your name_____

Physics 321 Quiz #2 - Wednesday, Sep. 10

Pair up to complete this assignment by the end of class. 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.

Consider the trajectory problem in class where we derived the following relations,

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

1. (2pts) 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, $R_B > R_A$. Which cannonball would have a larger value for γ? And which cannonball would travel further? Explain your answers.

The drag force is proportional to the area of the cannonball a, and since the acceleration is inversely proportional to the mass m, the γ term in the equations above scales as a/m. Since $a \sim R^2$ and $m \sim R^3$, you know $\gamma \sim 1/R$. Thus, *gamma* is largest for the smaller cannonball. A larger γ means less distance, so the range is larger for the heavier cannonball.

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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.