Problem-21

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A given coin has a mass of 3.0 g. Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other. For simplicity assume that the coin is entirely made of $_{29}Cu^{63}$ atoms (of mass 62.92960 u).

Solution:-

$m_p = 1.007825\,u$

$m_n = 1.008665\,u$

$m_{Cu} = 62.92960\,u$

No. of atoms in copper coin of mass 3 g is

$$n = \frac{N_A \times m}{A}$$

$$\therefore n = \frac{6.023 \times 10^{23} \times 3}{63}$$

$$\therefore n = 2.868 \times 10^{22}$$

Atomic no of $_{29}Cu^{63}$ is 29.

∴ No of protons in one atom is 29

no of neutrons " " " " 63 − 29 = 34

∴ Mass of all nucleons

$= 29 m_p + 34 m_n$

$= (29 \times 1.007825) + (34 \times 1.008665)$

$= 63.5215\ u.$

$\therefore$ Mass defect $\Delta m = 63.5215 - 62.92960$

$= 0.591935\ u$

$\therefore$ Mass defect of all atoms

$= n\,\Delta m$

$= 2.868 \times 10^{22} \times 0.591935$

$= 1.698 \times 10^{22}\ u.$

$\therefore$ Energy required to separate all protons & neutrons

$E = \Delta m \times 931.5\ MeV$

$\therefore E = 1.698 \times 10^{22} \times 931.5$

$\therefore E = 1.582 \times 10^{25}\ MeV$

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