TUT-SHEET (CHAPTER 4)

Q-1: what do u mean by dipole induced -dipoles interaction?

Q-2: Write a short note on following intermolecular force (i) induced dipole – induced dipole and (ii) ion dipole interaction (iii) dipole –dipole interaction (iv) ion-induced dipole interaction

Q-3: Write a short note on London forces? What r the factors which effect the strength of these forces?

Q-4: Derive the vander-waal'S equation of state for real gas including volume & pressure correction .

Q-5: Write down the vander-waal'S equation of state for real gas including volume & pressure correction and discuss the behavior of gas on the basis of such corrections.

Q-6:Discuss the critical temperature ,critical pressure and supercritical fluid.

Q-7: Define (i) critical pressure of gas (ii) critical volume of gas

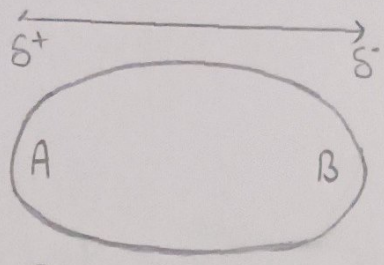
Q-8 : What is excluded volume ? Show that the excluded volume is four times the actual volume of gas .

Q-9 : Define compressibility factor. Briefly explain how real gases show deviations from ideal gas?

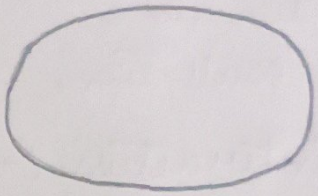
Q-10: Gas have higher compressibility but solids and liquids have poor compressibility. Comment on it.

Q1 What do you mean by dipole induced-dipole Interactions?

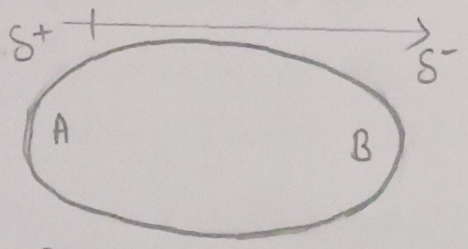
Ans :- A dipole induced dipole interaction is a weak attraction that results when the approach of polar molecule induces a dipole in an atom or in a non polar molecule by disturbing the arrangement of electrons in the non polar species:



Permanent dipole
(a polar molecule)



non polar molecule



Permanent dipole
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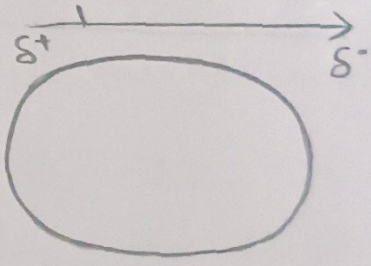


Induced dipole in a non polar molecule

Q2 Write a short note on following intermolecular force

(i) Induced dipole - Induced dipole

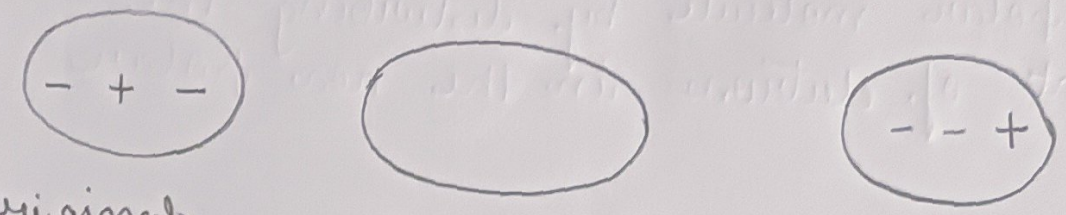
(ii) Ion dipole interaction

(iii) Dipole - Dipole Interaction

(iv) Ion induced dipole interaction

Ans 2:- (i) Induced dipole - Induced dipole :- Electron of neutral molecule keep on oscillating with respect to nuclei At a given instant, positive charge may be

concentrated in one space and -ve charge on another space of the same molecule so a non polar molecule may become polarised for a little while. So the interaction between such molecules is called Induced dipole - Induced dipole interaction.

