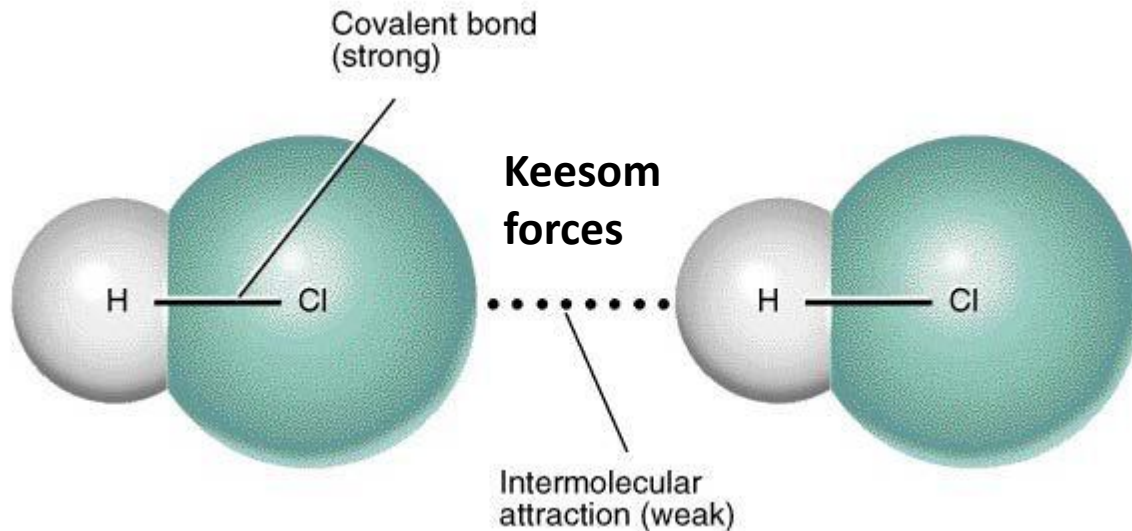
The nucleus of the chlorine atom pulls the electron pair involved in the chlorine hydrogen bond closer to itself and creates a permanent partial positive charge on the hydrogen and a permanent partial negative charge on the chlorine (**Permanent dipole**),



Attractive Dipole-Dipole Interactions



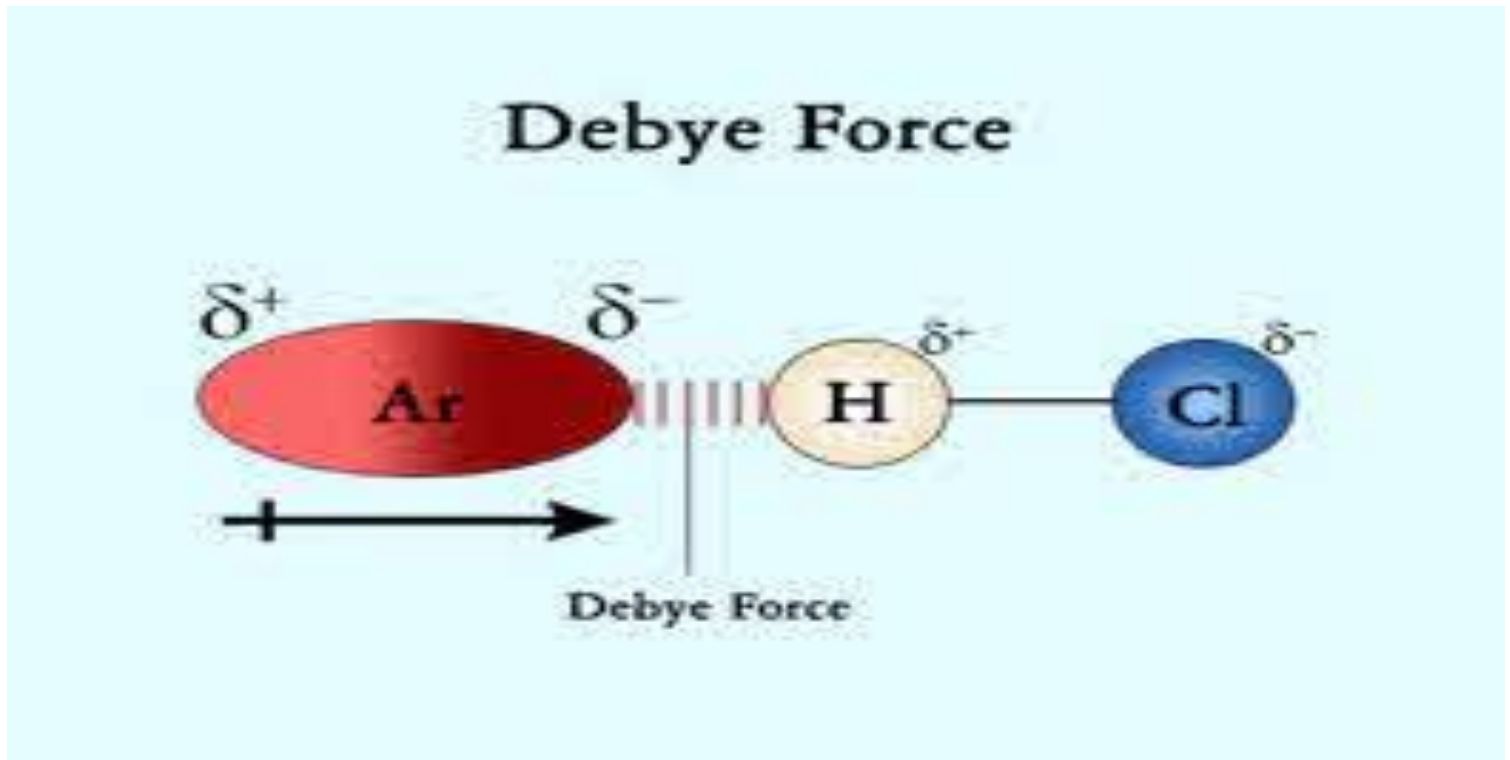
The Partial opposite charges (permanent dipoles) attract one another(**dipole-dipole interactions**)

