Activity

2-2 Standard Form of a Quadratic Function

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CRITIQUE & EXPLAIN

PE
MD
AS

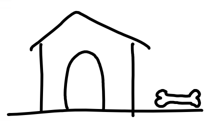
Jordan and Emery are rewriting the vertex form of the quadratic function $y = 2(x - 4)^2 + 5$ in the form $y = ax^2 + bx + c$.

Jordan	Emery
$y = 2(x-4)^2 + 5$	$y = 2(x-4)^2 + 5$
$= (2x-8)^2 + 5$	$= 2(x^2 - 16) + 5$
$= 4x^2 - 32x + 64 + 5$	$= 2x^2 - 32 + 5$
$= 4x^2 - 32x + 69$	$= 2x^2 - 27$

A. Communicate Precisely Did Jordan rewrite the equation correctly? Did Emery? Explain. MP.6

$(x-4)(x-4)\ldots$
expand & multiply
(distrib prop/FOIL)

illegal... power comes before mult



B. Without rewriting the equation, how could you prove that Jordan's or Emery's equation is not equivalent to the original?

- subst values
- graph eqns...

HABITS OF MIND

Reason Casey rewrote the vertex form, too.

$$y = 2(x-4)^2 + 5$$
$$= 2(x+1)^2$$
$$= 2(x^2 + 2x + 1)$$
$$= 2x^2 + 4x + 2$$

!!

Is Casey correct? Explain. MP.2

PE
MD
AS ?

$y = a(x-h)^2 + k$ vertex form

see textbook for proof

$y = ax^2 - 2ahx + ah^2 + k$ standard form

a b c

$b = -2ah$

$\frac{b}{-2a} = h$

or

$\boxed{\frac{-b}{2a} = h}$ x-value of vertex

also axis of symmetry

Notes

EXAMPLE 1 **Try It!** Find the Vertex of a Quadratic Function in Standard Form

ax^2+bx+c

1. What is the vertex of the graph of the function $f(x) = x^2 - 8x + 5$?

$h = \frac{-b}{2a} = \frac{-(-8)}{2 \cdot 1} = \frac{8}{2} = 4$

$V(4, ?)$

$f(4) = (4)^2 - 8(4) + 5$

$= 16 - 32 + 5$

$= -11$ $\therefore$ $\boxed{V:(4,-11)}$

EXAMPLE 2 **Try It!** Graph a Quadratic Function in Standard Form

2. Use key features to graph the function $f(x) = x^2 - 6x - 1$.

ax^2+bx+c

① vertex/aos?

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

V:(3, ?)

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

$f(3) = 9 - 18 - 1$

$f(3) = -10$

V(3, -10)

② y-intercept?

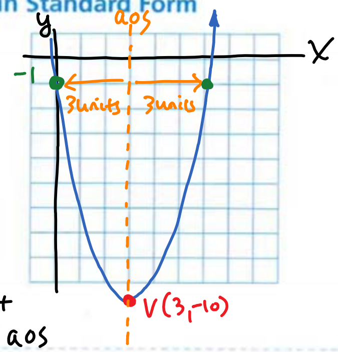
• set x=0

• c

$f(0) = 0^2 - 6(0) - 1$

③ parabola: symmetric

→ mirror y-intercept across the aos



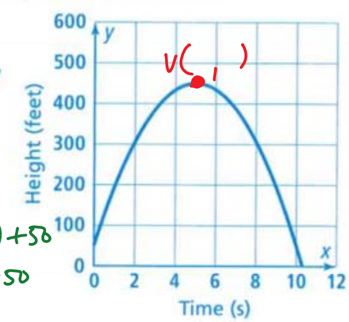
HABITS OF MIND

Error Analysis Yuson said that for the quadratic function $f(x) = 2x^2 + 3x + 1$, the vertex is at the point (0, 1). Is she correct? Explain. MP.3

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

EXAMPLE 3 **Try It!** Interpret the Graph of a Quadratic Function

3. A water balloon was ~~thrown~~ shot from a window. The height of the water balloon over time can be modeled by the function $y = -16x^2 + 160x + 50$. What was the maximum height of the water balloon after it was thrown?



