

Projectile Motion on the Graphing Calculator

Introduction:

In order to successfully understand and solve projectile motion problems, students must learn to isolate the horizontal (x) and the vertical (y) motions and visualize how the two motions combine to form a parabolic path. A graphing calculator and parametric equations offer an excellent mathematical model to accomplish this task.

Parametric Equations:

Parametric equations allow you to write an equation for the horizontal (x) motion and the vertical (y) motion, both as a function of time. Simply stated they are the "Etch a Sketch" of mathematics. In this activity your calculator will act as a high-tech. "Etch a Sketch".

Solve the following projectile motion problem and then we will model it using the graphing calculator.

Find the horizontal displacement and the time of flight. (Neglect air friction). Sketch the path of the projectile.

Horizontal (x)

Vertical (y)

Calculator (Casio) Instructions:

5 GRAPH

F3 TYPE

F3 PARM

Enter the horizontal function for position (Xt1:) and the vertical function for position (Yt1).

Xt1: $0 + 18T + (1/2)(0)T^2$ or $18T$

Yt2: $20 + (0)T + (1/2)(-9.8)T^2$ or $20-4.9T^2$

Now the window for your "Etch A Sketch" must be selected in order to view the entire motion.

SHIFT V-Window (F3)

Xmin: 0
Xmax: 40
Scale: 10
Ymin: 0
Ymax: 22
Scale: 5
T,(
min: 0
max:2.5
pitch: 0.05

EXIT

F6 DRAW

Use TRACE (F1) to check your calculations. It will give you values of x, y, and t for the flight of the projectile.

Additional Activities

Simultaneously view the x motion, y motion, and combined motion.

Project several objects horizontally with varying initial velocities to verify they strike the ground at the same time.

Fire a projectile at an angle and use TRACE to find the range, maximum height, and time of flight.

Find the projected angle that has the greatest range for a given initial velocity.

Kick field goals and hit home runs.

Model the hunter and the monkey problem.

Model circular motion to show its relationship to simple harmonic motion.

Helpful Hints

Make sure your window encloses the entire flight.

Make sure Tmax is long enough for the entire flight.

If the pitch is too large the motion will be jagged. If the pitch is too small the motion will be too slow.

Make sure your calculator is in degree mode if you are projecting at angles.

Sequential or simultaneous graphs may be appropriate depending on your activity.

Turn derivative on and as you TRACE dx/dt will remain constant and dy/dt will change depending on your position. Of course it will be zero at the top of the path.

Experiment yourself. The learning curve for a graphing calculator starts out steep, but levels off fairly quickly. Be patient and you will find the initial climb is worth it!

G. Woods/Modeling W.S. Summer 98

18m/s