**Question**

*Binding Energy*: Find the energies needed to remove a neutron from $^4_2$He, then to remove a proton, and finally to separate the remaining neutron and proton. Compare the total with the binding energy of $^4_2$He.

**Solution**

Using the atomic masses given in the Appendix of the text:

$^4_2\text{He} \rightarrow {}^3_2\text{He} + \text{n}$

Difference in mass = 4.002 603 - (3.016 029 + 1.008 665) = - 0.0221 $u$

$\rightarrow$ Binding energy = (0.022 091)(931.49) = 20.6 MeV

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$^3_2\text{He} \rightarrow {}^2_1\text{H} + {}^1_1\text{H}$

Difference in mass = 3.016 029 - (2.014 102 + 1.007 825) = - 0.00590 $u$

$\rightarrow$ Binding energy = (0.00590)(931.49) = 5.49 MeV

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$^2_1\text{He} \rightarrow {}^1_1\text{H} + \text{n}$

Difference in mass = 2.014 102 - (1.007 825 + 1.008 665) = - 0.00239$u$

$\rightarrow$ Binding energy = (0.00239)(931.49) = 2.22 MeV

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The sum of these three binding energies is 28.3 $MeV$.

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Using the formula for the binding energy of $^4_2$He (where $N = A - Z$)

$$\begin{aligned} E_b &= \left[Zm(^1_1\text{H}) + Nm(n) - m(^4_2\text{He})\right](931.49) \\ &= [2(1.007\,825) + 2(1.008\,665) - 4.002\,603](931.49) \\ &= 28.3\,MeV \end{aligned}$$

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Both calculations yield the same result.