ARJUNA NEET BATCH

States of Matter

LECTURE - 1

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→ Solid State ⟶ XII ⟶ 1^{st} chapter

→ Liquid State

→ Gaseous state ⟶ XI → 5^{th} Chapter

Objective of today's class

INTERMOLECULAR AND INTRAMOLECULAR FORCES

Bond

Force of attraction

INTRAMOLECULAR FORCES > INTERMOLECULAR FORCES

→ Covalent Bond

→ Ionic Bond

① ion-Dipole Forces

Dipole-Dipole

③ ion-induced Dipole

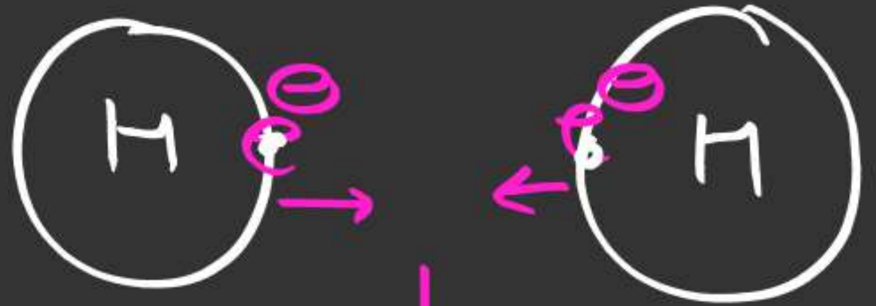
Dipole-Dipole.

⑤ induced-dipole-induced dipole Forces

Intramolecular Forces

$_1H$

→ Covalent Bond



$\boxed{H \overset{\uparrow\downarrow}{—} H}$

$2e^{-}$

Non-Polar

→ Ionic Bond

A^+ B^-

$\boxed{A \overset{\uparrow\downarrow}{—} B}$

$_{11}Na$ → 2, 8, 1

$_{17}Cl$ → 2, 8, 7

→ $Na^+ \leftrightarrow Cl^-$

Polar → Dipole

$H \longrightarrow H_2$

$O \longrightarrow O_2$

$He \longrightarrow He_2 \longrightarrow X$

Di - pole

↓ ↓

2 different charge

(+ , −)

or

$\boxed{\text{POLAR}}$

⇒ Electronegativity

→ tendency of an atom to attract shared pair of $e^{\ominus}$.

$\overset{\delta+}{H} - \overset{\delta-}{Cl}$ → Polar molecule

→ Yes Dipole is present

L → R (Along the period) → $EN^{\ominus}$ ↑

Down the gp → EN ↓

* Intermolecular Forces

① ion-Dipole FORCES > ② Dipole-Dipole Forces > ③ ion-Induced Dipole Forces > ④ Dipole-induced Dipole Force > ⑤ Induced Dipole-Induced Dipole Forces

① ion-Dipole Forces

$\overset{-}{Cl}$ ⋯ $\overset{\delta+}{H}-\overset{\delta-}{Cl}$

ion — Dipole

↓

Force of attraction

② Dipole-Dipole Forces

$\overset{\delta+}{H}-\overset{\delta-}{Cl}$ ⋯ $\overset{\delta+}{H}-\overset{\delta-}{Cl}$

↓

Force of attraction

D–D → FOA

③ ion-Induced Dipole Forces

$\overset{-}{Cl}$ ⋯ $\overset{\delta+}{H}-\overset{\delta-}{H}$

$e^{\ominus}$ $e^{\ominus}$

↓

ion-Induced Dipole

④ Dipole-induced Dipole Force

$\overset{\delta+}{H}-\overset{\delta-}{Cl}$ ⋯ $\overset{\delta+}{I}-\overset{\delta-}{I}$

