PHYSICS 202 – Physics and the Computer
Projects

Projectile motion revisited with programming

The goal for this project is to solve the problem of projectile motion with drag. But this time we will take advantage of Maple programming to make it a bit easier.

A large, flying object is affected by air resistance. The force due to drag can be approximated by \( \vec{F} = -b \vec{v} \cdot \vec{v} \) with \( \vec{v} \) and \( |\vec{v}| \) the velocity and its magnitude, and \( b \) is a constant that depends on the object and the medium. Consider a bowling ball (\( m = 8 \) kg) launched from a height of 1.5 m above the ground with an initial speed of 40 m/s at an angle of 35°. We want to determine the behavior for a range of values of the drag coefficient, say from \( b = 0 \) to \( b = 1 \) Ns²/m², and plot out the trajectories (\( y \) versus \( x \)) until the ball hits the ground for each \( b \) value. Finally, make a plot of the maximum horizontal distance the ball travels as a function of \( b \).

a) Determine expressions for the components of acceleration for a projectile with drag.
b) Write a routine using \texttt{dsolve} or Euler/Euler-Cromer that for a given value of \( b \), will solve for the position as a function of time and plot the trajectory (\( y \) vs. \( x \)).
c) Use a \texttt{while} loop so the program will stop when the particle hits the ground. Now save and output the coordinates \( (x_{hit}, y_{hit}) \) of the landing spot.
d) This has all been done for a particular value of \( b \). Put your program inside a \texttt{for} loop that will change the value of \( b \) from 0 to 1 in steps (say 0.2). Keep track of the landing spots for different values of \( b \). Be sure to name the plot of each trajectory so you can use it later.
e) After your loops are done you can use display to make a plot with all the trajectories.
f) Using the saved landing coordinates make a plot of \( x_{hit} \) vs. \( b \).