原子物理

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Q1

$$m_{^{210}Po} = 209.983u$$

$$m_{^{206}Pb} = 205.974u$$

$$m_\alpha = 4.001u$$

$$\Longrightarrow \Delta E = (m_{^{210}Po} - m_{^{206}Pb} - m_\alpha) \times 931.5MeV/u = 7.45MeV$$

Q2

$$E = (1.00728u + 3.01605u)\times 931.5MeV/u + 4MeV = (1.00866u + 3.01603u)\times 931.5MeV/u + T_n + T_{He}$$

$$\Longrightarrow T_n + T_{He} = 2.73316MeV$$

设质子动量为 p_p，中子动量为 p_n，则 He 动量为 $p_{He} = \sqrt{p_p^2 + p_n^2},\ p_p^2 = 2m_pT_p,\ p_n^2 = 2m_nT_n$

$$\Longrightarrow T_{He} = 1.347MeV,\ T_n = 1.387MeV$$

Q3

0.8 微居里= $0.8 \times 3.7 \times 10^4$ 次/秒 =2.96×10^4 次/秒

半衰期时：

$$N = N_0/2 = \exp\left(-\lambda t_{1/2}\right) \implies \lambda = \frac{\ln 2}{t_{1/2}} = 4.88435 \times 10^{-18}$$

$$N_{t=1s} = N_0 \exp\left(-\lambda \times 1s\right) = (1-\lambda) N_0$$

$$\implies N_0 = 2.96 \times 10^4/\lambda = 6.06 \times 10^{21}\text{个}$$

Q4

$$\begin{aligned} m_n = &\quad 1.009u \\ m_U = &\quad 235.044u \\ m_{Ba} = &\quad 143.923u \\ m_{Kr} = &\quad 88.918 \\ \implies &\Delta E = 172.328MeV \end{aligned}$$

消耗 U 原料：

$$\frac{10^9 W \times 365 \times 86400}{172.328MeV} \times m_U = 445.7kg$$

消耗煤：

$$\frac{10^9 W \times 365 \times 86400}{3.3 \times 10^7 J/kg} = 9.56 \times 10^8 kg$$