1. Consider He\(^+\) atoms in a gaseous evacuated glass tube.
   
a. (5 points) What is the energy of a photon (in eVs) created when an excited electron drops from the n=3 to the ground state? Neglect any effects of reduced mass. What is the type of radiation associated with this photon (e.g. IR, visible, UV, etc)?
   
   \[
   \Delta E = 13.6 \text{eV} \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)^z = 4(13.6 \text{eV}) \left( \frac{1}{1^2} - \frac{1}{3^2} \right) \\
   = \frac{8}{9} (4)(13.6 \text{eV}) = \boxed{48.4 \text{eV}} \\
   \Rightarrow 1 \text{eV} \Rightarrow 25.7 \text{nm} = \lambda
   \]

   b. (5 points) What is the energy (in eVs) required to ionize an electron in the n=4 state?
   
   \[
   |\Delta E^i| = -4(13.6 \text{eV}) \left[ \frac{1}{\infty^2} - \frac{1}{4^2} \right] \\
   = + \frac{13.6 \text{eV}}{4} = \boxed{3.4 \text{eV}}
   \]
2. An alpha particle of energy 5 MeV collides head on with a lead nucleus (Z=82).

a. (5 points) What is the distance of closest approach in Fermis and what is the impact parameter required for this to happen?

\[ \frac{kZe^2}{\Delta E} = 5\text{MeV} \Rightarrow D = \left( \frac{9 \times 10^9 \text{Nm}^2}{2} \right) \left( \frac{82 \times 1.6 \times 10^{-19}}{5 \times 10^6 \text{eV}} \right) \times 2 \]

\[ D = \frac{7}{5 \times 10^6} = 1.8 \times 82 \times 1.6 \times 10^{-16} \]

\[ = 4.72 \times 10^{-16} = \boxed{47.2 \text{Fm}} = 47 \text{Fermis} \]

b. (5 points) If instead another alpha particle scatters backwards by 135°, what is the impact parameter?

\[ b = \frac{D}{2} \cot \frac{\Theta}{2} = \left( \frac{23.6 \text{Fm}}{2} \right) \cot \left[ \frac{135°}{2} \right] = \]

\[ = \frac{47.2}{2} \text{Fm} \times 0.414 = \]

\[ = \left( 23.6 \text{Fm} \right) \times 0.414 = \boxed{9.77 \text{Fm}} \]