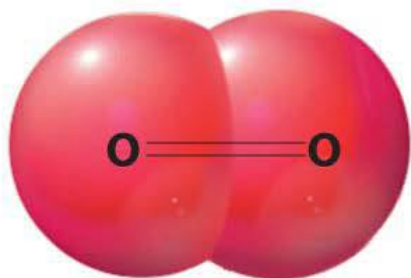


The dipole-dipole forces increases as the polarity of the molecule increases .Keesom forces are much weaker than ionic bonds because the charges involved in bonding are partial

Debye forces

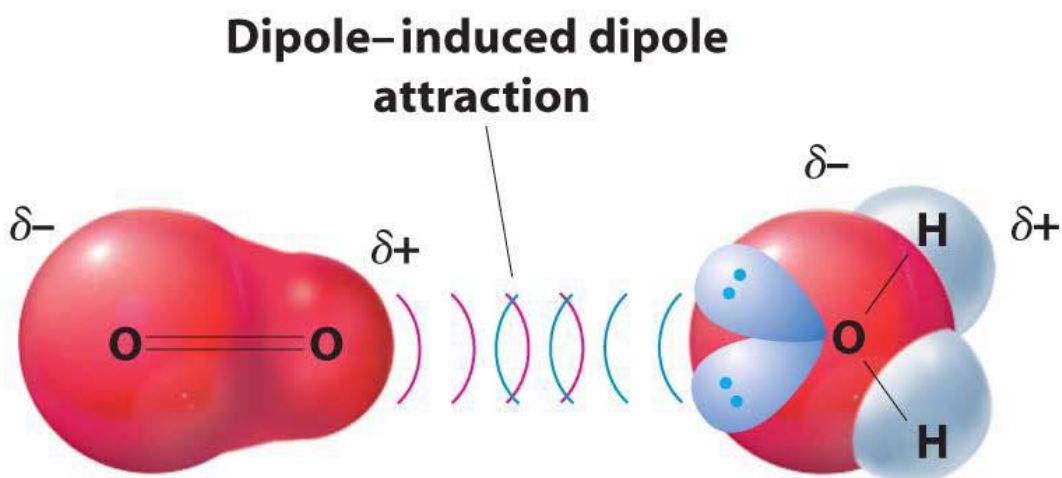
Debye forces occur between a polar and a non polar molecule in which the permanent dipole in the polar molecule induce an electric dipole in the non polar one (**dipole-induced dipole interactions**) or (**induction effect**). e.g. water and oxygen





