Class : 12th Physics
Chapter : 12 Atoms

Atoms

- Contribution
  - In 1898 J.J Thomson proposed the first model of atom also known as plum-pudding model
  - Energy of electron in each stationary orbits is
    Given by $E_n = -13.6\,\frac{Z^2}{n^2}$ eV
    Where n = 1,2,3….
    Z = atomic number of atom
    - These stationary energy orbits are also called energy levels.
    - When electron jumps from higher energy level to lower energy level it releases energy.
    $\Delta E = E_f - E_i = 13.6\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]Z^2$ eV
- Energy Level
- Postulates
  - Atoms have a central, massive, positively charged core called nucleus around which electron revolves
    - Size of nucleus
    ≈ 1 fermi $= 10^{-15}$m
  - Doesn't explain the stability of atom
  - Doesn't explain the atomic s ectrum
- Rutherford's Modal
  Draw backs
- α - particle scattering Experiment
  - α- particle bombarded on thin gold foil
  - Most of α– particle passed undeviated or with a small angle
  - 1 out of 8000 α particles were deflected by scattering angle
- Hydrogen Spectrum
  - Hydrogen gas heated in a sealed tube emits radiation which passes through prism
    - Component of different wavelength appears
    - Wavelength in each series given by
    $\bar{v} = \frac{1}{\lambda} = R\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right]$
    $n_f > n_i$
    - Lyman series [U.V. region]
    $n_i = 1,\ n = 2,3,4....$
    $\lambda_{min} = 912\ A^\circ,\quad \lambda_{max} = 1216\ A^\circ$
    - Balmer series [visible region]
    $n_i = 2 \quad n_f = 3, 4, 5.....$
    $\lambda_{min} = 3648\ A^\circ,\ \lambda_{max} = 6563\ A^\circ$
    - Paschan series [I–R region]
    $n_i = 3 \quad n_f = 4, 5, 6.....$
    $\lambda_{min} = 8208\ A^\circ,\ \lambda_{max} = 18761\ A^\circ$
    - Brackett series [I R region]
    $n_i = 4 \quad n_f = 5, 6, 7...$
    $\lambda_{min} = 14592\ A^\circ\ \ \lambda_{max} = 40533\ A^\circ$
    - Pf –band [I R region]
    $n_i = 5 \quad n_f = 6, 7, 8.....$
    $\lambda_{min} = 23580\ A^\circ\ \ \lambda_{max} = 74618\ A^\circ$
- Bohr Modal
  - Impact parameter
  $b = \frac{Ze^2 \cot\theta/2}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)}$
  - Postulates
    - Electron revolves around the nucleus in stationary orbits
    - Angular momentum of electron
    $mvr_n = n\frac{h}{2\pi}$
    n = Integers. It is also known as principle Quantum Number
    - It explains spectrum of hydrogen or hydrogen like [He$^+$, Li^{+2}] atom
  - Limitations
    - Fails to explain spectrum of complex atoms/ions of multi electron system
    - Dosn't explain Zeeman's and Stark's effect
  - Radius of nth Bohr's orbit
    $R_n = \frac{\varepsilon_0 h^2}{\pi me^2}\left(\frac{n^2}{Z}\right)$
    $= 0.53\,\frac{n^2}{Z}\,A^\circ$
  - Velocity of electron in nth Bohr's orbit
    $v_n = \frac{e^2}{2\varepsilon_0 h}\left(\frac{Z}{n}\right)$
    $= 2.2 \times 10^6\,\frac{Z}{n}$ m/s
  - Potential Energy
    $U_n = \frac{-KZe^2}{r_n}$
    $= \frac{-me^4}{4\varepsilon_0^2 h^2}\left(\frac{Z^2}{n^2}\right)$
    $= \frac{-27.2\,Z^2}{n^2}$ eV
  - Kinetic Energy
    $E_k = \frac{KZe^2}{2r_n}$
    $= \frac{me^4}{8\varepsilon_0^2 h^2}\frac{Z^2}{n^2}$
    $= \frac{13.6\,Z^2}{n^2}$ eV
  - Total Energy
    $E = U_n + E_k$
    $= \frac{-KZe^2}{2r_n}$
    $= \frac{-13.6\,Z^2}{n^2}$ eV
    $= \frac{U_n}{2} = -E_k$

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