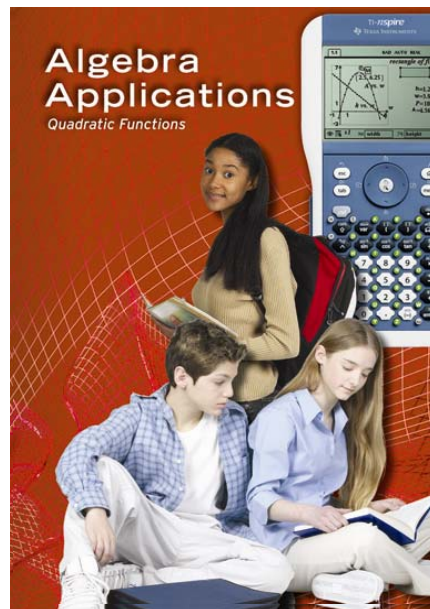




ALGEBRA APPLICATIONS

Quadratic Functions



Teacher's Guide

Series Overview

The *Algebra Applications* series brings real-world, relevant applications of algebra to today's classroom. This series also integrates technology through the use of the Texas Instruments TI-Nspire graphing calculator. The key features of this series include:

- Guided applications that are interdisciplinary and can be done as an in-class group activity.
- All keystrokes are clearly shown.
- Dynamic footage and animations bring math to life.
- Math concepts are developed clearly, making this series an ideal supplement to an Algebra 1 or Algebra 2 class.

Program Overview

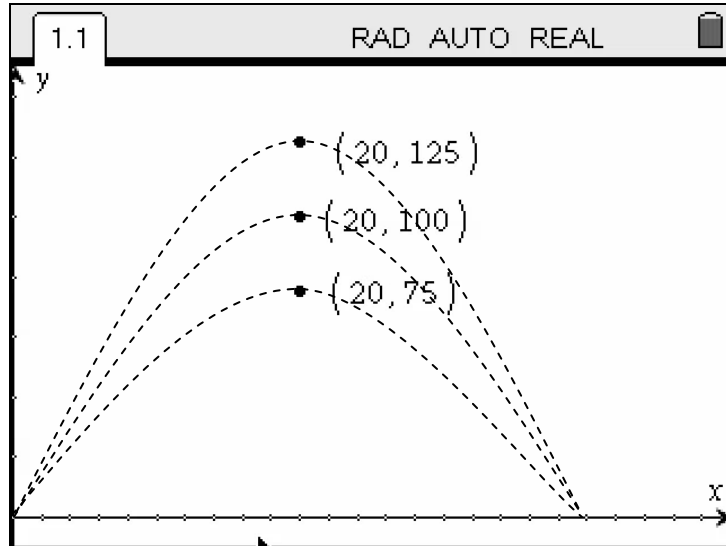
In this episode of *Algebra Applications*, three real-world explorations of linear functions are developed:







- **Pyrotechnics.** Fireworks displays are elegant examples of quadratic function. In this segment the basics of quadratic functions in standard form are developed visually and students are guided through the planning of a fireworks display.
- **Forensics.** The distance a car travels even after the brakes are applied can be described through a quadratic function. But there is also the reaction time, the split second before the brakes are applied. The total distance is known as the stopping distance and this segment analyzes the quadratic function. This is an equation that can be used by accident investigators.
- **Medicine.** From the time a baby is born to the time it reaches 36 months of age, there is dramatic growth in height and weight. An analysis of CDC data reveals a number of quadratic models that doctors can use to monitor and growth and development of children.




