Nuclei having odd number of each nucleons. — Nordheim rule.

If l_p & l_N are orbital angular momentum for unpaired proton & unpaired neutron ; J_p & J_N are corresponding to their total orbital angular momentum.

(i) if $l_p + l_N + J_p + J_N \Longrightarrow$ "Odd"

$$I = J_p + J_N$$

(ii) if $l_p + l_N + J_p + J_N \Longrightarrow$ "Even"

$$I = J_p - J_N$$

→ (3) (i) The parity is even when l_p & l_N are both even or odd.

(ii) And parity is odd when l_p is even and l_N is odd. and vice versa.

$$(-1)^{l_1 + l_2}$$

Q. Find the parity and Nuclear spin for the Nucleus. ${}^{6}_{3}Li_{3}$:

Sol^n

${}^{6}_{3}Li_{3}$

No. of protons (odd) — No. of neutrons (odd)

Nordheim rule ⟶ (I)

→ We have to check for l_p, l_N, J_p, J_N.

protons : (3) Neutrons = (3)

$1s_{1/2}^{2}$ $1p_{3/2}^{1}$ $1s_{1/2}^{2}$ $1p_{3/2}^{1}$

$1p_{1/2}$
$1p_{3/2}$
$1s_{1/2}$

$l_p = 1$ $J_p = \frac{3}{2}$ $l_N = 1$ $J_N = \frac{3}{2}$

	s	p	d	f
l =	0	1	2	3

Now $l_N + l_p + J_N + J_p = 1 + 1 + \frac{3}{2} + \frac{3}{2}$

$= 5$ → Odd

$\therefore$ $I = J_p + J_N$

$$= \frac{3}{2} + \frac{3}{2} = (3)$$

for parity $\rightarrow (-1)^{l_1 + l_2}$

$$= (-1)^{1+1} = (-1)^2 = +1 \rightarrow \text{even parity}$$

Merits of Shell Model:

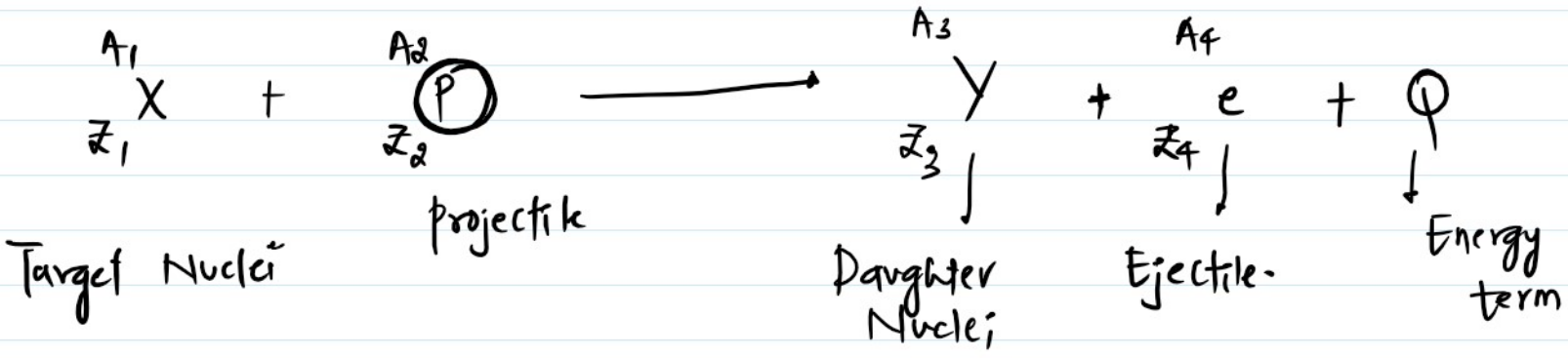
- Nuclear spin.
- Parity
- Magic number.
- Nuclear quadropole moment.

Nuclear Reaction:

$X + a \longrightarrow Y + b$

X: Stable Nuclid (Parent / Target Nuclei)
a: projectile
Y: Daughter Nuclei
b: ejectile.

According to Bethe's Notation.



X (a , b) Y

$^{A_1}_{Z_1}X\,(p, e)\,^{A_3}_{Z_3}Y$

Chemical Rxn.	Nuclear Reaction.
(1) No change in Nuclei of reactant atom occurs.	(1) Nuclear suffers change giving rise to a new element.
(2) Energy change occur due to phenomenon of Bond Breakage & Bond formation.	(2) The energy changed result from conservation of lost mass into energy. ∴ Acc. to Einstein. $\Delta E = mc^2$
(3) Less energy in released / produced in comparision to Nuclear reactim.	(3) Energy produced is millian times greater than energy produced through chemical

in comparision to Nuclear reactim.

④. It can be controlled by external conditians like pressure, temp., catalyst etc.

⑤. Ignoring the thermodynamic & kinetic isotope effect, all element behave identical in chemical rxn because of their similar electronic configuration.

than energy produced through chemical reaction.

④. Nuclear rxn are not dependent upon these external conditians.

⑤ The isotopes of a particular element differ in radioactive property.

