Nuclear 1° order rxn

$\ln A_t = -kt + \ln A_0$ $t_{1/2} = \frac{0.693}{k}$

(34) 5.2 min 1 g ^{210}Fr → 0.250 g $t_{1/2} = ?$

$\ln A_t = -kt + \ln A_0$ same time units!

$\ln 0.25 = -k(5.2) + \ln 1$

$k = 0.27\ min^{-1}$

$t_{1/2} = \frac{0.693}{0.27}$ → 2.6 min

(36) t = ? A_0 6.25 mg ^{51}Cr → A_t 0.75 mg

$t_{1/2} = 27.8$ days $k = days^{-1}$ or $\frac{1}{days}$

$\ln A_t = -kt + \ln A_0$

$\ln(0.75) = -0.025t + \ln(6.25)$

$-2.12 = -0.025t$

t = 85 days

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

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

$k = \frac{0.693}{27.8} = 0.025\ days^{-1}$

Nuclear Transmutations

→ changing to become stable

Natural decay

$^{118}_{54}Xe \rightarrow ^{0}_{+1}e + ^{118}_{53}I$

Positron emission

1 reactant.

Artificial Decay

Target nuclear

$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$

Use a particle to "bash it"

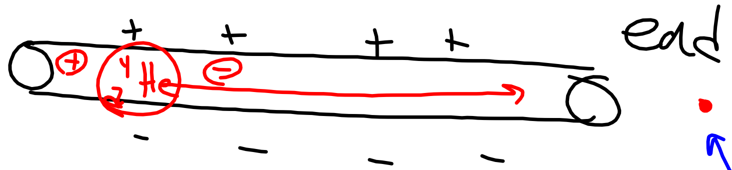
"Linear" Accelerator

Particle Accelerators → Aim at Target Nucleus

① Linear accelerator (Drag Strip)

start

end



Target Nucleus

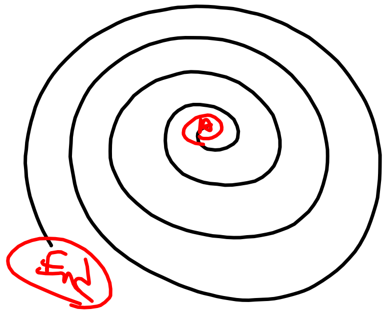
$^{4}_{2}He$

(+2) charge

Charges → accelerate

→ aim

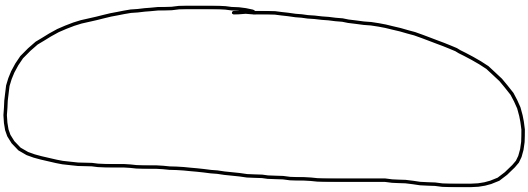
② Cyclotron



Linear → curled it up to save on realestate.

Same process as linear acceleration

③ Synchotron



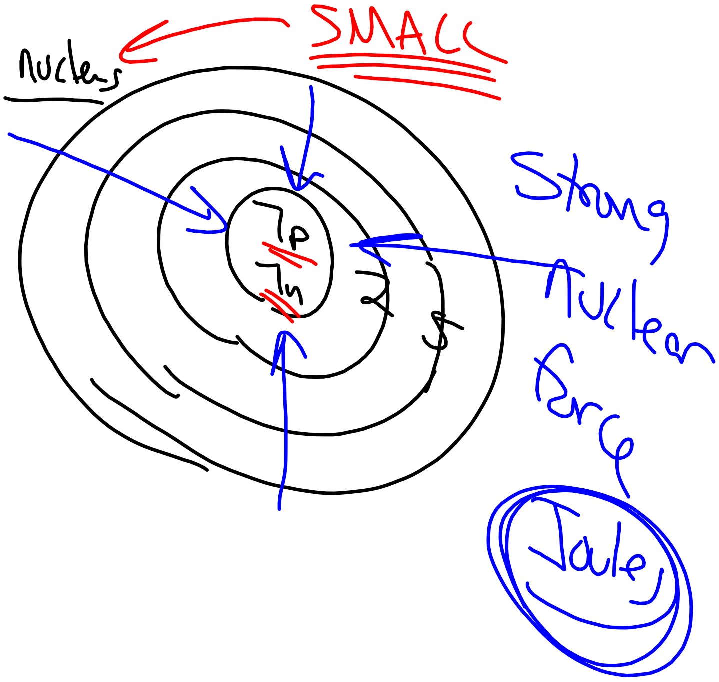
loop around
↓
speed
↓
Aim + smash target.

Stable

ATOMS At # < 83

$^{14}_{7}N$

7p : 7n



Strong Nuclear force (J) nuclear Binding Energy

$E = mc^2$

$^{4}_{2}He$ (#p+#n = 4; #p = 2) → 2p + 2n — 4 nucleon

He Nucleus mass = 4.0015 amu

p = 1.00728 amu, n = 1.00866 amu

	2p	2(1.00728)
+	2n	2(1.00866)
		4.03188 amu

← calculate mass He

Actual mass He	4.00150 amu ← Actual Given
	0.03038 amu

"Missing mass" — Mass Defect

Convert to energy / strong nuclear force

Binding energy — Holds it together → stable.

0.03038 amu missing mass $_2^4He$

$E = mc^2$ $c = 3 \times 10^8$ m/sec

$J = \frac{Kg}{1} \times \frac{m^2}{sec^2}$ (PT) $amu = \frac{g}{mole}$ g → Kg

$0.03038\,amu = \frac{0.03038\,g}{mole} = \frac{0.03038 \times 10^{-3}\,Kg}{mole}$

$E = mc^2$

$E = \left(\frac{0.03038 \times 10^{-3}\,Kg}{mole}\right)(3 \times 10^8)^2$

$E = \frac{2.7342 \times 10^{12}\,J}{mole}$

$\frac{2.7342 \times 10^{12}\,J}{mole} \times \frac{1\,mole}{6 \times 10^{23}\,particle} \times \frac{1\,particle}{4\,nuclei}$

atom He; (2p+2n); atom He; mole → particle

$_2^4He$ $\frac{J}{nucleon}$ resident of the nucleus

$= 1.14 \times 10^{-12}$ J/nucleon

Fission

Breakdown

Large → small.

Nuclear reactor

U-235

Fusion

Small → large

SUN

extreme heat

HW

21 PS#1

1-23