your names____

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Physics 321 Exercise: Trajectories and Newton's Method
Sep. 11, 2023 – Due Sep. 15, 2023

You will need to demonstrate functioning versions of the programs to receive credit for the latter two problems. Feel free to access the course lecture notes during class.

1. (5pts) Consider two cannons, A and B, with the same muzzle velocities and initial angles. Both cannon's fire spherical cannonballs made of solid iron. However, cannon B fires balls of larger radius, $R_B > R_A$. You can assume the drag force is proportional to the square of the velocity, $|F_{\mathrm{drag}}| = -c_W \rho_m A v^2$, where ρ_m is the density of the air, A is the cross-sectional area of the cannonball and c_W is the drag coefficient. Which cannonball would travel further? Explain your answer.

For the next problems, consider the trajectory problem with a linear drag force where we derived the following relations,

$$\begin{aligned}
x &= \frac{v_{0x}}{\gamma}\left(1 - e^{-\gamma t}\right), \\
v_x &= v_{0x} e^{-\gamma t}, \\
y &= -\frac{gt}{\gamma} + \frac{v_{0y} + g/\gamma}{\gamma}\left(1 - e^{-\gamma t}\right), \\
v_y &= (v_{0y} + g/\gamma) e^{-\gamma t} - g/\gamma
\end{aligned}$$

2. (5 pts) Write a program that when run from the command line prompts the user to enter v_0 in m/s and θ_0 in degrees for the projectile's initial velocity, then prompts the user for the drag term γ in s^{-1}. The program should then solve for the time at which the projectile returns to the horizontal, $y = 0$, using Newton's method.

3. (5 pts) Assume the cannon is situated on a cliff of height h in meters. Write a second version that additionally prompts for the height of the cannon above the plain over which it is aimed. Have the program solve for the range of the cannon and print out the answer.