**Isolated oxygen molecule
(nonpolar)**

(a)



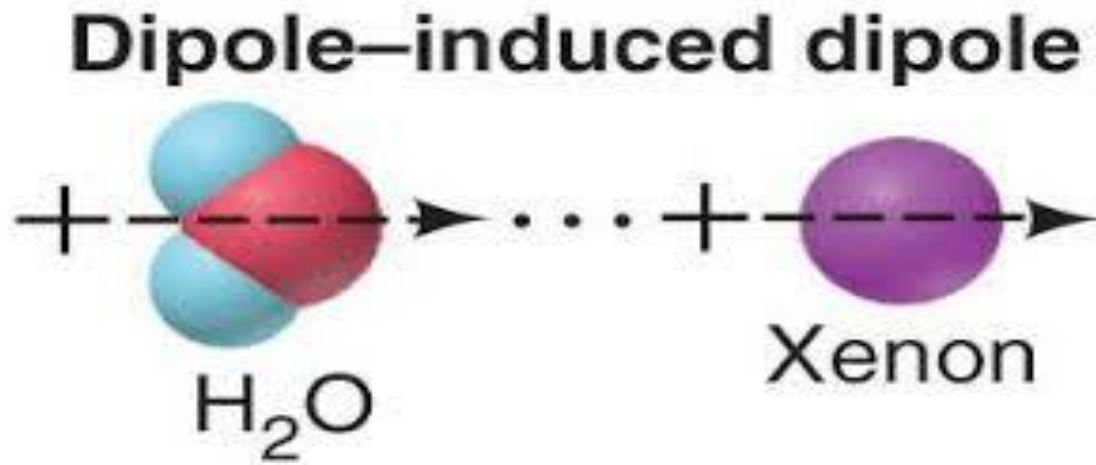
**Induced dipole
(oxygen molecule)**

(b)

**Permanent dipole
(water molecule)**

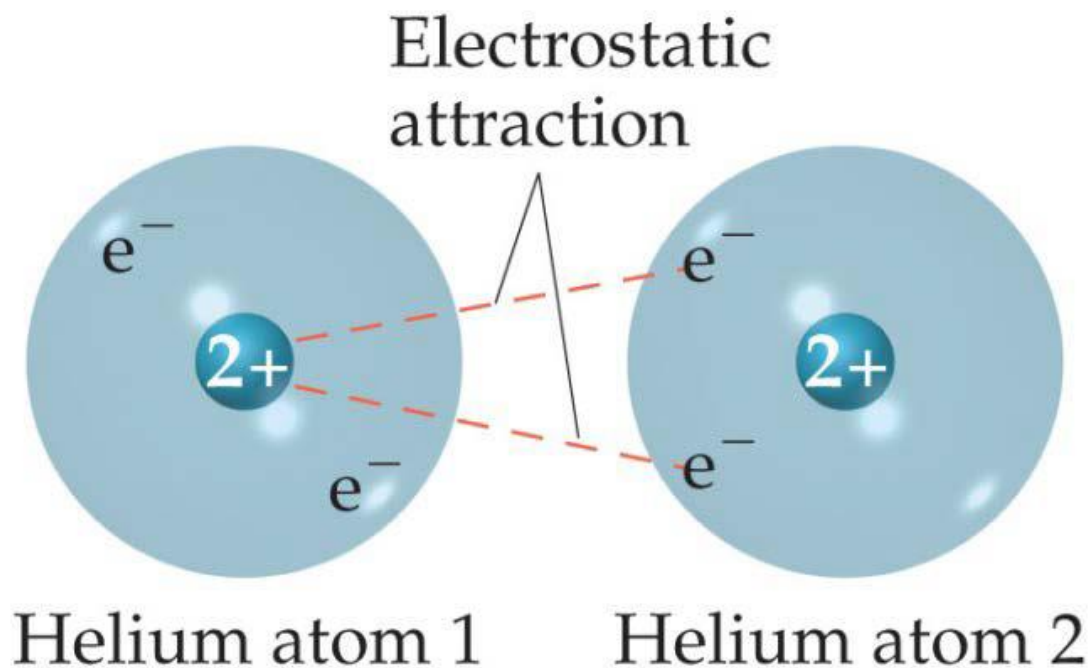
The strength of **Debye forces** increases with the ease of distortion of the electron cloud of the nonpolar molecule (i.e. polarizability of the molecule)

