

Exercice 1

$${}^{32}\text{S}: n_e = n_p = 16$$

$$n_n = 16; n_p + n_n = 32$$

$${}^{107}\text{Ag}: n_e = n_p = 47$$

$$n_n = 61; n_p + n_n = 108$$

$${}^{137}\text{Ba}: n_e = n_p = 56$$

$$n_n = 81; n_p + n_n = 137$$

Exercice 2

Isotopes: C, D

Isobares: B, D

Isotones: A, C

Exercice 3

$$a) \alpha_1 m_1 + \alpha_2 m_2 = m$$

$$\alpha_1 + \alpha_2 = 1 \quad \text{d'où } \alpha_2 = 1 - \alpha_1$$

$$\alpha_1 m_1 + (1 - \alpha_1) m_2$$

$$= \alpha_1 (m_1 - m_2) + m_2 = m$$

$$\alpha_1 = \frac{m - m_2}{m_1 - m_2} = \frac{10,91 - 11}{10 - 11} = 0,19 = 19\%$$

$$\alpha_2 = 1 - \alpha_1 = 0,81 = 81\%$$

$$b) \beta_1 = \frac{\alpha_1 m_1}{m} = 0,176 = 17,6\%$$

$$\beta_2 = \frac{\alpha_2 m_2}{m} = 0,824 = 82,4\%$$

Exercice 4

$$\rho_A = \frac{m_A}{V_A} = \frac{m_A}{(4/3)\pi R_A^3} = \frac{3m_A}{4\pi R_A^3}$$

$$\rho_N = \frac{m_N}{V_N} = \frac{m_N}{(4/3)\pi R_N^3} = \frac{3m_N}{4\pi R_N^3}$$

$$\frac{\rho_N}{\rho_A} = \left(\frac{R_A}{R_N}\right)^3 = 10^{12} \quad (m_A \approx m_N)$$

$$\rho_N \approx 10^{12} \rho_A = 7,8 \times 10^{12} \text{ g/cm}^3 \\ \approx 10^{13} \text{ g/cm}^3$$

Exercice 5

$$R = r_0 A^{1/3} \quad r_0 \approx 1,2 \text{ fm}$$

$$r = \frac{0,53 \text{ \AA}}{2}$$

$${}^2_1\text{H}: R = 1,31 \text{ fm}$$

$$r = 0,53 \text{ \AA} = 53000 \text{ fm}$$

$${}^{50}_{24}\text{F}: R = 4,59 \text{ fm}$$

$$r = 0,020 \text{ \AA} = 2038 \text{ fm}$$

$${}^{238}_{92}\text{U}: R = 7,44 \text{ fm}$$

$$r = 5,76 \times 10^{-3} \text{ f} = 576 \text{ fm}$$

Exercice 6

$$R_x = \frac{1}{3} R_{\text{Pu}}$$

$$r_0 A_x^{1/3} = \frac{1}{3} r_0 A_{\text{Pu}}^{1/3}$$

d'où:

