LESSON MAKER PRO

Find the Turning Point

Use vertex form to find a quadratic's highest or lowest value.

GRADE 8 · 8A.AF.A.6.b

8A.AF.A.6.b "Use the vertex form of a quadratic expression to reveal the maximum or minimum value and the axis of symmetry of the function it defines; complete the square to find the vertex form of quadratics with a leading coefficient of one."

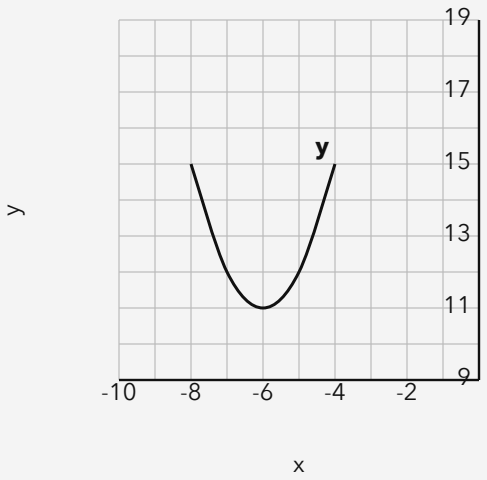
NAME _____ DATE _____

THE VERTEX TELLS YOU

In $y = a(x - h)^2 + k$, the vertex is (h, k) and the axis of symmetry is $x = h$. The value k is a minimum when a is positive and a maximum when a is negative. For $y = x^2 + bx + c$, add and subtract $(b/2)^2$ to complete the square.

WORKED EXAMPLE

Complete the square for $y = x^2 + 12x + 47$. Use the graph to check the vertex, then find the minimum value and axis of symmetry.

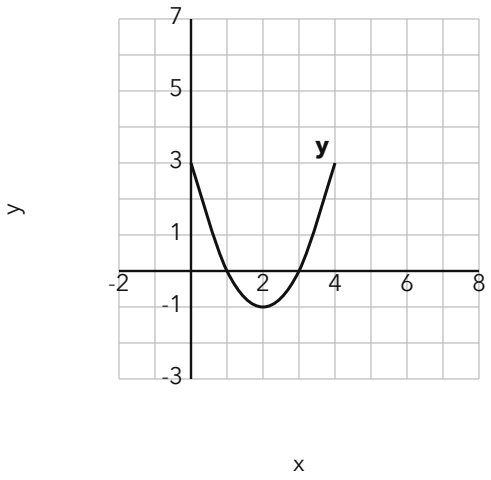


1. Half of 12 is 6, and $6^2 = 36$.
2. $y = (x^2 + 12x + 36) + 47 - 36$
3. $y = (x + 6)^2 + 11$
4. The graph confirms the vertex is $(-6, 11)$.

Answer: Vertex form: $y = (x + 6)^2 + 11$. Minimum value: 11. Axis of symmetry: $x = -6$.

PRACTICE 6 problems

1 Use the graph to find the minimum value and axis of symmetry.

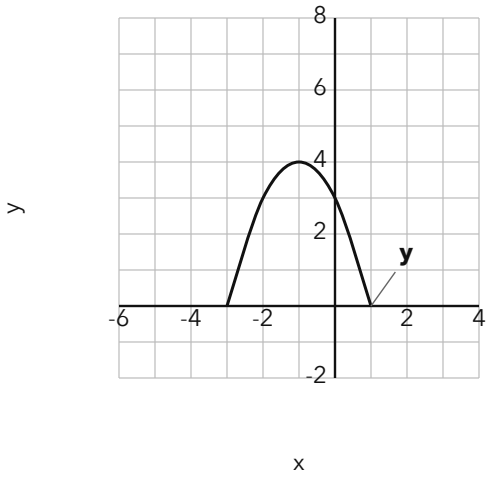


ANSWER _____

2 Complete the square for $y = x^2 - 4x + 7$. Give the vertex form and minimum value.

ANSWER _____

3 Use the graph to find the maximum value and axis of symmetry.



ANSWER _____

4 Complete the square for $y = x^2 + 8x + 19$. Give the vertex form and axis of symmetry.

ANSWER _____

5 For $y = -2(x - 3)^2 + 7$, find the maximum value and axis of symmetry.

ANSWER _____

6 Complete the square for $y = x^2 - 10x + 21$. Give the vertex form and minimum value.

ANSWER _____

APPLY IT Show your work

1 A game designer models the time to finish a level as $T(x) = x^2 - 8x + 30$ seconds, where x is the number of shortcuts used, from 0 to 8. Complete the square. How many shortcuts give the fastest time, and what is that time?

WORK SPACE

ANSWER _____

2 The height of a basketball, in feet, is $h(x) = -(x - 2)^2 + 10$, where x is its horizontal distance in feet from the player. What is the ball's greatest height, and how far from the player does it reach that height?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Which function has the smaller minimum value: $f(x) = x^2 - 2x + 7$ or $g(x) = (x - 4)^2 + 5$? Complete the square for f(x), then explain your choice using both minimum values.

WORK SPACE AND ANSWER

ANSWER KEY

Find the Turning Point

GRADE 8 · 8A.AF.A.6.b

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Use the graph to find the minimum value and axis of symmetry.	**Minimum value: -1. Axis of symmetry: x = 2.**
2	Complete the square for $y = x^2 - 4x + 7$. Give the vertex form and minimum value.	**Vertex form: $y = (x - 2)^2 + 3$. Minimum value: 3.**
3	Use the graph to find the maximum value and axis of symmetry.	**Maximum value: 4. Axis of symmetry: x = -1.**
4	Complete the square for $y = x^2 + 8x + 19$. Give the vertex form and axis of symmetry.	**Vertex form: $y = (x + 4)^2 + 3$. Axis of symmetry: x = -4.**
5	For $y = -2(x - 3)^2 + 7$, find the maximum value and axis of symmetry.	**Maximum value: 7. Axis of symmetry: x = 3.**
6	Complete the square for $y = x^2 - 10x + 21$. Give the vertex form and minimum value.	**Vertex form: $y = (x - 5)^2 - 4$. Minimum value: -4.**

PART 2 · APPLY IT

1. **$T(x) = (x - 4)^2 + 14$. Using 4 shortcuts gives the fastest time, 14 seconds.** Complete the square by adding and subtracting 16. The squared term is smallest when x = 4.
2. **The greatest height is 10 feet, reached 2 feet from the player.** The coefficient of the squared term is negative, so the vertex gives the maximum height. The vertex is (2, 10).

CHALLENGE

$f(x) = (x - 1)^2 + 6$, so its minimum is 6. The minimum of g(x) is 5. Therefore, g(x) has the smaller minimum value.

Accept equivalent notation for a function's vertex form. For graph items, students may identify the axis from the vertex or from matching heights on either side.