(12.5) Alpha-particles from ^{218}Po (E_α 6.0 MeV) are used to bombard a gold foil. (a) How close to the gold nucleus can these particles reach? (b) What is the nuclear radius of gold according to the radius-mass relation (r_0= 1.3 (fm))?

Define units, constants, and known values:

$\varepsilon_0 := 8.8541878 \cdot 10^{-12} \cdot \frac{coul}{volt \cdot m}$ $\quad q_e := 1.6021773 \cdot 10^{-19} \cdot coul$ $\quad fm := 10^{-15} \cdot m$

$u_n := 1.660540 \cdot 10^{-27} \cdot kg$ $\quad MeV := 1.60217733 \cdot 10^{-13} \cdot joule$ $\quad r_0 := 1.3 \cdot fm$

$m_{Au} := 196.97 \cdot u_n$ $\quad Z_{Au} := 79$ $\quad A_{Au} := 197$ $\quad Z_\alpha := 2$

Data from the text:

$E_\alpha := 6 \cdot MeV$ $\quad E_\alpha = 9.613 \cdot 10^{-13} \cdot joule$

(a) Use eqns (12.11) and (12.12):

$k := \frac{1}{4 \cdot \pi \cdot \varepsilon_0}$ $\quad$ k in eqn. (12.12)

$m_\alpha := \left(4.002603 - 2 \cdot 5.4857990 \cdot 10^{-4}\right) \cdot u_n$ $\quad$ Mass of He minus two electrons

$E_{CM} := \frac{E_\alpha \cdot m_{Au}}{\left(m_\alpha + m_{Au}\right)}$ $\quad$ Projectile energy in the center-of-mass system available for climbing the coulomb barrier.

$x := \frac{k \cdot Z_{Au} \cdot Z_\alpha \cdot q_e^{\,2}}{E_{CM}}$ $\quad$ From eqn. (12.16) $\quad x = 38.7 \cdot fm$

(b) $r_{Au} := r_0 \cdot A_{Au}^{\frac{1}{3}}$ $\quad$ Eqn. (3.7) $\quad r_{Au} = 7.56 \cdot fm$