LESSON MAKER PRO

Find the Turning Point

Connect vertex form, graphs, and maximum or minimum values.

HIGH SCHOOL · A1P.AF.A.6.b

A1P.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."

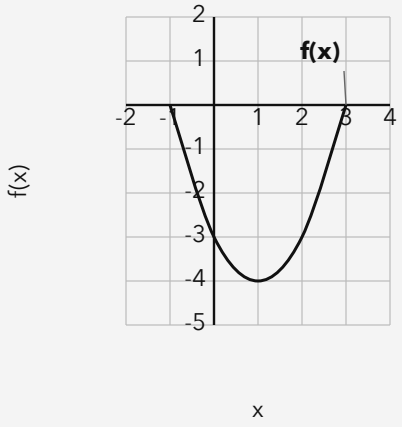
NAME _____ DATE _____

THE BIG IDEA

In $f(x) = a(x - h)^2 + k$, the axis of symmetry is $x = h$. The extreme value is k: a minimum when a is positive and a maximum when a is negative. When the leading coefficient is 1, complete the square by adding and subtracting the square of half the x coefficient.

WORKED EXAMPLE

Use the plotted parabola and complete the square for $f(x) = x^2 - 2x - 3$. Verify the graph's minimum value and axis of symmetry.



1. Half of -2 is -1, and $(-1)^2 = 1$.
2. $f(x) = (x^2 - 2x + 1) - 1 - 3$
3. $f(x) = (x - 1)^2 - 4$

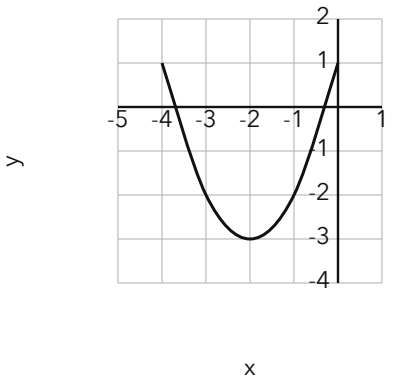
Answer: The graph's minimum value is -4, and its axis of symmetry is x = 1.

PRACTICE 6 problems

1 Complete the square for $f(x) = x^2 + 6x + 8$. Give its vertex form and minimum value.

ANSWER _____

2 For the plotted parabola, give the minimum value and axis of symmetry.



ANSWER _____

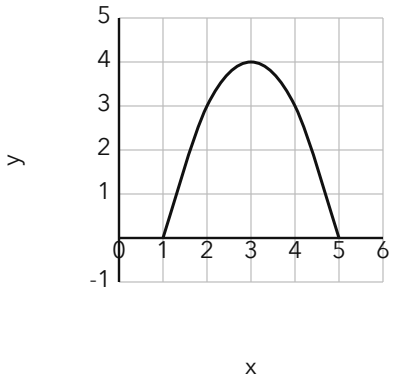
3 Complete the square for $f(x) = x^2 - 8x + 11$. Give its vertex form and axis of symmetry.

ANSWER _____

4 For $f(x) = -2(x + 1)^2 + 7$, give the maximum value and axis of symmetry.

ANSWER _____

5 For the plotted parabola, give the maximum value and axis of symmetry.



ANSWER _____

6 Complete the square for $f(x) = x^2 - 10x + 28$. Give its vertex form and minimum value.

ANSWER _____

APPLY IT Show your work

1 A 3D-printed phone stand has a curved base. Its height in centimeters is $h(x) = x^2 - 4x + 6$, where x is the distance in centimeters from one edge, with $0 \le x \le 4$. At what distance is the base lowest, and what is its lowest height?

WORK SPACE

ANSWER _____

2 A volleyball's height in feet is $h(x) = -x^2 + 6x + 5$, where x is its horizontal distance in feet from the hit, with $0 \le x \le 6$. How far from the hit does it reach its maximum height, and what is that height?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A quadratic function has a leading coefficient of 1, an axis of symmetry at $x = -3$, and a graph that passes through (0, 14). Write its vertex form and find its minimum value. Explain how you found the constant in vertex form.

WORK SPACE AND ANSWER

ANSWER KEY

Find the Turning Point

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Complete the square for $f(x) = x^2 + 6x + 8$. Give its vertex form and minimum value.	**$f(x) = (x + 3)^2 - 1$; minimum value: -1**
2	For the plotted parabola, give the minimum value and axis of symmetry.	**Minimum value: -3; axis of symmetry: x = -2**
3	Complete the square for $f(x) = x^2 - 8x + 11$. Give its vertex form and axis of symmetry.	**$f(x) = (x - 4)^2 - 5$; axis of symmetry: x = 4**
4	For $f(x) = -2(x + 1)^2 + 7$, give the maximum value and axis of symmetry.	**Maximum value: 7; axis of symmetry: x = -1**
5	For the plotted parabola, give the maximum value and axis of symmetry.	**Maximum value: 4; axis of symmetry: x = 3**
6	Complete the square for $f(x) = x^2 - 10x + 28$. Give its vertex form and minimum value.	**$f(x) = (x - 5)^2 + 3$; minimum value: 3**

PART 2 · APPLY IT

1. **The base is lowest 2 cm from the edge, at a height of 2 cm.** Complete the square to get $h(x) = (x - 2)^2 + 2$. Its minimum occurs at $x = 2$.
2. **The volleyball reaches a maximum height of 14 feet, 3 feet from the hit.** Rewrite the function as $h(x) = -(x - 3)^2 + 14$. The negative squared term makes 14 the maximum, which occurs at $x = 3$.

CHALLENGE

$f(x) = (x + 3)^2 + 5$, so its minimum value is 5. Substituting (0, 14) gives $14 = 3^2 + 5$.

For graph questions, accept the correct extreme value and axis without a vertex-form equation. For completion-of-the-square questions, the vertex form must be equivalent to the given function.