

51. (a) For the first reaction

$$\begin{aligned}Q_1 &= (m_{\text{Ra}} - m_{\text{Pb}} - m_{\text{C}})c^2 \\&= (223.01850 \text{ u} - 208.98107 \text{ u} - 14.00324 \text{ u})(931.5 \text{ MeV/u}) \\&= 31.8 \text{ MeV} ,\end{aligned}$$

and for the second one

$$\begin{aligned}Q_2 &= (m_{\text{Ra}} - m_{\text{Rn}} - m_{\text{He}})c^2 \\&= (223.01850 \text{ u} - 219.00948 \text{ u} - 4.00260 \text{ u})(931.5 \text{ MeV/u}) \\&= 5.98 \text{ MeV} .\end{aligned}$$

(b) From $U \propto q_1 q_2 / r$, we get

$$U_1 \approx U_2 \left(\frac{q_{\text{Pb}} q_{\text{C}}}{q_{\text{Rn}} q_{\text{He}}} \right) = (30.0 \text{ MeV}) \frac{(82e)(6.0e)}{(86e)(2.0e)} = 86 \text{ MeV} .$$