876.

Problem 55.29 (RHK)

In an atomic bomb (A-bomb), energy release is due to the uncontrolled fission of $^{239}\mathrm{Pu}$ *(or* $^{235}\mathrm{U}$*). The magnitude of the released energy is specified in terms of the mass of TNT required to produce the same energy release (bomb "rating"). One megaton* $\left(10^6 \text{ tons}\right)$ *of* TNT *produces* 2.6×10^{28} MeV *of energy. We have to calculate the rating, in tons of TNT, of an atomic bomb containing* 95 kg *of* $^{239}\mathrm{Pu}$, *of which* 2.5 kg *actually undergoes fission. For plutonium, the average Q is* 180 MeV.

Solution:

The total number of nuclides contained in 2.5 kg of $^{239}\mathrm{Pu}$ are

$$N_{^{239}\mathrm{Pu}} = \frac{6.02\times10^{23}\times2.5\times10^{3}\text{ g}}{239\text{ g}} = 6.297\times10^{24}.$$

For plutonium, the average Q is 180 MeV. Therefore, the amount of energy that will be released in fission of 2.5 kg of ${}^{239}\text{Pu}$ will be

$$E = N_{{}^{239}\text{Pu}} Q = 6.297 \times 10^{24} \times 180 \text{ MeV}$$

$$= 1.133 \times 10^{27} \text{ MeV}.$$

One megaton $\left(10^6 \text{ tons}\right)$ of TNT produces

2.6×10^{28} MeV of energy. Therefore, the rating of the atomic bomb equivalent in TNT will be

$$E = \frac{1.133 \times 10^{27} \text{ MeV}}{2.6 \times 10^{28} \text{ MeV per } 10^6 \text{ tons of TNT}}$$

$$= 4.35 \times 10^{-2} \times 10^6 \text{ tons of TNT}$$

$$= 43.5 \text{ kton of TNT}.$$