Debye forces is weaker than Keesom forces because the dipole in the nonpolar molecule is temporary (induced) and forms only when the two molecules are extremely close to each other

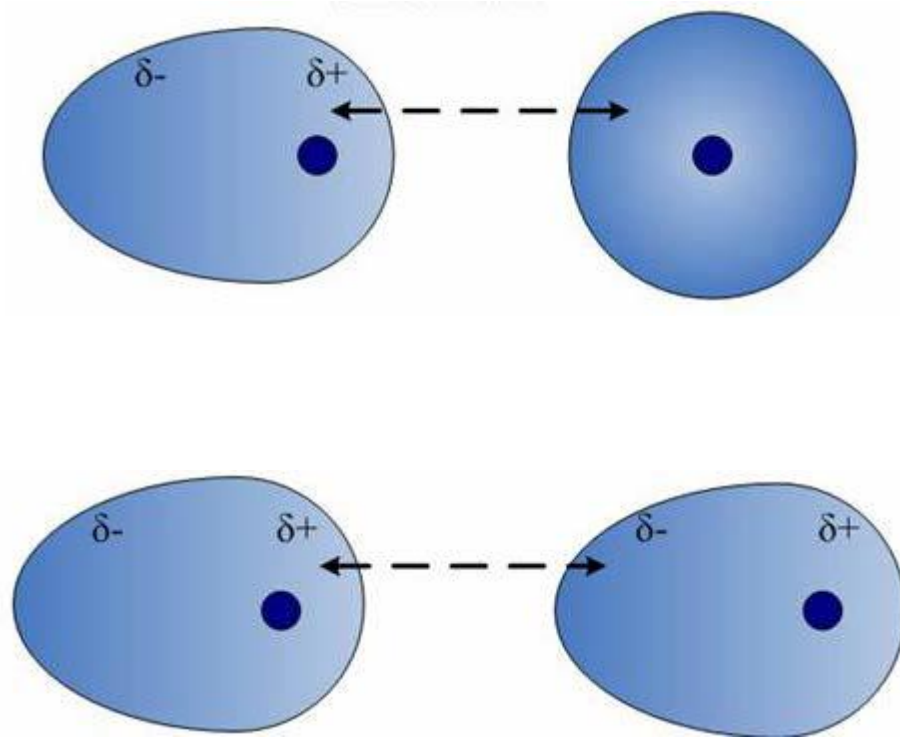


London forces

London forces occur between two nonpolar(neutral)molecules in which molecules can induce polarity on each other(**induced dipole-induced dipole interactions**)or(**dispersion effect**).e.g. Helium