$$A_x = \frac{A_{\text{Pu}}}{27} = \frac{243}{27} = 9$$

$$Z_x \approx A_x / 2 = 4 \text{ ou } 5$$

Naturel: ${}^9_4\text{Be}$

Exercice 7

$$B(12,6) = [6D_p + 6D_n - A(12,6)]c^2$$

$$= (6D_p + 6D_n)c^2$$

$$= 92,16 \text{ MeV}$$

$$B/A = 7,68 \text{ MeV/nucleon}$$

Exercice 8

$$B(16,9) = [8m_p + 8m_n - M(16,9)]c^2$$

$$= 127,62 \text{ MeV}$$

$$B/A = 7,98 \text{ MeV/nucleon}$$

$$B(57,26) = [26m_p + 31m_n - M(57,26)]c^2$$

$$= 499,91 \text{ MeV}$$

$$B/A = 8,77 \text{ MeV/nucleon}$$

$$B(17, 9) = [9m_p + 9m_n - m(17, 9)]c^2$$

$$= 1418.41 \text{ MeV}$$

$$B/A = 8,06 \text{ MeV/nucleon}$$

Exercice 9

$$a) S_n(17, 9) = B(17, 9) - B(16, 9)$$

$$= [9m_p + 9m_n - m(17, 9)]c^2 - [8m_p + 8m_n - m(16, 9)]c^2$$

$$= [m_n - m(17, 9) + m(16, 9)]c^2$$

$$= 4,14 \text{ MeV}$$

$$S_p(17, 9) = B(17, 9) - B(16, 9)$$

$$= [9m_p + 8m_n - m(17, 9)]c^2 - [8m_p + 8m_n - m(16, 9)]c^2$$

$$= [m_p - m(17, 9) + m(16, 9)]c^2$$

$$= 0,60 \text{ MeV}$$

$$b) S_p(16, 9) = B(16, 9) - B(15, 8)$$

$$= [8m_p + 8m_n - m(16, 9)]c^2 - [7m_p + 7m_n - m(15, 8)]c^2$$

$$= 12,13 \text{ MeV}$$

$$S_p(17, 8) = B(17, 8) - B(16, 7)$$

$$= [8m_p + 9m_n - m(17, 8)]c^2 - [7m_p + 8m_n - m(16, 7)]c^2$$

$$= 13,79 \text{ MeV}$$

Exercice 10

$$a) E_c = \frac{1}{4\pi\epsilon_0} \frac{e^2}{R} = \frac{1}{4\pi\epsilon_0} \times \frac{e^2}{r_0 A^{1/3}}$$

$$= 1,33 \times 10^{-13} \text{ J} = 0,83 \text{ MeV}$$

$$b) B(3, 1) - B(3, 2) = [m_p + 2m_n - m(3, 1) - 2m_p - m_n + m(3, 2)]c^2$$

$$= [m_n - m_p - m(3, 1) + m(3, 2)]c^2$$

$$= 0,79 \text{ MeV}$$

Exercice 11

$$B(23, 11) = 23a_v - 23a_s - \frac{11^2}{23^{1/3}} a_c - \frac{a_p}{23}$$

$$B(23, 12) = 23a_v - 23a_s - \frac{12^2}{23^{1/3}} a_c - \frac{a_p}{23}$$

$$B(23, 11) - B(23, 12) = \frac{12^2 - 11^2}{23^{1/3}} a_c$$

$$= 23^{2/3} a_c$$

$$B(23, 11) - B(23, 12) = [11m_p + 12m_n - m(23, 11) - 12m_p - 11m_n + m(23, 12)]c^2 = [m_n - m_p - m(23, 11) + m(23, 12)]c^2 = a_c \times 23^{2/3}$$

d'où :

$$a_c = \frac{1}{23^{2/3}} [m_n - m_p - m(23, 11) + m(23, 12)]c^2 \approx 0,6 \text{ MeV}$$

Ex. 12

$$B(A, Z) = a_v A - a_s A^{2/3} - a_c \frac{Z^2}{A^{1/3}} - a_p \frac{(A-2Z)^2}{A}$$

$$\frac{\partial B}{\partial Z} = -2a_c \frac{Z}{A^{1/3}} + \frac{4a_p}{A} (A-2Z) = 0$$

$$4a_p = \frac{2a_c Z}{A^{1/3}} + \frac{8a_p Z}{A} \quad \text{d'où}$$

$$Z = \frac{2a_p}{a_c/A^{1/3} + 4a_p/A} = \frac{2a_p A}{a_c A^{2/3} + 4a_p}$$

$$A = 25 \Rightarrow Z \approx 12 \quad ({}^{25}_{12}\text{Mg})$$

$$A = 43 \Rightarrow Z \approx 20 \quad ({}^{43}_{20}\text{Ca})$$

$$A = 77 \Rightarrow Z \approx 44 \quad ({}^{77}_{44}\text{Se})$$

Exercice 13

$${}^Z m(Z) = aZ^2 - bZ + c + \delta$$

$${}^Z m(Z+1) = a(Z+1)^2 - b(Z+1) + c - \delta$$

$${}^Z m(Z+2) = a(Z+2)^2 - b(Z+2) + c + \delta$$

$${}^Z m(Z+3) = a(Z+3)^2 - b(Z+3) + c - \delta$$

$$[m(Z+3) - 3m(Z+2) + 3m(Z+1) - m(Z)]c^2 = -8\delta = -8a_p A^{-3/4}$$

d'où :

$$a_p = -\frac{1}{8A^{-3/4}} [m(Z+3) - 3m(Z+2) + 3m(Z+1) - m(Z)]c^2 = 29 \text{ MeV}$$