(ii) Orbital or K-electron Capture —

Nucleus may capture an orbital e^- & thus convert a proton into a neutron $\bar{c}$ emission of neutrino.

$${}^{1}_{1}p + {}^{0}_{-1}e \longrightarrow {}^{1}_{0}n + \nu$$

→ N/p ratio ↑sed

→ Usually a e^- from shell closest to nucleus (K-shell) is captured. So, process is c/a.

K-electron capture.

An e^- from higher energy level drops back to fill vacancy in the K shell & characteristic X-radiation is emitted.

It occurs in nuclei in $\bar{c}$ N/p ratio is low & nucleus has insufficient energy for positron emission.

$$2 \times 0.51 = 1.02\,MeV$$

eg- ${}^{7}_{4}Be + {}^{0}_{-}e \longrightarrow {}^{7}_{3}Be + \nu$

$${}^{40}_{19}K + {}^{0}_{-1}e \longrightarrow {}^{40}_{18}K + \nu$$

(iii) Proton emission

For nuclei in very high energy state.

GAMMA RADIATION

Range → 0.1 to 1 mev.

Immediately after any nuclear change, neutrons & protons haven't arranged them in stable position. Thus newly formed daughter nucleus is in excited state & thus lowering energy to ground state, results in emission of radiation, (γ-rays)

HALF LIFE PERIOD

Time taken for half decay of radioactive nuclei.

→ Nuclear decay → I order rxn

If n → no. of radioactive nuclei
t → time interval.

then rate of decay

$$\frac{dn}{dt} = -\lambda n$$

$$\frac{dn}{-\lambda n} = dt$$

~~log[...]~~ or $\frac{dn}{n} = -\lambda dt$

$$[\log n]_{n_0}^{n} = -\lambda t$$

$$\therefore \frac{n}{n_0} = e^{-\lambda t}$$

n_0 → original no. of nuclei at time 0

n → no. remaining after time t

$t_{1/2} \rightarrow$ time taken for no. of radioactive nuclei to fall to half the original no.

$$n = \frac{1}{2} n_0.$$

$$\log \frac{n}{n_0} = -\lambda t$$

$$\log \frac{1}{2} = -\lambda t_{1/2}$$

$$t_{1/2} = -\frac{\log(1/2)}{\lambda}$$

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

* Change in temp. has no observable effect on rate of decay.

Unit $\rightarrow$ SI unit $\rightarrow$ becquerel (Bq)

↓

amt. of radio isotope ⊆ gives one disintegration per second.

$\rightarrow$ Curie (Ci) $\rightarrow$ traditionally measured.

↓

amt. of radio isotope ⊆ gives 3.7×10^{10} disintegrations per second.

$$1\ \text{Beq} = 27 \times 10^{-12}\ \text{Ci}$$

BINDING ENERGY AND NUCLEAR STABILITY

Mass of atom is less than the sum of mass of constituents neutrons, protons & electrons.

→ other eg − $^{14}_{6}C$ & $^{40}_{19}K$ → radio active in nature
↓
may decay β particle or K-capture

$$^{40}_{19}K \xrightarrow{\beta} {}^{40}_{20}Ca$$
$$^{40}_{19}K \xrightarrow{\text{K-Capture}} {}^{40}_{18}Ar$$

INDUCED NUCLEAR RXNs:

Many nuclear rxns are brought abt. by bombarding nucleus c̄ γ-rays or various particles.
Particles include β-particle, e^-, proton, neutron or α-particle.

NUCLEAR FISSION:

Very heavy nuclei have low B.E per nucleon than nuclei c̄ intermediate mass. Thus nuclei of intermediate mass are more stable than nuclei of heavy mass.

When a slow neutron enters nucleus of a fissionable atom eg. Uranium, extra energy may cause nucleus to split into 2 fragments & spontaneously emit 2 or more neutrons.
This is c/a <u>nuclear fission.</u>

Results in release of large amt. of energy.

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow \begin{cases} ^{144}_{56}Ba + {}^{90}_{36}Kr + 2({}^{1}_{0}n) \\ ^{138}_{53}I + {}^{95}_{39}Y + 3({}^{1}_{0}n) \\ ^{140}_{55}Cs + {}^{92}_{37}Rb + 4({}^{1}_{0}n) \end{cases}$$

↓ heavier nuclei) ↓ lighter nuclei (Atm. mass in

RADIOACTIVE DISPLACEMENT LAWS →

(I) Emission of α-particle results in ↓se of atm. wt by 4 & atm no. by 2 &

(II) Emission of β-particle results in no change in atm. wt. but atm. number ↑ses by one. & new element is one place right to parent in periodic table.

RADIOACTIVE DECAY SERIES :

Four decay series –

→ Thorium (4n) series.
→ Neptunium (4n+1) series
→ Uranium (4n+2) series
→ Actinium (4n+3) series.

☆ Neptunium → artificial post-uranium element.

⇒ Thorium, Uranium & Actinium series ends c̄ lead ($^{206}_{82}Pb$, $^{207}_{82}Pb$, $^{206}_{82}Pb$)

⇒ Neptunium series ends c̄ Bismuth $^{209}_{83}Bi$

All the members of a particular series have mass no. exactly divisible by 4, or divisible by four c̄ a remainder of 1, 2 or 3.