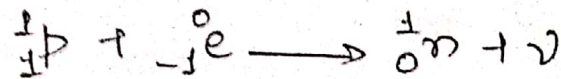


(i) Orbital or K-electron Capture

Nucleus may capture an orbital e^- & thus convert a proton into a neutron & emission of neutrino.



→ N/p ratio used

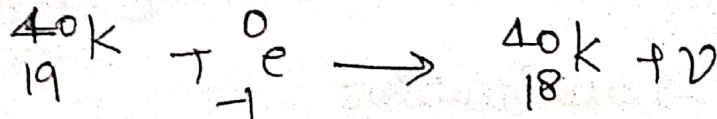
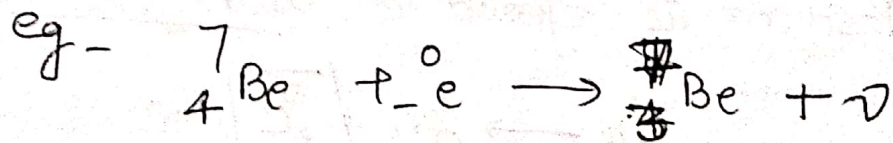
→ Usually a e^- from shell closest to nucleus is captured. So, process is C/q. (K-shell)

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 \leq N/p ratio is low & nucleus has insufficient energy for positron emission.

$$2 \times 0.51 = 1.02 \text{ MeV}$$



(ii) Proton emission

For nuclei in very high energy state.

GAMMA RADIATION

Range \rightarrow 0.1 to 1 meV.

Immediately after any nuclear change, neutrons & protons haven't rearranged themselves 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.

\rightarrow Nuclear decay \rightarrow 1st order rxn

If $n \rightarrow$ no. of radioactive nuclei

$t \rightarrow$ time interval.

then rate of decay

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

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

$$\int \frac{dn}{n} = -\lambda t \quad \text{or} \quad \frac{dn}{n} = -\lambda dt$$

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

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

$n_0 \rightarrow$ original no. of nuclei at time 0

$n \rightarrow$ no. remaining after time t

$t_{1/2}$ → 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 → SI unit → Becquerel (Bq)

↓
amt. of radio isotope \leq gives one disintegration per second.

→ Curie (Ci) → traditionally measured.

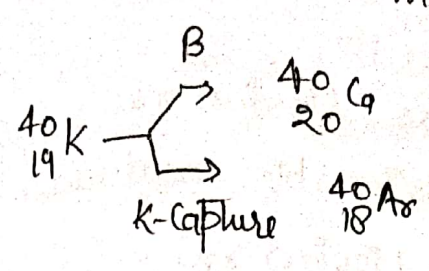
↓
amt. of radio isotope \leq gives 3.7×10^{10} disintegrations per second.

$$1 \text{ Bq} = 2.7 \times 10^{-12} \text{ Ci}$$

BINDING ENERGY AND NUCLEAR STABILITY

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

→ other eg - $^{14}_6\text{C}$ & $^{40}_{19}\text{K}$ → radio active isotopes
 ↓
 may decay β particle or K-capture



INDUCED NUCLEAR RXNS:

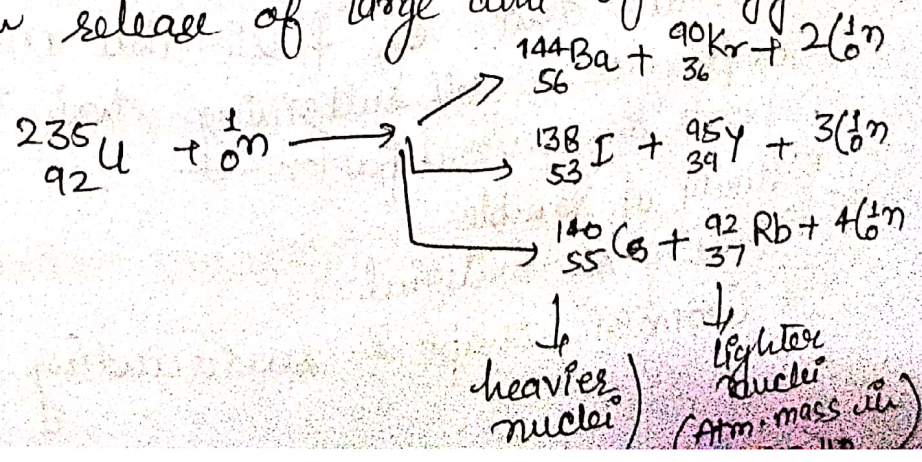
Many nuclear rxns are brought abt. by bombarding nucleus τ γ -rays or various particles.
 Particles include β -particle, e^- , proton, neutron or α -particle.

NUCLEAR FISSION:

Very heavy nuclei have low B.E per nucleon. than nuclei τ 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 n neutrons.
 This is c/a nuclear fission.

Results in release of large amt. of energy.



RADIOACTIVE DISPLACEMENT LAWS →

- ① Emission of α -particle results in size of atom. wt by 4 & atom no. by 2. α
- ② Emission of β -particle results in no change in atom. wt. but atom. number rises 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 \bar{c} lead (${}_{82}^{206}\text{Pb}$, ${}_{82}^{207}\text{Pb}$, ${}_{82}^{208}\text{Pb}$)

⇒ Neptunium series ends \bar{c} Bismuth ${}_{83}^{209}\text{Bi}$

All the members of a particular series have mass no. exactly divisible by 4, or divisible by four \bar{c} a remainder of 1, 2 or 3.