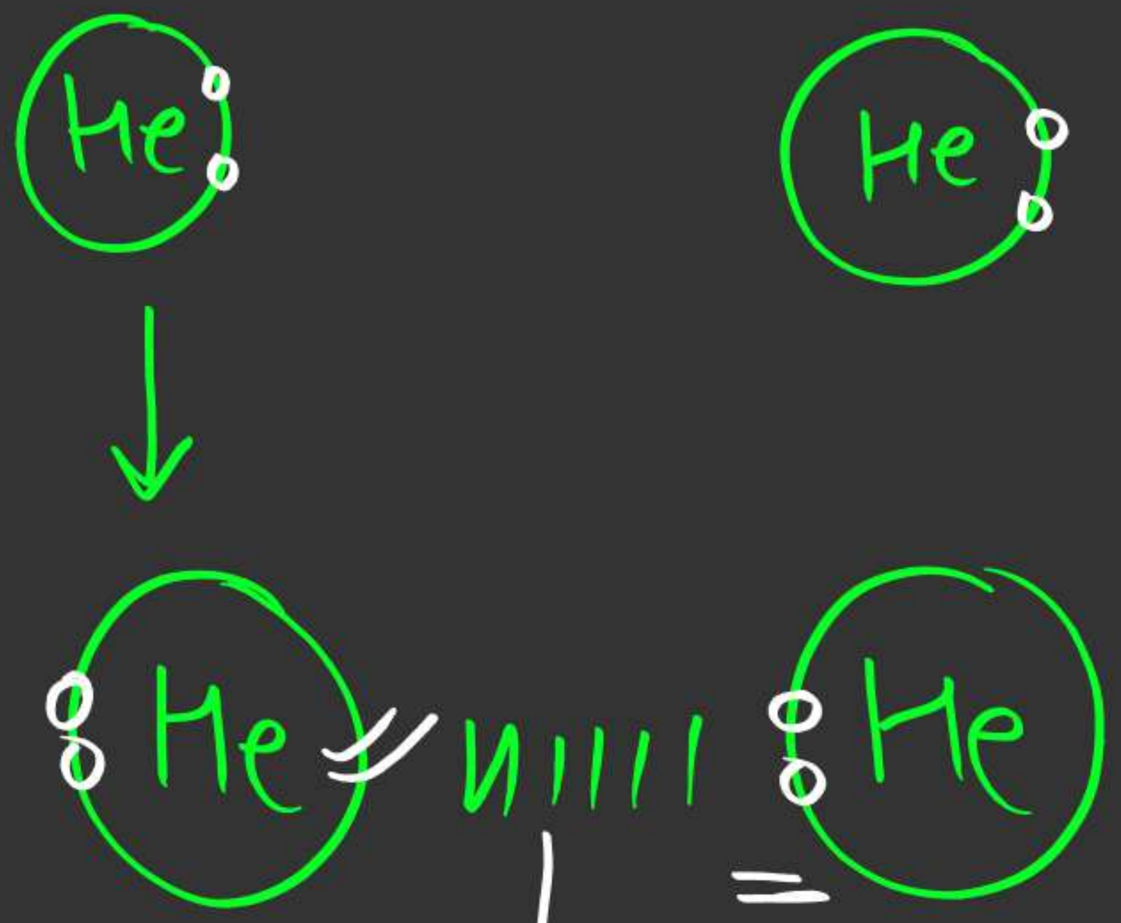
↓

Dipole-induced dipole force

⑤ Induced Dipole-Induced Dipole Forces

H–H H–H

(5) Induced Dipole-Induced-Dipole FOA



H–H ||||||| H–H

δ^+ δ^-

Dispersion forces or London forces or induced dipole-induced dipole force

Q. Arrange the following in ↓ing order of forces?

1) $Cl^{\ominus}$ $\overset{\delta+}{H}-\overset{\delta-}{Cl}$ > Br^- $H-H$ > $O-O$ $O-O$

ion Dipole > ion-induced dipole > O_2 O_2 induced - induced dipole dipole

2) $H-Cl$ $H-Cl$ > Cl^- CCl_4 > H_2 HBr

Dipole Dipole > ion Non-Polar > induced Dipole Dipole

→ ion-induced dipole

FOA

1)

Intramolecular Forces

- Intramolecular forces are the chemical forces that operate by the formation of bonds between the atoms to form molecules. Example : Ionic bond, Covalent bond.