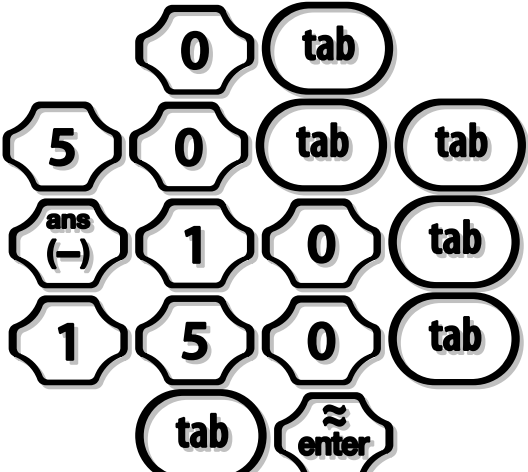


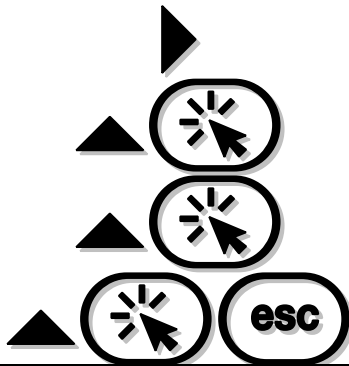

Concepts explored: quadratic functions in standard form, quadratic functions in vertex form, quadratic forms






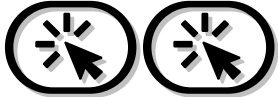

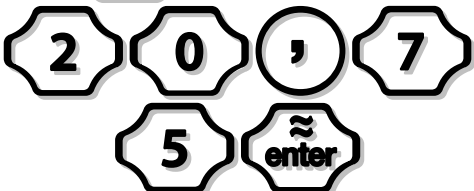





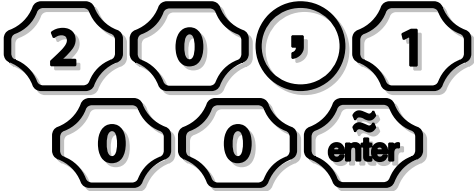


Application 1: Pyrotechnics


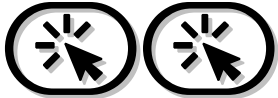

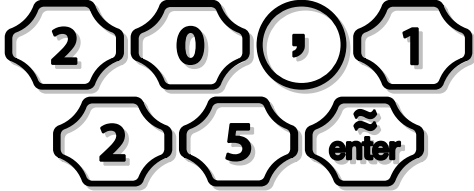
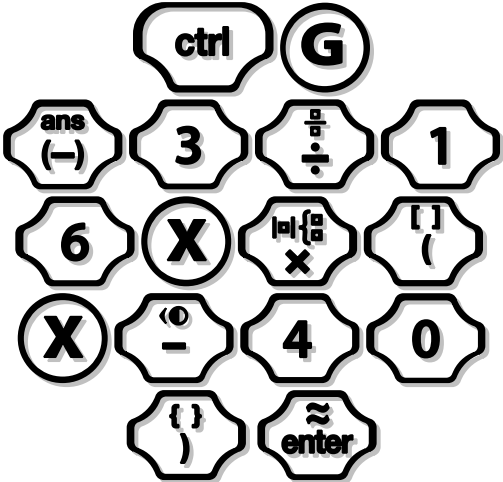
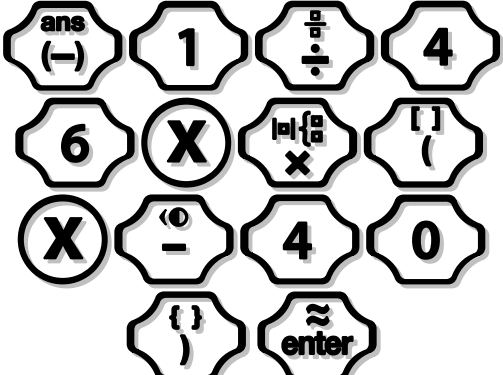
In this application, students graph the equations of three parabolas that show the paths of fireworks and that cross the three points shown.

