Homework Work 4 - Physics 240

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1 Introduction

This is an excerise to calculate and plot the trajectory of a baseball using both the numerical and anaytical approach. The goal is to plot $y(x)$ versus time for the baseball.

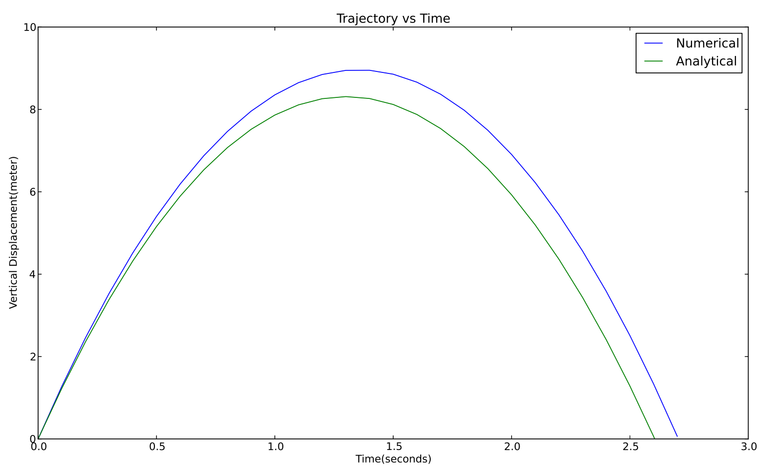

Figure 1: Numerical and Analytical solutions without air resistance

In figure(1) above, $v_0 = 15$ m/s, $\theta_0 = 45^0$, and Δt = 0.1 sec. This is without air resistance, the results of the range and flight time is showned below:
Numerical range is: 22.0635
Numerical Flight time is: 2.8
Analytical range is: 22.0635
Analytical Flight time is: 2.8

I could not do the error analysis for the range and flight time because there is no difference for range is both values, so instead, I did the error analysis for the maximum hight instead. And the absoulte error for the maximum height of both solutions is 0.6393 m. Changing the value of Δt from 0.1 to 0.02 decrease this error to 0.12 m or about 10 cm, which is what we want, and produces this plot below. ** Updated: There's something in my code, althouth the first plot shows the difference in the range, the values don't say so, and I still don't know why. I'm still keeping the Δt value.

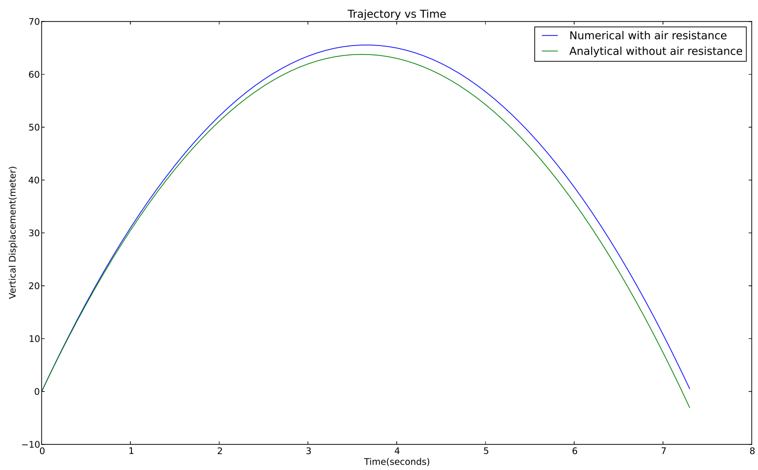

Figure 2: Numerical and Analytical solutions without air resistance Δt = 0.02

2 With Air resistance

Using the new Δt value above, I now apply the air resistance into the equation, with $v_0 = 50\ m/s$, drag coefficent $C_d = 0.35$, air density $= 1.2\ kg/m^3$, the cross-section area $= 0.004\ m^2$, and the mass of the ball is 0.15 kg. The equation for air resistance is:

$$\vec{F_a} = \frac{-1}{2} C_d \rho A |\vec{v}| \vec{v}$$

applying this air resistance factor into the equation, the results are shown in figure(3) below:

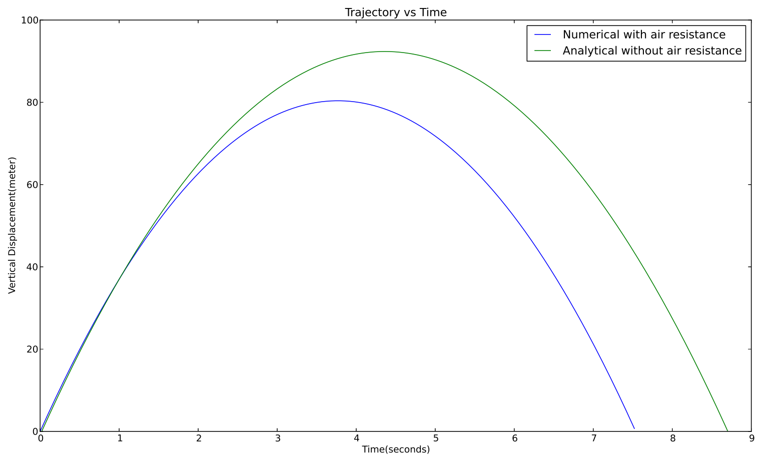

Figure 3: Approximation using the new identity for e^x

And the results for the range and flight time is:
Numerical range with air resistance is: 198.046 m
Numerical Flight time with air resistance is: 7.54 s
Analytical range is: 229.040 m
Analytical Flight time is: 8.72 s