

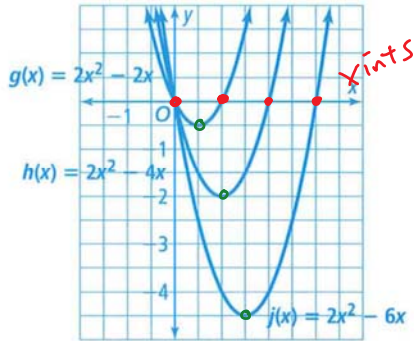
8-3

Quadratic Functions in Standard Form

PearsonRealize.com

EXPLORE & REASON

Three functions of the form $f(x) = ax^2 + bx$ are graphed for $a = 2$ and different values of b .



A. What do the graphs have in common? In what ways do they differ?

- same shape
- opens up
- intersect at origin
- different vertices

B. What do you notice about the x-intercepts of each graph? What do you notice about the y-intercepts of each graph?

X-ints : zero (0,0), 2, 4, 6 | y-int : same y-int : 0
origin

C. **Look for Relationships** Look at the ratio $\frac{b}{a}$ for each function and compare it to its graph. What do you notice? © MP7

$\frac{b}{a}$ bx ax^2 -----

HABITS OF MIND

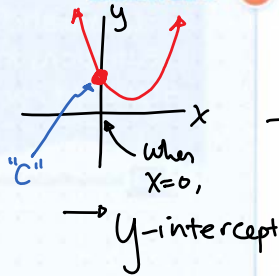
Construct Arguments Can more than one parabola have the same description? Explain. © MP3



Standard Form

Notes

EXAMPLE 1

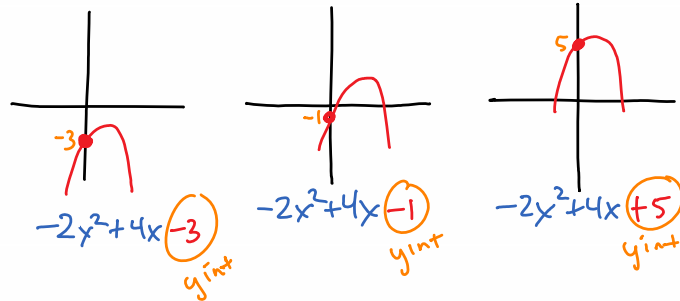


Try It! Analyze the Axis of Symmetry for $f(x) = ax^2 + bx + c$

- Evaluate $f(x) = ax^2 + bx + c$ for $x = 0$. How does $f(0)$ relate to result in Example 1?

$$f(0) = a(0)^2 + b(0) + c$$

\leftarrow y-intercept



$f(x) = ax^2 + bx + c$
Standard Form

y-int: (set $x=0$)

Axis of Symmetry: $x = -\frac{b}{2a}$

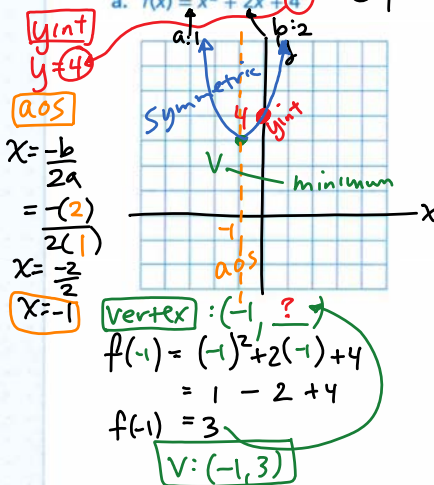
Vertex: $\left(-\frac{b}{2a}, \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\right)$
Subst $-\frac{b}{2a}$ into $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ eqn.

EXAMPLE 2

Try It! Graph a Quadratic Function in Standard Form

- Graph each function. What are the y-intercept, the axis of symmetry, and the vertex of each function?

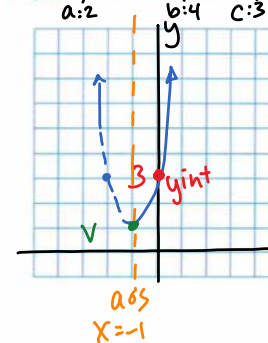
a. $f(x) = x^2 + 2x + 4$ $c: 4$



$x = -\frac{b}{2a}$
 $= -\frac{2}{2(1)}$
 $x = -\frac{2}{2}$
 $x = -1$

Vertex: $(-1, ?)$
 $f(-1) = (-1)^2 + 2(-1) + 4$
 $= 1 - 2 + 4$
 $f(-1) = 3$
 V: $(-1, 3)$

b. $g(x) = -0.75x^2 + 3x - 4$



$x = -\frac{b}{2a} = -\frac{3}{2(-0.75)} = \frac{3}{1.5} = 2$
 $x = 2$
 Vertex: $(2, ?)$
 $f(2) = -0.75(2)^2 + 3(2) - 4$
 $= -0.75(4) + 6 - 4$
 $= -3 + 6 - 4$
 $f(2) = -1$
 V: $(2, -1)$

HABITS OF MIND

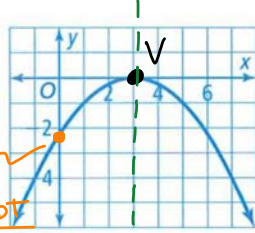
Use Appropriate Tools Suppose you want to graph a quadratic function in standard form on a graphing calculator. How could finding the vertex, axis of symmetry, and y-intercept of the function help you choose a viewing window for the graph? © MP.5

$$ax^2 + bx + c$$

EXAMPLE 3 Try It! Compare Properties of Quadratic Functions

3. Compare $f(x) = -0.3x^2 - 0.6x - 0.2$ to function g , shown in the graph. What are the maximum values? Which function has the greater maximum value?

