

Chapter 35 Problem 17 †

Given

$$L = 15 \text{ fm} = 15 \times 10^{-15} \text{ m}$$

Solution

Find the minimum energy of an alpha particle in a uranium nucleus.

Treat the nucleus as if it were a 1D infinite square well. The energy levels of an infinite square well are given by the formula

$$E_n = \frac{n^2 h^2}{8mL^2}$$

The ground-state corresponds to $n = 1$. The mass of the alpha particle is four times the mass of the proton. Therefore,

$$E_1 = \frac{(1)^2 (6.63 \times 10^{-34} \text{ J} \cdot \text{s})^2}{8(4)(1.67 \times 10^{-27} \text{ kg})(15 \times 10^{-15} \text{ m})^2} = 3.66 \times 10^{-14} \text{ J}$$

Converting to electron-volts gives

$$E_1 = 228 \text{ keV}$$

†Problem from Essential University Physics, Wolfson