835.

Problem 54.42 (RHK)

A ²³⁸U nucleus emits an α particle of energy 4.196 MeV. We have to calculate the disintegration energy Q for this process, taking the recoil energy of the residual ²³⁴Th nucleus into account. The atomic mass of an α particle is 4.0026 u and that of the ²³⁴Th is 234.04 u.

Solution:



$$p = \sqrt{2m_{\alpha}E_{\alpha}} = \sqrt{2 \times 4.0026 \times 931.5 \times 4.196}$$
 MeV c⁻¹
= 176.88 MeV c⁻¹.

By conservation of momentum we note that the magnitude of the recoil momentum of the residual 234 Th nucleus will also be p. The mass of 234 Th nuclide is 234.04 u. Therefore, the kinetic energy of 234 Th nuclide will be

$$\frac{p^2}{2m_{{}^{234}}{}_{\rm Th}} = \frac{176.88^2}{2 \times 234.04 \times 931.5} \text{ MeV}$$
$$= 0.0717 \text{ MeV}.$$

The disintegration energy Q for α emission of a ²³⁸U nucleus will therefore be

$$Q = (4.196 + 0.0717)$$
 MeV = 4.267 MeV.