Eg ⇒

- Covalent bond formation in H_2 molecule → Covalent bond $H \overset{\uparrow}{—} H$

Eg ⇒

- Ionic bond formation in NaCl molecule → $Na^+ \cdots\cdots Cl^-$ ↓ Ionic bond

2)

Intermolecular Forces

Intermolecular forces: (Forces that exist between molecules)

- ❖ Intermolecular forces are the physical forces or just the interactions which act between the neighbouring bonded molecules.
- ❖ The intermolecular forces are weaker than the intramolecular forces.
- ❖ The forces of attraction and repulsion between the interacting particles (atoms and molecules) are called intermolecular forces.
- ❖ These are the electrostatic forces of attraction that exist between an area of negative charge on one molecule and an area of positive on a second molecule.

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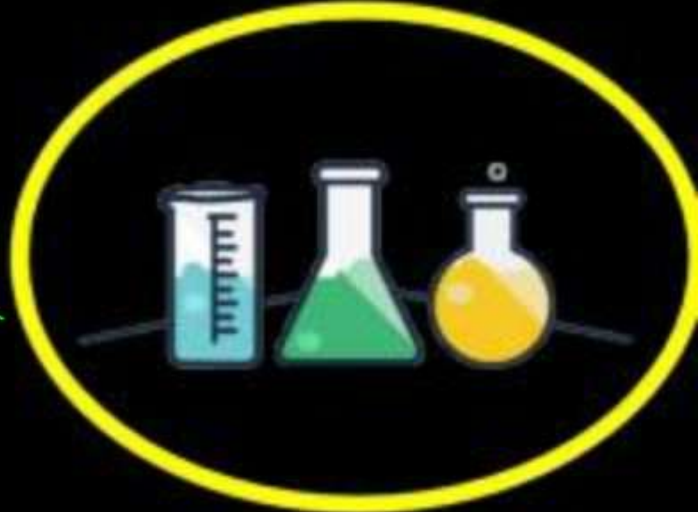
(1)

Dispersion Forces or London Forces

or induced-dipole — induced dipole Forces

Dispersion Forces or London Forces: (Associated with NON POLAR structures)

- These forces are present in non-polar molecules like H_2, O_2 and N_2 and also in nonpolar monoatomic molecules such as noble gases like He, Ne, Ar etc. Which exist with intermolecular forces and no bonding at all.
- These non-polar molecules are electrically symmetrical, so there is no dipole moment.
- (But sometimes the temporary dipoles can be formed.



