

Experiment - 1

Aim - To determine the surface tension of
 using drop number method

787

⑥ Organic coating \rightarrow Paints, varnishes
 enamels are used as a barrier
 layer to protect metal from corrosion.

Unit - 3Intermolecular forces and Potential Energy Surfaces

Introduction \Rightarrow The forces present between the molecules of the substances are called intermolecular forces.

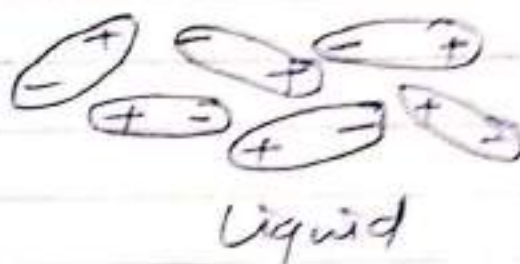
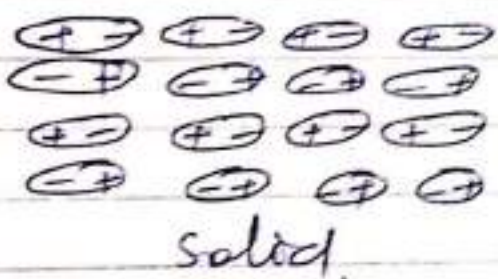
These forces are present in all kinds of molecules. These are also present in non-polar molecules (H_2 , O_2 , CH_4) and also in inert gases

• Types of Intermolecular forces (He, Ne, Ar)

① Dipole-dipole interaction \Rightarrow These are second strongest intermolecular forces. These forces exist between

permanent dipoles. The dipoles tend to align with oppositely charged ends directed at each other.

As permanent dipoles exist only in polar compounds, so these interactions occur only in polar compounds. eg. acetone and dichloromethane.



These forces are also called as Keesom forces.

② Induced dipole- Induced dipole interaction or London or Dispersion forces.

It exists among non polar molecules such as O_2 , N_2 and also in He , Ne , Ar etc.

In 1930, F. London Explains the existence of force of attraction b/w non-polar molecules on the basis of quantum mechanics. Electrons of the neutral molecule keep on oscillating with respect to the nuclei of the atoms. As a result, at a given instant, positive charge may be concentrated in one space and negative charge in another space of the same molecule. Thus, a non-polar molecule may become polarised for a little while, this polarised molecule may induce a dipole moment in a neighbouring molecule with anti-parallel orientation.



original
molecule



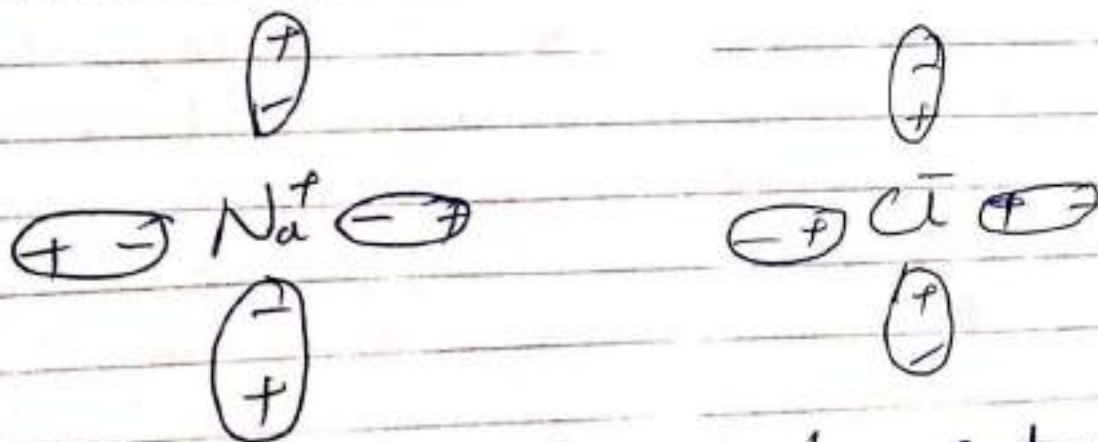
original
dipole due
to electron
oscillation



Induced
dipole

The electrostatic forces of attraction between induced dipoles and the original dipoles are known as London forces or dispersion forces.

