$^A_Z X$ - istope/element

A ← mass number : #p + #n → rel. atomic mass

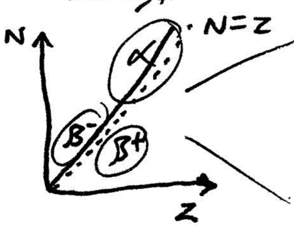
unit : u

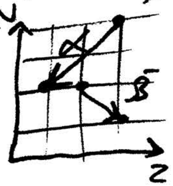
$1u = \frac{1}{12}$ mass of ^{12}C atom

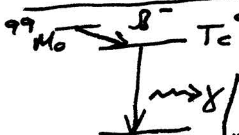
Z ← atomic number : #p

N: here, #neutrons (= A − Z)

More neutrons = more unstable







RADIOACTIVITY

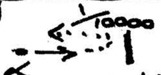
$$A = (-)\lambda N$$ (~~neutrons~~)

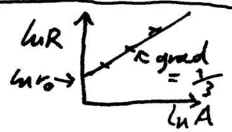
activity (Bq) ↓ decays s^{-1}

nuclei

decay constant, prob of nucleus decaying in certain time (s^{-1}, h^{-1}, y^{-1})

Rutherford: nucleus: small, +ve





$R = r_0 A^{\frac{1}{3}}$ ∴ $\frac{R_1}{A_1^{\frac{1}{3}}} = \frac{R_2}{A_2^{\frac{1}{3}}}$

$$\frac{A}{A_0} = \frac{N}{N_0} = \frac{m}{m_0} = e^{-\lambda t}$$

ratio, 0 → 1
how much of orig. amount left

$$\ln\left(\frac{A}{A_0}\right) = -\lambda t$$

If $\frac{1}{2}$ left, $t = t_{\frac{1}{2}}$, half-life

∴ $$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

radon gas, cosmic, medical

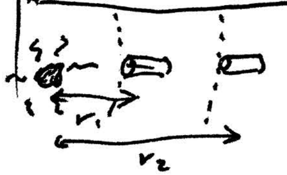
↑ - back ground count!

(measured count (counts per sec))

Intensity decreases with distance, inv. sq. law.

$$I \propto \frac{1}{r^2}$$

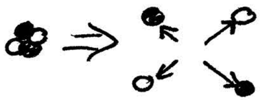
$$I_1 r_1^2 = I_2 r_2^2$$



BINDING ENERGY

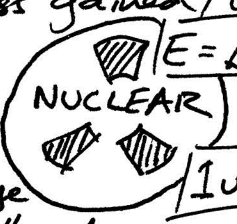
BINDING ENERGY : E needed to separate nucleus (/atom) into constituents.

energy/work needed



lighter   heavier ("buying" back mass)

Any process/interaction : Δm : mass defect, mass gained/lost.

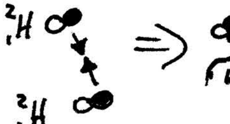


$$E = \Delta m c^2$$

↓ shortcut

$$1u = 931.5 \text{ MeV}$$

FUSION e.g.



high KE needed to get within strong range

deuterium

more stable ('fallen down potential well')

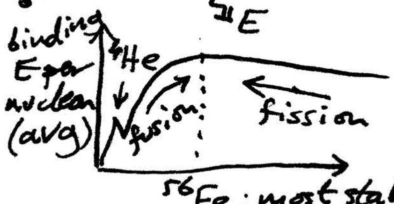
lighter

higher binding E (overall and 'per nucleon')

E released (EM + KE).

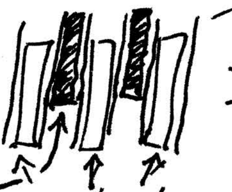
FISSION

absorbed by other U, chain reaction



^{56}Fe : most stable

REACTOR



moderator. slows neutrons to thermal speeds to be absorbed by U. Water/graphite

control rods (Boron)

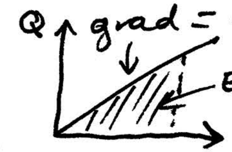
fuel rods, 235U

Coolant : CO_2
Takes heat from rods to water in boiler, turned to steam.

absorb n w/o causing fission
raised/lowered to change output

Waste/Spent rods placed underground + vitrified (glass - non-porous)!

STORE CHARGE/ENERGY

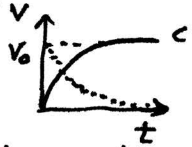


grad = C, capitance (Farad) or ('CV^{-1}')

∴ $C = \frac{Q}{V}$ ⇒ $$Q = VC$$

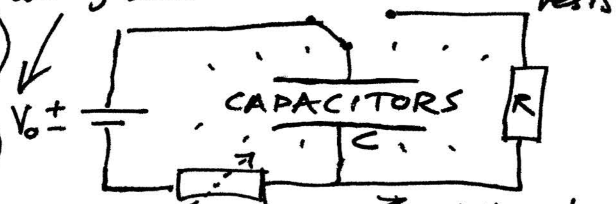
$$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

charging:



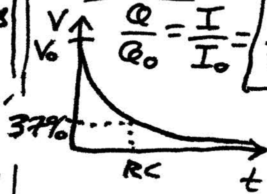
or if at constant I : $$Q = It$$

always shared across C and changing resistor



Discharging

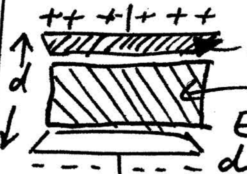
$$\frac{Q}{Q_0} = \frac{I}{I_0} = \frac{V}{V_0} = e^{-\frac{t}{RC}}$$



When t = RC, $e^{-1} = 0.37$
37% of orig.

$$t_c = RC$$ time constant

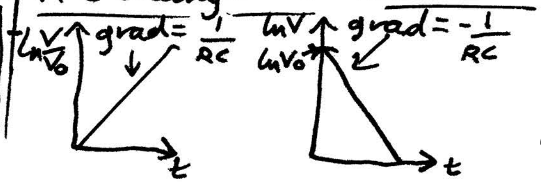
$$C = \frac{A\varepsilon_0\varepsilon_r}{d}$$ ← 1 for air



dialectric → increases Electric field strength due to dipoles lining up along field lines. ($\varepsilon_r > 1$)

Connected? V constant
Q + C change → $E = \frac{1}{2}CV^2$ ∴ $E \propto C$

Disconnected? Q constant
V + C change → $E = \frac{1}{2}\frac{Q^2}{C}$ ∴ $E \propto \frac{1}{C}$



Video