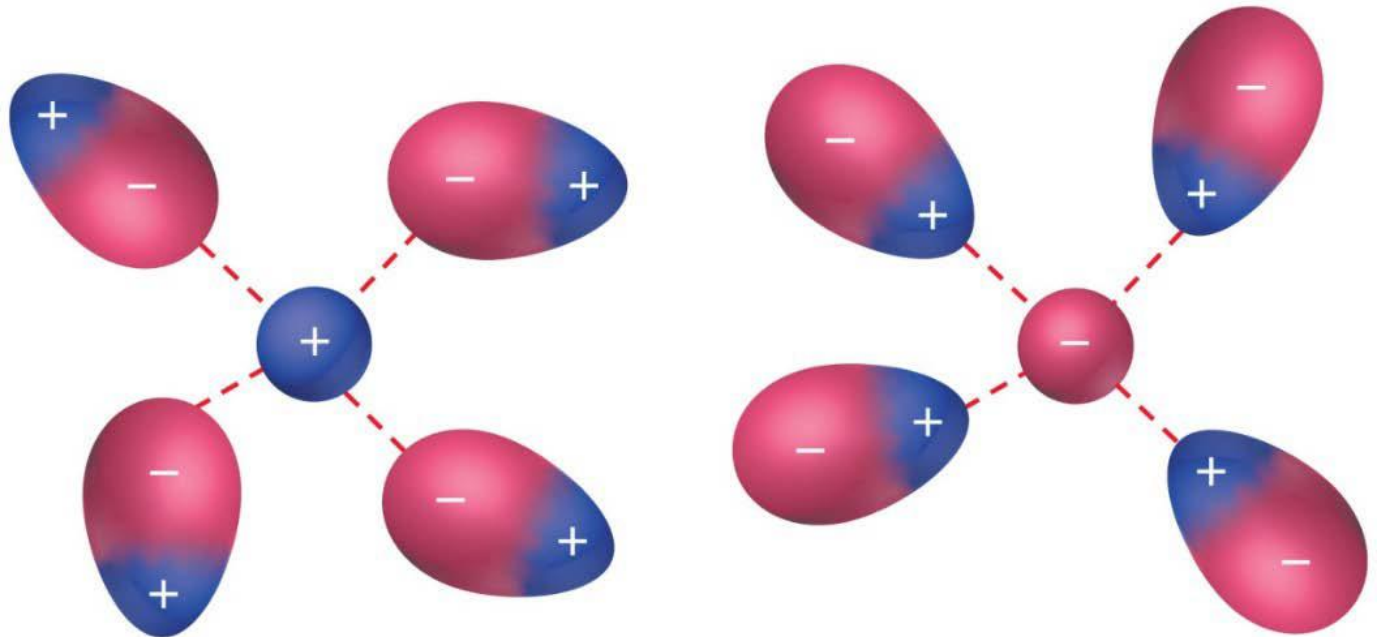


Two Helium atoms are nonpolar and possess no dipoles. The average distribution of electrons around each nucleus is spherically symmetrical.



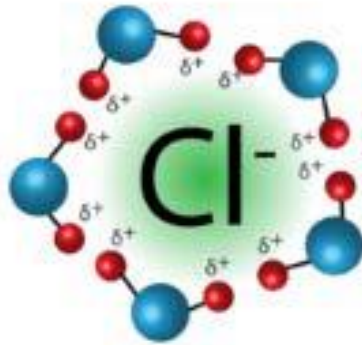
2- Ion-dipole interaction

An **ion-dipole interaction** is the result of an electrostatic **interaction** between a charged **ion** and a molecule that has a **dipole**. It is an attractive force that is commonly found in solutions, especially **ionic** compounds dissolved in polar liquids.

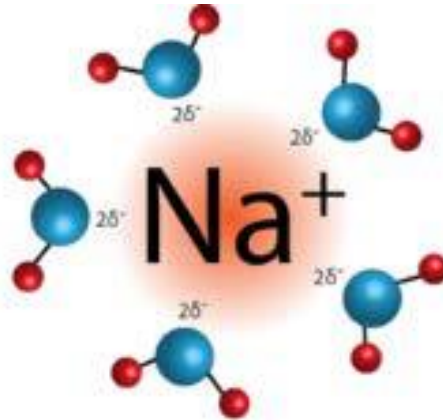


Cation–dipole attractions

Anion–dipole attractions



Slightly positive hydrogen are attracted to chlorine anions



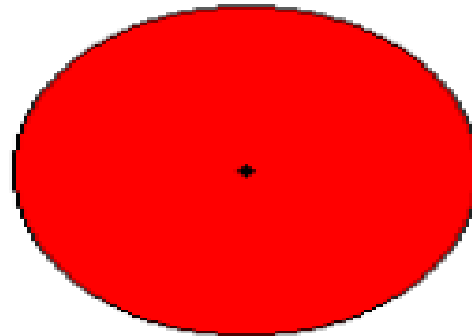
Slightly negative oxygen are attracted to sodium cations

3-Ion-induced dipole interaction

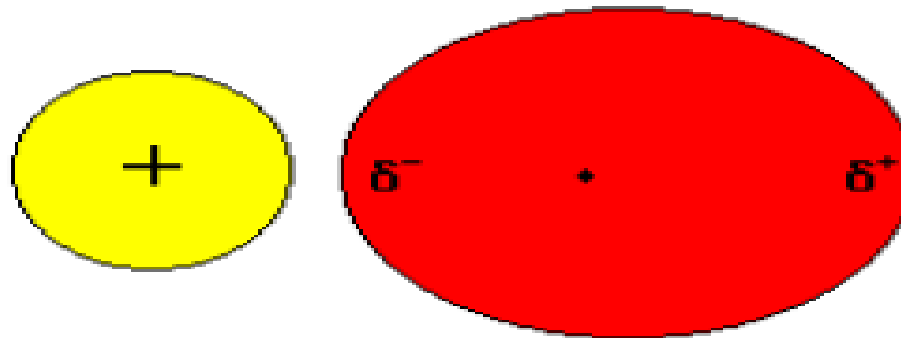
Ion Induced dipole forces occur between a **charged ion** and a **nonpolar** molecule.

