Intermolecular forces

From the results of Joule - Thomson experiments, and from fact that cohesion exists in liquids, we conclude that molecules at one another. What is the fundamental cause for this attraction betw molecules? The cause are -

i. Attraction due to interaction of permanent dipoles. The magn and sign and this attractive force depends on the relative orienta of the dipoles. Hence this phenomenon is called orientation eff

ii. Attraction due to induced dipoles, induced by dipolar molecules adjacent molecules. This phenomenon is called induction effe

The attractive forces are classified as follows ; van der Waals forc London forces or dispersion forces.

Van der Waals Forces

All molecules attract one another. There is electrostatic attracti between the nuclei of one molecule and the electrons of the other. The is also electrostatic repulsion of electrons of one molecule by th electrons of the other and repultion of the nucleus of one by the nucle of the other. On the whole, the attractive forces are slightly more th the repuslive forces. Thus there is a resultant weak attraction betwe two molecules. This is called the van der Waal's forces for attraction

Van dar Waals forces of attraction are extremely weak.

Elements whcih form molecules in which each atom has the sam electronic configuration as the noble gas, experience the van der Waa forces of attraction. On cooling and compressing, these form van de Waals liquids or solids, E.g., noble gases. halogens, oxygen, nitroge etc.,

Non polar molecules also experience the van der Waals forces o attraction. They form low boiling liquids and low melting solids E.g., Pertroleum ether, waxes etc.

Factros determining the van der Waals forces :

i. ***Number of electrons peresent in a molecule :***

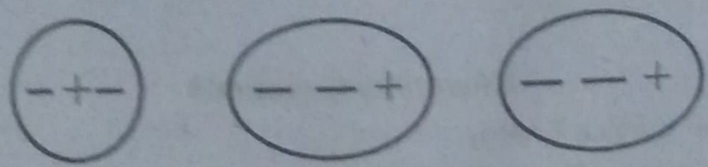
Van der Waals forces increase with an increase in the number o electrons in the molecule. This is why the boiling points of halogen and inert gases increase as we move down the group.

ii. ***Molecular size / Molecular weight :***

The larger the molecular size or the molecular weight, the stronger will be the van der Waals forces. This is why the boiling point of ethane is more than that of methane.

London forces :

H_2, O_2, CH_4 and inert gases do not possess permanent dipoles. Even then, there is attraction between the molecules. To account for this attraction F. London suggested that even in monoatomic molecules, the nuclei and electrons undergo some kind of vibration with respect to each other. Therefore temporary dipoles are produced. These produce dipoles in other molecules. Thus there is a net attraction between the molecules. These forces of attraction are called dispersion forces or London forces. London forces are thus applicable to non - polar molecules. They are additive in nature and account for cohesion.



Original molecule   Original dipole due to electron oscillation   Induced dipole

Thus van der Waals forces in non - polar molecules is exclusively due to London forces.

University Problems

1. Calculate the lattice energy of sodium chloride from the following data.

1. Sublimation energy of sodium	= 26.0 k.cal..
2. Dissociation energy of chlorine	= 58.0 k.cal.
3. Electron affinity of chlorine	= – 87.3 k.cal.
4. Ionisation potential of sodium	= 120.0 k. cal.
5. Heat of formation of sodium chloride	= –98.2 k.cal.

Solution :

Sublimation energy of sodium	= +S = 26.0 k.cal.
Dissociation energy of chlorine	= +D = 58.0 k.cal.
Electron affinity of chlorine	= –E = – 87.3 k.cal.

Ionisation potential of sodium $= + I = 120.0$ k.cal

Heat of formation of sodium chloride $= -Q = -98.2$ k. cal

Lattice energy of sodium chloride $= -U_o = ?$

We know,

$$U_o = Q + S + \frac{1}{2} D + I - E$$

$$= 98.2 + 26.0 + (\frac{1}{2} \times 58) + 120 - 87$$

$$= + 98.2 + 26.0 + 29 + 120 - 87$$

$$= 273.2 - 87 = 186.2 \text{ k.cal}$$

Lattice energy $= - U_o = - 186.2$ k. cal

Answer :

Lattice energy of sodium chloride $= - 186.2$ k.cal

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