Spring Training

ID: 12647

Time Required
15-20 minutes

Activity Overview

In this activity, students will explore parametric equations by finding the horizontal and vertical distances traveled by a projectile. Parametric equations will be converted into quadratic equations for the purpose of exploring projectile motion problems.

Topic: Parametric Equations

- *Graphing Parametric Equations*
- *Converting From Parametric to Quadratic Equations*

Teacher Preparation and Notes

- *This activity was designed for use with TI-Nspire technology, both CAS and non-CAS versions.*
- *The first problem explores parametric equations. The second problem engages students in the conversion of a parametric equation model to a quadratic model for projectile motion.*
- *Point out to students that air resistance is not considered in these problems, but in reality, wind direction and speed play a critical role in the motion of projectiles.*
- *Make sure that the Angle setting is set to Degree mode.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to education.ti.com/exchange and enter "12647" in the keyword search box.***

Associated Materials

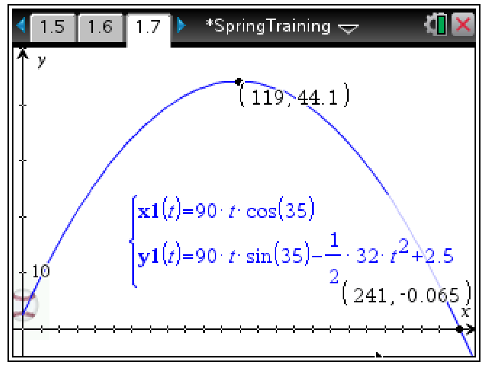
- *SpringTraining_Student.doc*
- *SpringTraining.tns*
- *SpringTraining_Soln.tns*

Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

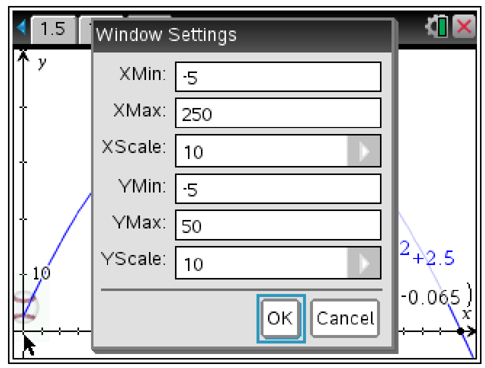
- *Exploring Parametric Equations With the "Human Cannonball" (TI-Nspire technology) — 9554*
- *Make the Basket (TI-Nspire technology) — 10221*

Problem 1 – Introduction to Parametric Equations

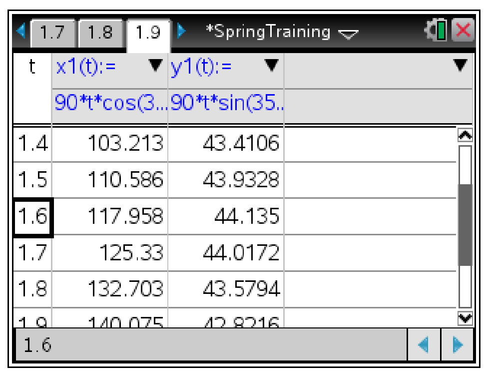


Students are introduced to the use of parametric equations to model the motion of a baseball. Remind students to be watchful of units as they write their equations! A common error is to choose the wrong value for *g*. If velocity is in ft/s, students must use 32 ft/s^2. If velocity is in m/s, they must use 9.8 m/s^2.

Once equations are written, students graph the equations on page 1.7. Instructions are provided in the .tns file for changing the graph type to parametric. For the purpose of the problems contained in this activity, students do not need to modify *t* or *t* step values.



Students will need to adjust their viewing windows to view key details, such as the maximum and zeros. Discuss with students values that are reasonable for the context of the problem. Many students have difficulty with the concept of large distances, such as those involved in the problems in this activity.



If using Option 1 from page 1.8, students will plot a point on the graph using the **Point On** tool and drag the point to find the maximum point. To find out how much time has elapsed when the maximum point occurs, they can substitute the point into the parametric equations and solve for *t*.

