Nuclear Shape, Size & Density

Size: Q. Calculate mass number of that nucleus whose Radius is half of Ge(72)

$R \propto A^{1/3}$

$R_{Ge} \propto (72)^{1/3}$

$R_{\frac{Ge}{2}} \leftarrow R_x \propto (A_x)^{1/3}$

Divide

$2^3 = \left(\frac{72}{A_x}\right)$

$\Rightarrow A_x = 72/8$

$\boxed{A_x = 9}$

Nuclear Shape, Size & Density

ABLES KOTA

Density:

$$\rho = \frac{\text{Mass of Nucleus}}{\text{Vol. of nucleus}} \simeq \frac{\text{Atomic Mass}}{\text{Vol. of Nucleus}}$$

$$R = R_0 A^{1/3}$$

$$= \frac{A \times (1\,amu)}{\frac{4}{3}\pi R^3} = \frac{A\,(amu)}{\frac{4}{3}\pi R_0^3 \times (A^{1/3})^3}$$

$$\rho = \frac{1.66 \times 10^{-27}\,kg}{4/3 \times 3.14 \times (1.2 \times 10^{-15})^3\,m^3}$$

$$= \frac{1\,amu}{\frac{4}{3}\pi R_0^3}$$

$$\rho_{nucleus} \simeq 2 \times 10^{17}\,kg/m^3$$

$$\rho_w = 10^3\,kg/m^3$$

Nuclear Shape, Size & Density

Density:

- (Spherical) → $\propto A^{1/3}$
  - → increase with A
  - → $R_0 = 1.2$ Fm
- → Uniform for all nuclei
  - → $\sim 2 \times 10^{17}$ kg/m^3.
  - → indep. of A.

Nuclear Shape, Size & Density

Density: Q. Find nuclear density of Iron whose mass is 55.85 a.m.u. and its A = 56

$$\rho_{\text{Iron nucleus}} = \frac{(55.85)\,\text{amu}}{\frac{4}{3}\pi R_0^3 (A^{1/3})^3}$$

$$= \frac{55.85 \times 1.66 \times 10^{-27}\,\text{kg}}{4/3\,\pi (1.2 \times 10^{-15})^3 \times A} \rightarrow 56$$

$$\simeq 2 \times 10^{17}\ \text{kg/m}^3.$$

isotopic effect.

Nuclear constitution summary:

- protons, neutrons, (A, Z, a.m.u., MeV/c^2)
- Nuclear force
- Sha[illegible]ensity

Classifications of Nuclei

- 1st Classification: based on similarity

  isotopes

- 2nd Classification: based on stability

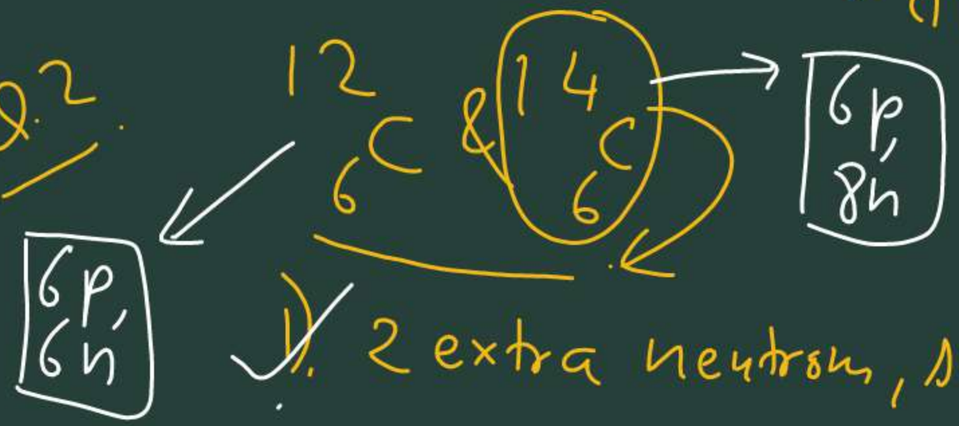
Ex - Nuclear Constitution & Nuclear Force :

Q1) Mass of C-atom in ground state →

1) exact 12 u 2) < 12 amu 3) > 12 amu

4) It depend → graphite
→ diamond.

Q.2)



1) 2 extra neutrons, same e⁻ 2) 2 extra proton, same e⁻

3) —u— 2 extra e⁻ 4) None.

Ex: Nuclear Force

Q.1. Two protons @ 10nm.

F_N & F_e.

1). $F_e = F_n$ ~~2). $F_e >> F_N$~~ 3). $F_e << F_N$

4). F_e & F_n are slightly diff.

Q.2. F_{pp}, F_{pn} & F_{nn} → mag. of NET forces.

Sep. → 1 fm

↳ D) same

a). $F_{pp} > F_{pn} = F_{nn}$

~~b). $F_{pp} = F_{pn} = F_{nn}$~~

c). $F_{pp} > F_{pn} > F_{nn}$

d). $F_{pp} < F_{pn} = F_{nn}$.

Q.2 Spin of two neutrons → $n_1 \longrightarrow +\frac{1}{2}$

$n_2 \longrightarrow +\frac{1}{2}$

Comment upon Nuclear force?

(a) attractive (b) repulsive (c) stronger (d) weaker.

Atomic Number & Mass Number

Atomic Number → It is the number of protons in a nucleus. (Z). For a neutral atom no of electrons equals atomic no.

Mass Number → It is no. of nucleons (protons + neutrons) in the nucleus. (A).

Atomic Mass → It is the mass of all the nucleons in a nucleus.

Nuclear Shape, Size & Density

Shape: Spherical (up to 90%)

Size: Q 1). Different nuclei should be of same size or different?
Q 2). Nucleus w.r.t. atom v/s w.r.t. other nuclei?

H (1, 1) nucleus v/s Na (23, 11) nucleus

$^{1}_{1}H \rightarrow (1p, 0n)$ $^{23}_{11}Na \rightarrow (11p, 12n)$

Volume of nucleus α No of nucleons → by Rutherford

Nuclear Shape, Size & Density

Size: Volume of nucleus α No of nucleons $(n_p + n_n)$

$R \rightarrow$ Radius of nucleus

$$\frac{4}{3}\pi R^3 \propto A$$

$$\Rightarrow R^3 \propto A$$

$$\Rightarrow \boxed{R \propto A^{1/3}} \Rightarrow \boxed{R = R_0 A^{1/3}}$$

$R_0 \approx 1.2\ Fm = 1.2 \times 10^{-15}\ m.$