861.

Problem 55.1 (RHK)

We wish to produce 1.0 GJ *of energy. We have to calculate and compare* (a) *the amount of coal needed if we wish to obtain the energy by burning coal and* (b) *the amount of natural uranium needed if we wish to obtain the energy by fission in a reactor. We may assume that the combustion of* 1.0 kg *of coal releases* 2.9×10^{7} J; *the fission of* 1.0 kg *of uranium in a reactor releases* 8.2×10^{13} J.

Solution:

We assume that the combustion of 1.0 kg of coal releases 2.9×10^{7} J; and the fission of 1.0 kg of uranium in a reactor releases 8.2×10^{13} J.

(a)

Therefore, for producing 1.0 GJ of energy the amount of coal needed will be

$$M_{\text{coal}} = \frac{1.0\times10^{9}\ \text{J}}{2.9\times10^{7}\ \text{J kg}^{-1}} = 34.48\ \text{kg}.$$

(b)

And, the amount of uranium required for release of energy by fission in a reactor will be

$$M_{\text{uranium}} = \frac{1.0\times10^{9}\ \text{J}}{8.2\times10^{13}\ \text{J kg}^{-1}} = 12.195\ \text{mg}.$$

The ratio of M_{coal} and M_{uranium} will be

$$\frac{M_{\text{coal}}}{M_{\text{uranium}}} = \frac{34.48\ \text{kg}}{12.195\times10^{-6}\ \text{kg}} = 2.83\times10^{6}.$$