

## BSC-III, PAPER-5

### Degree of freedom of molecule

The position of point mass i.e. atom in molecule is specified by a number of coordinate. These number of co-ordinate is called degree of freedom of molecule.

An atom (point mass) is specified by three coordinate along x, y, z, axis and hence it has three co-ordinate and hence one atom has three degree of freedom. For N atoms in a molecule, total degree of freedom will be  $3N$ .

According to

Kinetic theory of gas, when a molecule absorbs energy, it is translated in two forms -

- (i) Translational energy
- (ii) Internal energy of molecule.

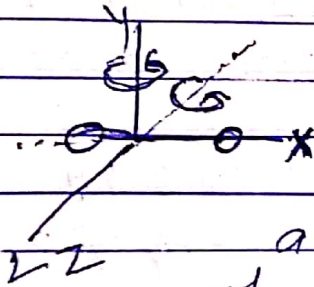
Due to ~~absorption~~ translation of translational energy, molecule move as a whole and this movement is represented by three co-ordinate i.e. along x, y, z axis and hence

it has three translational degree of freedom. Thus remaining degree of freedom is  $3N-3$ .  $3N-3$  degree

of freedom will be attributed to the internal energy. Internal energy consists of rotational and vibrational energy.

~~Let us~~ Let us study the rotational degree of freedom of molecules. ~~Let us~~ Let us consider the rotational motion of linear and non-linear molecules.

Linear molecule or diatomic has only two degrees of rotational freedom as shown in below figure.

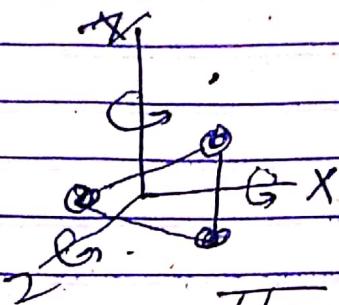


The rotational degree of freedom will be along two axis only because the coordinate of rotation along one axis where is molecule, will be zero.

This remaining degree of freedom (except translational and rotational) will be  $3N - 3 - 2 = 3N - 5$  for linear vibrational.

For non-linear diatomic or polyatomic ~~the~~ rotational degree of freedom will be three. i.e. along x, y, and z axis.

Three rotational degree of freedom for non-linear molecule will thru which is shown below



Thus The remaining degree of freedom i.e vibrational degree of freedom for non-linear molecule will be  $3N - 3 - 3 = 3N - 6$ .

i This clearly shows that vibrational ~~energy~~ degree of freedom for linear molecule =  $3N - 5$

ii Vibrational degree of freedom for non-linear molecule =  $3N - 6$

Example (i) For Diatomic molecule the vibrational degree of freedom =  $3 \times 2 - 5 = 1$

(ii) Linear polyatomic molecule vibrational degree of freedom like  $\text{CO}_2$  will be  $3 \times 3 - 5 = 4$ .

