



# State of matter

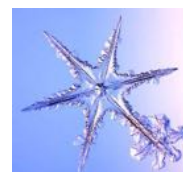
By  
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## Objectives

- Inter and intra-molecular forces
- Supercritical states and their utility in pharmaceutical technology.
- Properties of different states of matter and pharmaceutical application (drug delivery systems).

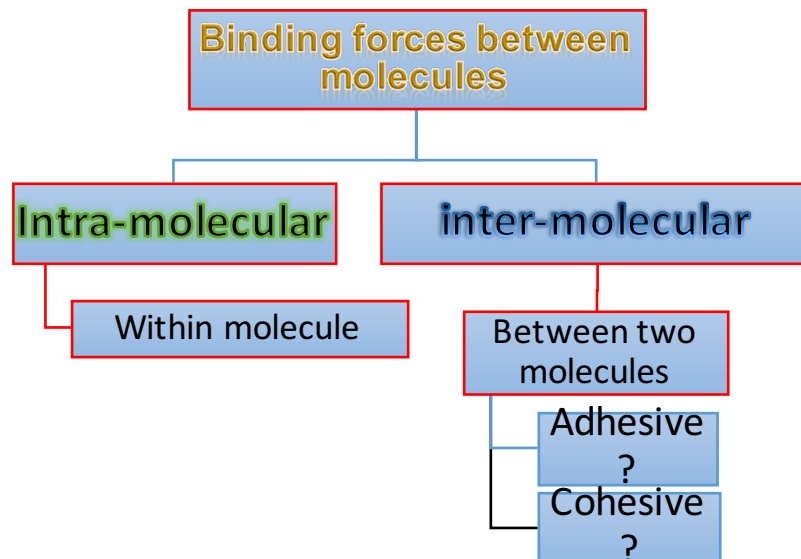




## Objectives

- Description and characterisation of solid state, crystallinity, solvates, and polymorphism.
- Differentiation between polymorphism and solvate using specific analytical methods (DSC and TG).
- Phase transition of three main states of matter.

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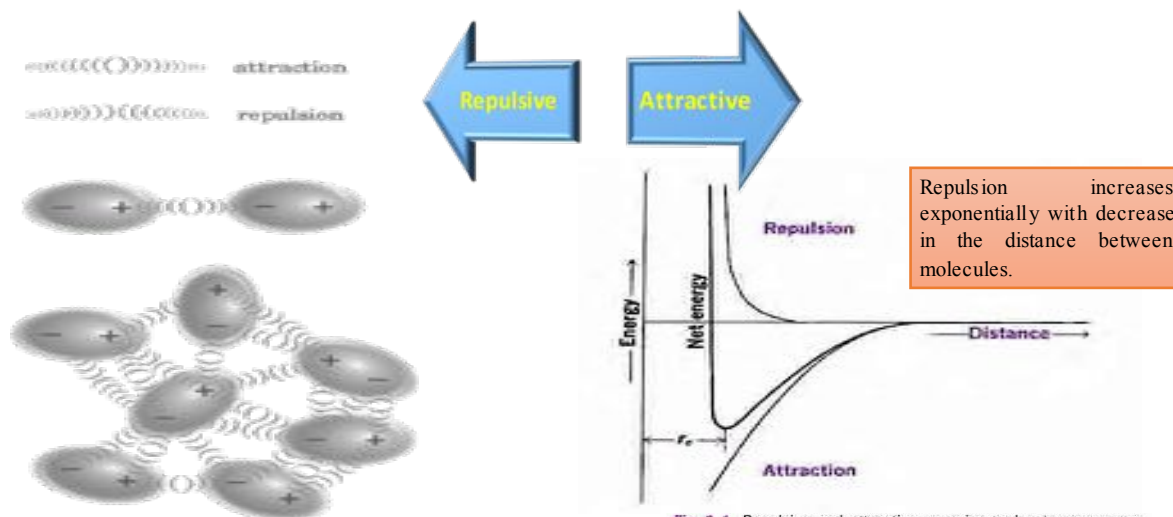


Fig. 2-1. Repulsive and attractive energies and net energy as a function of the distance between molecules. Note that a minimum occurs in the net energy because of the different character of the attraction and repulsion curves.



## Intermolecular forces

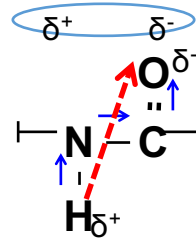
- Van der Waals forces
- Orbital overlap
- Ion-dipole and ion-induced dipole forces
- Ion-ion interactions
- Hydrogen bonds



**Attractive intermolecular forces**

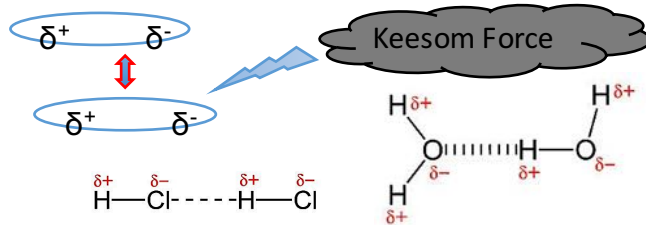
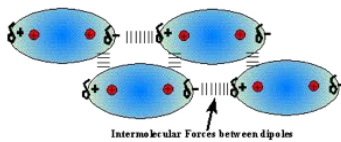
Van Der Waals:-

- Weak forces
- dispersion of Charge ( Dipole)
- It is related to nonionic interaction



**Polarize Molecule  
Or permanent dipole**

➤ Dipole- dipole



Van Der Waals:-  
like magnet ( align themselves)

