

SUBJECT - CHEMISTRY

CLASS - B.Sc (Hons) PART - III

PAPER - V

TOPIC - PLANCK'S QUANTUM THEORY

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PLANCK'S QUANTUM THEORY

The first Successful theory for the Spectral distribution of black body radiation i.e how the energy is distributed among different wavelengths emitted by a black body was proposed by planck to The Berlin physical Society on DEC 14 1900 by discarding the classical Concept that an oscillator emits or takes up energy continuously. followings are the main points of this theory -

1 As oscillator absorbs or emits radiation discontinuously in the form of energy packets called quanta. Quanta may be taken as behaving like a stream of particles having mass, energy and momentum. The energy of a quantum of radiation is given as

$$E = h\nu \Rightarrow E \propto \nu$$

where ν = frequency of radiation and h = planck's Constant.

Hence the magnitude of quantum is not fixed, rather varies directly with the frequency of the oscillator.

2 The oscillator has definite amounts of energy in discrete levels called energy levels. The energy of the n th energy level is given as -

$$E = nh\nu$$

where n is an integer having values 0, 1, 2, ... The energies of different energy levels will be 0, $h\nu$, $2h\nu$, $3h\nu$, ...

The surface of a piece of white paper before our eyes is continuous with respect to whiteness. If we put ink-dots in a line dots will look discontinuous (discrete) because of gaps in between them.

→ ELECTROMAGNETIC RADIATION

The radiation is a wave that consists of oscillating electric and magnetic fields. Hence it is also called electromagnetic wave.

At the end of the 19th century Maxwell proposed that light consists of electromagnetic waves. Electromagnetic radiation is considered as being produced by the oscillating motion of an electric charge. This oscillation results in a periodically changing electric field surrounding the charge and also produces an oscillating magnetic field. This electric and magnetic disturbances then propagate through the space as radiation. The electromagnetic radiation consists of various forms of radiations such as UV, IR, X-ray, radio waves etc.

Sound waves like mechanical waves need a medium to travel and this in no way is associated with magnetic and electric fields and there cannot be any deviation of sound waves in applied magnetic or electric field.

Characteristics: 1 They can freely travel in space and in vacuum without the support of any medium in vacuum,

The speed of all radiations is the speed of light ($3 \times 10^8 \text{ ms}^{-1}$)

2 They are produced by the oscillation of electric charges and magnetic field. The electric and magnetic fields are mutually perpendicular to each other and move towards the direction of the propagation. External magnetic and electric fields can change the direction of radiation.

3. They are characterised by their frequency (ν) or wave-length (λ) which are related as-

$$\nu = \frac{c}{\lambda} \quad \text{where } c = \text{velocity of radiation}$$