

# 7 Vertex Form of a Quadratic (7.6)

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FOM 11

Ch 7 Day 7: Vertex Form of a Quadratic Function (7.6)

## Goals:

- Use the *vertex form* of a quadratic function to sketch its graph
- Find the *equation* in vertex form of a quadratic function given its graph.

A QUADRATIC FUNCTION can be written in:

STANDARD form  $y = ax^2 + bx + c$   $\longleftrightarrow$  FACTORED form  $y = a(x-r)(x-s)$   $\longleftrightarrow$  VERTEX FORM  $y = a(x-p)^2 + q$

$\uparrow$  y-int  $\uparrow$  x-intercepts  $\uparrow$  vertex (p, q)

The VERTEX FORM of a quadratic function is  $y = a(x-p)^2 + q$

$q \uparrow \oplus$  up q units  
 $\downarrow \ominus$  down q units

$p \rightarrow \oplus$  RIGHT p units  
 $\leftarrow \ominus$  LEFT

$y = (x-3)^2$   
 $y = (x+3)^2$   
 $y = (x-3)^2$

**Example 1:** What is the vertex in

a)  $y = a(x-2)^2 + 5$ ?

vertex (2, 5)

b)  $y = a(x+4)^2 - 1$ ?

(-4, -1)

**Example 2:** Sketch a graph for the function  $y = 2(x-3)^2 - 4$

Does the parabola open **UP** or **DOWN**?  
 $a = 2$

What is the **vertex**?  
(3, -4)

What is the **axis of symmetry**?  
 $x = p$   $x = 3$

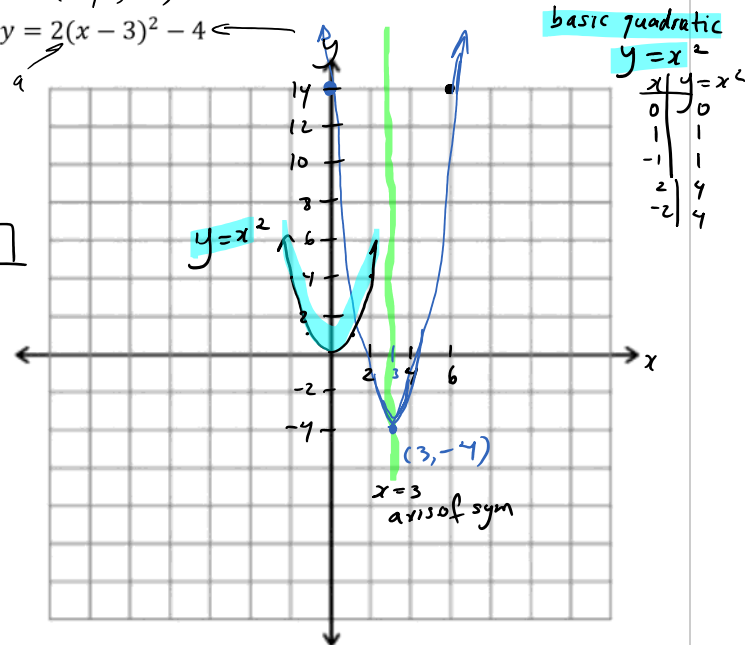
What is the **y-intercept**? (Hint: Let  $x = 0$ ).

$$y = 2(0-3)^2 - 4$$

$$= 2(-3)^2 - 4$$

$$= 2(9) - 4$$

$$y = 14$$



Plot another point that is the **mirror image** of the y-intercept (use the **symmetry**!).

