

SUBJECT - CHEMISTRY

CLASS - B.Sc (Hons) PART - III

PAPER - V

TOPIC - Types of molecular energy

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Q Explain different types of molecular energy ? Explain with suitable diagram.

Ans. Molecular energy: We know from the kinetic theory of gases that molecules of a gas are in constant motion and molecules of a liquid are also in constant motion, called as Brownian motion. There are also considerable motions of atoms within a molecule. A molecule is associated with many different types of motion e.g. a moving molecule can translate, rotate and its bonds can vibrate and even its electrons move. Hence the energy of a moving molecule arises due to translational motion, rotational motion and vibrational motion of its atoms and also due to electronic energy.

Translation energy: A moving molecule has kinetic energy due to its motion in space, known as its translational energy. A molecule can move in x, y and z directions, hence it has three translational degrees of freedom. From kinetic theory of gases, we know that translational energy for one mole is given by $E_{trans} = \frac{3}{2} RT$ where T is the temperature in absolute scale. Therefore the average translational energy of molecule along a particular direction is $\frac{1}{2} kT$.

Rotational energy: Non-linear molecule can rotate about the three mutually perpendicular axes that pass through the centre of gravity of the molecules,

So these molecules have three rotational degrees of freedom.

Linear molecules have only two rotational degrees of freedom.

Due to rotation, the molecule acquires rotational energy. The rotational energy is given by

$$E_J = \frac{h^2}{8\pi^2 I} J(J+1)$$

where h = Planck's constant

J = rotational quantum number having values 0, 1, 2, ...

and I = moment of inertia of the molecule, which is expressed as

$$I = \mu r^2 = \frac{m_1 m_2}{m_1 + m_2} \cdot r^2$$

where μ = reduced mass and r = bond length of two bonded atoms having masses m_1 and m_2