

Nuclei

ch. 13

NCERT Examples

Ex. 1.

$$\begin{aligned}\text{Given, } m_{Fe} &= 55.85 \text{ u} \\ &= 55.85 \times 1.66 \times 10^{-27} \text{ kg} \\ &\quad [1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}] \\ &= 92.711 \times 10^{-27} \\ &= 9.27 \times 10^{-26} \text{ kg}\end{aligned}$$

Volume of nucleus (sphere shape)

$$V = \frac{4}{3} \pi R^3$$

$$= \frac{4}{3} \pi (R_0 A^{1/3})^3 \quad [R = R_0 A^{1/3}]$$

$$= \frac{4}{3} \pi \times (1.2 \times 10^{-15} \times 56^{1/3})^3$$

$$V = \frac{4}{3} \times 3.14 \times (1.2)^3 \times 10^{-45} \times 56$$

$$\text{Nuclear density} = \frac{\text{Mass}}{\text{Volume}}$$

$$= \frac{9.27 \times 10^{-26} \times 1000}{\frac{4}{3} \times 3.14 \times 1.2 \times 1.2 \times 1.2 \times 56 \times 10^{-45}}$$

$$= \frac{9.27 \times 10^{-23+45}}{16 \times 3.14 \times 144 \times 56}$$

$$= \frac{9.27 \times 10^{22}}{50.24 \times 144 \times 56}$$

$$= \frac{9.27 \times 10^{22}}{7234.56 \times 56}$$

$$= \frac{9.27 \times 10^{22}}{405135.36}$$

$$= \frac{9.27 \times 10^{22}}{4.05 \times 10^5}$$

$$= \frac{9.27 \times 10^{17}}{4.05}$$

$$= 2.288 \times 10^{17}$$

$$\text{density} = 2.29 \times 10^{17} \text{ kg m}^{-3} \quad \underline{\underline{Ans}}$$

Ex. 2.

$$m = 1 \text{ g}$$

$$= 1 \times 10^{-3} \text{ kg}$$

$$c = 3 \times 10^8 \text{ m/s}$$

Now by mass energy relation

$$E = mc^2$$

$$= 1 \times 10^{-3} \times (3 \times 10^8)^2$$

$$= 9 \times 10^{-3+16}$$

$$E = 9 \times 10^{13} \text{ J} \quad \underline{\underline{Ans}}$$

Ex. 3.

$$1 \text{ u} = 1.6605 \times 10^{-27} \text{ kg}$$

By mass energy equivalence

$$E = mc^2$$

$$= 1.6605 \times 10^{-27} \times (2.9979 \times 10^8)^2$$

$$= 1.6605 \times 2.9979 \times 2.9979 \times 10^{-27+16}$$

$$= 14.923585 \times 10^{-11}$$

$$E = 1.4924 \times 10^{-10} \text{ J} \quad \underline{\underline{Ans}}$$

Energy in eV

$$E = \frac{1.492 \times 10^{-10}}{1.602 \times 10^{-19}} \text{ eV}$$

$$= 0.9315 \times 10^9 \text{ eV}$$

$$E = 931.5 \times 10^6 \text{ eV}$$

$$E = \underline{931.5 \text{ MeV}} \quad \underline{\text{Ans}} \quad [1 \text{ MeV} = 10^6 \text{ eV}]$$

Mass defect for $^{16}_8\text{O}$ in MeV/c^2

$$E = mc^2$$

$$= \underline{931.5}$$

For $^{16}_8\text{O}$ $\Delta M = 0.13691 \text{ u}$

$$= 0.13691 \times \frac{931.5}{c^2}$$

$$\Rightarrow m = \frac{931.5}{c^2}$$

$$\Delta M = 127.5 \text{ MeV}/c^2$$

Ans

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