



# Graphing Calculator

A Preview of Lesson 6-6

Sharp EL-9900

## Families of Parabolas

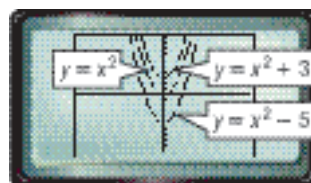
The general form of a quadratic equation is  $y = a(x - h)^2 + k$ . Changing the values of  $a$ ,  $h$ , and  $k$  results in a different parabola in the family of quadratic functions. You can use a Sharp EL-9900 graphing calculator to analyze the effects that result from changing each of these parameters.

### Example 1

Graph each set of equations on the same screen in the standard viewing window. Describe any similarities and differences among the graphs.

$$y = x^2, y = x^2 + 3, y = x^2 - 5$$

The graphs have the same shape, and all open up. The vertex of each graph is on the  $y$ -axis. However, the graphs have different vertical positions.



Example 1 shows how changing the value of  $k$  in the equation  $y = a(x - h)^2 + k$  translates the parabola along the  $y$ -axis. If  $k > 0$ , the parabola is translated  $k$  units up, and if  $k < 0$ , it is translated  $k$  units down.

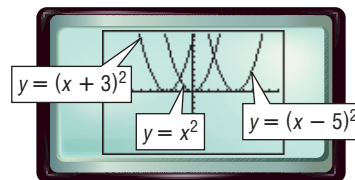
How do you think changing the value of  $h$  will affect the graph of  $y = x^2$ ?

### Example 2

Graph each set of equations on the same screen in the standard viewing window. Describe any similarities and differences among the graphs.

$$y = x^2, y = (x + 3)^2, y = (x - 5)^2$$

These three graphs all open up and have the same shape. The vertex of each graph is on the  $x$ -axis. However, the graphs have different horizontal positions.



Example 2 shows how changing the value of  $h$  in the equation  $y = a(x - h)^2 + k$  translates the graph horizontally. If  $h > 0$ , the graph translates to the right  $h$  units. If  $h < 0$ , the graph translates to the left  $h$  units.



[www.algebra2.com/other\\_calculator\\_keystrokes](http://www.algebra2.com/other_calculator_keystrokes)

# Investigation

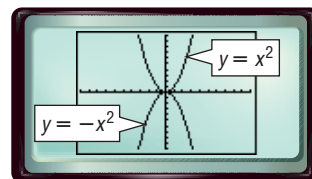
How does the value  $a$  affect the graph of  $y = x^2$ ?

## Example 3

Graph each set of equations on the same screen in the standard viewing window. Describe any similarities and differences among the graphs.

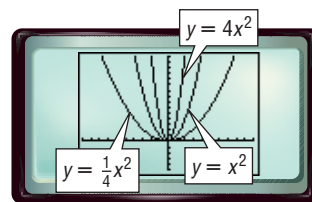
a.  $y = x^2$ ,  $y = -x^2$

The graphs have the same vertex and the same shape. However, the graph of  $y = x^2$  opens up and the graph of  $y = -x^2$  opens down.



b.  $y = x^2$ ,  $y = 4x^2$ ,  $y = \frac{1}{4}x^2$

The graphs have the same vertex,  $(0, 0)$ , but each has a different shape. The graph of  $y = 4x^2$  is narrower than the graph of  $y = x^2$ . The graph of  $y = \frac{1}{4}x^2$  is wider than the graph of  $y = x^2$ .



$[-10, 10]$  scl: 1 by  $[-5, 15]$  scl: 1

Changing the value of  $a$  in the equation  $y = a(x - h)^2 + k$  can affect the direction of the opening and the shape of the graph. If  $a > 0$ , the graph opens up, and if  $a < 0$ , the graph opens down or is *reflected* over the  $x$ -axis. If  $|a| > 1$ , the graph is narrower than the graph of  $y = x^2$ . If  $|a| < 1$ , the graph is wider than the graph of  $y = x^2$ . Thus, a change in the absolute value of  $a$  results in a *dilation* of the graph of  $y = x^2$ .

## Exercises 1–3. See margin.

Consider  $y = a(x - h)^2 - k$ .

- How does changing the value of  $h$  affect the graph? Give an example.
- How does changing the value of  $k$  affect the graph? Give an example.
- How does using  $-a$  instead of  $a$  affect the graph? Give an example.

Examine each pair of equations and predict the similarities and differences in their graphs. Use a graphing calculator to confirm your predictions. Write a sentence or two comparing the two graphs. **4–15. See pp. 343A–343F.**

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| 4. $y = x^2$ , $y = x^2 + 2.5$                     | 5. $y = -x^2$ , $y = x^2 - 9$                                |
| 6. $y = x^2$ , $y = 3x^2$                          | 7. $y = x^2$ , $y = -6x^2$                                   |
| 8. $y = x^2$ , $y = (x + 3)^2$                     | 9. $y = -\frac{1}{3}x^2$ , $y = -\frac{1}{3}x^2 + 2$         |
| 10. $y = x^2$ , $y = (x - 7)^2$                    | 11. $y = x^2$ , $y = 3(x + 4)^2 - 7$                         |
| 12. $y = x^2$ , $y = -\frac{1}{4}x^2 + 1$          | 13. $y = (x + 3)^2 - 2$ , $y = (x + 3)^2 + 5$                |
| 14. $y = 3(x + 2)^2 - 1$ ,<br>$y = 6(x + 2)^2 - 1$ | 15. $y = 4(x - 2)^2 - 3$ ,<br>$y = \frac{1}{4}(x - 2)^2 - 1$ |