$x = \frac{-(160)}{2(-16)} = 5$

$y = -16(5)^2 + 160(5) + 50$

$= -16(25) + 800 + 50$

$= -400 + 800 + 50$

$= \boxed{450}$

HABITS OF MIND

Make Sense and Persevere How long did it take for the water balloon to reach its maximum height? MP.1

5 seconds

Notes

Assess

EXAMPLE 4 **Try It!** **Write the Equation of a Parabola Given Three Points**

4. What is the equation of a parabola that passes through the points (2, −12), (−1, −15), and (−4, −90)? • substitute....

$y = ax^2 + bx + c$

$-12 = a(2)^2 + b(2) + c$

$\boxed{-12 = 4a + 2b + c}$

$-15 = a(-1)^2 + b(-1) + c$

$\boxed{-15 = a - b + c}$

$-90 = a(-4)^2 + b(-4) + c$

$\boxed{-90 = 16a - 4b + c}$

System of eqns

$4a + 2b + c = -12$

$a - b + c = -15$

$16a - 4b + c = -90$

$a = -4,\ b = 5,\ c = -6$

$\therefore \boxed{y = -4x^2 + 5x - 6}$

QuadReg

EXAMPLE 5 **Try It!** **Use Quadratic Regression** "Curve of Best Fit"

5. A fan threw a souvenir football into the air from the top of the bleachers toward the bottom of the bleachers. The table shows the height of the football, in feet, above the ground at various times, in seconds. If the football wasn't touched by anyone on its way to the ground, about how long did it take the football to reach the ground after it was thrown?

Time (s)	0	0.2	0.4	0.6	0.8	1.0
Height (ft)	10	11.76	12.24	11.44	9.36	6.0

GC → STAT → L1: Time, L2: Height

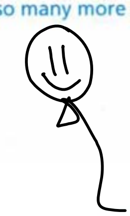
→ GRPH → GPH1 → CALC → X^2

$y = -16x^2 + 12x + 10$

HABITS OF MIND

Model With Mathematics How many points does it take to determine the equation of a quadratic function? Why are so many more points used in Example 4? MP.4

3 points



Assess

Do You UNDERSTAND?

1. ESSENTIAL QUESTION What key features can you determine about a quadratic function from an equation in standard form?

$x = \frac{-b}{2a}$

$v(\_\_, \_\_)$

2. **Error Analysis** Cameron said that the y-intercept of a quadratic function always tells the maximum value of that function. Explain Cameron's error. MP.3

3. **Vocabulary** Write a quadratic function in standard form.

4. **Make Sense and Persevere** Why do you need at least three points to graph a quadratic function without an equation? MP.1

Do You KNOW HOW?

Find the vertex and y-intercept of the quadratic function.

5. $y = 3x^2 - 12x + 40$ (a, b, c; y-int)

$x = \frac{-b}{2a} = \frac{-(-12)}{2(3)} = \frac{12}{6} = 2$

$y = 3(2)^2 - 12(2) + 40$
$= 3 \cdot 4 - 24 + 40$
$= 12 - 24 + 40 = -12 + 40 = 28$

$\therefore v(2, 28)$

6. $y = -x^2 + 4x + 7$ (a, b, c; y-int)

$x = \frac{-b}{2a} = \frac{-(4)}{2(-1)} = \frac{-4}{-2} = 2$

$y = -(2)^2 + 4(2) + 7$
$= -4 + 8 + 7$
$= 4 + 7 = 11$

$\therefore v(2, 11)$

For 7 and 8, find the maximum point of the parabola.

7. $y = -2x^2 - 16x + 20$ (a, b)

$x = \frac{-b}{2a} = \frac{-(-16)}{2(-2)} = \frac{16}{-4} = -4$

$y = -2(-4)^2 - 16(-4) + 20$
$= -2(16) + 64 + 20$
$= -32 + 64 + 20 = 32 + 20 = 52$

8. $y = -x^2 + 12x - 15$ (a, b)

$x = \frac{-b}{2a} = \frac{-(12)}{2(-1)} = \frac{-12}{-2} = 6$

$y = -(6)^2 + 12(6) - 15$
$= -36 + 72 - 15$
$= 36 - 15 = 21$

9. Find the equation in standard form of the parabola that passes through the points (0, 6), (−3, 15), and (−6, 6). see ex 4) GCF

$y = -x^2 - 6x + 6$

10. $y = 3x^2 + 6x - 2$

$x = \frac{-b}{2a}$ ... $v(\_\_, \_\_)$

11. $y = -2x^2 + 4x + 1$