(10.2) Calculate the distance of closest approach for 5 MeV α-particles to a gold target.

Given data:

$Z_{\alpha} := 2$ $\quad Z_{Au} := 79$ $\quad A_{Au} := 197$ $\quad MeV := 1.60217733\cdot 10^{-13}\cdot joule$ $\quad barn := 10^{-28}\cdot m^2$

$\varepsilon_0 := 8.8541878\cdot 10^{-12}\cdot \frac{coul}{volt\cdot m}$ $\quad q_e := 1.6021773\cdot 10^{-19}\cdot coul$ $\quad u_n := 1.660540\cdot 10^{-27}\cdot kg$

Calculations:

$k := \frac{1}{4\cdot \pi\cdot \varepsilon_0}$ — k in eqn. (10.13)

$m_{\alpha} := \left(4.002603 - 2\cdot 5.4857990\cdot 10^{-4}\right)\cdot u_n$ — mass of He without two electrons

$m_{Au} := 196.97\cdot u_n$

$E_{\alpha} := 5\cdot MeV$ — $E_{\alpha} = 8.011\cdot 10^{-13}\cdot joule$

$E_{CM} := \frac{E_{\alpha}\cdot m_{Au}^2}{\left(m_{\alpha} + m_{Au}\right)^2}$ — Center-of-mass energy which can be derived from (5.5), (5.6), assuming $E_{kin} = m^* v^2/2$.

$r_c := \frac{k\cdot Z_{Au}\cdot Z_{\alpha}\cdot q_e^2}{E_{CM}}$ — Eqn. (10.14) solved for r_c

$r_c = 4.737\cdot 10^{-14}\cdot m$