Nuclear Binding Energy

"Strong forces" that hold the nucleus together (STABLE)

Holds the walls up!

STEPS

1. Add up mass of p + n
2. Subtract the given Mass ⇒ Mass defect.
3. Missing Mass → Energy $E = mc^2$ (kg)

mass = amu = g/mole ⇒ kg (Nucl)

Total E in $\frac{\text{Joules}}{\text{Mole}} \times \frac{1\,\text{Mole}}{6*10^{23}\,\text{particle}} \times \frac{1\,\text{particle (atom)}}{\#\,\text{Nucleons}}$

(# Nucleons: Present of Nucleons)

J / Nucleon

Decay → given off → Product side

Capture → gain it → Product side

$^{4}_{2}He$

R ⟶ $^{4}_{2}He$ + P

Proton $^{1}_{1}H$ $1p$

deuterium $^{2}_{1}H$ $1p+1n$
deuteron

tritium $^{3}_{1}H$ $1p+2n$
triton

$^{238}_{92}U + {}^{2}_{1}H \Rightarrow {}^{238}_{93}Np + 2\ {}^{1}_{0}n$

2

0

(18)

$^{73}_{32}Ge + {}^{4}_{2}He \rightarrow {}^{77}_{34}Se$

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

(22) ^{210}Pb $t_{1/2} = 22.3\,yr$ $\frac{k}{1} = \frac{0.693}{t_{1/2}} = \frac{0.693}{22.3} = 0.0311\,yr^{-1}$

7.5g → ^{206}Hg ← ?g

after 17.5yrs

$^{210}Pb \rightarrow {}^{210}Pb + {}^{206}Hg$

7.5g → 4.35 + 3.15

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

$\ln A_t = -(0.0311)(17.5\,yr) + \ln 7.5$

$\ln A_t = 1.47$

$A_t = 4.35g$ Pb now

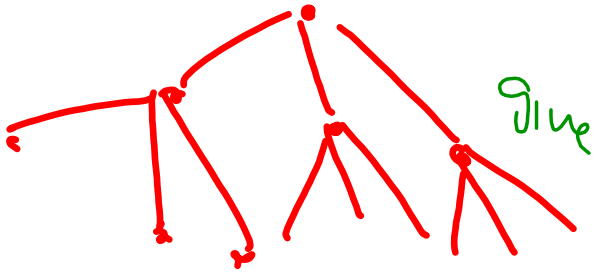
Pb decayed 3.15g

$\frac{^{206}Hg}{^{210}Pb}$ 3.04g Hg

Fission

remove excess $_0^1n$

$$^{235}_{92}U + {}^1_0n \rightarrow {}^{142}_{56}Ba + {}^{91}_{36}Kr + 3\,{}^1_0n$$



BAD !!

(B) + (Cd) → Absorb neutrons

Control Rod → removes excess $_0^1n$ to prevent an uncontrolled chain reaction → MELT DOWN.

Fission

Moderator → slows $_0^1n$ down.

↳ Heavy water (H_2O) or graphite

// Use (Water or ^2_1H)

Fusion Rxn

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He$$

$$^{1}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He$$

Measure Radioactivity

RAD - Radiation Absorbed Dose.

RBE → Relative Biological Effectiveness

*REM → Roentgen Equivalent for Man.

REM = RAD x RBE

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