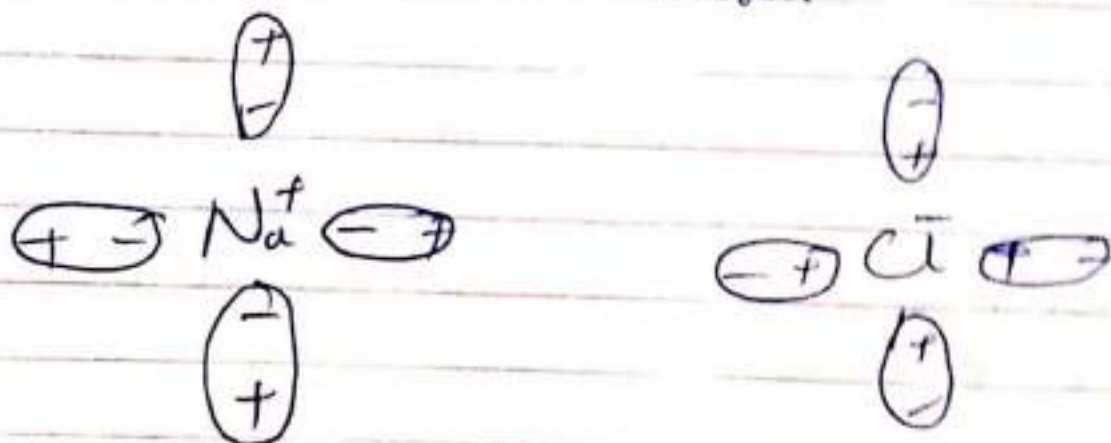
- ③ Ion-dipole forces These are the strongest inter-molecular forces. They occur between the ions formed by dissolving the ionic compound in polar solvents. The negative end of the dipole will be attracted to positive ions and vice-versa.



The magnitude of the interaction between these dipoles and ions depends upon the ionic charges and size of dipoles.

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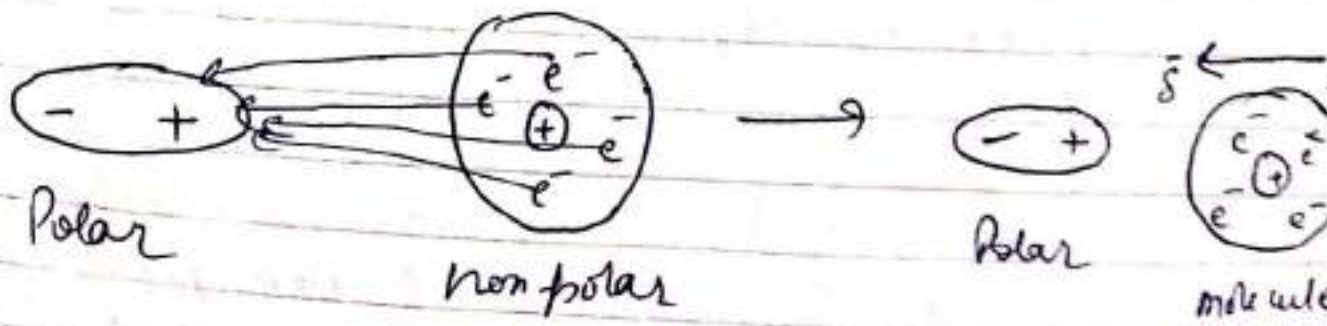


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4.) Ion-Induced dipole interaction :-
 these interaction occurs in between
 an ion and the induced dipole.
 for exp - Benzene dissolved in acetone

Benzene	Acetone
↓	↓
Non polar	Ion (Polar)

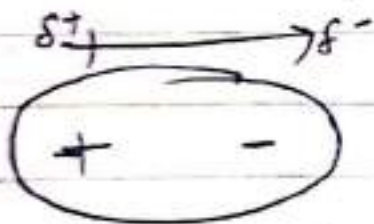
When ion approaches towards non-polar molecule, the symmetrical distribution of a non polar molecule will get distorted because the e⁻s of the non polar molecule will attracted towards the polar molecule



The interaction between two molecule lasts as long as the polar molecule is near the non polar.

⑤ Instantaneous dipole - instantaneous induced dipole forces.

