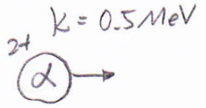
Additional Practice Solution

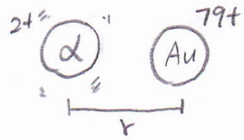
1. Ans. B

Before collision:



$K = 0.5\,\text{MeV}, \; U = 0$

Closest approach:



$K = 0, \; U = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r}$

Conservation of energy, $0.5\times10^{6}\times1.6\times10^{-19} = 8.99\times10^{9} \cdot \frac{2\times1.6\times10^{-19}\times79\times1.6\times10^{-19}}{r}$

(Note that $^{4}_{2}He$ has 2 protons and the nuclei of Au has 79 protons.)

$$\therefore r = \frac{8.99\times10^{9}\times2\times1.6\times10^{-19}\times79\times1.6\times10^{-19}}{0.5\times10^{6}\times1.6\times10^{-19}} = 4.54\times10^{-13}\,m = 454\times10^{-15}\,m = 454\,fm$$ //

2. Ans. C

$E_b = [Z \cdot M(H) + N \cdot m_n - M(^{A}_{Z}X)] \cdot c^2$ (N = number of neutrons = 56 − 26 = 30)

$= [26 \cdot 1.6726\times10^{-27} + 30 \cdot 1.6749\times10^{-27} - 55.9\times1.6605\times10^{-27}] \times (2.9979\times10^{8})^2$

$= 0.9127\times10^{-27} \times (2.9979\times10^{8})^2 = 8.2024\times10^{-11}\,(J) = 512.65\,\text{MeV}$

E_b per nucleon $= \frac{E_b}{56} = 9.15\,\text{MeV}$ //

3. Ans. B

$^{238}_{92}U \rightarrow ^{YY}_{XX}Th + ^{4}_{2}He \Rightarrow YY = 234, \; XX = 90$

$\Rightarrow ^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He.$

Energy released $= [M(^{238}_{92}U) - M(^{234}_{90}Th) - M(^{4}_{2}He)] \cdot c^2$

$= [238.050788 - 234.043601 - 4.002] \times 931.494 = 4.83\,\text{MeV}$

4. Ans. A   Fusion reaction : ${}^{1}_{1}H + {}^{1}_{1}H \rightarrow {}^{2}_{1}H + e^{+} + \nu$ (textbook)

5. Ans. D $N(t) = N_0 e^{-\lambda t}$, $\because T_{1/2} = \frac{0.693}{\lambda} = 26\ hr \Rightarrow \lambda = 0.02665\ hr^{-1}$

$\frac{N(t)}{N_0} = e^{-\lambda t} = \frac{1}{10} \Rightarrow e^{-0.02665 \cdot t} = \frac{1}{10}$

$\Rightarrow -0.02665 \cdot t = \ln\left(\frac{1}{10}\right) = -2.3026 \Rightarrow t = 86.4\ hr$ //

6. Ans. E $2d\sin\theta = m\lambda$, $m = 1, 2, 3, \ldots$

second order $\Rightarrow m=2 \Rightarrow 2d\sin\theta = 2\lambda \Rightarrow d\sin\theta = \lambda$

$\therefore d = \frac{\lambda}{\sin\theta} = \frac{0.085\ (nm)}{\sin 21.5^\circ} = 0.23\ nm$ //