

B. Sc. Hons. Part I Chemistry

Paper : Physical Chemistry (I A)

Topic : Physical Properties of Liquids

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The molecules in the liquid state are in contact with each other. The forces of attraction between the molecules (i.e. intermolecular attractions) are strong enough to hold them together. Molecules in liquids are able to move past one another through the available intermolecular spaces. The molecules in a liquid move in a random fashion. At any instant, molecules may form clusters, leaving vacant space or hole here and there. A liquid may be defined as "a collection of molecules held close to each other and executing random motion through intervening spaces."

Intermolecular Forces in liquids :

Most of the physical properties of liquids are actually controlled by the strengths of intermolecular attractive forces. Intermolecular forces in liquids are collectively called van der Waals forces. These forces are essentially electrical in nature and result from the attraction of charges of opposite sign.

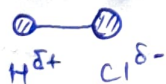
The principal kinds of intermolecular attractions are :

(1.) Dipole-dipole attractions

(2.) London forces

(3.) Hydrogen bonding

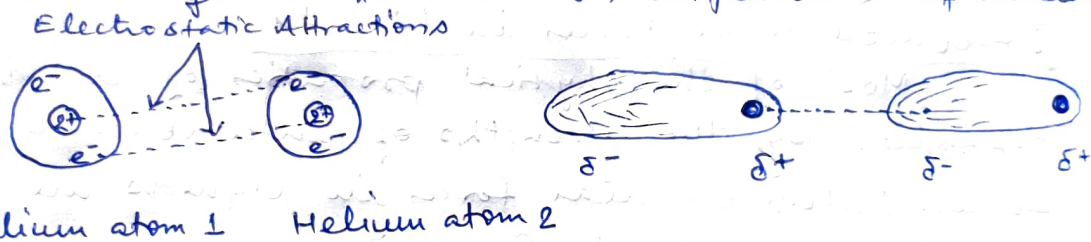
Dipole - Dipole Attractions :- Dipole-dipole attractions exist between polar molecules. It requires the presence of polar bonds and an unsymmetrical molecule. These molecules have a permanent separation of positive and negative charge. e.g.



In the above illustration, the H end of HCl

molecule is permanently slightly positive charge. The Cl end of HCl molecule has a permanent slight negative charge. The H atom of one molecule is attracted to the Cl atom in a neighbour. The intermolecular force is weak compared to a covalent bond, but this dipole-dipole interaction is one of the stronger intermolecular attractions.

London Dispersion Forces :- London dispersion forces exist in nonpolar molecules. These forces are resulted from temporary or charge imbalances. The temporary charges exist because the electrons in a molecule or ion move randomly in the structure. The nucleus of one atom attracts electrons from the neighbouring atom. At the same time, the electrons in one particle repel the electrons in the neighbour and create a short-lived charge imbalance. e.g., Explanation of London force:



As we see in the above figure, the temporary charges in one molecule or atom attract opposite charges in nearby molecules or atoms. A local slight positive charge δ^+ in one molecule will be attracted to a temporary slight negative charge δ^- in a neighbouring molecule.

Hydrogen Bonding :- Hydrogen bonding is a unique type of intermolecular attraction. There are two requirements:

- (a) Covalent bond between a H atom and either F, O or N. These are the three most electronegative elements.
- (b) Interaction of the H atom in this kind of polar bond with a lone pair of electrons on a nearby atom like F, O or N. e.g., Hydrogen bonding in water