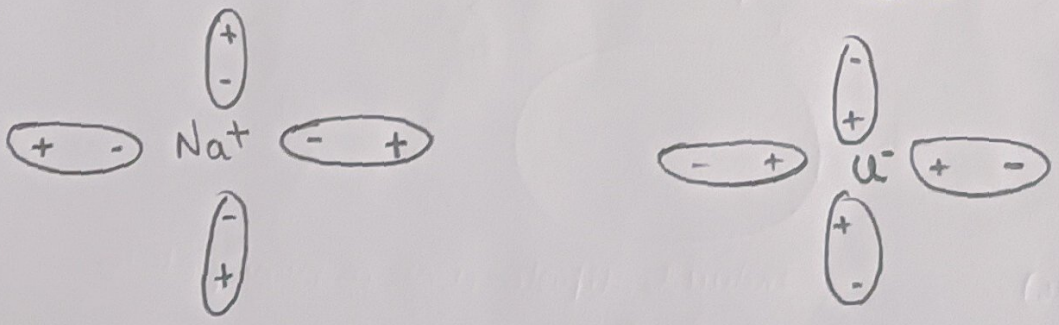


original molecule.

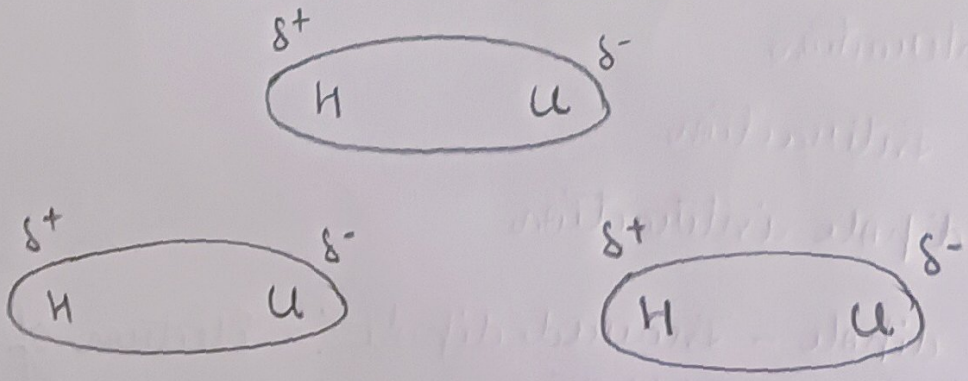
original dipole due to e^- oscillation

Induced dipole

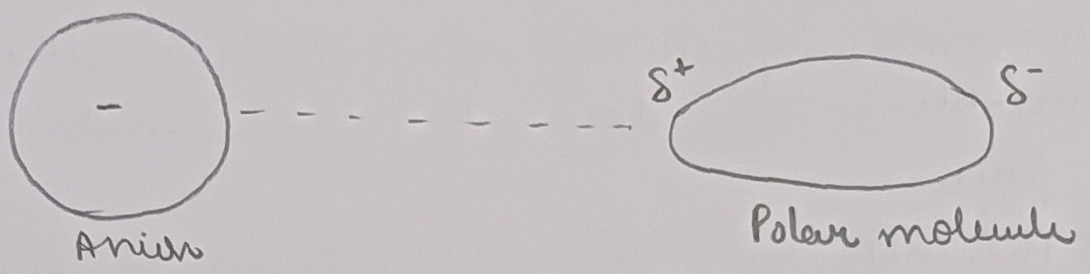
(ii) Ion-dipole interaction :- It occurs between the ions formed by dissolving the ionic compound in polar solvents. The negative end of the dipole will be attracted to -ve ions.

