

WARMUP! 😊

Write a rule for g and identify the vertex.

Let g be a horizontal shrink by a factor of 2, followed by a translation 2 units down and 1 unit right of the graph of $f(x) = (8x - 4)^2 + 4$.

Today you will:

- Write equations of quadratic functions using vertices, points and x-intercepts
 - Using vertex form
 - Using intercept form
- Practice using English to describe math processes and equations

Review

- Vertex form of a quadratic: $f(x) = a(x - h)^2 + k$
 - Immediately gives us the vertex (h, k)
- Intercept form of a quadratic: $f(x) = a(x - p)(x - q)$
 - Immediately gives us the x-intercepts: $(p, 0)$ and $(q, 0)$

Review

- What is the $y = mx + b$ form of equation for the following two points? (1, 4), (2, 3)

- First find the slope $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 4}{2 - 1} = \frac{-1}{1} = -1$

- Now find b ... by using what we know ...

- We know m , and 2 points ... which means we know m , *plus* an x and the y that goes with it.

- $y = mx + b$

- $4 = -1(1) + b$

- $b = 5$

- **So the equation is $y = -x + 5$**

Try it yourself: write the equation of the parabola that passes through the point $(-1, 2)$ and has a vertex of $(4, -9)$.

Which form should we use for the equation?

...given the vertex so use Vertex Form: $f(x) = a(x - h)^2 + k$

$$h = 4$$

$$k = -9$$

...also given a point $(-1, 2)$ on the parabola. So when $x = -1$, we know that $f(x) = 2$

Plug everything we know into the vertex form which will just leave a . Then solve for a .

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

$$2 = a((-1) - 4)^2 - 9$$

$$2 = a(-5)^2 - 9$$

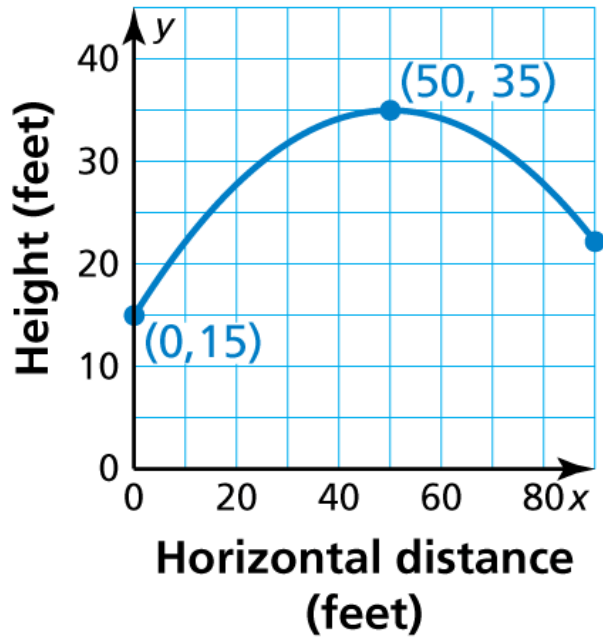
$$25a - 9 = 2$$

$$a = \frac{11}{25}$$

So the equation of the parabola is $f(x) = \frac{11}{25}(x - 4)^2 - 9$

Example 1

Human Cannonball



The graph shows the parabolic path of a performer who is shot out of a cannon, where y is the height (in feet) and x is the horizontal distance traveled (in feet). Write an equation of the parabola. The performer lands in a net 90 feet from the cannon. What is the height of the net?

SOLUTION

From the graph, you can see that the vertex (h, k) is $(50, 35)$ and the parabola passes through the point $(0, 15)$. Use the vertex and the point to solve for a in vertex form.

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

Vertex form

$$15 = a(0 - 50)^2 + 35$$

Substitute for h , k , x , and y .

$$-20 = 2500a$$

Simplify.

$$-0.008 = a$$

Divide each side by 2500.

Because $a = -0.008$, $h = 50$, and $k = 35$, the path can be modeled by the equation $y = -0.008(x - 50)^2 + 35$, where $0 \leq x \leq 90$. Find the height when $x = 90$.

$$y = -0.008(90 - 50)^2 + 35$$

Substitute 90 for x.

$$= -0.008(1600) + 35$$

Simplify.

$$= 22.2$$

Simplify.

► So, the height of the net is about 22 feet.

Try it yourself: write the equation of the parabola that passes through the point (2, 5) and has x-intercepts -2 and 4.

Which form should we use for the equation?

