**VERTEX FORM** Recall from Lesson 4.2 that the vertex form of a quadratic function is  $y = a(x - h)^2 + k$  where (h, k) is the vertex of the function's graph. To write a quadratic function in vertex form, use completing the square.

# EXAMPLE 6 Write a quadratic function in vertex form

Write  $y = x^2 - 10x + 22$  in vertex form. Then identify the vertex.

 $y = x^2 - 10x + 22$ Write original function.  $y + \mathbf{?} = (x^2 - 10x + \mathbf{?}) + 22$  Prepare to complete the square.  $y + 25 = (x^2 - 10x + 25) + 22$  Add  $\left(\frac{-10}{2}\right)^2 = (-5)^2 = 25$  to each side.  $y + 25 = (x - 5)^2 + 22$  Write  $x^2 - 10x + 25$  as a binomial squared.  $y = (x-5)^2 - 3$ Solve for v.

The vertex form of the function is  $y = (x - 5)^2 - 3$ . The vertex is (5, -3).

### EXAMPLE 7 Find the maximum value of a quadratic function

**BASEBALL** The height *v* (in feet) of a baseball *t* seconds after it is hit is given by this function:

 $v = -16t^2 + 96t + 3$ 

Find the maximum height of the baseball.

## Solution

y + (-

 $\rightarrow v + (-$ 

The maximum height of the baseball is the y-coordinate of the vertex of the parabola with the given equation.



$$y = -16t^{2} + 96t + 3$$
$$y = -16(t^{2} - 6t) + 3$$
$$-16)(?) = -16(t^{2} - 6t + ?) + 3$$
$$(-16)(9) = -16(t^{2} - 6t + 9) + 3$$
$$y - 144 = -16(t - 3)^{2} + 3$$

 $v = -16(t-3)^2 + 147$ 

Write original function. Factor -16 from first two terms. Prepare to complete the square. Add (-16)(9) to each side. Write  $t^2 - 6t + 9$  as a binomial squared. Solve for v.

The vertex is (3, 147), so the maximum height of the baseball is 147 feet. Animated Algebra at classzone.com

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**AVOID ERRORS** 

side, not just 9.

When you complete the square, be sure to add

(-16)(9) = -144 to each

## **GUIDED PRACTICE** for Examples 6 and 7

Write the quadratic function in vertex form. Then identify the vertex.

**13.** 
$$y = x^2 - 8x + 17$$

**14.**  $y = x^2 + 6x + 3$  **15.**  $f(x) = x^2 - 4x - 4$ 

16. WHAT IF? In Example 7, suppose the height of the baseball is given by  $y = -16t^2 + 80t + 2$ . Find the maximum height of the baseball.

### 287 4.7 Complete the Square