What is the **domain**?  $\{x | x \in \mathbb{R}\}$

What is the **range**?  $\{y | y \geq -4, y \in \mathbb{R}\}$

Characteristics of **vertex form**:

$p = 3$  RIGHT by 3  
 $q = -4$  DOWN by 4

**Example 3:** Write the equation for the given parabola. (Like #11 in HW)

**Step 1:** What is the vertex,  $(p, q)$ ?  $(-2, 9)$

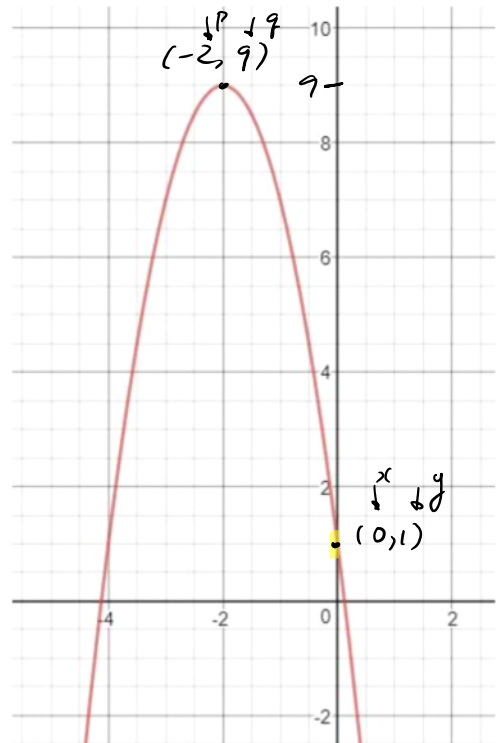
**Step 2:** To find  $a$ , identify a point  $(x, y)$  on the parabola. Plug the  $(x, y)$  and  $(p, q)$  into  $y = a(x - p)^2 + q$  to solve for  $a$ .

**Step 3:** Write  $y = a(x - p)^2 + q$  using the actual numbers for  $a$ ,  $p$  and  $q$  only. (Leave  $x$  and  $y$  as variables).

$$\begin{aligned}
 y &= a(x - p)^2 + q \\
 1 &= a(0 - (-2))^2 + 9 \\
 1 &= a(2^2) + 9 \\
 1 &= 4a + 9 \\
 -9 & \quad \quad -9 \\
 \hline
 -8 &= 4a \\
 \frac{-8}{4} &= \frac{4a}{4} \\
 a &= -2
 \end{aligned}$$

step 3)

$$\begin{aligned}
 y &= a(x - p)^2 + q \\
 y &= -2(x - (-2))^2 + 9 \\
 y &= -2(x + 2)^2 + 9
 \end{aligned}$$



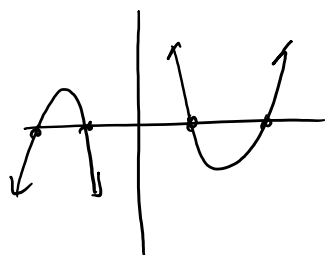
**Example 4:** Determine the equation of parabola with vertex (6, -2) that is congruent to the graph  $y = 2x^2$  and opens down

$a = 2$   
 $a$  is neg  $\Rightarrow a = -2$   
 Same shape  
 So same a

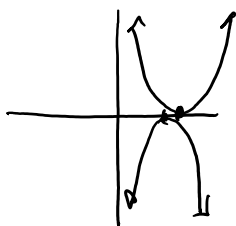
$$y = a(x-p)^2 + q$$

$$y = -2(x-6)^2 - 2$$

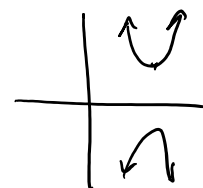
**Number of Zeros that a Quadratic Function Can Have**