Standard Form



• opens down
 → $a < 0$ negative
 vertex: $(3, 0)$
 → maximum

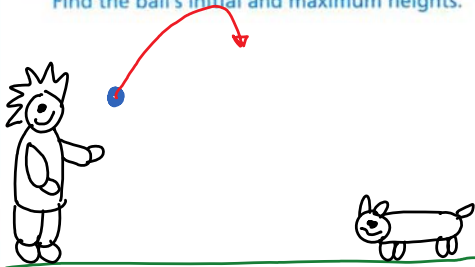
aos: axis of symmetry

HABITS OF MIND

Reason In Example 3, how can you tell from the equation of function f that the function has a maximum? How can you tell from the table that the function representing Fountain B has a maximum? © MP.2

EXAMPLE 4 Try It! Analyze the Structure of Different Forms

4. Suppose the path of the ball in Example 4 is $f(x) = -0.25(x - 1)^2 + 6.25$. Find the ball's initial and maximum heights.



$$a(x-h)^2 + k$$

$v: (h, k)$
 $v: (1, 6.25)$
 1 sec. feet

HABITS OF MIND

Use Structure Consider the different forms of the quadratic function. Which form would you use to find the y-intercept of its graph? Which form would you use to find the maximum or minimum of the function? Explain. © MP.7

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How is the standard form of a quadratic function different from the vertex form?

$$f(-2) = 2(-2)^2 + 8(-2) - 1$$

$$= 2(4) - 16 - 1$$

$$= 8 - 16 - 1 = -8 - 1 = -9$$

aos

$$x = \frac{-b}{2a} = \frac{-8}{2(2)} = \frac{-8}{4} = -2$$

Vertex $(-2, -9)$

2. **Communicate Precisely** How are the form and graph of $f(x) = ax^2 + bx + c$ similar to the form and graph of $g(x) = ax^2 + bx$? How are they different? **MP.6**

3. **Vocabulary** How can you write a function in standard form, given its vertex form?

$$f(-1) = -3(-1)^2 - 6(-1) - 5$$

$$= -3 \cdot 1 + 6 - 5$$

$$= -3 + 6 - 5$$

$$= 3 - 5$$

$$= -2$$

4. **Error Analysis** Sage began graphing $f(x) = -2x^2 + 4x + 9$ by finding the axis of symmetry $x = -1$. Explain the error Sage made. **MP.3**

Do You KNOW HOW?

Graph each function. For each, identify the axis of symmetry, the y-intercept, and the coordinates of the vertex $ax^2 + bx + c$

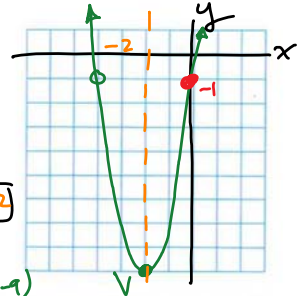
5. $f(x) = 2x^2 + 8x - 1$

y-int
-1

aos

$$x = \frac{-b}{2a} = \frac{-8}{2(2)} = \frac{-8}{4} = -2$$

Vertex $(-2, -9)$



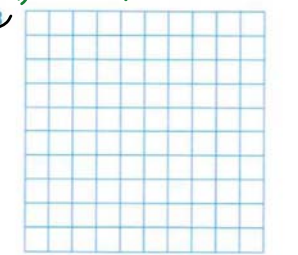
6. $f(x) = 0.5x^2 - 2x + 2$

y-int
2

aos

$$x = \frac{-b}{2a} = \frac{-(-2)}{2(0.5)} = \frac{2}{1} = 2$$

Vertex $(2, 0)$



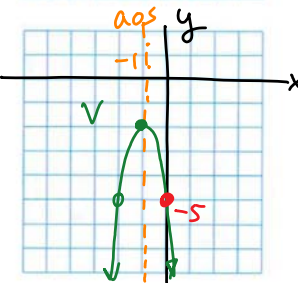
7. $f(x) = -3x^2 - 6x - 5$

y-int
-5

aos

$$x = \frac{-b}{2a} = \frac{-(-6)}{2(-3)} = \frac{6}{-6} = -1$$

Vertex $(-1, -2)$



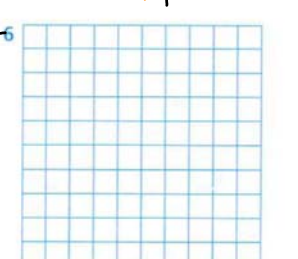
8. $f(x) = 0.25x^2 - 0.5x - 6$

y-int
-6

aos

$$x = \frac{-b}{2a} = \frac{-(-0.5)}{2(0.25)} = \frac{0.5}{0.5} = 1$$

Vertex $(1, -6.25)$



9. A water balloon is tossed into the air. The function $h(x) = -0.5(x - 4)^2 + 9$ gives the height, in feet, of the balloon from the surface of a pool as a function of the balloon's horizontal distance from where it was first tossed. Will the balloon hit the ceiling 12 ft above the pool? Explain.