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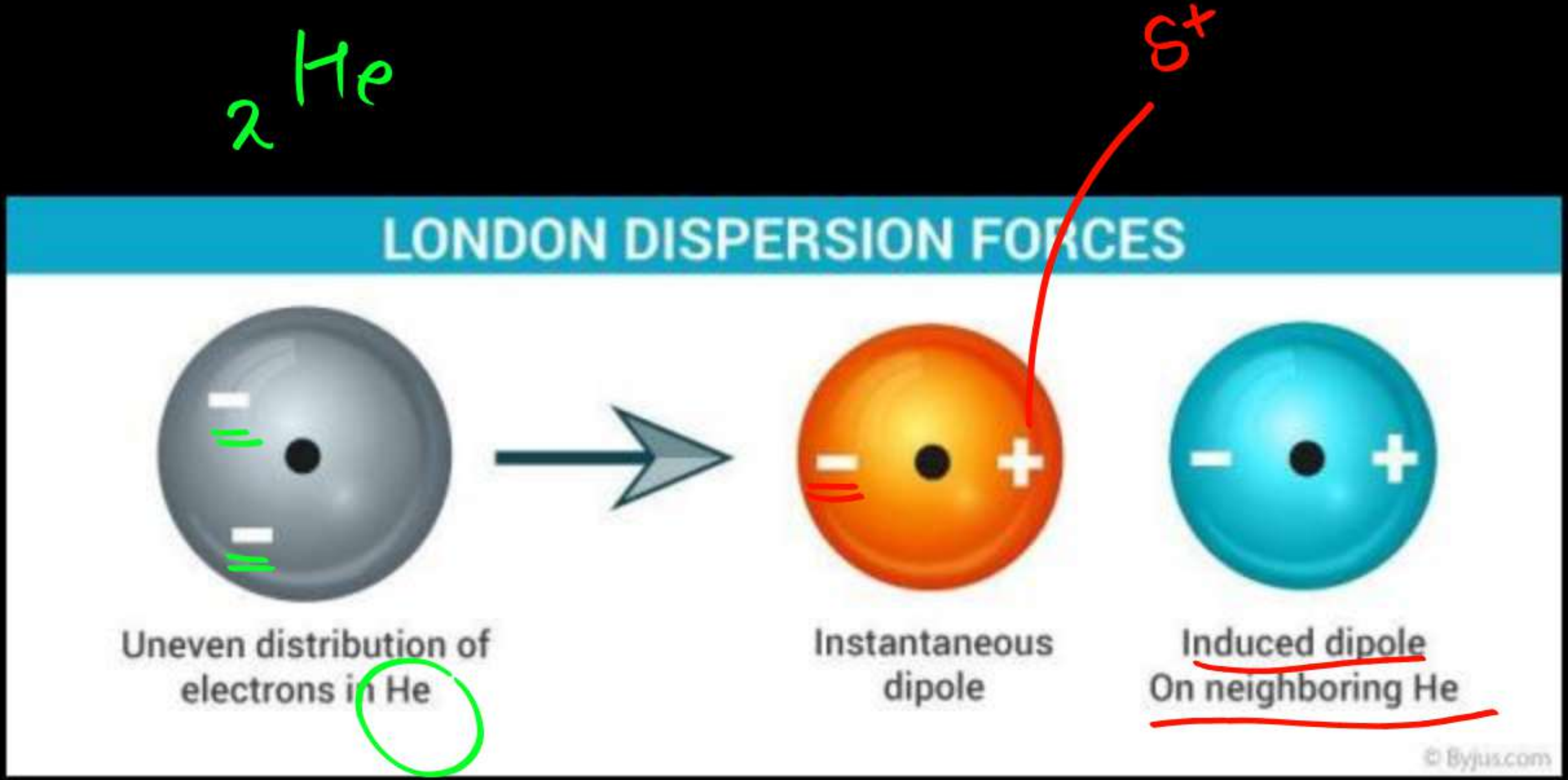
$_2He$


LONDON DISPERSION FORCES
Uneven distribution of electrons in He
Instantaneous dipole
Induced dipole On neighboring He
© Byjus.com
δ^+

He He

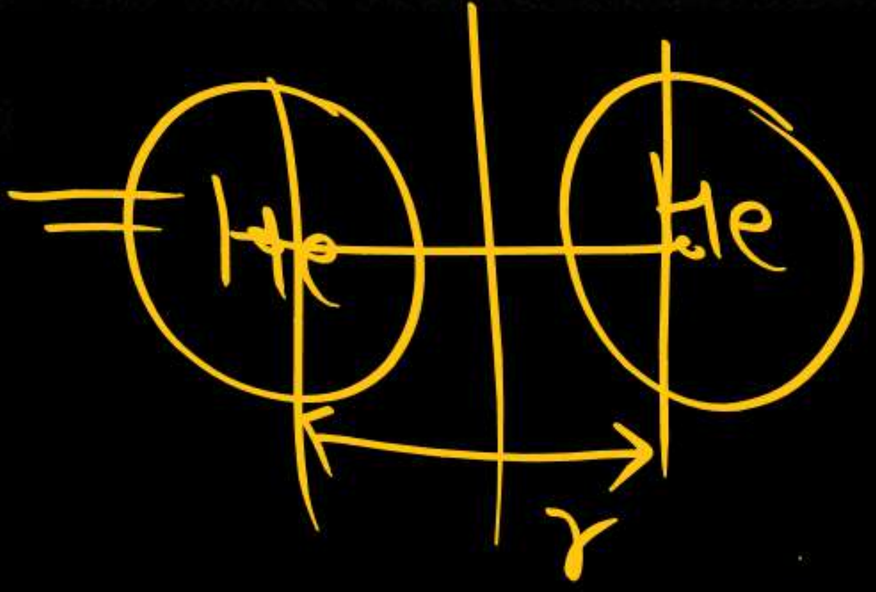
- The electrons of a neutral molecule keep on oscillating with respect to the nuclei of the atoms.
- As a result of this, at a given instant, positive charge may be concentrated in one region and the negative charge in another region of the molecule.
- Thus the non polar molecule develops momentarily dipole due to unsymmetrical electronic charge distribution.
- This polarized molecule distorts the electron density of the neighbouring molecule and dipoles are developed in the neighbouring molecule. These interactions are therefore also known as induced dipole induced dipole interactions.