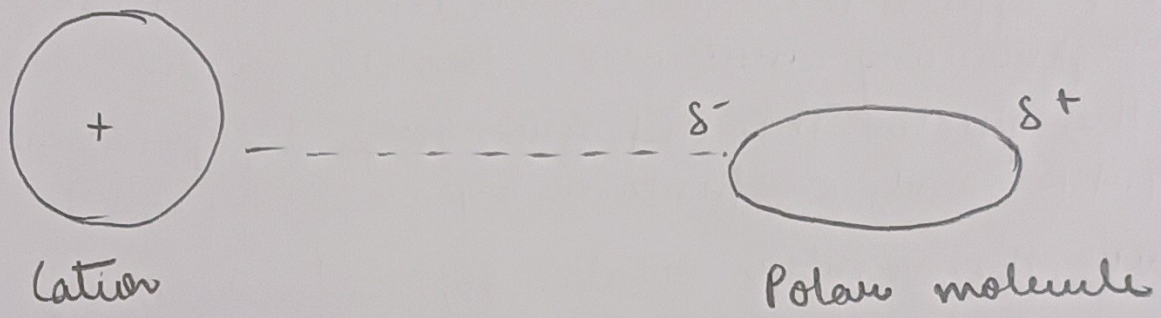


(iii) Dipole - Dipole interactions :- Dipole - Dipole forces are attractive forces between the +ve end of the polar molecule and the negative end of another polar molecule



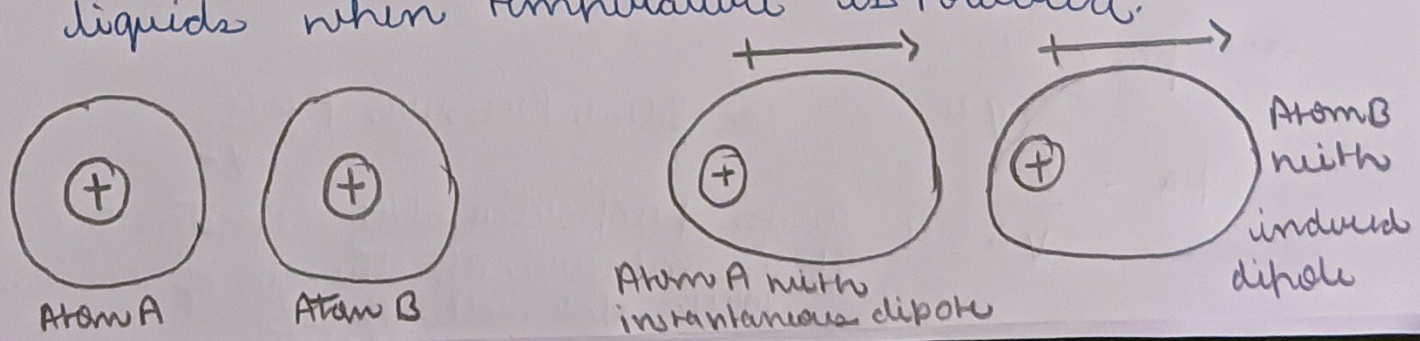
Ion - Induced dipole Interactions :- An ion induced dipole attraction is a weak attraction that results when the approach of an ion - induces a dipole in a non - polar molecule by disturbing the arrangement of e^- in the non polar molecule.





Q3 Write a short note on London forces ? What are the factors which effect the strength of these forces?

Ans 3 London forces are dispersion forces, These arise from temporary variations in electron density of atom and molecules. At any instant, the electron distribution may be unsymmetrical and hence produce an instantaneous dipole. This can cause an induced dipole in the neighbouring molecule and cause the molecule to be attracted. It is the weakest intermolecular force. These forces are the attraction forces that cause non polar molecules to condense to liquids when temperature is lowered.



Factors affecting the strength of dispersion force:-

- Distance between molecule :- Molecules must be very close together for these attractive forces to occur.
- Polarizability :- which is the ease with which an electron cloud can be deformed. Larger molecules have greater number of electrons. and therefore are more polarizable. This leads to strong London dispersion force.
- Shape of the molecule :- The shape of the molecule (3D shape) affects the area available for interaction with neighbouring molecules. The larger the surface area, the greater the dispersion force. (eg. pentane b.p 309.4K and neopentane b.p. 282.7.4K)

Q4 Derive the vander waals Eq^n of state of real gas including volume and pressure correction.

