



Subject : Physics

Class : XII

Kannada

Nuclei

Recall what did you study in previous class

Nucleus

- The atomic nucleus is the small, dense region consisting of protons and neutrons at the center of an atom.
- **Atomic Number (Z):** Number of protons in a nucleus.
- **Mass Number (A):** Number of protons + neutrons.
- **Properties of Nucleus:**

Radius of nucleus, $R = R_0 A^{1/3}$ (Where $R_0 = 1.2 \times 10^{-15} \text{m}$)

$$\text{Volume of Nucleus, } V = \frac{4\pi R_0^3 A}{3}$$

$$\text{Density of Nucleus, } d = \frac{m}{v} = \frac{3m}{4\pi R_0^3} = 2.3 \times 10^7 \text{ Kg/m}^3$$

Mass Energy Equivalence Relation

- According to Einstein; $[E = mc^2]$
 $1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV}$
 (where E is total energy of mass m, c is speed of light)

Mass Defect: It is difference between total mass of nucleons and nucleus.

$$\Delta m = [Zm_p + (A - Z)m_n] - M_{\text{nucleus}}$$

Binding Energy: The Energy required to bring the nucleons from infinity to form the nucleus.

$$\text{Binding Energy} = (\Delta m) \times 931.5 \text{ MeV}$$

$$\text{Packing fraction} = \frac{\text{Mass excess}}{\text{Mass number}}$$

Nuclear Force

- Strongest force in nature.
- Short range force.
- Charge independent.
- Depends on spin or angular moment of nuclei.
- Non-central force.

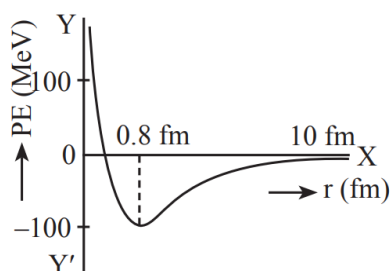
Plot of Potential Energy Vs Distance

Important Features:

Attraction is maximum at $r_0 = 0.8 \text{ fm}$

For $r < r_0$, Force is repulsive.

For $r > r_0$, Force is attractive.





Radioactivity

Radioactive Decays: Generally, there are three types of radioactive decays

- (i) α decay
- (ii) β^- and β^+ decay
- (iii) γ decay

α decay: By emitting a particle, the nucleus decreases its mass number and move towards stability. Nucleus having $A > 210$ shows a decay.

β decay: In beta decay, either a proton is converted into neutron and positron (β^+) or neutron is converted into proton and electron (β^-)

γ decay: When an α or β decay takes place, the daughter nucleus is usually in higher energy state, such a nucleus comes to ground state by emitting a photon or photons called as γ -rays.

Order of energy of γ photon is 100 keV

$$\text{Average life } t_{av} = \frac{1}{\lambda}$$

$$\text{Activity } R = \lambda N = R_0 e^{-\lambda t}$$

Units of activity 1Bq = 1 decay/s,

$$1 \text{ curie} = 3.7 \times 10^{10} \text{ Bq,}$$

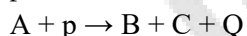
$$1 \text{ rutherford} = 10^6 \text{ Bq}$$

$$\text{After } n \text{ half live Number of nuclei left} = \frac{N_0}{2^n}$$

$$\text{Probability of a nucleus for survival of time } t = \frac{N}{N_0} = \frac{N_0 e^{-\lambda t}}{N_0} = e^{-\lambda t}$$

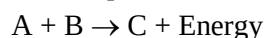
Nuclear Fission

- By bombarding a particle on a heavy nucleus ($A > 230$), it splits into two or more light nuclei. In this process certain mass disappears which is obtained in the form of energy (enormous amount)



Nuclear Fusion

It is the phenomenon of fusing two or more light nuclei to form a single heavy nucleus.



The product (C) is more stable than reactants (A and B) and $m_c < (m_a + m_b)$ and mass defect $D_m = [(m_a + m_b) - m_c] \text{ amu}$ Energy released is $E = (\Delta m) 931 \text{ MeV}$