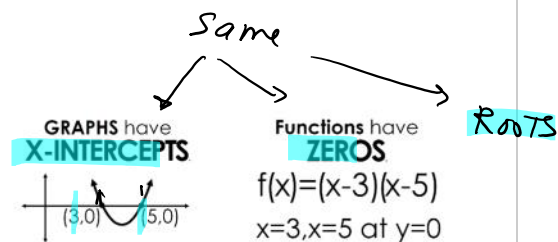
2 zeros



1 zero

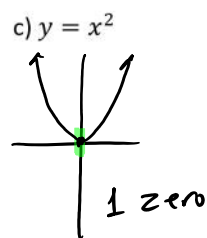
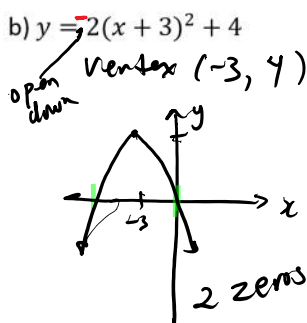
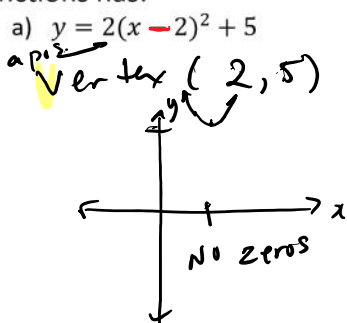


No zeros

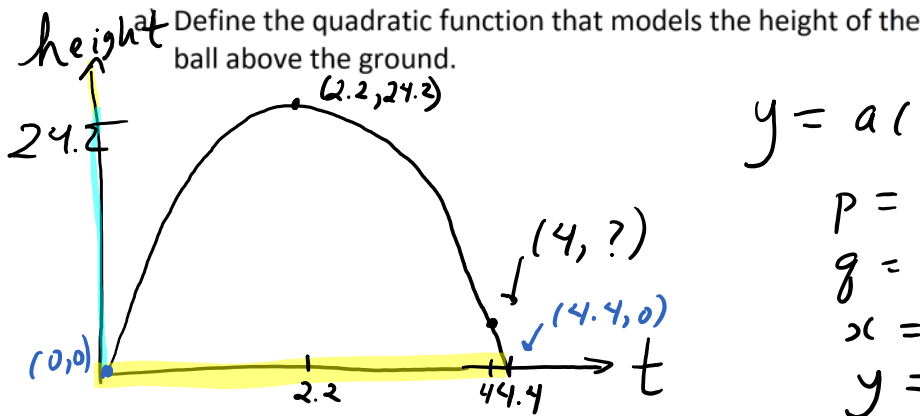


(Like #1 & 2 HW)

**Example 5:** Predict the number of zeros (roots) that each of the following quadratic functions has:



**Example 6 – Ball kick/toss:** A goalie kicked a soccer ball from the ground. It reached its maximum height of 24.2 m after 2.2 s. The ball was in the air for 4.4 s.



$$y = a(x - p)^2 + q$$

$$p = 2.2$$

$$q = 24.2$$

$$x = 0$$

$$y = 0$$

Plug in p, q, x & y to find a.

$$0 = a(0 - 2.2)^2 + 24.2$$

$$0 = a(-2.2)^2 + 24.2$$

$$0 = 4.84a + 24.2$$

$$-24.2 = 4.84a$$

$$\frac{-24.2}{4.84} = \frac{4.84a}{4.84}$$

$$a = -5$$

$$y = a(x - p)^2 + q$$

$$y = -5(x - 2.2)^2 + 24.2$$

$$h = -5(t - 2.2)^2 + 24.2$$

$$D: \{x \mid 0 \leq x \leq 4.4, x \in \mathbb{R}\}$$

$$R: \{y \mid 0 \leq y \leq 24.2, y \in \mathbb{R}\}$$

b) After 4 s, how high was the ball above the ground?

Plug  $t = 4$ :

$$h = -5(4 - 2.2)^2 + 24.2$$

$$= -5(1.8)^2 + 24.2$$

$$= -16.2 + 24.2$$

$$h = 8 \text{ m}$$

English sentence!

The ball was 8 m above the ground at 4 sec.



Assignment: Sec 7.6, p. 417, #1abd, 2be, 3, 7, 10, 11b, 14

$$y = -3(x - 2)^2 + 3$$

$$= -3(x - 2)(x - 2) + 3$$

$$\begin{aligned} &= -3(x^2 - 2x - 2x + 4) + 3 \\ &= -3x^2 + 12x - 12 + 3 \\ &= -3x^2 + 12x - 9 \end{aligned}$$