Ans Ideal gas equation : $PV = RT$ — (1)

Volume correction

$V = V - b$

'b' is the effective volume of the molecule

Pressure correction

Ideal pressure $P = P + p_a$

Also $p_a \propto d^2$ where d = density

$d \propto \frac{1}{Vol}$

So $p_a \propto \frac{1}{V^2}$

So Ideal Pressure $P + \frac{a}{V^2}$

$p_a = \frac{a}{V^2}$, a is proportionality constant

It is measure of strength of vanderwaal force b/w mols of gas.

, Gas Equation become, by putting $P = \left(P + \frac{a}{V^2}\right)$ and $V = (V-b)$ in eq^n ①

we get $\left(P + \frac{a}{V^2}\right)(V-b) = RT$

known as van der waal equation of state

For n moles of gas eq^n becomes

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

Q5 Write down the vander waal's equation of state for real gas including volume and pressure correction and Discuss the behaviour of gas on the basis of such corrections.

Ans 5:- Vander waal's eq^n of State :-

$$\left(P + \frac{a}{V^2}\right)(V-b) = RT$$

or $PV + \frac{a}{V} - Pb - \frac{ab}{V^2} = RT$

Neglecting $\frac{ab}{V^2}$, we get.

$$PV - Pb + \frac{a}{V} = RT = P'V'$$

where P', V' are ideal pressure and ideal volume of gas respectively.

(i) At low pressure :- Gas has large volume and volume taken by molecules is unimportant so, $\frac{a}{V}$ ∴ over weight Pb i.e.

$$\frac{a}{V} > Pb$$

So $\frac{a}{V} - Pb$ = Positive quantity

$PV + Z = RT = P'V'$

$PV = RT - Z = P'V' - Z$

So, observed PV is less than $P'V'$

As $PV < P'V'$

So, intermolecular attractive forces cause a negative deviation so at low pressure $PV \downarrow$ with $\uparrow$ in pressure

(ii) At high pressure :- Volume is small, so small volume according to molecule can't be neglected. Hence Pb, overweights $\frac{a}{V}$ i.e. $Pb > \frac{a}{V}$ i.e.

$$\frac{a}{V} - Pb = -ve \text{ quantity}$$

$$PV + (-y) = P'V' \quad \text{or} \quad PV - y = P'V'$$

$$PV = P'V' + y$$

So, $PV > P'V'$ so, we get positive deviation

This explain the fact that PV, after reaching a minimum increases with further increase in pressure.

(iii) At extremely low pressure and high temp :- When P is very small, V will be very large. In this case both a and b are neglected and eqn reduces to $PV = R$, Hence, at extremely low pressure and high temperature, all gases obey the ideal gas law.

(iv) At medium Pressure :- As, Pb predominates at high pressure and $\frac{a}{V^2}$ predominates at low pressure So at medium pressure they balance each other i.e

$$Pb = \frac{a}{V}$$

So eqn becomes ; $PV = RT = P'V'$ and gas behaves like an ideal gas.

... Kuwilly explain how

At high temperature :- V is very large, hence both Pb and $\frac{a}{V}$ will be neglegibly small so eq^n is

$$PV = RT = P'V'$$ i.e. gas behaves like Ideal gas

(vi) At low temperature :- Both P and V are small, hence both $\frac{a}{V}$ and Pb are appreciable, with the result.

(vii) Exceptional behaviour of H and He :- As mol have very small mass so the force of attraction between the molecule is always negligible $\frac{a}{V}$, eq^n becomes

$$PV - Pb = RT = P'V'$$

$$PV = P'V' + Pb$$

So $PV > P'V'$, even at low pressure

Ques 6 :- Discuss the critical temperature, critical pressure and supercritical fluid.