These forces result when the approach of an ion induces a dipole in an atom or in a nonpolar molecule by disturbing the arrangement of electrons Ion-induced dipole forces are presumably involved in the formation of the iodide complex





**Spherical atom with no dipole.
The dot indicates the location
of the nucleus.**

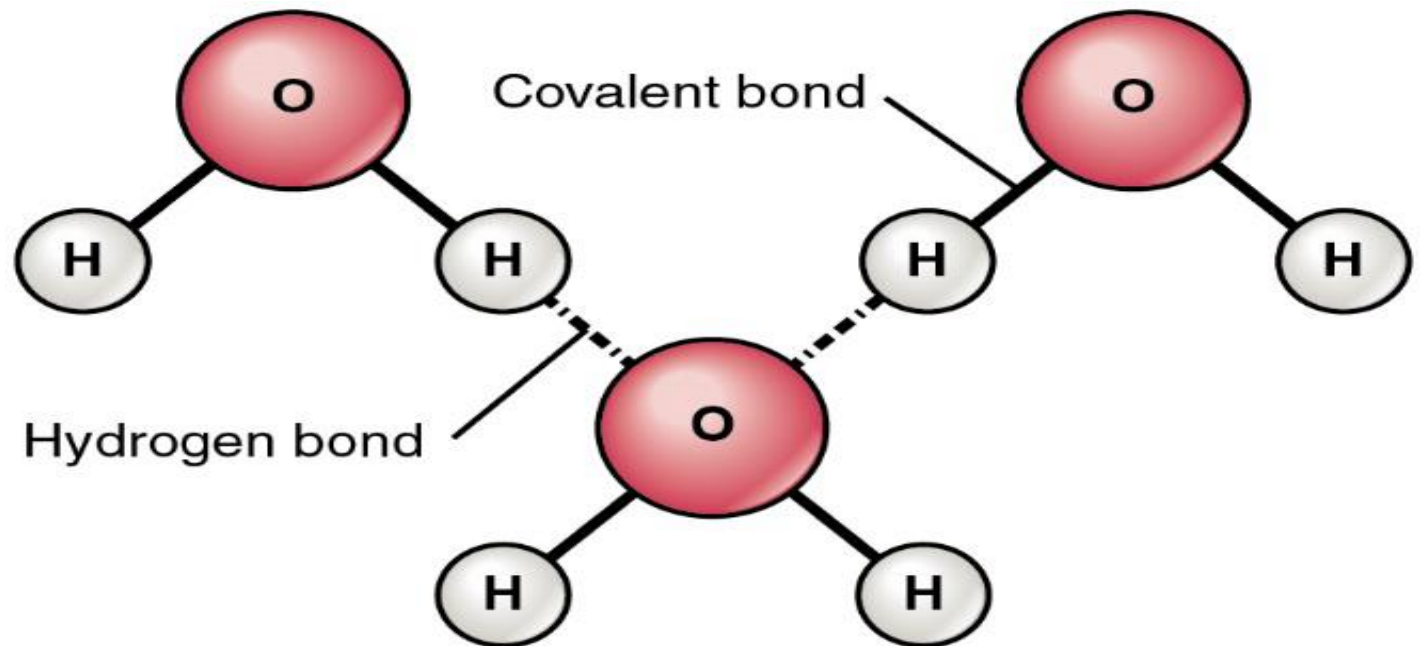


**Upon approach of a charged ion,
electrons in the atom respond and
the atom develops a dipole.**

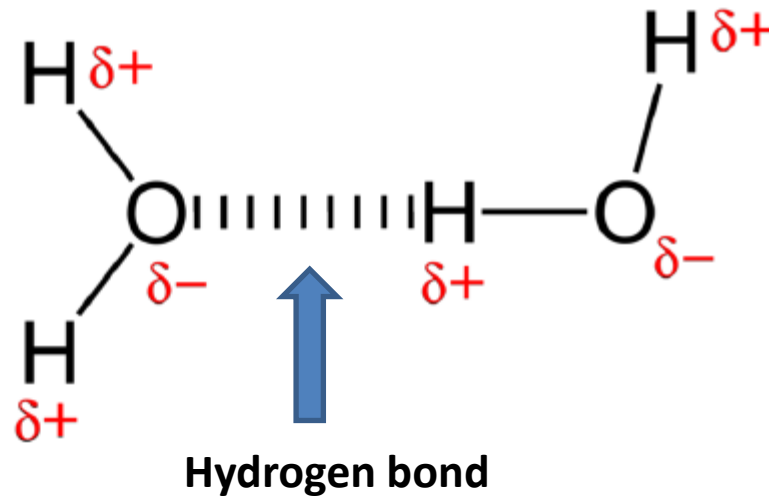
4-Hydrogen bond

Hydrogen bond is a strong type of dipole-dipole interaction that occurs between a molecule containing a hydrogen atom and a strongly electronegative atom such as fluorine, oxygen, or nitrogen

In order to create the bond, the hydrogen atom must be covalently attached to another electronegative atom



