862.

Problem 55.3 (RHK)

We have to answer the following:

(a) *How many atoms are contained in* 1.00 kg *of pure* $^{235}\mathrm{U}$? (b) *How much energy, in joules, is produced by the complete fissioning of* 1.00 kg *of* $^{235}\mathrm{U}$? *We may assume* $Q = 200$ MeV. (c) *For how many years would this energy light a* 100-W *lamp*?

Solution:

(a)

The number of $^{235}\mathrm{U}$ atoms in 1.00 kg of pure $^{235}\mathrm{U}$ will be

$$N = \frac{6.02\times10^{23}\times10^{3}\ \mathrm{g}}{235\ \mathrm{g}} = 2.56\times10^{24}.$$

(b)

It is given that energy released by fission per $^{235}\mathrm{U}$ nucleus is 200 MeV. Therefore, the total energy, in joules, produced by complete fissioning of 1.00 kg of pure $^{235}\mathrm{U}$, or 2.56×10^{24} $^{235}\mathrm{U}$ atoms, will be

$$E = 2.56 \times 10^{24} \times 200 \times 1.6 \times 10^{-13} \text{ J}$$
$$= 8.197 \times 10^{13} \text{ J}.$$

(c)

The total time for which a light bulb of 100 W will glow with this energy will be

$$t = \frac{8.197 \times 10^{13} \text{ J}}{100 \text{ J s}^{-1}} = 8.197 \times 10^{11} \text{ s}$$
$$= \frac{8.197 \times 10^{11} \text{ s}}{3.156 \times 10^{7} \text{ s/y}}$$
$$= 2.59 \times 10^{4} \text{ y}.$$