Ans 6 :- (i) Critical Temperature :- The minimum temperature which must be reached before the gas can be liquified by the application of pressure. Tc for CO_2 is 31.1°C.

(ii) Critical Pressure :- It is the minimum pressure necessary for liquification of gas at critical temperature for e.g. Pc for CO_2 is 72.9 atm

(iii) Supercritical fluid :- It is a material that can be either liquid or gas, used in a state above the critical temperature and critical pressure where gases and liquids can co-exist.

Ques 7. Define (i) Critical Pressure of gas (ii) Critical volume of gas.

Ans 7. Critical Pressure of gas :- It is the minimum pressure necessary for the liquification of gas at

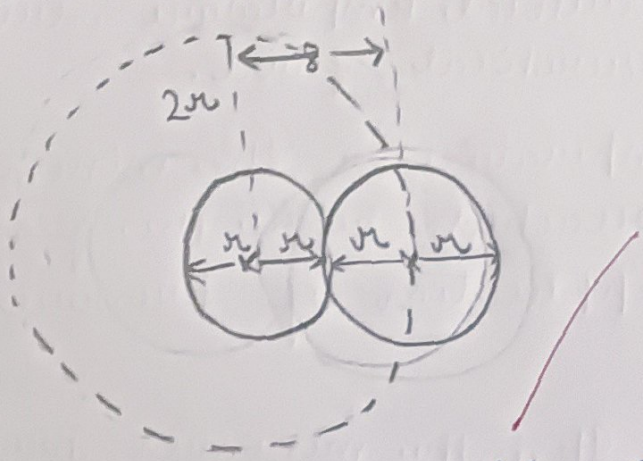
critical temperature. P_c for CO_2 is 72.9 atm.

(ii) Critical Volume of a gas:- Volume occupied by one mole of gas under critical pressure and critical temperature.

Ques 8. What is excluded Volume? Show that the excluded volume is four times the actual volume of gas

Ans (8) According to vander waals the actual free space available inside the vessel for the movement of molecules, is not V, but V-b, where 'b' is effective volume of molecules, 'b' is also called excluded volume of molecules.

Consider two molecules approaching each other. They both have diameter (S) and radius (r)



within the sphere of radius ($S = 2r$), no volume will occupied by this pair of molecule.

Thus, excluded vol for pair of molecule $= \frac{4}{3}\pi(2r)^3$

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

Excluded volume for a single molecule

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

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

where V_m is volume occupied by single molecule. So, Excluded volume is 4 times the actual volume of the gas.

Q9 Define compressibility factor. Briefly explain how real gases show deviation from ideal gas?

Ans 9: Compressibility factor is a measure of deviation from ideality $Z = \frac{PV}{RT}$, where V is the volume occupied by 1 mole of gas at a given temperature (T) and pressure (P).

For an Ideal gas, $Z = 1$.

The amount by which the actual factor differs from the value of unity gives measure of deviation from ideal behaviour. Since $(PV)_{ideal} = RT$,