- The attraction between the two oppositely charged ends of the two neighbouring molecules attract each other and this type of force of attraction is called **London Force** after the name of the German Physicist Fritz London who proposed this type of force of interaction. This force is also known as **dispersion force**.

- London forces are attractive in nature and the interaction energy is inversely proportional to the sixth power of the distance between the two interacting particles.

- Interaction energy $\propto \frac{1}{r^6}$ where r is the intermolecular distance between two interacting particles.

$$\boxed{I.E. = \frac{1}{r^6}}$$



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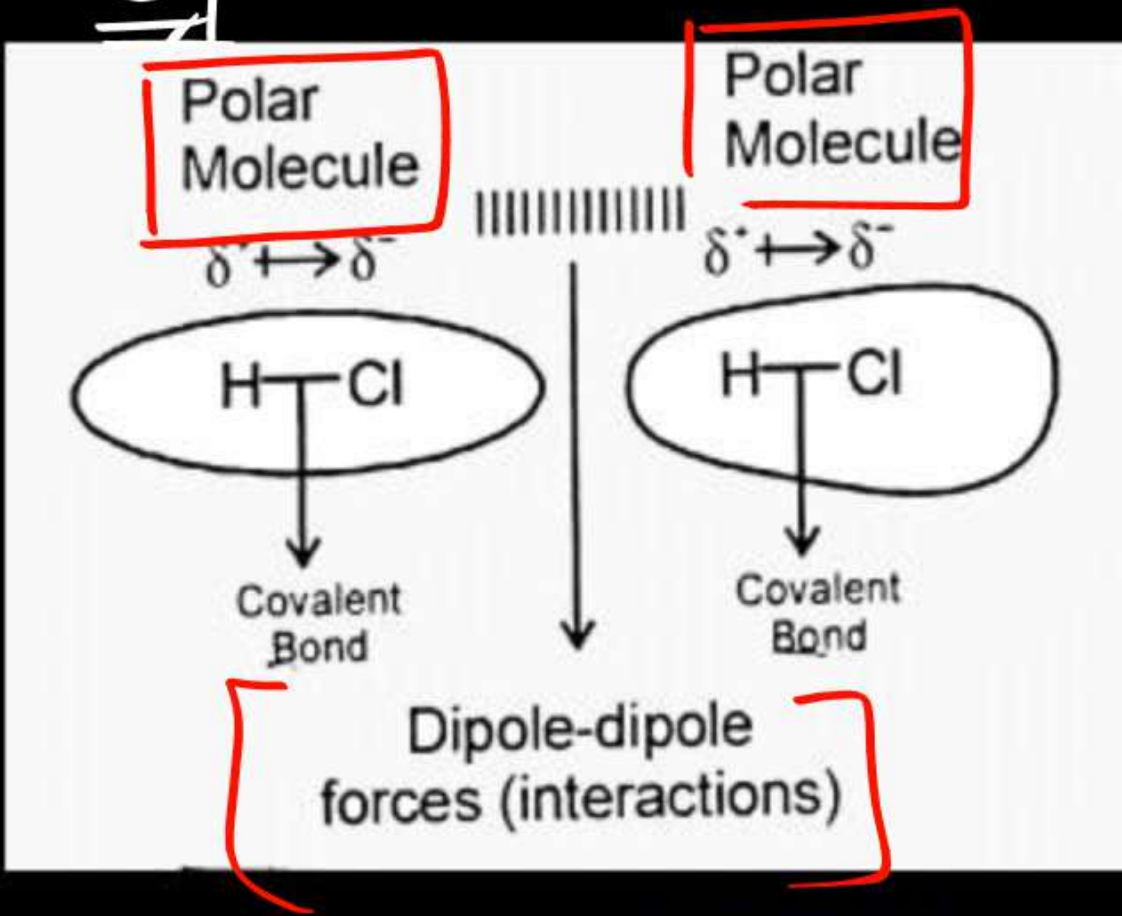
Dipole-Dipole Forces