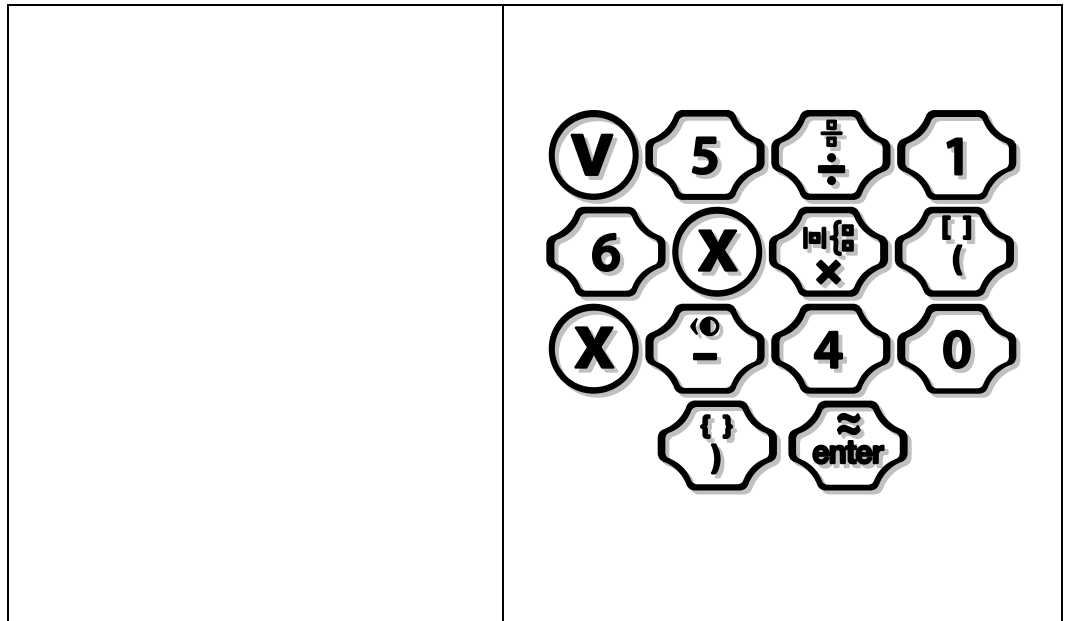


TI- <i>N</i> spire Keystrokes	
Turn on the <i>N</i> spire.	
Press the home key followed by 6, or ctrl N to open a new document.	  OR  
A previous document may be open: if so, a prompt will ask if you wish to save the document. Click to choose “yes” or press tab then click to choose “no.”	 OR

	
Select 2 to create a Graphs and Geometry Page.	
Change the window settings to show the first quadrant.	
Change Xmin to 0 Xmax to 50 Ymin to -10 Ymax to 150	
Hide the entry line.	
Add points to the first quadrant by pressing Menu, 6, and 1.	
Use the NavPad to move to the middle of the x-axis. From there move up to place three points equally spaced and aligned vertically.	
Add coordinate labels to each point. Press Menu, 1, and 7.	

<p>Use the NavPad to move the pointer above one of the points. Press Click twice. Repeat for the other two points.</p>	 <p>(Repeat with the other two points.)</p> <p>Press  after the last click.)</p>
<p>You'll see that the coordinates don't match the desired coordinates. Highlight each set of coordinates and change them to the correct ones.</p>	<p>(Use   to move the pointer above one of the coordinate labels.</p> <p>The pointer should look like this .)</p> 
<p>Change the coordinates to these:</p> <p>(20, 75)</p> <p>(20, 100)</p> <p>(20, 125)</p>	<p>(Use  to delete the coordinate.)</p>  <p>(Use   to move the pointer above the second coordinate labels.</p> <p>The pointer should look like this .)</p>  <p>(Use  to delete the coordinate.)</p>  <p>(Use   to move the pointer above the third coordinate labels.</p>

	<p>The pointer should look like this  .)</p>  <p>(Use  to delete the coordinate.)</p> 
<p>The coordinates are now the correct ones. Graph the three quadratic functions that have these coordinates as their vertices.</p>	 



Assessment

Choose the correct response.

1. The equation of a parabola with y-intercept at the origin is of the form

- a. $y = ax^2 + bx + c$
- b. $y = ax^2 + bx$
- c. $y = ax^2 + c$
- d. $y = bx + c$

2. Which expression is used to find the x-intercept of a quadratic function in standard form?

- a. $\frac{-b}{2a}$
- b. $\frac{-b}{a}$
- c. $\frac{-a}{2b}$

d. $\frac{-a}{2b}$

Find the equation of the parabola that has the coordinates shown as the vertex.


