This is temporary. It exists only for a small instant of time. When two noble gases are very close to each other, each atom is uncharged because the e^- distribution is symmetrical. But due to the motion of e^- around the nucleus, it is possible that for the fraction of time, electron distribution is not symmetrical because of the distortion of e^- cloud. As a result a temporary dipole is formed. Called induced or instantaneous dipole.



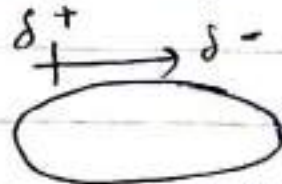
Permanent Dipole.



Permanent Dipole



non-polar



non polar

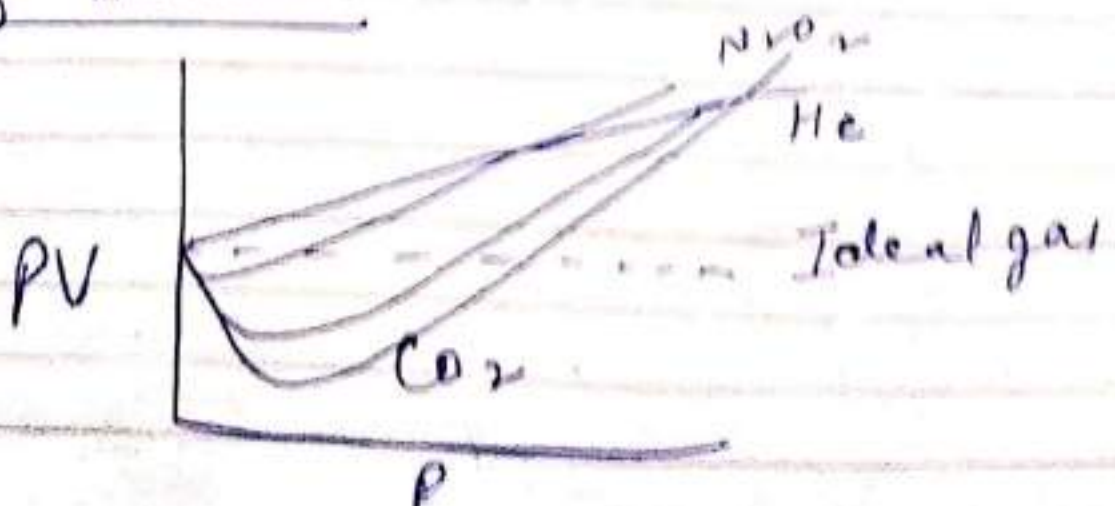
Ideal and Real Gases

Ideal Gases \rightarrow Gases which obey gas equation $PV = RT$ rigidly for all values of temperature T and pressure P are called ideal or perfect gases.

Real Gas \rightarrow Real gas is a gas which obeys the gas laws fairly well under low pressure and high temperature.

Deviations of Real gases from Gas laws (Boyle's law)

Effect of Pressure:-

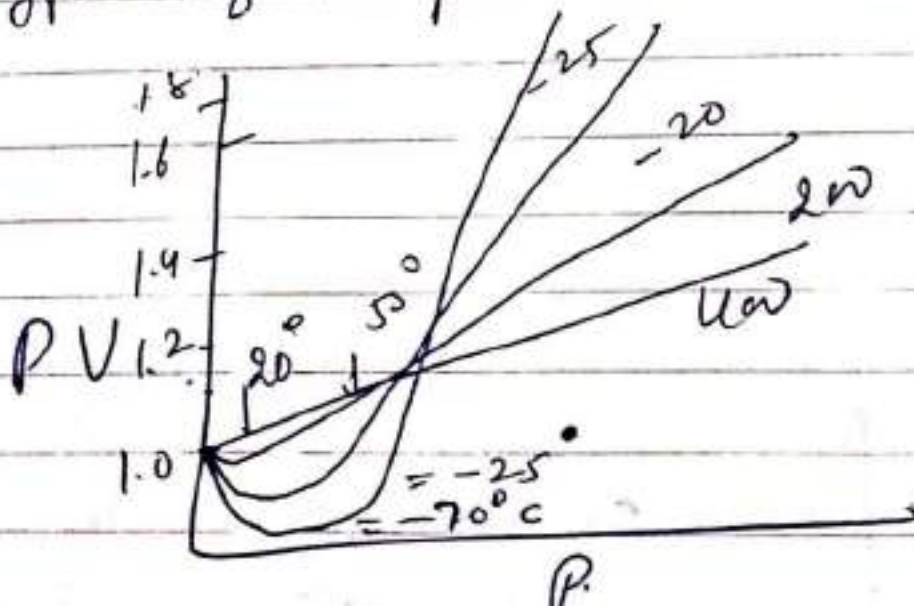


For ideal gas the plot is straight line.
Rest gases in the graph are
real gas. Two types of gases
are there

