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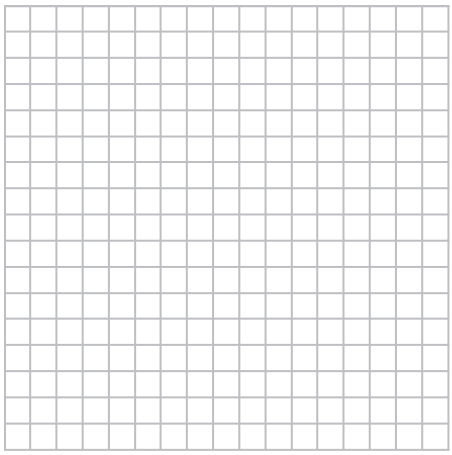
Lesson 5: Be There or Be Square

Practice Understanding

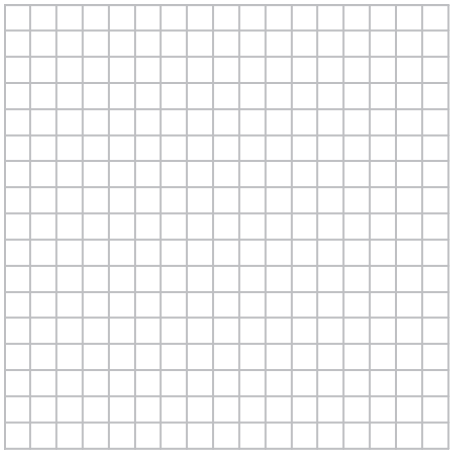
Jump Start

Graph each function with at least two precise points on either side of the line of symmetry.

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



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



Learning Focus

Use completing the square to change the form of a quadratic equation.

Graph quadratic equations given in standard form.

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How might completing the square help us to graph parabolas?

Open Up the Math
Launch, Explore, Discuss

Quilts and Quadratic Graphs

Optima's niece, Jenny, works in the shop, taking orders and drawing quilt diagrams. When the shop isn't too busy, Jenny pulls out her math homework and works on it. One day, she is working on graphing parabolas and notices that the equations she is working with look a lot like an order for a quilt block. For instance, Jenny is supposed to graph the equation: $y = (x - 3)^2 + 4$. She thinks, "That's funny. This would be an order where the length of the standard square is reduced by 3 and then we add a little piece of fabric that has as area of 4. We don't usually get orders like that, but it still makes sense. I better get back to thinking about parabolas. Hmmm…."

1. Fully describe the parabola that Jenny has been assigned to graph.

2. Jenny returns to her homework, which is about graphing quadratic functions. Much to her dismay, she finds that she has been given: $y = x^2 - 6x + 9$. "Oh dear," thinks Jenny. "I can't tell where the vertex is, or identify any of the transformations of the parabola in this form. Now what am I supposed to do?"

   "Wait a minute—is this the area of a perfect square?" Use your work from Lesson 3, Building the Perfect Square, to answer Jenny's question and justify your answer.

3. Jenny says, "I think I've figured out how to change the form of my quadratic equation so that I can graph the parabola. I'll check to see if I can make my equation a perfect square." Jenny's equation is: $y = x^2 - 6x + 9$.

   See if you can change the form of the equation, find the vertex, and graph the parabola.

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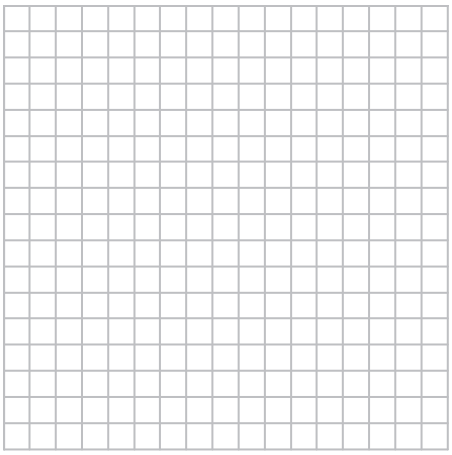
a. $y = x^2 - 6x + 9$

New form of the equation:

b. Vertex of the parabola:

c. Graph (with at least 3 precise points on each side of the line of symmetry):



4. The next quadratic to graph from Jenny's homework is $y = x^2 + 4x + 2$. Does this expression fit the pattern for a perfect square? Why or why not?

a. Complete the square so that the equation can be written in vertex form, $y = a(x - h)^2 + k$.

b. Is the equation you have written equivalent to the original equation? If not, what adjustments need to be made? Why?

c. Identify the vertex, and graph the parabola with three precise points on both sides of the line of symmetry.

