PHY221 Lab-03-1: Rutherford Scattering

Objective: Write a VPython program that simulates an alpha particle colliding with (i.e. scattering off of) a fixed gold nucleus.

Initial Conditions

mass of gold nucleus	$79m_p = 79(1.67 \times 10^{-27}\text{ kg}) = 1.32 \times 10^{-25}\text{ kg}$
mass of helium nucleus (alpha particle)	$2m_p = 2(1.67 \times 10^{-27}\text{ kg}) = 3.34 \times 10^{-27}\text{ kg}$
charge of gold nucleus	$+79(1.6 \times 10^{-19}\text{ C}) = 1.264 \times 10^{e-17}\text{ C}$
charge of helium nucleus	$+2(1.6 \times 10^{-19}\text{ C}) = 3.2 \times 10^{e-19}\text{ C}$
initial position of gold nucleus	$\langle 0, 0, 0\rangle$ m
initial position of alpha particle	$\langle -2.7 \times 10^{-12}, 0, 0\rangle$ m
initial velocity of the alpha particle	$\langle 2 \times 10^{7}, 0, 0\rangle$ m/s
force constant	$9 \times 10^{9}\text{ Nm}^2/\text{C}^2$

Writing your Program

1. Start with your simulation of Earth's orbit.
2. Change the name of the Sun object to `gold` and the Earth object to `alpha`.
3. Set the radii of the nuclei to 3×10^{-14} m.
4. Set the constants and initial conditions of the particles.
5. Calculate the net force on the alpha particle using Coulomb's law.
6. Run your program.

Application

1. By printing data for time and position, determine the closest distance of the alpha particle from the gold nucleus during a head-on collision.
2. Change the initial y-position of the alpha particle to be 6×10^{-14} m. Run your program. Determine the angle of the final velocity of the alpha particle (a long time after the collision).
3. In the previous interaction, is the momentum of the alpha particle conserved? Explain your answer.