Nuclear Physics

⇒ Radioactivity

→ Spontaneous and random emmision of radiation from an unstable radioactive nucleus.

→ These radiations are of three types:

→ alpha radiation

→ beta radiation

→ gamma radiation

	Alpha (α)	Beta (β)	Gamma (γ)
Content	2p 2n	fast moving e^-	electromagnetic radiati
Mass	4 amu	1/1836 amu	No mass
Charge	+2	-1	No charge
Symbol	${}^{4}_{2}\alpha$	${}^{0}_{-1}\beta$	${}^{0}_{0}\gamma$
Speed	5% of 'c'	50% to 99% of 'c'	$c = 3.0 \times 10^8$ m/s
Range	5 to 10cm	few metres	several thousand kilom
Penetration	thick paper	5mm of Al	8-10cm of Pb or 5 to 6 metre of conc
Ionisation energy	Strong	weak	very weak

Radioactive Decay

→ alpha decay (reduces 2p and 2n)

$${}^{A}_{Z}X \xrightarrow{\alpha\text{-decay}} {}^{A-4}_{Z-2}Y + {}^{4}_{2}\alpha$$

→ during α-decay nucleon number reduces by 4 and proton number reduces by 2.

→ Beta Decay (increases $1e^-$)

→ $${}^{A}_{Z}X \xrightarrow{-\beta\text{-decay}} {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \bar{\nu}$$
anti-neutrino

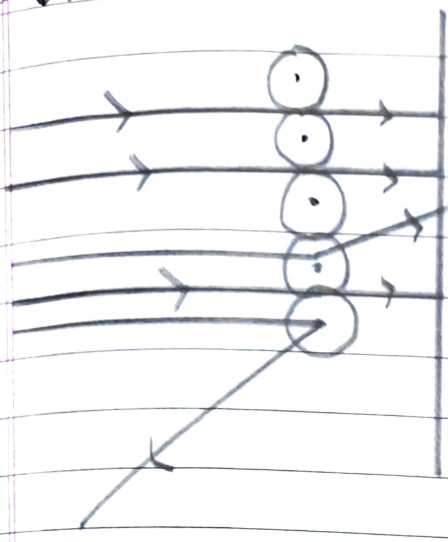
$${}^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e$$
neutron breaks into proton and electron

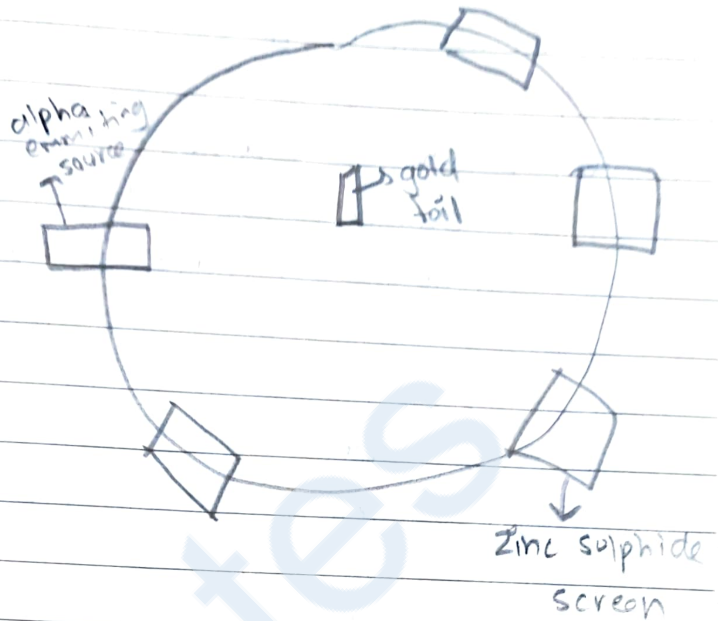
→ $${}^{1}_{1}p \longrightarrow {}^{1}_{0}n + {}^{0}_{+1}\beta + \nu$$
proton breaks into neutron and positron

$${}^{A}_{Z}X \xrightarrow{+\beta\text{-decay}} {}^{A}_{Z-1}Y + {}^{0}_{+1}\beta + \nu$$
neutrino

→ When any particle goes under any decay process the new element formed will be in an excited state and will release gamma radiations until it gets stable.

Rutherford Gold foil experiment





Observations

- most α-particles passed through the foil undeflected
- very few α-particles were deflected through large angles
- extremely less α-particles came back from the gold foil

Conclusion

- As very few α-particles were deflected / came back, the majority of ~~an atom~~ the space in an atom is empty
- As few α-particles were deflected, they must have come across a very strong +ve charge, which causes them to repel.
- Few α-particles came back from the gold foil, it indicates that it must have hit a very strong region within the atom, whose size is very less compared to the atom size. This region is called as nucleus, where entire mass and entire +ve charge is present.

⇒ Hadrons

⇒ Quarks

$+2/3$ UP → anti-up $= -2/3$	$+2/3$ CHARM → anti-charm $= -2/3$	$+2/3$ TOP → anti-top $= -2/3$
DOWN $-1/3$	strange $-1/3$	Bottom $-1/3$

Hadrons < Baryons, Mesons

→ Baryons are made of 3 quarks, example: Proton and Neutrons
UUD UDD

→ Mesons are made of 1quark and 1anti-quark, example: pions 1up 1anti-down

→ Gluons holds protons and neutrons in the nucleus.

→ Every quark has its anti-quark, these can give rise to antiparticles
ex: antineutron $= \bar{u}\bar{d}\bar{d}$. when these collide they form energy.

$\tau > \mu > e$

existance of ~~neutrons~~ neutrinos in β-decay
→ β-particles emmitted have a range of kinetic energies.

$1eV = 1.6 \times 10^{-19} J$

→ fundamental particle
→ cannot be broken down any further.

→ Comparing quark and anti-quark
same mass
same magnitude of charge
both fundamental particles
opporite sign of charge
one is matter and the other is antimatter.