Projectile motion task

Introduction to programming

November 2025

Projectile Motion Simulation in C#

Write a console application in C# that simulates the motion of a body thrown at an angle to the horizon (projectile motion without air resistance).

Task Description

A point-like body is thrown from the ground with initial speed v_0 at an angle α (in degrees) to the horizontal. Assume motion takes place in a vertical plane and air resistance is neglected. Gravitational acceleration is constant and equal to

$$g = 9.81\ m/s^2.$$

Your program should perform the following steps:

1. Read from the keyboard:
   - initial speed v_0 (m/s),
   - launch angle α (degrees),
   - time step Δt (seconds, e.g. 0.1 s).
2. Compute the components of the initial velocity:

   $$v_{0x} = v_0 \cos \alpha, \qquad v_{0y} = v_0 \sin \alpha,$$

   remembering to convert α from degrees to radians before using trigonometric functions.
3. Using discrete time steps, simulate the motion of the body from $t = 0$ until it hits the ground again ($y \leq 0$).

   Use the following update formulas for each step:
   - Position:

     $$x_{new} = x_{old} + v_x\, \Delta t,$$

     $$y_{new} = y_{old} + v_y\, \Delta t;$$

- Velocity (vertical component changes due to gravity):

$$v_{y,new} = v_{y,old} - g\,\Delta t,$$

while the horizontal component remains constant:

$$v_x = v_{0x}.$$

4. At each time step, output to the screen a table row with:
   - time t,
   - horizontal position x,
   - vertical position y.

   Stop the simulation when the body reaches the ground ($y \leq 0$).
5. Additionally, compute and display:
   - the maximum height reached by the body:

$$h_{\max} = \frac{v_0^2 \sin^2 \alpha}{2g},$$

   - the range (horizontal distance) for ideal continuous motion:

$$R = \frac{v_0^2 \sin(2\alpha)}{g}.$$

Requirements

- Use appropriate data types (e.g. `double`).
- Format the output clearly (e.g. columns for t, x, y).
- Comment the code to explain how the formulas are implemented.