

51. (a) $Q = (5m_{^2\text{H}} - m_{^3\text{He}} - m_{^4\text{He}} - m_{^1\text{H}} - 2m_n)c^2 = [5(2.014102 \text{ u}) - 3.016029 \text{ u} - 4.002603 \text{ u} - 1.007825 \text{ u} - 2(1.008665 \text{ u})](931.5 \text{ MeV/u}) = 24.9 \text{ MeV}.$

(b) Assuming 30.0% of the deuterium undergoes fusion, the total energy released is

$$E = NQ = \left(\frac{0.300M}{5m_{^2\text{H}}} \right) Q .$$

Thus, the rating is

$$\begin{aligned} R &= \frac{E}{2.6 \times 10^{28} \text{ MeV/megaton TNT}} \\ &= \frac{(0.300)(500 \text{ kg})(24.9 \text{ MeV})}{5(2.0 \text{ u})(1.66 \times 10^{-27} \text{ kg/u})(2.6 \times 10^{28} \text{ MeV/megaton TNT})} \\ &= 8.65 \text{ megaton TNT} . \end{aligned}$$