Transformation T-STEM 2013

New Directions | New Pathways | New Outcomes

Quadratics Activity

Overview

Quadratic functions are explored in various forms from Algebra 1 through college level math. This VI graphs quadratic functions that are in **standard form**, identifies the **vertex** of the graph, puts the equation in **vertex form**, calculates the **discriminant**, and provides the solutions (**roots** or **zeros**) of the function.

Quadratic functions can be used to model the motion of objects falling to earth. If you know how an object's **initial velocity** and **height**, you can find out how long it will take for it to hit the ground if it is dropped.

Objectives

Students will:

- Solidify their understanding of standard form and vertex form for the equation of a quadratic.
- Gain a firm understanding of the real roots of a quadratic function.
- Learn how the discriminant is calculated.
- See the relationship between the equations and graphs of quadratic functions.
- Use quadratic functions to solve free-fall problems

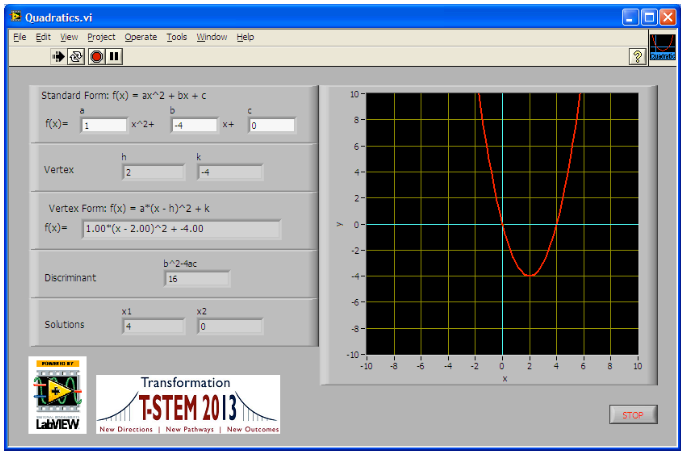
Standards (TEKS)

A.9, A.10, A.11
2A.6, 2A.7, 2A.8, 2A.9
P1

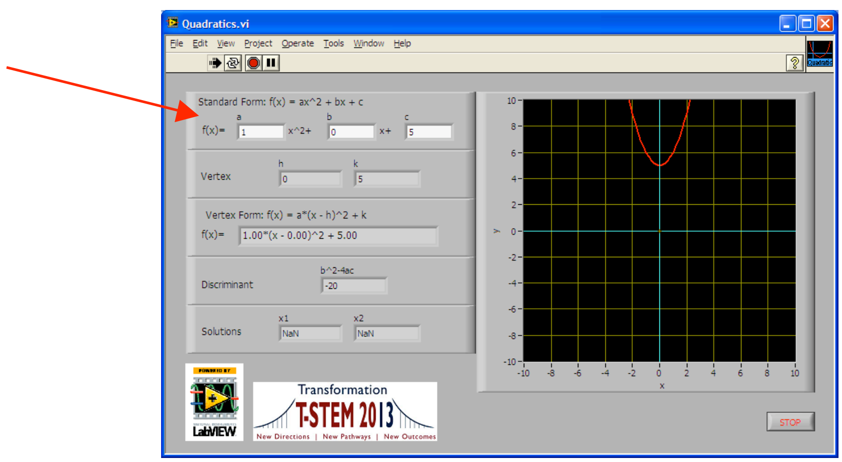
Activity

When objects fall, their heights over time can be calculated using quadratic functions. Quadratic functions can also be used to find out how long it will take for an object to hit the ground. For example, if a construction worker drops a wrench from 400 feet up, it will take 5 seconds for it to hit the ground. Before using the Quadratics VI to solve this sort of free-fall problem, let's get familiar with the VI and with quadratic functions in general.

1) Open and run the VI.
2) Notice that the default equation is $f(x) = x^2 - 4x$ in **Standard Form**. Take a look at the vertex that has been devised from this equation. What does the vertex represent?
3) Review the **Vertex Form** of the default equation, $f(x) = 1 * (x-2)^2 - 4$. Where might some of these values originate? (Hint: How are they related to the **vertex**?)



