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QUESTION WORKBOOK

Mass–energy and binding energy

Nuclear physics · Year 13

AQA 3.8.1.6 · CIE 11.1, 23.1 · OCR A 6.4.4

10 questions · 30 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 State the equation linking mass and energy, and define the binding energy of a nucleus. [2]

A2 A mass of 1.0×10^{-28} kg is converted entirely into energy. Calculate the energy released ($c = 3.0 \times 10^{8}$ m s^{-1}). [2]

A3 State the energy equivalent of one atomic mass unit (u) in MeV. [2]

SECTION B · Standard

B1 A helium-4 nucleus has a mass of 4.00150 u. The masses of a proton and a neutron are 1.00728 u and 1.00867 u. Calculate the mass defect and the binding energy in MeV (1 u = 931.5 MeV). [4]

B2 Using the binding energy of helium-4 found above (28.3 MeV), calculate its binding energy per nucleon. [3]

B3 Express the binding energy of helium-4 (28.3 MeV) in joules (1 MeV = 1.60×10^{-13} J). [3]

B4 In a reaction 2.0×10^{-11} J of energy is released. Calculate the mass converted into this energy. [3]

SECTION C · Stretch

C1 A nucleus with nucleon number 12 has a mass defect of 0.099 u. Calculate its binding energy and its binding energy per nucleon (1 u = 931.5 MeV). [4]

C2 Sketch the shape of the binding energy per nucleon curve against nucleon number, and use it to explain why both fusion of light nuclei and fission of heavy nuclei release energy. [4]

C3 Explain the significance of the peak of the binding energy per nucleon curve. [3]