

Bohr's Atomic Model

Atomic Structure

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In 1913 a Danish Physicist Neil Bohr has forwarded a new atomic model which is based on Planck's quantum theory of radiation and some postulates of classical physics. It explains the origin of hydrogen spectrum. The important postulates on which the Bohr's model was based are described below.

(1) An atom consists of a dense nucleus situated at the centre with the electron revolving round it in circular orbits without emitting any energy. This orbital rotation without emitting energy (radiation) follows the Newtonian law i.e. the force of attraction between the nucleus and an electron is equal to the centrifugal force of moving electron.

(2) An electron can revolve only in those orbits whose angular momentum (mvr) is an integral multiple of $(\text{the factor}) \frac{h}{2\pi}$.

$$\text{i.e. } mvr = n \cdot \frac{h}{2\pi}$$

where m = mass of electron, v = velocity of electron, r = radius of orbit, n = No. of orbit in which electron is present.

(3) As long as an electron is revolving in an orbit it neither loses nor gains energy. Hence these orbits are called stationary states. Each stationary state is associated with a definite amount of energy and it is known as energy levels.

(4) An electron continues to move in a particular stationary state without losing energy. Such state of the atom is called ground state or normal state. This is the most stable state of the atom.

(5) If energy is supplied ^{in terms of quanta} to an electron, it may jump (excite) instantaneously from a lower energy level (say 1) to a higher energy level (say 2, 3, 4, etc.) by absorbing one or more quanta of energy. This new state of electron is called the excited state.

Similarly the electron jumps from higher energy level to lower energy level by emitting one or more quanta of energy (or $h\nu$) in the form of radiation of suitable wave length.

The absorption or emission of energy takes place not as continuous waves but as small packets or bundles of discrete (separate) units of waves i.e. quanta or photons.

The energy absorbed or released in an electron jump (ΔE) is given by the following equation.

$$\Delta E = E_2 - E_1 = h\nu \quad \left[\text{where } h = \text{Planck Const} \right. \\ \left. h = 6.624 \cdot 10^{-34} \text{ J} \cdot \text{s} \right]$$

where E_1 and E_2 are the energy of electron in the first and second energy levels. ν is frequency of radiation.

Quantum theory of Hydrogen Atom: - Working on the basis of above postulates, Bohr has calculated (i) radii of the various orbits in which electron of hydrogen & hydrogen like species (having one electron i.e. H, He⁺, Li²⁺ etc) can reside and energy of electron moving in different orbits around nucleus in hydrogen like species.