Dipole-Dipole Forces: (Associated with POLAR structures)

- Polar molecules have a partially positive side and partially negative side or a dipole.
- Dipole-dipole forces operate between the molecules which are though neutral but posses permanent dipole.
- The separation of partial charges depends upon the electronegativity of the bonded atoms in a molecule.

Eg



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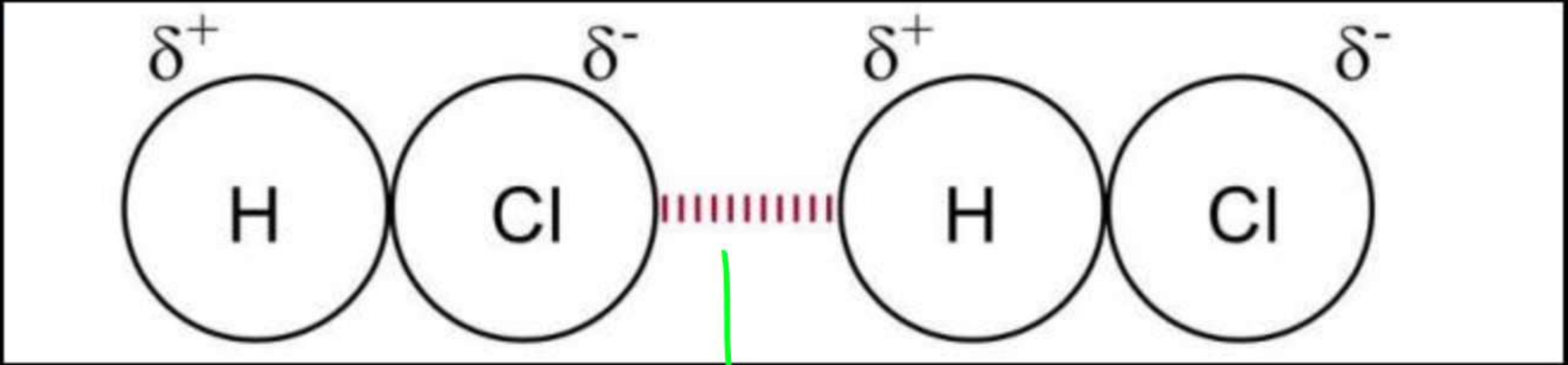
- Dipole-Dipole forces are present between the two HCl molecules.
- Chlorine being more electronegative pulls the shared pair of electrons towards itself.

Eg:-



D-D

Stationary polar molecules

Dipole-dipole Interaction energy is inversely proportional to the third power of the distance between stationary polar molecules (in solids)

$$\boxed{\text{Interaction energy} \propto \frac{1}{r^3}}$$

Rotating polar molecules

- Dipole-dipole Interaction energy is Inversely proportional to the sixth power of the distance between the rotating polar molecules (like water)

$$\boxed{\text{Interaction energy} \propto \frac{1}{r^3}}$$

- Dipole-dipole forces are stronger than the London forces because permanent dipoles are involved but weaker than the ion-ion interaction because partial charges present in the polar molecules are always less than the unit electronic charge (1.6×10^{-19}C) present on the ions.

❖ The magnitude of this type of interaction depends upon the dipole moment of the molecule concerned. The greater is the dipole moment, the greater is the dipole-dipole interaction.

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$H-Cl^{\ominus}$ $\quad$ $^{\delta+}I \ggg I^{\delta-}$

Dipole-induced Dipole Forces

Dipole-induced Dipole Forces : (Between a polar and a non-polar molecule)

- This type of forces operate between a polar molecule which has a permanent dipole and a non-polar molecule whose electron density is symmetrical. A polar molecule may sometimes polarise a non-polar molecule thereby deforming its electronic cloud which lies in its vicinity. So, in this manner it induces the di-polarity in the non polar molecule.