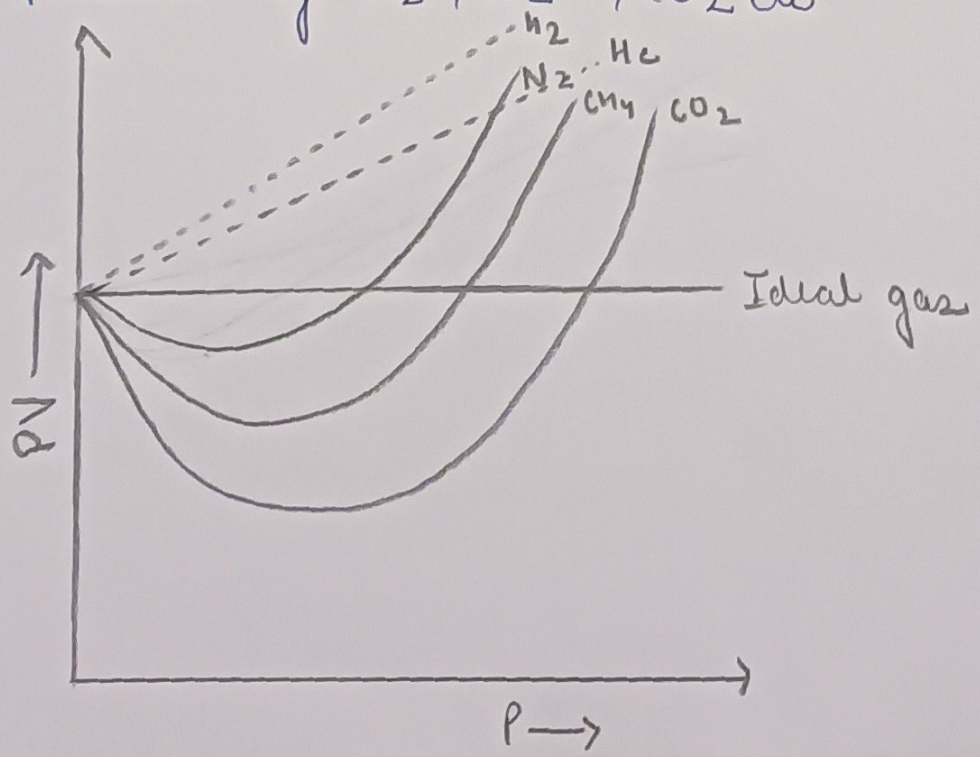
$$Z = \frac{PV}{RT} = \frac{PV}{PV_{(ideal)}}$$

Deviation of real gas from ideal gas:-

① Effect of Pressure:- Plots of PV versus P for various gases at 0°c are depicted. For an ideal gas the plot should be straight line.

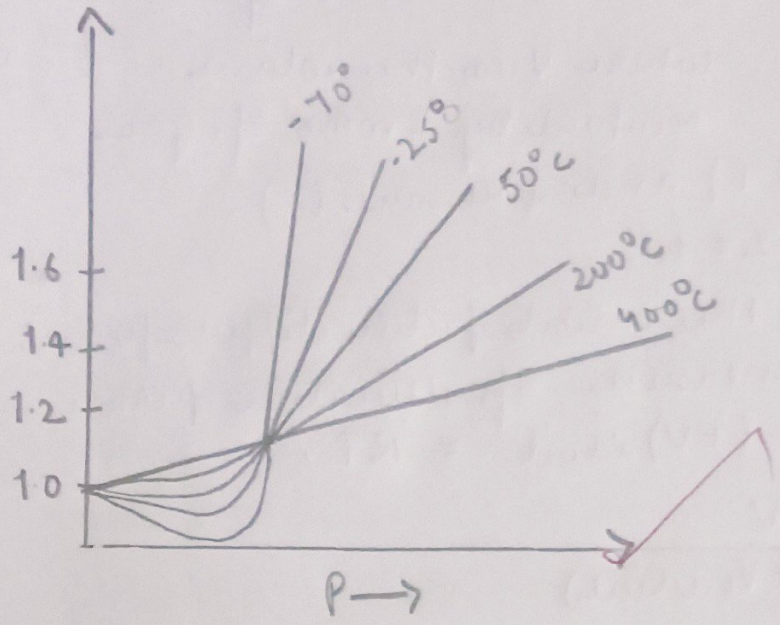
Type 1:- PV ↑ continously with increase in P. Eg N_2 and He

Type 2:- Decrement in PV in beginning, Passes through a minimum and begins to increase with increasing pressure. Eg O_2, N_2, CO_2 etc



⇒ Effect of temperature :- As the temperature decreases the dip in the curve is more pronounced.

PV versus P curve for Nitrogen at different temperature



Ques 10 Gas have higher compressibility but solids and liquids have poor compressibility. Comment on it.

Ans 10:- This is because the inter-particle spaces present. In gases the interparticle spaces are very large and they are compressible but in case of solids and liquids, particles are close to each other and hence cannot be compressed.

x x x