SHORT NOTES FOR RADIOACTIVITY

- **Activity** $(A) = -\frac{dN}{dt} = \lambda N$
- **N = number of radioactive nuclei at any time t :**

$$N = N_0 e^{-\lambda t}$$

where N = number of radioactive nuclei at any time t :
N_0 = number of radioactive nuclei at t = 0;
λ = decay constant.

- **Units of activity :**

Disintegration per second (dps). 1 dps = 1 Bq (Becquerel)
1 Ci (Curie) = 3.7×10^{10}dps.
Specific activity = dps/gm

- **Half life ($t_{1/2}$) :** The time taken by half the nuclei (originally present) to decay.

$$t_{1/2} = \frac{0.693}{\lambda}$$

- After n half-lives have passed, activity is reduced to $\frac{1}{2^n}$ of its initial value.
- **Average life (t_{av})**

$$T_{avg} = \frac{1}{\lambda} = \frac{t_{1/2}}{0.693} = 1.44\, t_{1/2}$$

- **THEORIES REGRANDING NEUCLEAR STABILITY :**

(A) Neutron / porton ratio and stability belt

For atomic number < 20, most stable nuclei have n : p ratio nearly 1 : 1 (except H & Ar).
For n/p ratio > 1.52, nucleus is unstable.

Largest stable nucleus is $^{209}_{83}Bi$ for which n/p ratio is 1.52.

For atomic number > 83, there are no stable nuclei.

(B) Magic numbers and nuclear stability

Nuclei with 2, 8, 20, 50, 82 or 126 protons or neutrons are exceptionally stable and have a larger number of stable isotopes than neighboring nuclei in the periodic table. These numbers are called magic numbers. Nuclei with magic number of protons as well as neutrons have notably high stbilities.

[eg. $^{4}_{2}He$, $^{16}_{8}O$, $^{40}_{20}Ca$ and $^{208}_{82}Pb$]. 165 such stable nuclei are known.

(C) Even odd theory of nuclear stability

The number of stable nuclides is maximum when both p and n are even number.

p	n	No. of stable nucleus
even	even	165
odd	even	55
even	odd	50
odd	odd	5

(D) Binding Energy :

Binding energy, $E = (\Delta m) \times c^2 = [Z\, m_H + (A - Z)m_n - M] \times c^2$ (where $c = 3 \times 10^8$ m/s)

- Nuclear binding energy is maximum for mass number 50–60.
- Fe, Co, Ni very high nuclear binding energy.