

CONCEPT MAP

Atoms and Nuclei

Atomic Models

Spectral Series of Hydrogen atom:

Lyman Series:

$$\frac{1}{\lambda} = R \left[\frac{1}{1^2} - \frac{1}{n^2} \right]$$

Balmer Series:

$$\frac{1}{\lambda} = R \left[\frac{1}{2^2} - \frac{1}{n^2} \right]$$

Paschen Series:

$$\frac{1}{\lambda} = R \left[\frac{1}{3^2} - \frac{1}{n^2} \right]$$

Brackett Series:

$$\frac{1}{\lambda} = R \left[\frac{1}{4^2} - \frac{1}{n^2} \right]$$

Pfund Series:

$$\frac{1}{\lambda} = R \left[\frac{1}{5^2} - \frac{1}{n^2} \right]$$

Bohr's Model: Bohr developed a theory of hydrogen and hydrogen-like atoms which have only one orbital electron.

$$L = \frac{nh}{2\pi} \text{ or } mvr = \frac{nh}{2\pi}$$

Bohr's Formulae:

$$r_n = \frac{4\pi\epsilon_0 n^2 h^2}{4\pi^2 m Z e^2} = \frac{0.53 n^2}{Z} \text{ \AA}$$

Composition of Nucleus: The nucleus of an atom contains protons and neutrons which are collectively known as nucleons.

Isotopes: Isotopes of an element are the atoms of the element which have the same atomic number but different mass numbers. e.g. ${}_1\text{H}^1, {}_1\text{H}^2, {}_1\text{H}^3$

Isotones: Isotones are the nuclides which contain the same number of neutrons e.g. ${}_{17}\text{Cl}^{37}$ and ${}_{19}\text{K}^{39}$.

Nuclear Radius:

$$R = R_0 A^{1/3}$$

Rutherford's Model of Atom: The entire positive charge and most of the mass of the atom is concentrated in a small volume known as nucleus with electrons.

Rutherford's Scattering Formula:

$$N(\theta) = \frac{N_i n t Z^2 e^4}{(8\pi\epsilon_0)^2 r^2 K^2 \sin^4(\theta/2)}$$

Isobars: Isobars are the atoms of different elements which have the same mass number but different atomic numbers. e.g. ${}_{11}\text{Na}^{22}$ and ${}_{10}\text{Ne}^{22}$

Mass Defect: The difference in mass of a nucleus and its constituents is known as the mass defect.

$$\Delta m = [Zm_p + (A-Z)m_n - m_N]$$

Nuclear Density:

$$\rho = \frac{\text{Mass of nucleus}}{\text{Volume of nucleus}}$$

Impact Parameter:

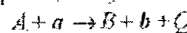
$$b = \frac{Ze^2 \cot(\theta/2)}{4\pi\epsilon_0 K}$$

Radioactivity: Radioactivity is the spontaneous disintegration of nuclei of some nuclides (called radionuclides) with the emission of alpha particles or beta particles some accompanied by gamma rays.

Binding Energy:

$$E_b = \Delta mc^2 = [Zm_p + (A-Z)m_n - m_N]c^2 = [Zm_p + (A-Z)m_n - m_N] \times 931.49 \text{ MeV/u}$$

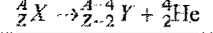
Nuclear Reaction: A nuclear reaction is represented by



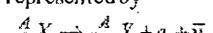
Nuclear Fusion: It is the phenomenon of fusing two or more lighter nuclei to form a single heavy nucleus. e.g. ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^4 + 24 \text{ MeV}$

Nuclear Fission: It is the phenomenon of splitting a heavy nucleus into two or more smaller nuclei. e.g. ${}_{92}\text{U}^{235} + {}_0\text{n}^1 \rightarrow {}_{56}\text{Ba}^{141} + {}_{36}\text{Kr}^{92} + 3{}_0\text{n}^1 + Q$

Alpha Decay: It is represented by



Beta Decay: It is represented by



Gamma Decay: It is represented by



Symbols Used:

$N(\theta)$ = number of α particles per unit area
 K = kinetic energy of the alpha particles
 b = impact parameter
 m = mass of the electron
 t = foil thickness
 E_b = binding energy

N_i = total number of alpha particles that reach the screen
 v = velocity of electron
 Δm = mass defect
 X = nucleus before decay
 X' = nucleus in excited state
 Y = nucleus after decay
 Z = atomic number of the foil atoms

λ = wavelength
 r = distance of the screen from the foil
 h = Planck's constant
 R = Rydberg's constant
 n = number of atoms