Portfolio 1: Numerical Solvers and Modelling.

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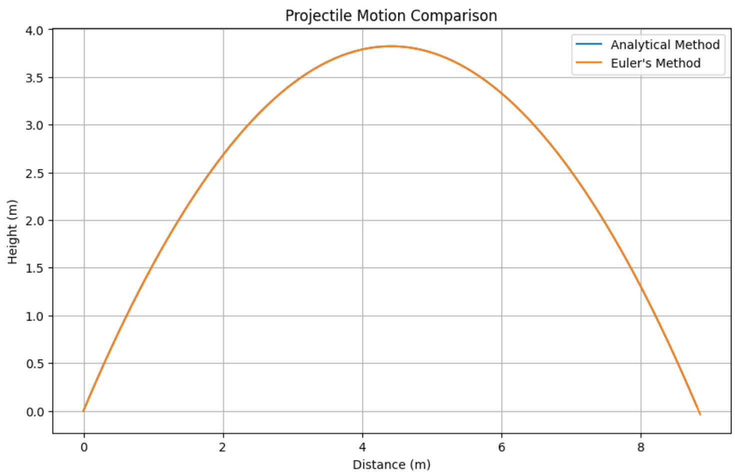
Q1.

For my code for question 1 I started by setting my defining my constants and variables, gravity, the total time for the simulation the time step in which the simulation will be progressing. I decided to add a second portion in which I could compare the accuracy of the Euler's method to the analytical method. Overall, this was achieved by defining 2 functions, Euler's projectile motion and analytical projectile motion, both as a function of initial velocity, theta (angle of projection), time step, gravity, and total time. The variables can be changed at the start of the code, but they must be the same for both the Euler's method and for the analytical method. When looking at both lines on the graph they both overlap completely but if you remove the plot for one method the other remains below it. This shows the accuracy of my model.

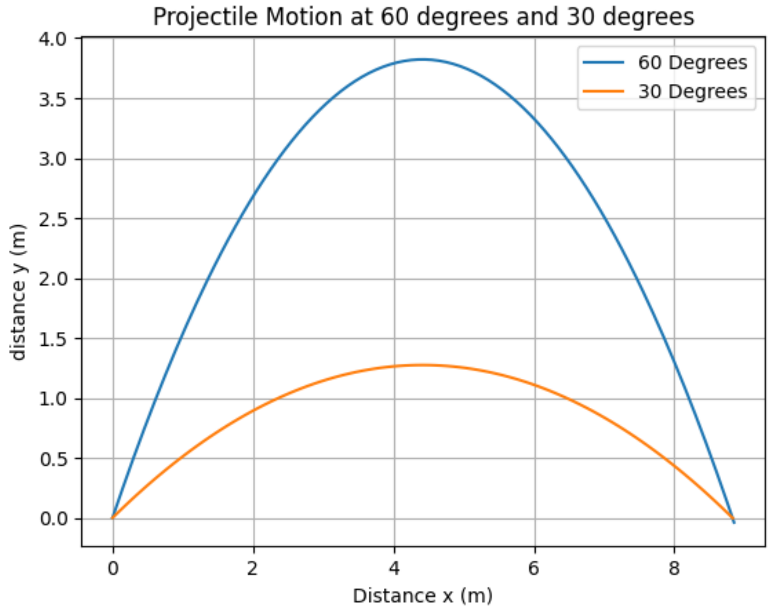


Q2.

For this question I took used just the Eulers method for the projectile motion and defined new variable for angle of projection. The function had to run twice, once when being projected at 30 degrees and once at 60 degrees.

The timestep is an important factor in the code as it affects the resolution of the graph, and it is what maintains the accuracy of the graphs shape. If the timestep is too large then the graph would appear to have sharp corners which imply quick changes of direction but this would be an unnatural occurrence and doesn't accurately represent the event. This means you must pick a small enough time step so data can appropriately be approximated and visualised.

On the other hand, a small time-step would fit much better for the visualisation of the motion of the projectile, due to this i picked 0.01 seconds as my time step which ensured a smooth curve for the entire journey of the projectile until it reached 0 metres in the y plane again. However picking a time step that is much smaller e.g. 10^{-5} can lead to a much larger processing requirement which will produce data that is more accurate but to the human eye is negligible when viewing on a graph



Q3.

As i change the time step the amount of bounces that are modelled on the graph changes with it and they also change the shape of the curve becoming more or less smooth.

As i increased the time step the number of bounces recorded decreases and comes to a sudden stop towards the end which is unrealistic due to the hard-sphere model making the particle completely rigid so it should bounce at a lower and lower height and should eventually approach 0 rather than a sudden stop.

If you decrease the time interval the ball comes to a stop later recording more and more bounces as the end is reached. Due to this i chose 0.001 as my time interval because it records very many small bounces at the end which slowly level out to a height of 0 rather than sudden stop that is given by higher magnitudes.