

819.

Problem 54.3 (RHK)

We may assume that a gold nucleus has a radius of 6.98 fm, and an α particle has a radius of 1.8 fm. We have to find the energy the α particle must have to touch the gold nucleus.

Solution:

The atomic number of gold is 79. Therefore, the charge of a Au nucleus is $79e$. It is given that we may use for the radius of gold nucleus 6.98 fm and for the radius of α particle 1.8 fm. When the α particle just touches the Au nucleus the separation between their centres will be

$$R = (6.98 + 1.8 = 8.78) \text{ fm} = 8.78 \times 10^{-15} \text{ m}.$$

The energy that the α particle must have to touch the gold nucleus will therefore be equal to the potential energy of the α particle and the gold nucleus when the separation of their centres is $8.78 \times 10^{-15} \text{ m}$. We have

$$\begin{aligned} E &= \frac{79 \times 2 \times (1.6 \times 10^{-19})^2}{4\pi\epsilon_0 \times (8.78 \times 10^{-15})} \text{ J} \\ &= \frac{79 \times 2 \times (1.6 \times 10^{-19})^2 \times 8.99 \times 10^9}{(8.78 \times 10^{-15})} \text{ J} \\ &= 4.14 \times 10^{-12} \text{ J} = \frac{4.14 \times 10^{-12}}{1.6 \times 10^{-13}} \text{ MeV} = 25.8 \text{ MeV}. \end{aligned}$$