① Type 1 - Gases like H_2 , He
the value of PV increases with
increasing pressure

② Type 2 - Gases like O_2 , N_2 , CO_2
the value of PV decreases with
increasing pressure

③ Effect of Temperature :-



with the increase in temperature, no deviation occurs.

at low pressure — value of PV for all gases except hydrogen, helium and neon are lower than expected for ideal gas.

at high pressure. — value of PV for all gases including H_2 , He , Ne etc are higher than those expected for ideal gas.

Effect of temp. → At a particular pressure the deviation of a gas from ideal gas at low temperature.

Causes of Deviation from Ideal Behaviour

The failure of ideal gas equation $PV = RT$ over an extensive range of temp. and pressure has been explained by Van der Waal's due to the too wrong or faulty assumptions based on kinetic theory.

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(i) The actual volume occupied by the gas is negligible as compared to the total volume of the gas.

(ii) The molecules exert no inter-molecular attraction among themselves.
But both assumptions are not true. Specially at low temp. and high pressure.

Van der Waal's Equation (Reduced Equation of State)

The gas equation $PV = RT$

Volume Correction:-

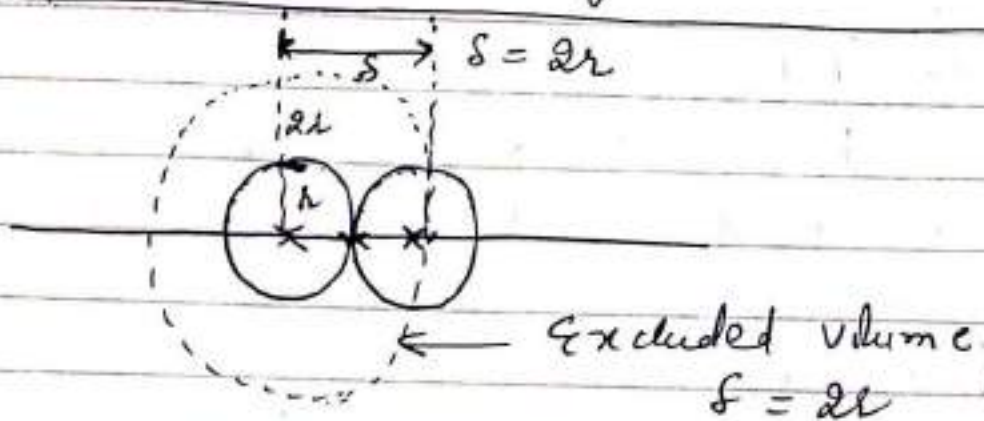
Acc. to Vander waal the actual free space available inside the vessel for the movement of the molecules is not V , the volume of the container, but

Water

b] Apparatus Required \rightarrow Beaker, Turbidity ...

(87)

$(V-b)$, where b is the effective volume of the molecules. Effective volume of the molecules in motion is equal to 4 times the actual volume which is against Kinetic theory.



Let us consider two molecules approaching each other. Let S and r represent the diameter and radius of each molecule. Within a sphere of radius $S = 2r$ no volume will be occupied by pair of molecules.

$$\begin{aligned} \text{Excluded volume per pair of molecule} \\ = \frac{4}{3} \pi (2r)^3 = 8 \left(\frac{4}{3} \pi r^3 \right) \end{aligned}$$

Excluded volume occupied by a single molecule =

$$\frac{8}{2} \left(\frac{4}{3} \pi r^3 \right) = 4V_m$$

(88)

where V_m is the volume of the gas occupied by a single molecule.

Hence excluded volume for a single molecule. $b = 4V_m N$

the corrected volume = $V - b$

① Pressure correction :- Acc to Kinetic

theory there is no intermolecular attraction is not justified at high pressure when molecules are quite close to each other.

Consider particles A and B in the gas. The net force of intermolecular attraction on particle 'A' situated in the interior is zero.

However molecule B just near the boundary is having net attraction