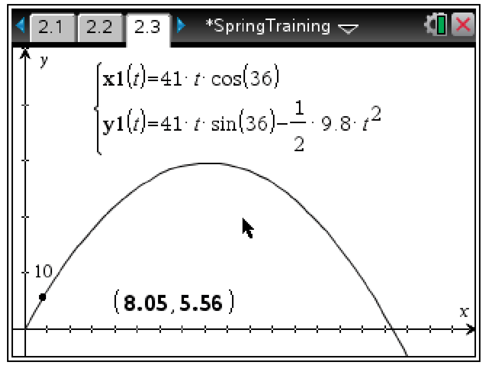
If using Option 2 from page 1.8, students are instructed to convert a *Lists & Spreadsheet* page to a function table for the purpose of exploring function values.

Point out to students that t is the first column and they must select the horizontal component, **x1(t)**, for the second column and the vertical component, **y1(t)**, for the third column.

Point out to students that they can change the step value for the table by pressing **MENU > Table > Edit Table Settings** and adjusting the Table Step. Making adjustments to this setting will help students obtain more accurate answers for time related questions.

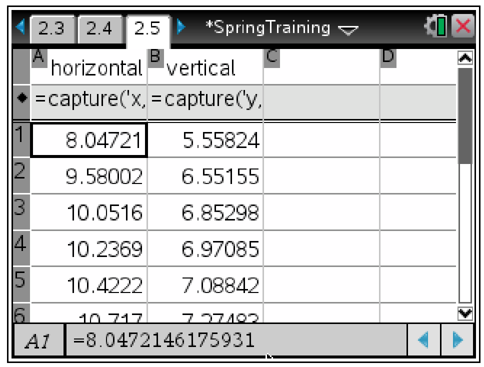
Problem 2 – Parametric to Quadratic

In this problem, students use a parametric graph to generate a quadratic function. Both graphs are used in determining key values from the graph to answer relevant questions.

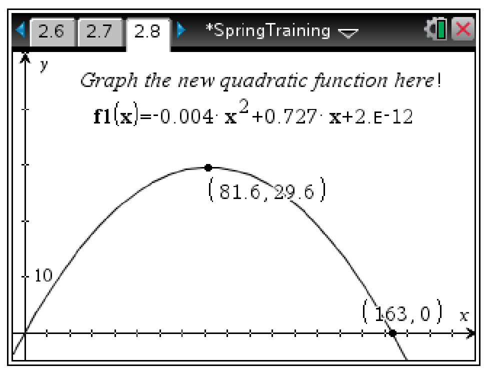


Students are provided with a problem and a graph related to the motion of a golf ball. They are asked to grab and drag a point along the parametric graph.

As the point is dragged, the spreadsheet on page 2.5 is populated with horizontal and vertical coordinates that are then used to generate a quadratic equation.



On page 2.7, students are to perform a quadratic regression to generate the quadratic function that corresponds to the parametric equations. This function is to be graphed on page 2.8 by arrowing up to **f1(x)** in the Entry Line and pressing [enter].



Students should find that the quadratic function is useful in that key values are easily obtained on the graph of the function. When a point is placed on the graph and dragged along the graph, it is easy to locate the maximum and zeros. The Analyze Graph options will also help students locate these key points easily.

Ask students, *what information parametric equations provide in this situation that quadratic functions do not provide?* Students should note that time is present in the parametric equations, but not in the quadratic equation.

Students answer a variety of questions related to interpreting the graphs and finding key function values.

Solutions – Student Worksheet

1. 32 ft/sec^2 because the units are in feet.
2. $x(t) = 90t\cos(35°)$

   $y(t) = 90t\sin(35°) - \frac{1}{2} \cdot 32t^2 + 2.5$
3. about 44 feet
4. about 241 feet
5. about 3.3 seconds
6. $y = -0.0045x^2 + 0.7265x$

   Note that the constant term is so small that it may be left out because of rounding to the nearest ten thousandth
7. about 163 meters
8. about 4.9 seconds
9. about 29.6 meters
10. Answers will vary, depending on the data points captured. Sample answer: Yes; at 150 meters from the golfer the ball is about 8.66 meters high.