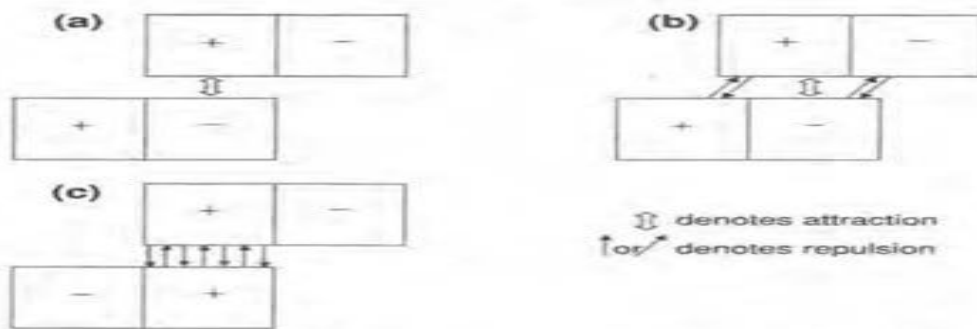
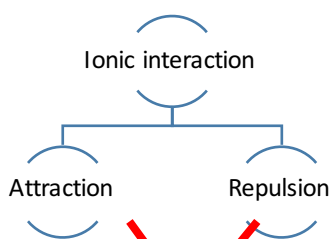
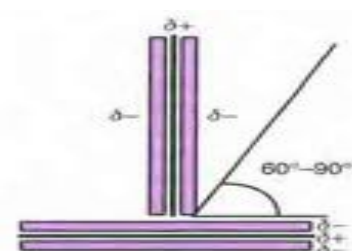
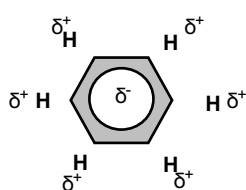


Fig. 2-2. (a) The attractive, (b) partially repulsive, and (c) fully repulsive interactions of two magnets being brought together.

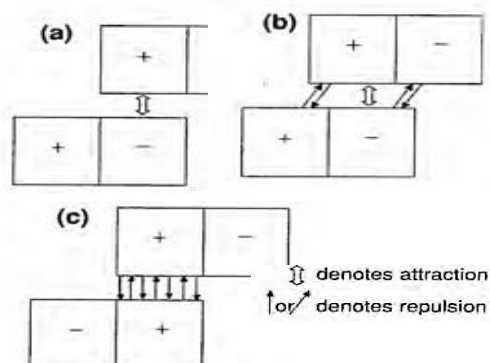


## Orbital overlap

In dipole-dipole interaction ---- Pi orbital



type? ,,,, Intermolecular



Give specific energetically favored dispersion of molecules =  
Lattice structure

Intermolecular ionic interaction such  $\text{CaPO}_4$  in acidic solution.

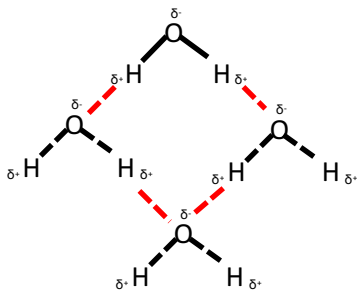
Intramolecular as in salt bridge between counter ions of proteins.



**Hydrogen bond**

**Discovered by Latimer and Rodebush in 1920**

**Interaction between  $H^{\delta+}$  and ????**

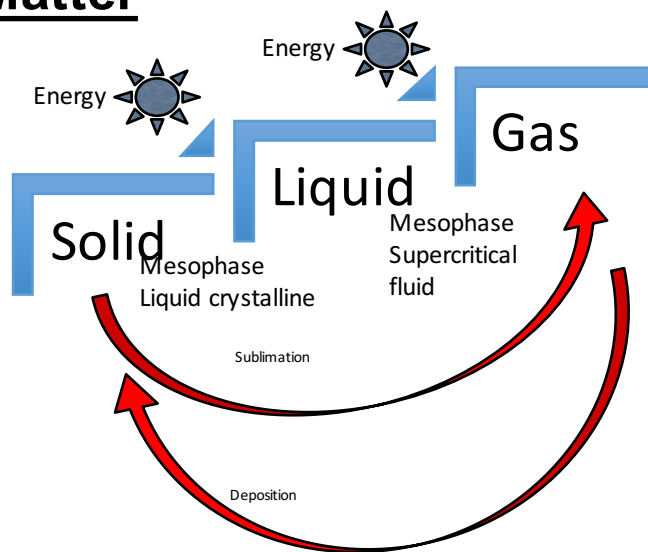


**Responsible for :**  
**High bp**  
**Low vp**  
**High ec**

- **Formic acid and acetic acid as dimer???**
- **Salicylic acid???? Inter and intra**
- **Boric acid as layer in crystal?????**



**States Of Matter**

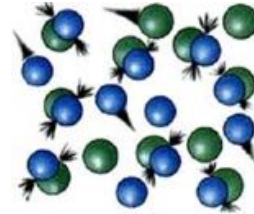




## The Gaseous state:

Molecules  
random, vigorous  
and rapid motion

Collisions



Between  
Molecules

Walls of  
container

\*Pressure  
(Dyne/cm<sup>2</sup>)

\* Volume  
(Liter or cm<sup>3</sup>)



## Notes:

- Internal pressure is increased with increasing the polarity.
- **Application**: Mineral oil is immiscible with water, Why?
- If volume of a gas is large, the molecules are well dispersed, and less or no attractive forces (as an ideal gas).
- **Application** *a* and *b* become insignificant with respect to *P* and *V*