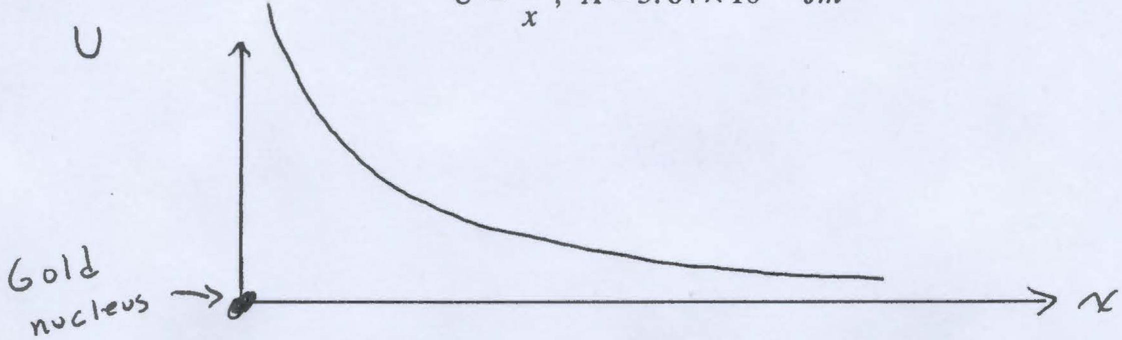
4. (10 pts.) An alpha particle (mass $m_\alpha = 6.64 \times 10^{-27}$ kg) is launched with initial speed $v_{\alpha,i} = 1.55 \times 10^7$ m/s at a gold nucleus that is held (by some external force) fixed at the origin. (This is known as Rutherford scattering.) Initially, when it is far away, the potential energy of the alpha particle is 0, but as it approaches the gold nucleus, the potential is

$$U = \frac{A}{x}, \quad A = 3.64 \times 10^{-26}\, Jm$$



Find the distance of closest approach. That is, find how close to the gold nucleus the alpha particle will get before it comes to a stop and heads back out.

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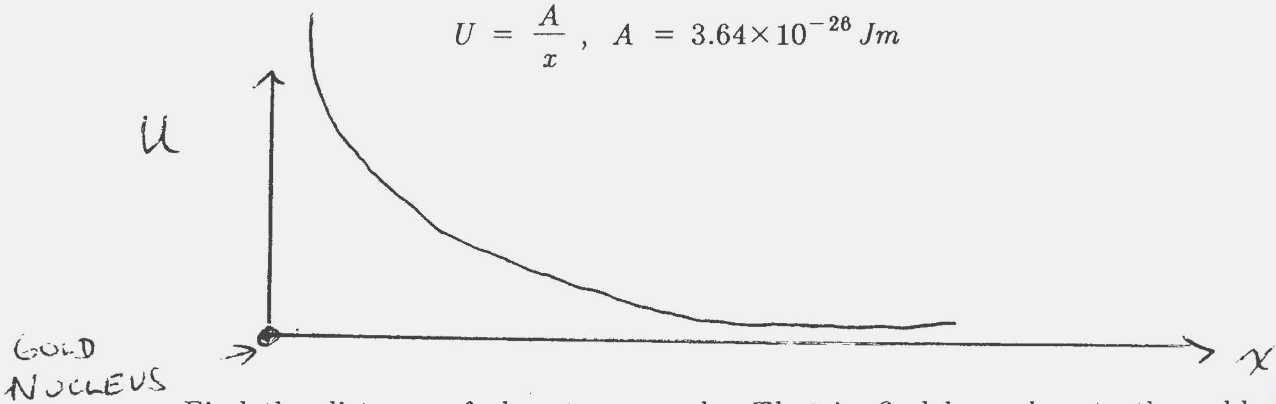

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$$E_i = E_f$$

$$U_i + K_i = U_f + K_f$$

$$0 + \frac{1}{2} m_\alpha v_{\alpha,i}^2 = \frac{A}{x} + 0$$

$$x = \frac{A}{\frac{1}{2} m_\alpha v_{\alpha i}^2} = \frac{3.64 \times 10^{-26}}{\frac{1}{2}(6.64 \times 10^{-27})(1.55 \times 10^7)^2}$$

$$\boxed{x = 4.56 \times 10^{-14}\ m.}$$