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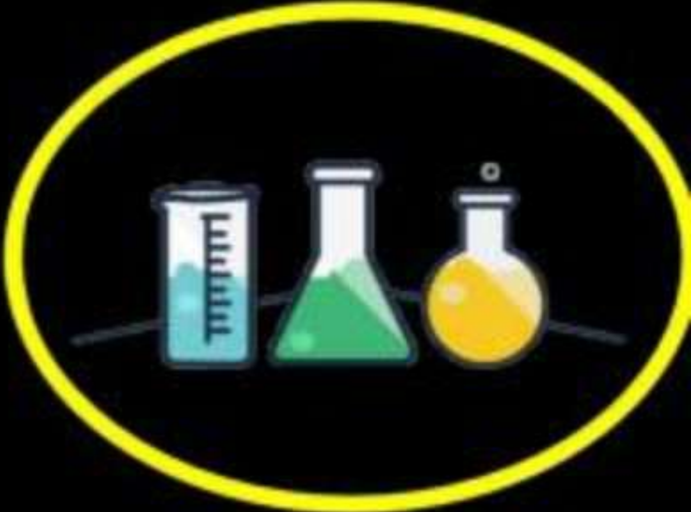
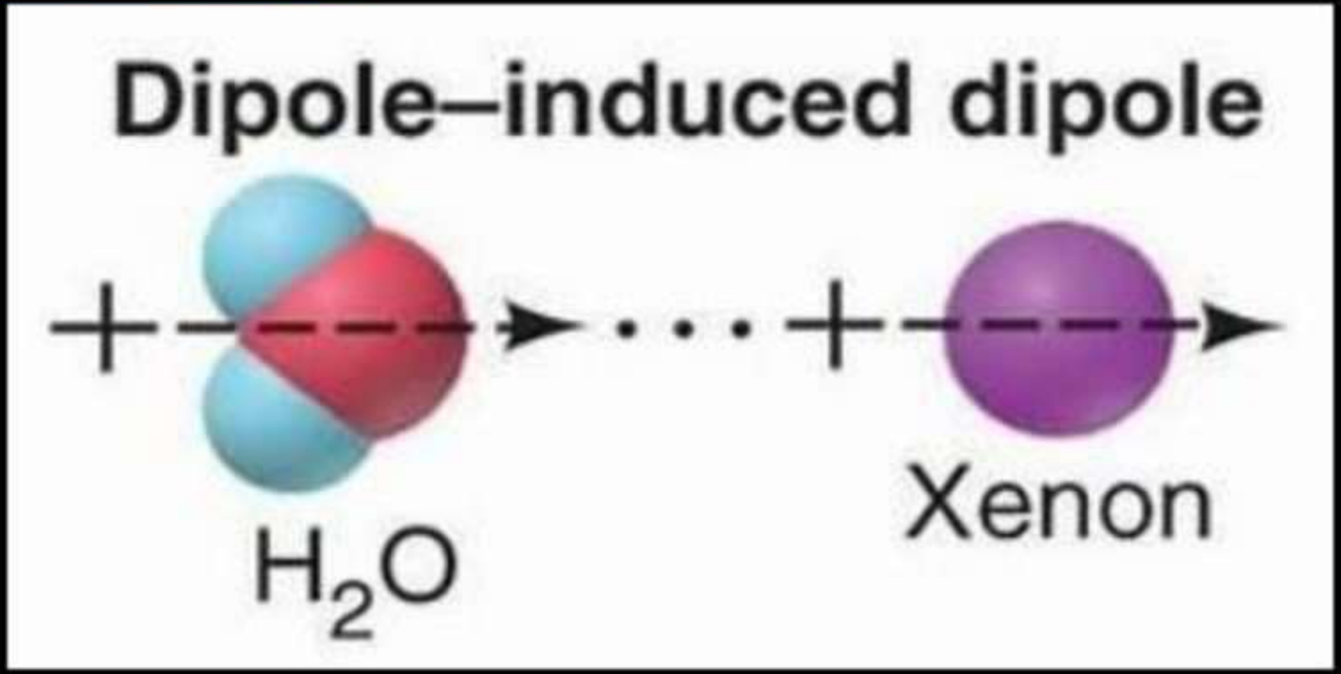