4) What is the relationship between the Standard Form of the equation and the **discriminant**?
5) What do the **solutions**, also called **roots** or **zeros**, represent? How do you know? Write them as coordinates.
6) Let's practice:
   a) Enter in the following values into the Standard Form equation: a = 1, b = 0, c = 5. What is the resulting Standard Form for the equation?



   b) What is the vertex? How can you determine the vertex just by looking at the graph?
   c) What is the resulting Vertex Form for the equation?
   d) What is the resulting discriminant? Show how you would calculate the discriminant without the program.
   e) What are the solutions/roots/zeros of the function? Why do you think the program calculated them this way?

7) More practice:
   a) Enter the following values into the Standard Form: a = –1, b = –6, and c = 8. What is the resulting equation?
   b) What is the vertex? How can you determine the vertex just by looking at the graph?
   c) What is the resulting Vertex Form for the equation?
   d) What is the resulting discriminant? Show how you would calculate the discriminant without the program.
   e) What are the solutions/roots/zeros of the function? How could you determine the solutions/roots/zeros of the function just by looking at the graph? Write those solutions as coordinates.

Now, you are almost ready to use the VI to solve free-fall problems. In general, when an object falls to the ground, it **accelerates**, as it falls, at 32 feet per second. So, an object's height is a function of time, of how long it has been falling. The function you will use to model this behavior is $h(t) = -16t^2 + v_0 t + h_0$, where

t = **elapsed time**,
v_0 = **initial velocity**, and
h_0 = **initial height**.

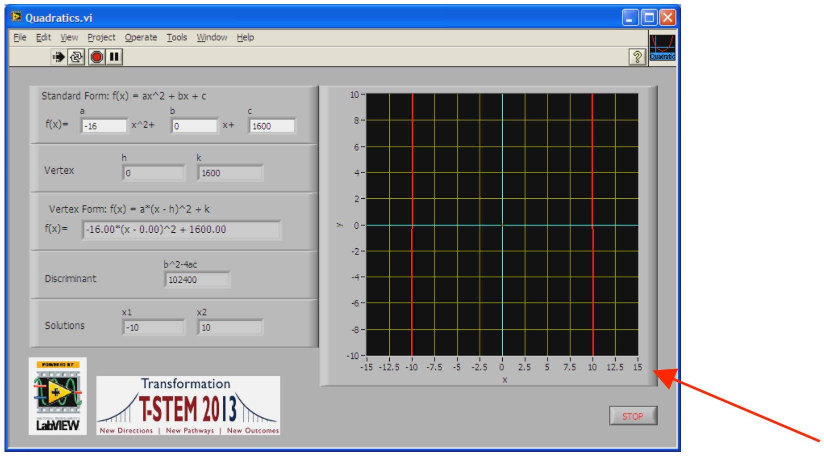
The coefficient of t^2 is negative since gravity has objects fall (Using 16 will make sense once you study calculus).

Since the Quadratics VI is set up using *x* instead of *t*, use $f(x) = -16x^2 + v_0 x + h_0$. You will plug in values for v_0 and h_0 from given information. The key will be to remember the *x*-axis is our time axis.

For example, in the problem about the falling wrench, the wrench was dropped, not thrown. So, it's initial velocity, v_0, is 0. It fell from 400 feet, so the initial height, h_0, is 400.

8) Use the VI to see that it takes 5 seconds for the wrench to reach the ground.
   a) Plug the following values into the VI: a = –16, b = 0, c = 400
   b) Is it clear from the graph and solutions that it takes 5 seconds for the wrench to reach the ground?
9) What if the worker had dropped the wrench from 800 feet up?
   a) Plug in the appropriate values for a, b, and c into the VI.
   b) How long will it take for the wrench to hit the ground?
   c) The height is doubled. Why doesn't the time just double?
10) How long will it take if the wrench is dropped from 1600 feet?
   a) You may want to change the window to see more of the graph.
      i. Double-click on "10" in the lower right corner and change its value to 15.

ii. You can change the viewing window of the graph by making this sort of change to the minimum or maximum values of *x* or *y*.



11) What if the worker didn't just drop the wrench, but threw it up at a rate of 40 ft/sec?
   a) Plug the following values into the VI: a = –16, b = 40, c = 1600
   b) How much longer does the wrench fall, compared to when it simply fell?
   c) What do you think the vertex represents in this problem?

12) Let's say you throw a rock straight up from the ground at 50 ft/sec.
   a) Plug in the appropriate values for a, b, and c into the VI.
   b) How high does the rock get?
   c) How long before the rock hits the ground?