18.Concept of discrete Energy Levels

Definition

- Discrete energy levels are specific, **quantized energy values** that an electron in an atom or molecule can occupy.
  Electrons **cannot exist between these levels,** they can occupy only certain allowed states.
- This concept forms the foundation of quantum mechanics and explains why atoms emit or absorb light at specific wavelengths.
- Mathematically, $E_n = -13.6/n^2\ eV\ (n=1,2,3,\ldots,\ldots)$
- where E_n is the energy of the nth level in a hydrogen atom.

Explanation

- According to **quantum mechanics**, electrons in atoms do not move freely but occupy certain **stationary states** called **energy levels**.
- Each level corresponds to a specific **wavefunction (ψ)** that satisfies the Schrödinger equation for that atom.
- These levels arise because the allowed electron energies must satisfy **boundary conditions** imposed by the atom's potential well.
- When an electron **jumps from a lower to a higher level**, it **absorbs energy**
  ΔE = hv.
- When it **falls back**, it **emits energy** of the same amount as radiation.

$$\Delta E = E_2 - E_1 = hv$$

- where
  $h \rightarrow$ Planck's constant,
  $v \rightarrow$ frequency of radiation.

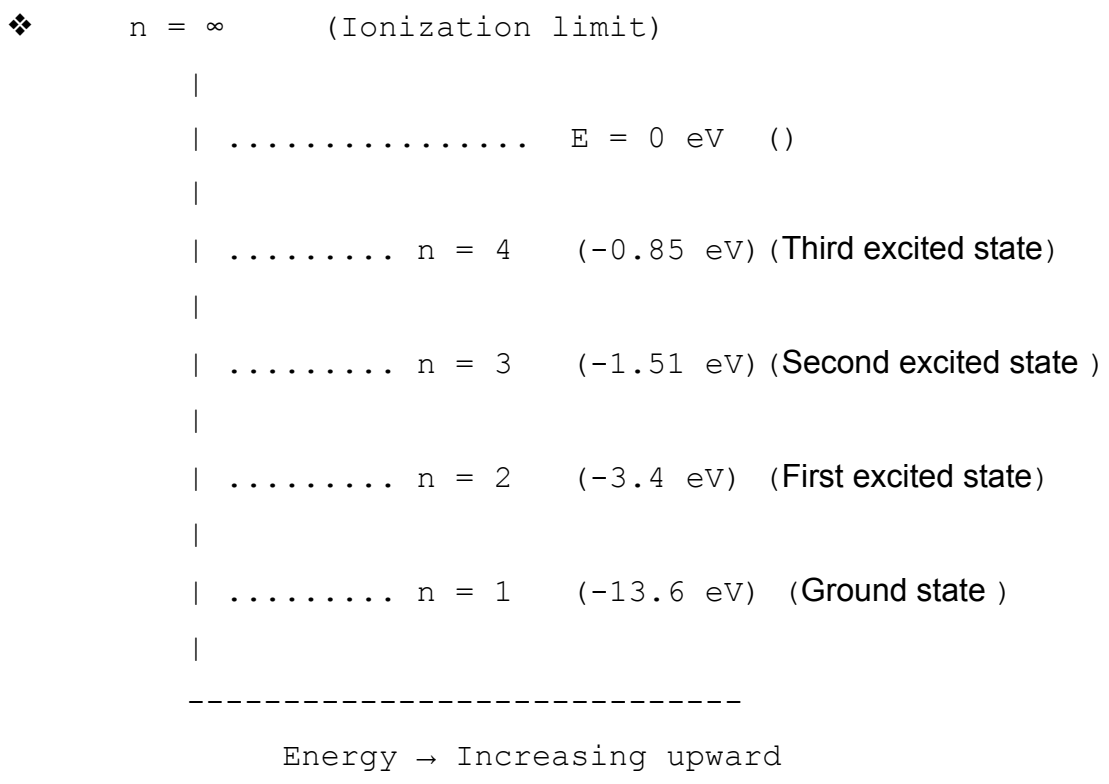
Example: Hydrogen Atom

- For a hydrogen atom, energy levels are given by

$$E_n = -13.6/n^2 \ eV$$

- When an electron transitions from $n=3$ to $n=2$ => $\Delta E=(-3.4)-(-1.51)=1.89 \ eV$
- This energy appears as a photon of visible light as a part of the **Balmer series**.

Diagram :Energy Level Diagram for Hydrogen Atom



- The distance between levels decreases as '**n' increases**.
- At $n=\infty$, the electron is **free** (ionized atom).