Interaction Energy

$\frac{1}{r^3}$

Interaction Energy is Inversely proportional to the sixth power of the distance between the two molecules.

$$\boxed{\text{Interaction energy} \propto \frac{1}{r^6}}$$



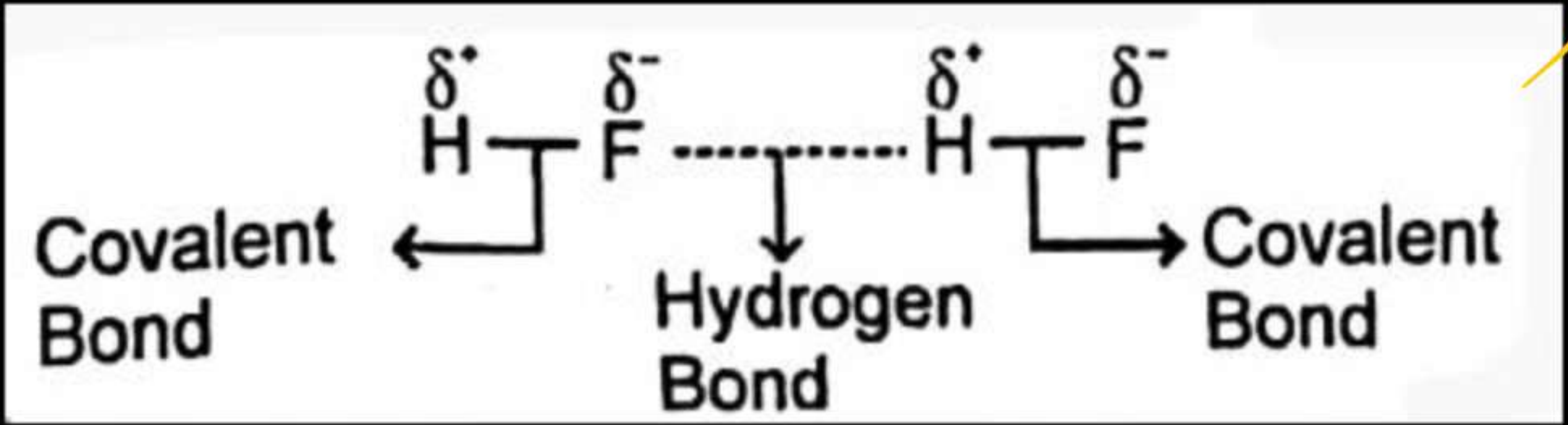
Dipole Moment / Polarisability

The induced dipole moment depends upon mainly on two factors :

- **Dipole Moment** : Present in the permanent dipole (polar molecule)
- **Polarisability** of the electrically neutral molecule (Non-polar molecule). Molecules of larger size get polarised easily, thereby strength of attractive interactions increases.

Hydrogen Bonding

Hydrogen bonding is a special type of dipole-dipole interaction. But the difference is that for hydrogen bonding there is large difference in the electronegativity of the covalently bonded atoms. That means hydrogen bonds are formed between the highly polar N–H, O–H and H–F bonds. Thus, hydrogen bonding is the force of attraction between the hydrogen atom attached to the highly electronegative atom and the electronegative atom of the other polar molecule. Example H_2O, NH_3, HF etc.



N, O, F ·········· H — F, O, N

∵ Dipole

$\boxed{\text{H-Bonding}}$

Repulsive Forces

Repulsive Forces : The intermolecular forces discussed like London forces, dipole-dipole interactions, dipole Induced dipole interactions and hydrogen bonding are all attractive. But the molecules also exert repulsive forces on one another. When the molecules come very close to each other or just come in contact with each other, then repulsive forces operate between the electron clouds of the two molecules and between the nuclei of two molecules.

thanks
for watching

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