...given x-intercepts so Intercept Form: $f(x) = a(x - p)(x - q)$

$$p = -2$$

$$q = 4$$

...also given a point (2, 5) on the parabola. So when $x = 2$, we know that $f(x) = 5$

Plug everything we know into the intercept form which will just leave a . Then solve for a .

$$f(x) = a(x - p)(x - q)$$

$$5 = a(0 - (-2))(0 - (4))$$

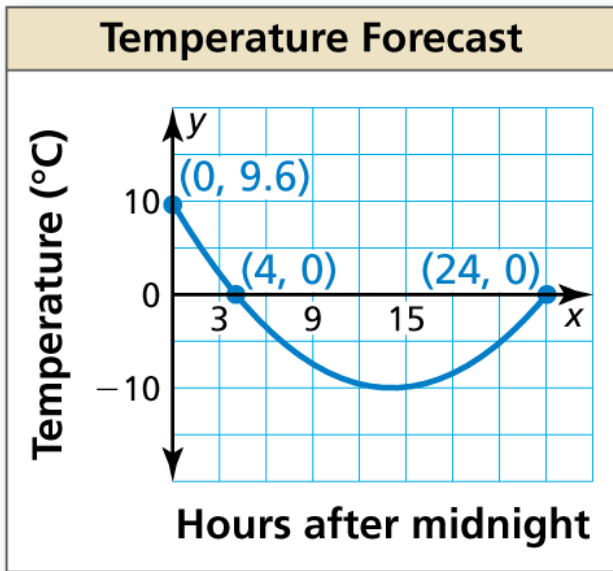
$$5 = a(2)(-4) = -8a$$

$$-8a = 5$$

$$a = -\frac{5}{8}$$

So the equation of the parabola is $f(x) = -\frac{5}{8}(x + 2)(x - 4)$

Example 2



A meteorologist creates a parabola to predict the temperature tomorrow, where x is the number of hours after midnight and y is the temperature (in degrees Celsius).

- Write a function f that models the temperature over time. What is the coldest temperature?
- What is the average rate of change in temperature over the interval in which the temperature is decreasing? increasing? Compare the average rates of change.

SOLUTION

- The x -intercepts are 4 and 24 and the parabola passes through (0, 9.6). Use the x -intercepts and the point to solve for a in intercept form.

$$y = a(x - p)(x - q)$$

Intercept form

$$9.6 = a(0 - 4)(0 - 24)$$

Substitute for p , q , x , and y .

$$9.6 = 96a$$

Simplify.

$$0.1 = a$$

Divide each side by 96.



Because $a = 0.1$, $p = 4$, and $q = 24$, the temperature over time can be modeled by $f(x) = 0.1(x - 4)(x - 24)$, where $0 \leq x \leq 24$.

$$\begin{aligned} f(14) &= 0.1(14 - 4)(14 - 24) && \text{Substitute 14 for } x. \\ &= -10 && \text{Simplify.} \end{aligned}$$

► So, the coldest temperature is -10°C at 14 hours after midnight, or 2 P.M.

REMEMBER

The average rate of change of a function f from x_1 to x_2 is the slope of the line connecting $(x_1, f(x_1))$ and $(x_2, f(x_2))$:

$$\frac{f(x_2) - f(x_1)}{x_2 - x_1}$$

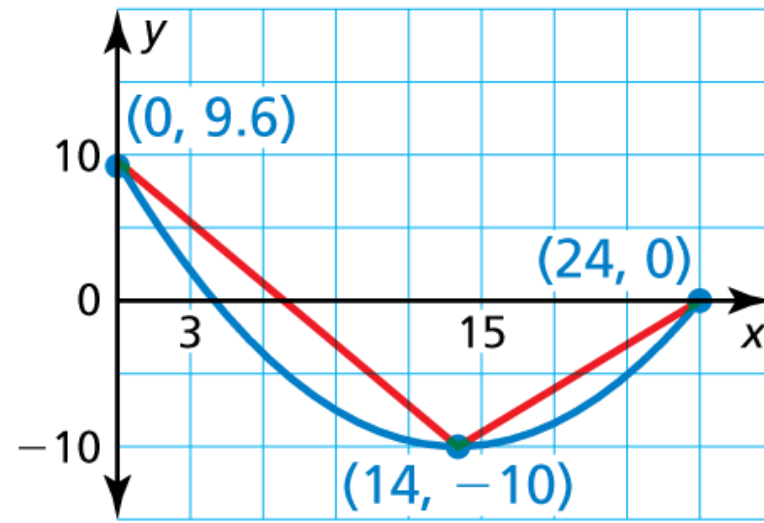
- b. The parabola opens up and the axis of symmetry is $x = 14$. So, the function is decreasing over the interval $0 < x < 14$ and increasing over the interval $14 < x < 24$.

Average rate of change
over $0 < x < 14$:

$$\frac{f(14) - f(0)}{14 - 0} = \frac{-10 - 9.6}{14} = -1.4$$

Average rate of change
over $14 < x < 24$:

$$\frac{f(24) - f(14)}{24 - 14} = \frac{0 - (-10)}{10} = 1$$



Homework:

- Pg 80, #1-20