CHAPTER

# 2 Atomic Structure

## Mass Number and Atomic Number

Mass number of an element = No. of protons (Z) + No. of neutrons (n).

Atomic Number (Z) = No. of Protons

## Wave and its Characteristics (For emission/ Absorption of energy)

$\bar{\nu} = \frac{1}{\lambda}$ $\bar{\nu} =$ Wave Number

$E = h\nu$ ($\nu$ - Frequency of light)

$E = \frac{hc}{\lambda}$ (c - speed of light)

## Photoelectric Effect

$h\nu = h\nu_0 + \frac{1}{2} m_e v^2$, where, $\nu_0$ = Threshold frequency, V = Velocity of photoelectron

$\nu$ = Incident Frequency

## Bohr's Model of Atom

- $\frac{mv^2}{r} = \frac{Ke^2Z}{r^2}$
- $mvr = \frac{nh}{2\pi}$
- $r = \frac{n^2h^2}{4\pi^2 mKZe^2}$
- $r_n = 0.529 \times \frac{n^2}{Z}$ Å
- $V = \frac{2\pi Ze^2K}{nh}$
- $V_n = 2.18 \times 10^6 \times \frac{Z}{n}$ m/sec
- $T = \frac{2\pi r}{v}$
- $f = \frac{v}{2\pi r}$
- $T.E. = E_n = -\frac{2\pi^2 me^4 k^2}{h^2}\left(\frac{z^2}{n^2}\right)$
- $E_n = -13.6 \frac{Z^2}{n^2}$ eV / atom
- $T.E. = \frac{1}{2}$ P.E.
- $E_n = -2.18 \times 10^{-18} \frac{Z^2}{n^2}$ J/atom
- T.E. = – K.E.

For H-atom

$r_n = 0.529 \times n^2$

$V_n = \frac{V_1}{n}$

$En = E_1/n^2$

n = orbit no.

## Emission Spectrum of Hydrogen & H-like species.

$\Delta E = h\nu = \frac{hC}{\lambda}$ ; h = Planck's Constant($h = 6.62 \times 10^{-34}$ JS)

C = Velocity of Light

$\lambda$ = Wavelength

- $\frac{1}{\lambda} = \bar{\nu} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

  R = Rydberg constant = $1.09678 \times 10^7\ m^{-1}$

  $n_1$ = Lower energy level

  $n_2$ = Higher energy level

- Number of different line produce = $\frac{\Delta n(\Delta n+1)}{2}$, where $\Delta n = n_2 - n_1$.

  $n_2$ = higher energy orbit, $n_1$ = lower energy orbit.

- For single isolated atom maximum number of spectral lines observed = (n – 1).

## de-Broglie's Hypothesis

$\lambda$ = de-Broglie wavelength

h = Planck's Constant

m = mass of particle

e = charge on particle

V = Accelerated Potential

- $\lambda = \frac{h}{mv} = \frac{h}{p}$, p = momentum
- $\lambda = \frac{h}{\sqrt{2emV}}$
- $\lambda = \frac{12.3}{\sqrt{V}}$ Å

## Heisenberg's Uncertainty

- $\Delta x \,.\, \Delta p \geq \frac{h}{4\pi}$ or $\Delta x \,.\, (m\Delta v) \geq \frac{h}{4\pi}$
- $\Delta E.\Delta t \geq \frac{h}{4\pi}$ ; $\Delta x$ = change in position

$\Delta p$ = change in Momentum
$P = \psi^2 dv$, P = probability of finding electron

where, $\psi$ = wave function

- Radial nodes = $n - \ell - 1$,
- Angular nodes = $\ell$,
- Total nodes = n – 1

## Quantum Numbers

- Number of subshell present in $n^{th}$ shell = n.
- Number of orbitals present in $n^{th}$ shell = $n^2$.
- The maximum number of electrons in a principal energy shell = $2n^2$.
- Angular momentum of any orbit = $\frac{nh}{2\pi}$.
- Number of orbitals in a subshell = $2\ell + 1$
- Maximum number of electrons in particular subshell = $2 \times (2\ell + 1)$.
- $L = \frac{h}{2\pi}\sqrt{\ell(\ell+1)} = \hbar\sqrt{\ell(\ell+1)}\left[\hbar = \frac{h}{2\pi}\right]$.
- Orbitals present in a main energy level is '$n^2$'.
- $\mu = \sqrt{n(n+2)}$ B.M. , n = No. of unpaired electron.
- Spin angular momentum $= \frac{h}{2\pi}\sqrt{s(s+1)}$.
- Maximum spin of atom = $\frac{1}{2}$ × No. of unpaired electron.