Modern Physics-III- Stability of Nuclei

$m({}^{1}_{1}H) = 1.00783\,u$

$m({}^{0}_{1}n) = 1.00867\,u$

$m({}^{0}_{-1}e) = 0.0005486\,u$

$1u \equiv 931.5\,MeV/c^2$

Q.1 Find mass of ${}^{14}_{7}N$

$p \to 7$
$n \to 7$
$e^- \to 7$

$m({}^{14}_{7}N)_{expected} = (7 \times 1.00783 + 7 \times 1.00867 + 7 \times 0.0005486)\,u$

$= 14.119368\,u$

$m({}^{14}_{7}N)_{obs} = 14.00307\,u$

$\Delta m = 0.116298\,u$

$\equiv 108.33\,MeV/c^2$

$\Delta E = 108.33\,MeV$

${}^{56}_{26}Fe \to$

$p \to 26$
$n \to 30$
$e^- \to 26$

$m({}^{56}_{26}Fe)_{expected} = 26 \times (1.00783) + 30 \times (1.00867) + 26 \times (0.0005486)$

$= 56.47887\,u$

$m({}^{56}_{26}Fe)_{obs} = 55.93494\,u$

$\Delta m = 0.54397\,u \equiv 506.70\,MeV/c^2$

Q.2 α particle, ${}^{4}_{2}He$

$p \to 2$
$n \to 2$
$e^- \to 2$

$m({}^{4}_{2}He)_{expected}$

$= 2 \times 1.00783 + 2 \times 1.00867 + 2 \times 0.0005486$

$= 4.17503\,u$

$m({}^{4}_{2}He)_{obs} = 4.00260\,u$

$\Delta m = 0.17243\,u$

$= 160.62\,MeV/c^2$

$\Delta E = \Delta m c^2 = 160.62\,MeV$

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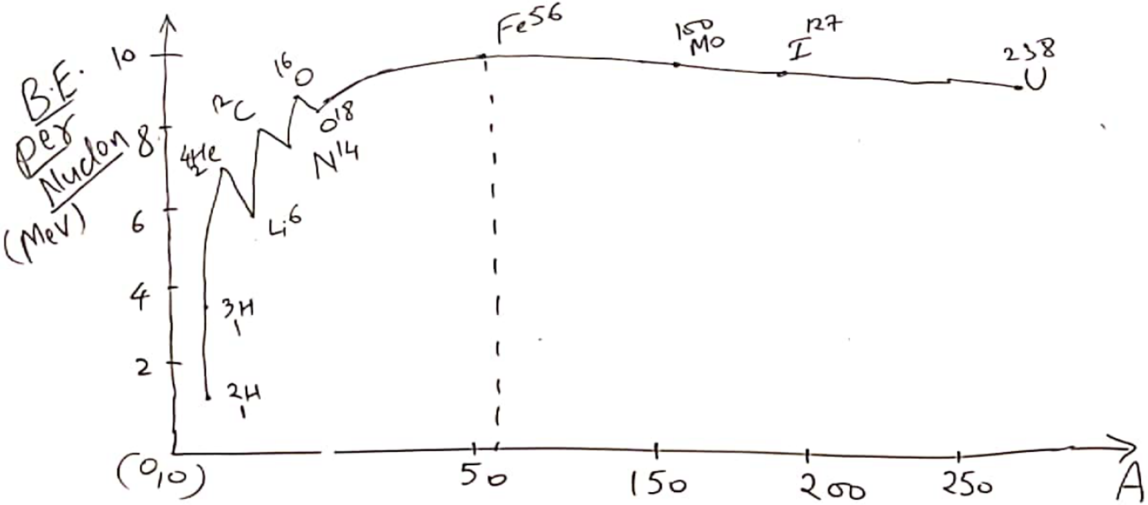

$m(^1_1H) = 1.007834$ u

$m(^0_1n) = 1.008674$ u

$m(^0_{-1}e) = 0.0005486$ u

$1u \equiv 931.5\ MeV/c^2$

Criteria for stability

binding energy / nucleon — $(\Delta E/A)$

if $(\Delta E/A)\uparrow$ stability $\uparrow$

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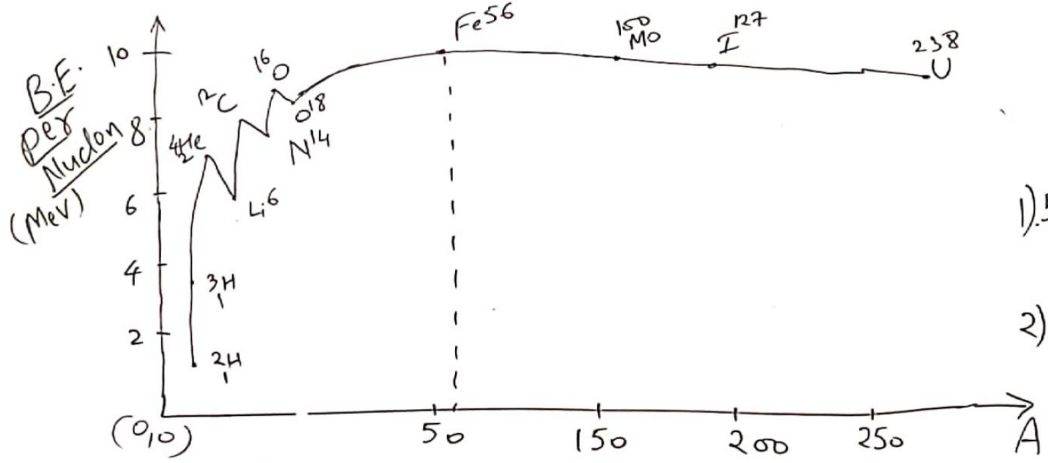

$m(^1_1H) = 1.00783u$

$m(^1_0n) = 1.00867u$

$m(^0_{-1}e) = 0.0005486u$

$1u \equiv 931.5 \, MeV/c^2$

1). $50 < A < 80$, → Nuclei are most stable. $(\Delta E/A) \sim 8+$ MeV

2). $A = 56 \rightarrow {}^{56}_{26}Fe \rightarrow$ The most stable nucleus

3). $A > 80$, rate of decrease of $(B.E)/A \rightarrow$ is lesser.

4). $A < 50$, rate of decrease of $(B.E)/A \rightarrow$ is sharp.

5). For heavier nuclei → nucleus will split into lighter nuclei → Nuclear Fission.

$$^{100}Z \rightarrow {}^{55}X + {}^{45}Y + Q = 50\,MeV$$

	^{100}Z	^{55}X	^{45}Y	
B.E. (MeV)	750	440	360	→ total B.E. = 800 MeV
(B.E/A) →	750/100 = 7.5	440/55 = 8	360/45 = 8	