Nuclei Ch. 13

NCERT Examples

Ex. 1. Given, $m_{Fe} = 55.85\ u$

$= 55.85 \times 1.66 \times 10^{-27}\ kg$

$[1\ u = 1.66 \times 10^{-27}\ kg]$

$= 92.711 \times 10^{-27}$

$= 9.27 \times 10^{-26}\ kg$

Volume of nucleus (sphere shape)

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

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

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

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

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

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

$$= 9.27 \times 10^{-23+45}$$

$$= \frac{9.27 \times 10^{22}}{16 \times 3.14 \times 144 \times 56}$$

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

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

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

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

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

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

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

Ex. 2. $m = 1\ g$

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

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

Now by mass energy relation

$$E = mc^2$$

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

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

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

Ex. 3. $1\ u = 1.6605 \times 10^{-27}\ kg$

By mass energy equivalence

$$E = mc^2$$

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

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

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

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

Energy in eV

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

$= 0.9315 \times 10^9$ eV

$E = 931.5 \times 10^6$ eV

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

Ans

Mass defect for $^{16}_{8}O$ in MeV/c^2

$E = mc^2$

$= \underline{931.5}$

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

For $^{16}_{8}O$ $\Delta M = 0.13691$ u

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

$\Delta M = 127.5$ MeV/c^2

Ans