3. (0, 25)

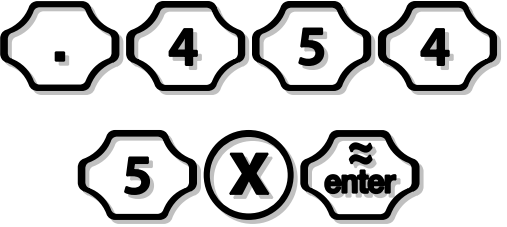
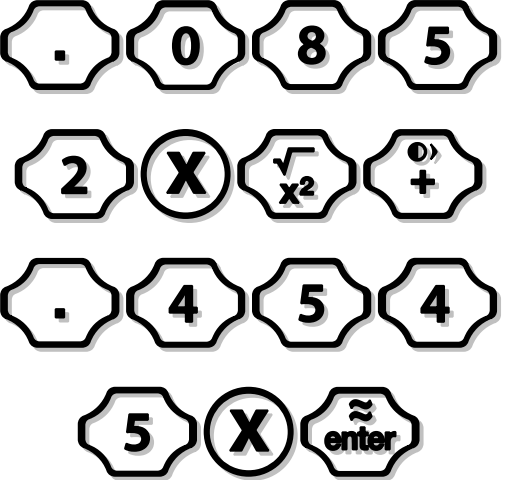
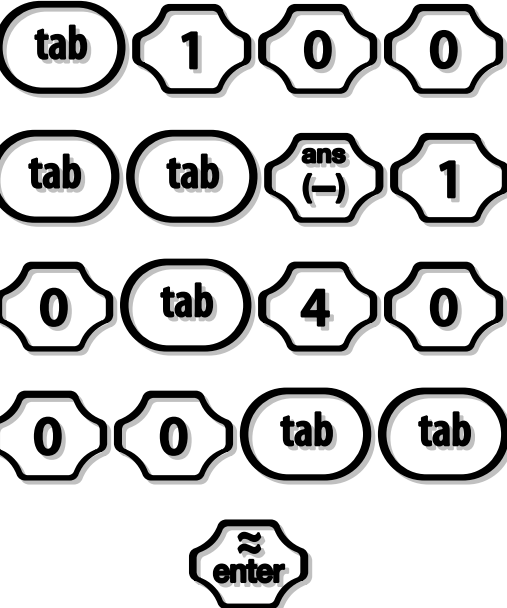

4. (20, 20)





5. (5, 0)

Application 2: Stopping Distance

In this application, students calculate the speed of a car based on its stopping distance. Students graph two quadratic functions, one that represents stopping distance on a dry road and the other represents stopping distance on a wet, rainy road.

TI- <i>n</i> spire Keystrokes	
Turn on the <i>n</i> spire.	
Press the home key followed by 6, or ctrl N to open a new document.	  OR  
A previous document may be open: if so, a prompt will ask if you wish to save the document. Click to choose “yes” or press tab then click to choose “no.”	 OR  
Select 2 to create a Graphs and Geometry Page.	
Graph the quadratic function $y = 0.0682x^2 + 0.4545x$ This is the equation of speed vs stopping distance on a dry road.	       

	
<p>Graph the quadratic function</p> $y = 0.0852x^2 + 0.4545x$ <p>This is the equation of speed vs stopping distance on a wet road.</p>	
<p>Change the window settings:</p> <p>Xmin: -10</p> <p>Xmax: 100</p> <p>Ymin: -10</p> <p>Ymax: 400</p>	
<p>Now graph $y=250$. This is the stopping distance.</p>	

<p>Add an intersection point where each parabola crosses the horizontal line. Activate the Point On tool.</p>	
<p>Place a point at each intersection. The x-coordinate of each intersection point represents the speed a car was going that had a stopping distance of 250 feet.</p>	<p>(Use  to move the pointer above the first intersection point. The pointer should look like this  .)</p>  <p>(Repeat with the second intersection point.)</p>

Assessment

Use the following equations to answer the questions.

$$y = 0.0682x^2 + 0.4545x \leftarrow \text{Dry road}$$
















$$y = 0.0852x^2 + 0.4545x \leftarrow \text{Wet road}$$

For each equation, x is the total stopping distance and y is the speed of the car when the brakes were applied.

