PYQ Solution [IIT-JAM]

(Chapter 2 Binding Energy)

Ans. 1: (c)

Solution: In reaction (i), all conservation laws are valid. In reaction (ii), charge is not conserved.

Ans. 2: (c)

Solution: $A \to \frac{A}{2} + \frac{A}{2} \quad or \quad 180 \to 90 + 90$

Product B.E $= 90 \times 6 + 90 \times 6 = 1080\ MeV$

B.E. of nucleus $A = 180 \times 4 = 720\ MeV$

Since, B.E of the product nucleus is greater than the nucleus A, hence in this process, energy is released and that is $= (1080 - 720) MeV = 360\ MeV$.

PYQ Solution [GATE]

Ans. 1: (c)

Ans. 2: 2.833

Solution: $Q = 152.930414 - (152.927581) = 2.833 \times 10^{-3}\ a.m.u.$

PYQ Solution [NET-JRF]

Ans. 1: (c)

Ans. 2: (b)

Solution: $E_S = \frac{B}{A} = \frac{A^{\frac{2}{3}}}{A} \propto A^{-\frac{1}{3}} \Rightarrow \frac{E_S(Al)}{E_S(Z_n)} = \frac{(27)^{-\frac{1}{3}}}{(64)^{-\frac{1}{3}}} = \frac{(64)^{\frac{1}{3}}}{(27)^{\frac{1}{3}}} = \frac{4}{3}$

Ans. 3: (a)

Solution: $\left.\frac{\partial B}{\partial Z}\right|_{Z=Z'} = 0 \Rightarrow Z' = \frac{A}{2}\left(1 - \frac{A^{2/3}}{160}\right)^{-1}$

Ans. 4: (c)

Solution: For the most stable isobar for a nucleus $\frac{dB}{dZ} = 0 \Rightarrow -a_{sym}\frac{2(2Z-A)\times 2}{A} + \frac{2a_C Z}{A^{1/3}} = 0$

$$\Rightarrow 24\frac{2(2Z-216)\times 2}{216} + 0.75\frac{2Z}{(216)^{1/3}} = 0 \Rightarrow \frac{4(2Z-216)}{9} + \frac{3}{4}\frac{2Z}{6} = 0$$

$$\Rightarrow \frac{4(2Z-216)}{9} + \frac{Z}{4} = 0 \Rightarrow 16(2Z-216) + 9Z = 0 \Rightarrow 41Z = 216\times 16 \Rightarrow Z = 82.3$$

Ans. 5: (c)

Solution: $Z_0 = \frac{4a_a + a_c A^{-1/3}}{2a_c A^{-1/3} + 8a_a A^{-1}} = \frac{4a_a A + a_c A^{2/3}}{8a_a + 2a_c A^{2/3}} \Rightarrow Z_0 = \frac{4\times 22.5\times 125 + 0.7\left(5^3\right)^{2/3}}{8\times 22.5 + 2\times 0.7\left(5^3\right)^{2/3}}$

$$\Rightarrow Z_0 = \frac{11250 + 17.5}{180 + 35} = \frac{11267.5}{215} = 52.4 \Rightarrow Z_0 \approx 52$$

Ans. 6: (c)

Solution: $Z_0 = \frac{A}{2 + \frac{a_c}{2a_a}A^{2/3}} \Rightarrow \frac{Z_0}{A} = \frac{1}{2 + \frac{a_c}{2a_a}A^{2/3}}$

given $a_c = 0.714$ and $a_a = 23.2$

$$\therefore \frac{Z_0}{A} = \frac{1}{2 + \frac{0.714}{2\times 23.2}A^{2/3}} = \frac{1}{2 + 0.015A^{2/3}} = \frac{1}{2 + 0.015(64)^{2/3}} = 0.45$$

Thus correct option is (c)

Ans. 7: (c)

Solution: $B = a_1 A - a_2 A^{2/3} - a_3 Z^2 A^{-1/3} - a_4 (A-2Z)^2 A^{-1}$

For most isobar $\frac{\partial B}{\partial Z} = 0 \Rightarrow -\frac{a_3(2Z)}{A^{1/3}} - \frac{a_4 2(A-2Z)(-2)}{A} = 0$

$$\Rightarrow a_3\frac{Z}{A^{1/3}} = 2a_4\frac{A}{A} - 4a_4\frac{Z}{A}$$

$$\Rightarrow \frac{Z}{A}\left(a_3A^{2/3} + 4a_4\right) = 2a_4 \Rightarrow Z = \frac{2a_4A}{a_3A^{2/3} + 4a_4} = \frac{A}{2 + \frac{a_3}{2a_4}A^{2/3}}$$

$$\Rightarrow Z = \frac{A}{2 + \frac{1}{60}A^{2/3}} = \frac{60A}{120 + A^{2/3}}$$

Ans. 8: (b)

Solution: $R = \frac{3e^2}{5\cdot\Delta W}\left(Z_1^2 - Z_2^2\right) = \frac{3\times1\times10^{-15}}{5\times6}\left(25^2 - 24^2\right) = 4.9\times10^{-15}\,m.$

Ans. 9: (c)

Solution: From conservation of energy

$$E_\alpha + m_\alpha c^2 = m_{_1H^3}c^2 + m_{_1H^1}c^2$$

or $E_\alpha = \left[m_{_1H^3} + m_{_1H^1} - m_\alpha\right]\times938\,MeV = 19.5\,MeV$

Ans. 10: (a)

Solution: Energy carried by the $\propto -$ particle is

$$KE_\propto = \left(\frac{A-4}{A}\right)Q = \frac{228}{232}Q = \frac{57}{58}Q$$

Ans. 11: (a)

Solution: For $^{63}Zn_{30} \rightarrow {}^{63}Cu_{29} + e^+ + \nu_e$

$$Q_1 = \left(Zn - 30e\right) - \left[Cu - 29e + e\right] = Zn - Cu - 2e = 2.4\,MeV$$

For $^{63}Cu_{29} + p \rightarrow {}^{63}Zn_{30} + n$

$$Q_0 = \left[\left(Cu - 29e\right) + p\right] - \left[\left(Zn - 30e\right) + n\right]$$

$$= Cu - Zn + e + p - n = \left(-Q_1 - 2e\right) + e + p - n = -Q_1\left[e - p + n\right]$$

$$= -2.4 - \left(0.5 - 938 + 939.5\right) = -4.4.\,MeV$$