Ex: $^{12}_{6}C \longrightarrow$ Stable

$^{14}_{6}C \longrightarrow$ Disintegrate spontaneously.

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \bar{\nu}^{0}_{0}$$

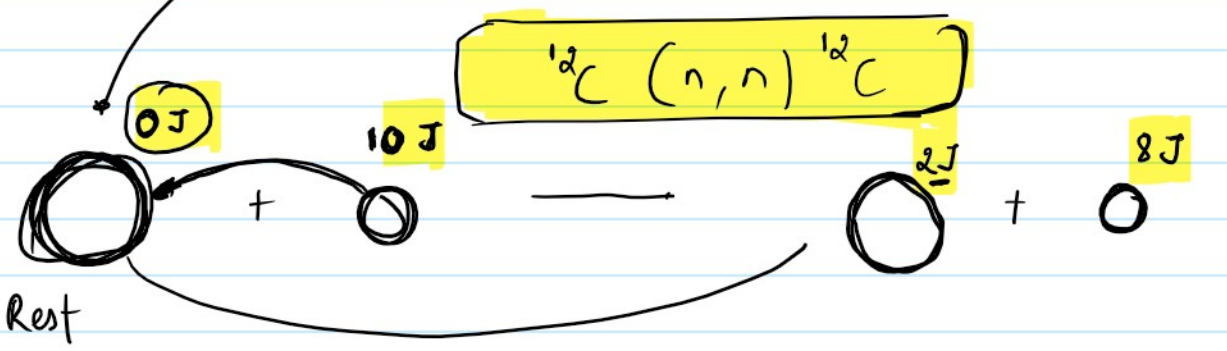
Classificatim of Nuclear Reactian :

① Elastic Scattering :

Ejectile & projectile is same and conservation of K.E takes place.

K.E of projectile = Gain of K.E of Target nuclei + K.E of ejectile.

Ex: $^{12}_{6}C + {}^{1}_{0}n \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$

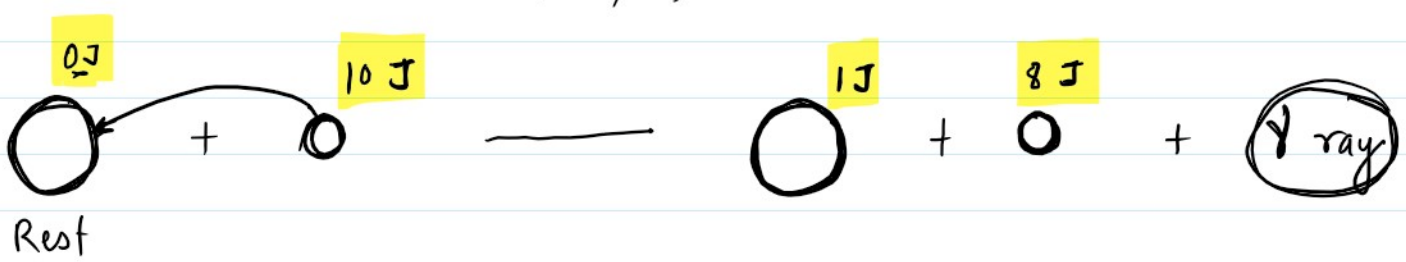


② Inelastic Collision :

Projectile & ejectile are same, but K.E is not conserved

$$^{238}U + {}^{1}_{0}n \longrightarrow {}^{238}U^{*} + {}^{1}_{0}n$$

$$^{238}U\ (n,n)\ ^{238}U^{*}$$



→ In those reaction, generally γ-rays emit.

③ Particle/ projectile/ Radioactive Capture.

In this process, the projectile is captured by target nucleids followed by emission of one or more gamma photons.

* n-γ rxns tendering to synthesis of different radioisotopes.

Ex: ① $^{1}_{1}H\ (n,\gamma)\ ^{2}_{1}H$

② $^{23}_{11}Na\ (n,\gamma)\ ^{24}_{11}Na$

③ $^{19}_{9}F\ (p,\gamma)\ ^{20}_{10}Ne$

④ $^{27}_{13}Al\ (p,\gamma)\ ^{28}_{14}Si$

} Ex of Radioactive Capture.

HW

Q. ① Identify radioactive capture from the following nuclear reaction:

(a) $^{9}Be\ (\gamma, n)\ ^{8}Be$

(b) $^{23}Na\ (n,\gamma)\ ^{24}Na$

(c) $^{63}Cu\ (p, p, 3n, 2\alpha)\ ^{24}Na$.

(d) $^{107}Ag\ (n,n)\ ^{107}Ag$.

④ Partilce - Particle reaction.

Here the ejectile & projectile, both are particle in nature except neutron; $\underline{p}, \underline{\alpha}, \underline{d}$ etc. being positively charged, experience a Columbic repulsion. so these particle are accelerated by special technique.

⑤ Heavy - Ion projectile induced rxn:

Here Li, C, N, O etc. have been utilized as projectile.

Ex: $^{14}_{7}N + ^{10}_{5}B \longrightarrow ^{13}_{7}N + ^{11}_{5}B$

⑥ Special Reaction

Fission Fusion

Thank you ☺