1. A car's total stopping distance on a wet road is 400 ft. How fast was it traveling when the brakes were applied?
2. On a dry road, a car going 80 mph slams on its brakes after a half-second delay. What is the total stopping distance?

Application 3: Growth and Development


In this application, students look at growth chart data from the CDC and develop quadratic models for two different data sets.

TI- <i>N</i> spire Keystrokes													
Turn on the <i>N</i> spire.													
Press the home key followed by 6, or ctrl N to open a new document.	  OR  												
A previous document may be open: if so, a prompt will ask if you wish to save the document. Click to choose “yes” or press tab then click to choose “no.”	 OR  												
Select 3, a lists and spreadsheet window.													
Input the following data. Start with column A. <table border="1" data-bbox="444 1608 894 1871"> <thead> <tr> <th colspan="2">Growth Chart—Boys in the 5th Percentile</th> </tr> <tr> <th>Age (months)</th> <th>Height (cm)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>45.56841</td> </tr> <tr> <td>0.5</td> <td>48.55809</td> </tr> <tr> <td>1.5</td> <td>52.72611</td> </tr> <tr> <td>2.5</td> <td>55.77345</td> </tr> </tbody> </table>	Growth Chart—Boys in the 5 th Percentile		Age (months)	Height (cm)	0	45.56841	0.5	48.55809	1.5	52.72611	2.5	55.77345	      (Input the data from the first column in the
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4.5	60.33647
5.5	62.18261
6.5	63.84166
7.5	65.35584
8.5	66.75398
9.5	68.05675
10.5	69.27949
11.5	70.43397
12.5	71.52941
13.5	72.57318
14.5	73.5713
15.5	74.52871
16.5	75.44958
17.5	76.33742
18.5	77.19523
19.5	78.0256
20.5	78.83077
21.5	79.61271
22.5	80.37315
23.5	81.11363
24.5	81.83552
25.5	82.58135
26.5	83.31105
27.5	84.02609
28.5	84.72769
29.5	85.41688
30.5	86.09452
31.5	86.76134
32.5	87.41799
33.5	88.06503
34.5	88.70301
35.5	89.33242

table. Press  after each entry.)



(Keep pressing  until you reach the top of column B.)




(Input the data from the second column in the





















table. Press  after each entry.)



















Copy the contents of Column A to Column E.







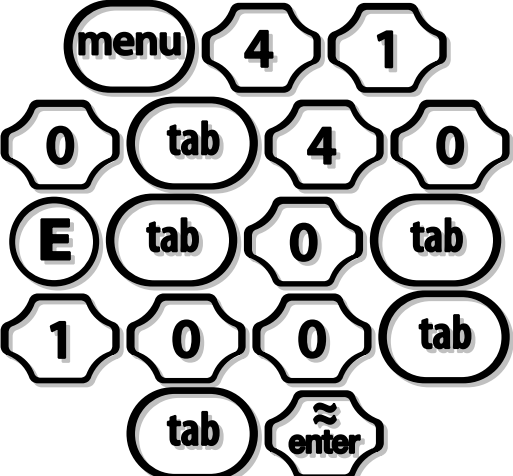
(Use     to move the pointer to the top of Column A.)

(Press  once more to highlight Column A.)



