

Nuclear Physics

A: mass number (atomic weight)

$$A = Z + N$$

Z: atomic number (proton number), implied by the chemical symbol

$$Z(\text{H}) = 1 ; Z(\text{Cl}) = 17 \text{ etc.}$$

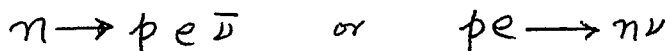
N: neutron number

Size \Rightarrow $R = R_0 A^{1/3}$ ($R_0 = 1.5 \text{ fm}$; $1 \text{ fm} = 10^{-15} \text{ m}$, ten thousand smaller than atom)

Isotopes: ${}^1_1\text{H}$; ${}^2_1\text{H}$; ${}^3_1\text{H}$ \rightarrow hydrogen, deuterium, tritium.

${}^{12}_6\text{C}$; ${}^{14}_6\text{C}$ (carbon fourteen is not stable; it is used for dating)

status of proton and neutron can be changed by β decay or e-capture

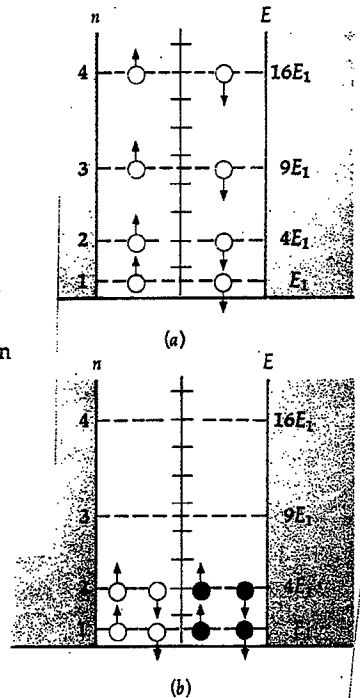


Pauli Principle would suggest

$$Z \approx N$$

(a) Eight neutrons in a one-dimensional box. In accordance with the exclusion principle, only two neutrons (with opposite spins) can be in a given energy level.

(b) Four neutrons and four protons in a one-dimensional box. Because protons and neutrons are not identical particles, two of each can be in each energy level. The total energy is much less for this case than for (a).



$$1 \text{ u} = \frac{1}{12} \text{ mass of } {}^{12}_6\text{C} \text{ atom}$$

$$= \frac{1}{12} \frac{12 \text{ gm}}{N_A (\text{avogadro's number } 6.022 \times 10^{23})}$$

$$= \frac{1 \text{ gm}}{6.022 \times 10^{23}} = 1.6606 \times 10^{-24} \text{ g} =$$

$$1 \text{ u c}^2 = 931.5 \text{ MeV}$$

Compare mass of $2 {}^1_1\text{H} + 2 n$ and ${}^4_2\text{He}$

$2(1.007825 \text{ u}) + 2(1.008665 \text{ u})$	4.002603
4.03298	

$$E_b/A = \frac{28.29}{4} = 7.07 \text{ MeV/nucleon}$$

Discrepancy $E_b = 0.030377 \text{ u}$
 $= 28.29 \text{ MeV}$