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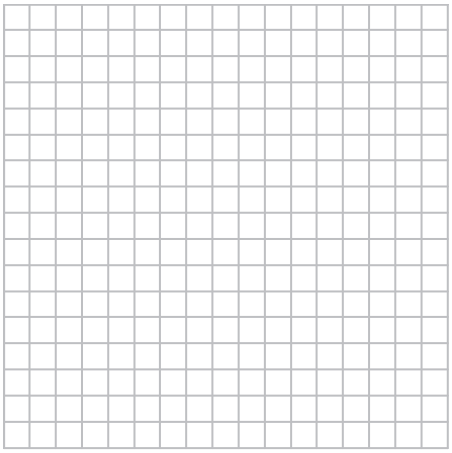

5. Jenny had hoped that she wasn't going to need to figure out how to complete the square on an equation where b is an odd number. Of course, that was the next problem. Help Jenny to find the vertex of the parabola for this quadratic function:

$g(x) = x^2 + 7x + 10$

6. Don't worry if you had to think hard about problem 5. Jenny needs to do a couple more:

a. $g(x) = x^2 - 5x + 3$

b. $g(x) = x^2 - x - 5$

7. It just gets better! Help Jenny find the vertex, and graph the parabola for the quadratic function $h(x) = 2x^2 - 12x + 17$.

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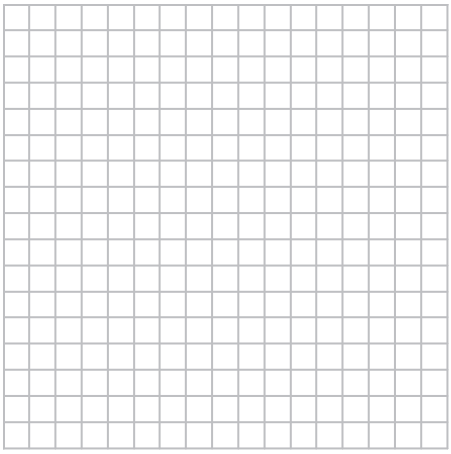
Equation:

Vertex:



8. This one is just too cute—you've got to try it! Find the vertex, and describe the parabola that is the graph of $f(x) = \frac{1}{2}x^2 + 2x - 3$.

Ready for More?

Use technology to experiment with graphing a quadratic function in standard form: $y = ax^2 + bx + c$. Check out the effect of changing a, b, or c. Are there patterns you can find that help you predict if the parabola opens up or down? Can you predict intercepts or the location of the vertex?

Takeaways

A method for graphing a quadratic equation in standard form: $y = ax^2 + bx + c$.

1.

2.

3.

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Vocabulary

- **standard form of a quadratic function**
- vertex form

Bold terms are new in this lesson.

Lesson Summary

In this lesson, we learned to graph a quadratic function in standard form. We used the process of completing the square to help identify the transformations and locate the vertex. From there, we were able to use the quick-graph method to graph the parabola.

Retrieval

In future lessons you will work with quadratic equations. A quadratic equation can be expressed in the form $ax^2 + bx + c = 0$ using the properties of algebra and equality. Identify whether each equation represents a quadratic equation. Justify your answer.

1. $x(6x - 11) = 0$

   Quadratic or not? Justification:

2. $6x^2 + x = 6x^2 - 11$

   Quadratic or not? Justification:

3. $x^2 - 8x + 4 = 0$

   Quadratic or not? Justification:

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Identify whether the table represents a linear or quadratic function. Write the recursive equation for each table.

4.

x	$f(x)$
1	3
2	12
3	27
4	48
5	75

Type of function:

Equation(s):

5.

x	$f(x)$
1	7
2	10
3	13
4	16
5	19

Type of function:

Equation(s):

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