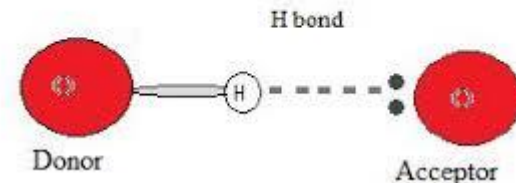
In a **water molecule** ,the hydrogen has single electron is pulled by the covalently attached oxygen atom ,creating a naked nucleus on the side of the hydrogen atom facing away(partial positive charge).



Hydrogen bonds are responsible for many unusual physical properties of water including

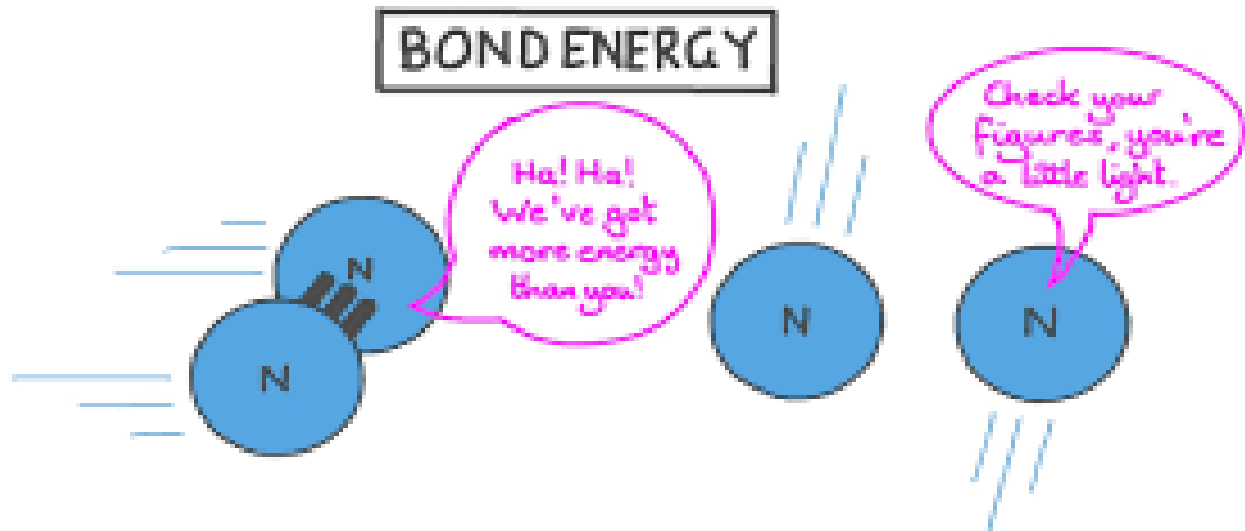
- ✓ it's abnormally low vapor pressure ,
- ✓ high boiling point ,and the
- ✓ greater volume of ice water.

Hydrogen bonding is stronger than all VanderWaals intermolecular forces (they are given their own classification) ,but are still weaker than ionic and covalent bonds



➤ Bond energy

Bond energy is a measure of bond strength. It is the heat required to break one mole of molecules into their individual atoms.



Thank you

