MODERN PHYSICS DAY 10: NUCLEAR MASS, BINDING ENERGY, FISSION, AND FUSION

CED 15.7 · Skill 2.B · FRQ: Multiple Representations

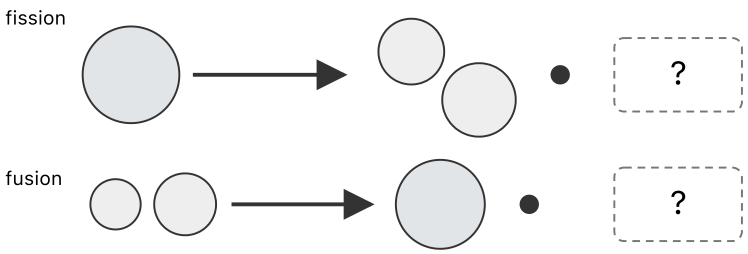
PREDICT

The products of a fission reaction have slightly less rest mass than the initial system. What accounts for the difference?

A. released energy **B. measurement error only** **C. lost charge** **D. missing nucleons**

Commit before the missing system output is identified.

TWO NUCLEAR PATHWAYS — OUTCOME WITHHELD



Track the full system: nuclei, emitted particles, and the unidentified output.

NOTES / REASONING

MASS DEFECT IS AN ENERGY DIFFERENCE

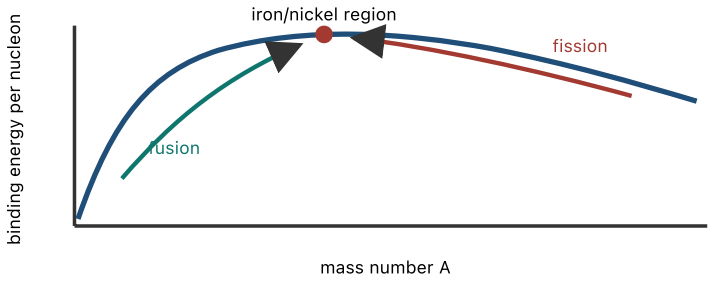
$$E = \Delta m c^2 \qquad 1\,\text{u}c^2 = 931.5\,\text{MeV}$$

For an exothermic reaction, $\Delta m = m_{initial} - m_{final} > 0$. The released energy completes the before/after account.

WE DO A fission reaction has $\Delta m = 0.215\,\text{u}$. Calculate the released energy in MeV.

READ THE BINDING-ENERGY CURVE

BINDING ENERGY PER NUCLEON



A larger binding energy per nucleon means nucleons are more tightly bound. Reactions that move nuclei toward the broad iron/nickel maximum can release energy.

1. Explain why a heavy nucleus can release energy by splitting.

2. Explain why two light nuclei can release energy by joining.

COMPARE WITH A STATED BASIS

1. A D–T fusion reaction has $\Delta m = 0.0189\,\text{u}$. Find the energy released per reaction.

2. The fission example releases more energy per event than the D–T example. Explain why common fusion fuel can still release more energy per unit fuel mass.

3. A student says “fusion always releases more energy than fission.” Rewrite the statement so the comparison basis is physically meaningful.