	 (Make sure you are at the top of Column V.)  																																																
Modify the heading for Column E.	     																																																
Input the data from the second column of this table to Column F (the age data has already been pasted to Column E.). Start by adding a heading to Column F.	          (Input the data from the second column in the table. Press  after each entry.)																																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left;">Growth Chart—Boys in the 50th Percentile</th> </tr> <tr> <th style="text-align: left;">Age (months)</th> <th style="text-align: left;">Height (cm)</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">0</td><td style="text-align: center;">45.56841</td></tr> <tr><td style="text-align: center;">0.5</td><td style="text-align: center;">48.55809</td></tr> <tr><td style="text-align: center;">1.5</td><td style="text-align: center;">52.72611</td></tr> <tr><td style="text-align: center;">2.5</td><td style="text-align: center;">55.77345</td></tr> <tr><td style="text-align: center;">3.5</td><td style="text-align: center;">58.23744</td></tr> <tr><td style="text-align: center;">4.5</td><td style="text-align: center;">60.33647</td></tr> <tr><td style="text-align: center;">5.5</td><td style="text-align: center;">62.18261</td></tr> <tr><td style="text-align: center;">6.5</td><td style="text-align: center;">63.84166</td></tr> <tr><td style="text-align: center;">7.5</td><td style="text-align: center;">65.35584</td></tr> <tr><td style="text-align: center;">8.5</td><td style="text-align: center;">66.75398</td></tr> <tr><td style="text-align: center;">9.5</td><td style="text-align: center;">68.05675</td></tr> <tr><td style="text-align: center;">10.5</td><td style="text-align: center;">69.27949</td></tr> <tr><td style="text-align: center;">11.5</td><td style="text-align: center;">70.43397</td></tr> <tr><td style="text-align: center;">12.5</td><td style="text-align: center;">71.52941</td></tr> <tr><td style="text-align: center;">13.5</td><td style="text-align: center;">72.57318</td></tr> <tr><td style="text-align: center;">14.5</td><td style="text-align: center;">73.5713</td></tr> <tr><td style="text-align: center;">15.5</td><td style="text-align: center;">74.52871</td></tr> <tr><td style="text-align: center;">16.5</td><td style="text-align: center;">75.44958</td></tr> <tr><td style="text-align: center;">17.5</td><td style="text-align: center;">76.33742</td></tr> <tr><td style="text-align: center;">18.5</td><td style="text-align: center;">77.19523</td></tr> <tr><td style="text-align: center;">19.5</td><td style="text-align: center;">78.0256</td></tr> <tr><td style="text-align: center;">20.5</td><td style="text-align: center;">78.83077</td></tr> </tbody> </table>	Growth Chart—Boys in the 50 th Percentile		Age (months)	Height (cm)	0	45.56841	0.5	48.55809	1.5	52.72611	2.5	55.77345	3.5	58.23744	4.5	60.33647	5.5	62.18261	6.5	63.84166	7.5	65.35584	8.5	66.75398	9.5	68.05675	10.5	69.27949	11.5	70.43397	12.5	71.52941	13.5	72.57318	14.5	73.5713	15.5	74.52871	16.5	75.44958	17.5	76.33742	18.5	77.19523	19.5	78.0256	20.5	78.83077	
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<p>Highlight Column B.</p>	<p style="text-align: center;"> </p>																														
<p>Perform a quadratic regression on the data in columns A and B.</p>	<p style="text-align: center;">   </p> <p>(Press  until you reach the OK button.)</p> <p style="text-align: center;"></p>																														
<p>Move the cursor to the top of Column E and highlight the column.</p>	<p>(Use     to move the pointer to the top of Column E.)</p> <p style="text-align: center;"></p>																														

Highlight Column F.	
Perform a quadratic regression on the data in columns E and F.	 <p>(Press  until you reach the OK button.)</p> 
Create a graphs and geometry window.	
Select and graph $f_1(x)$ and $f_2(x)$.	
Change the window settings. Xmin: 0 Xmax: 40 Ymin: 0 Ymax: 100	

Assessment

1. Create a regression model for the following growth data.

Growth Chart—Boys in the 90th Percentile	
Age (months)	Height (cm)
0	53.36
0.5	56.03
1.5	59.97
2.5	62.98
3.5	65.50
4.5	67.69
5.5	69.66
6.5	71.46
7.5	73.12
8.5	74.66
9.5	76.12
10.5	77.50
11.5	78.81
12.5	80.07
13.5	81.27
14.5	82.42
15.5	83.54
16.5	84.61
17.5	85.65
18.5	86.67
19.5	87.65
20.5	88.60
21.5	89.54
22.5	90.44
23.5	91.33
24.5	92.20
25.5	93.07
26.5	93.92
27.5	94.74
28.5	95.54
29.5	96.32
30.5	97.08
31.5	97.81
32.5	98.53
33.5	99.24
34.5	99.92

35.5	100.59
------	--------

2. A 10-month boy is 75 cm tall. Which percentile is this child most likely to be associated with?
3. Since a child's change in height during the first 36 months is nonlinear, do you think the same applies to a child's weight? Why or why not?