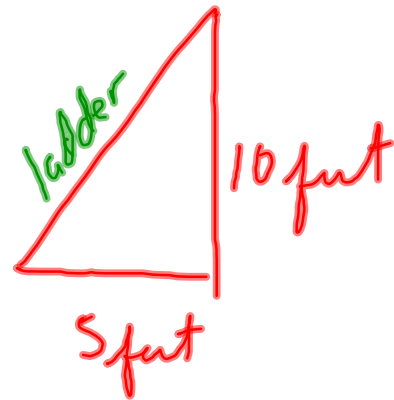


## 9.1

Square Roots and the  
Pythagorean Theorem

47. *Length of a Ladder* A ladder is placed against the trunk of a cherry tree. It reaches a height of 10 feet on the tree. The bottom of the ladder extends 5 feet from the base of the tree. How long is the ladder?



$$a^2 + b^2 = c^2$$

$$10^2 + 5^2 = c^2$$

$$100 + 25 = c^2$$

$$125 = c^2$$

$$\sqrt{125} = c$$

$$\text{ladder} \Rightarrow 11.18 \text{ feet} \approx c$$

## 9.2

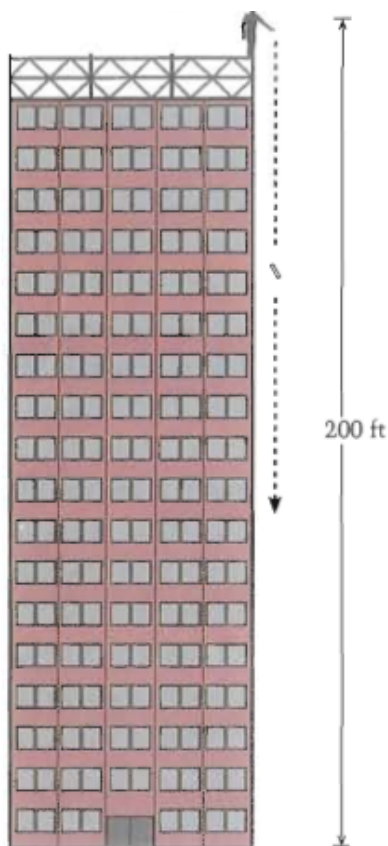
Solving Quadratic Equations  
by Finding Square Roots**Example 4** *Watch Out Below!*

A construction worker on the top floor of a building accidentally drops a heavy wrench. How many seconds will it take to hit the ground? (Assume it drops from a height of 200 feet.)

$$h = -16t^2 + vt + S$$

Diagram illustrating the variables in the equation  $h = -16t^2 + vt + S$ :

- $h$ : height you want
- $t$ : time in seconds
- $v$ : velocity
- $S$ : starting height



hit the ground? (Assume it drops from a height of 200 feet.)

**Solution** Because the wrench drops from a height of 200 feet, the model for the height of the wrench at time  $t$  is  $h = -16t^2 + 200$ . The table gives heights at different times.

Time, $t$ in seconds	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5
Height, $h$ in feet	200	196	184	164	136	100	56	4

From the table, you can say that the wrench will take a little more than  $3\frac{1}{2}$  seconds to hit the ground. Another way to solve the problem is to solve the quadratic equation for the time that gives a height of  $h = 0$  feet.

$$-16t^2 + 200 = h \quad \text{Falling object model}$$

$$-16t^2 + 200 = 0 \quad \text{Substitute 0 for } h.$$

$$200 = 16t^2 \quad \text{Add } 16t^2 \text{ to both sides.}$$

$$12.5 = t^2 \quad \text{Divide both sides by 16.}$$

$$\sqrt{12.5} = t \quad \text{Find the positive square root.}$$

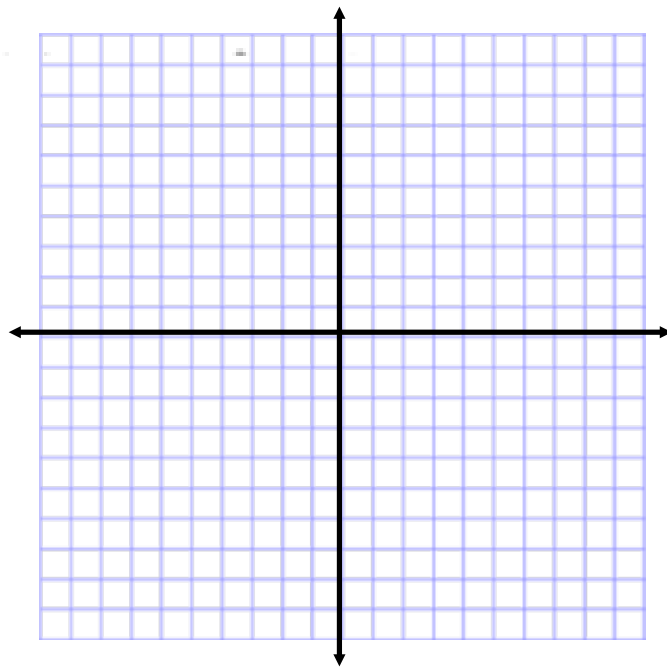
$$3.54 \approx t \quad \text{Use a calculator.}$$

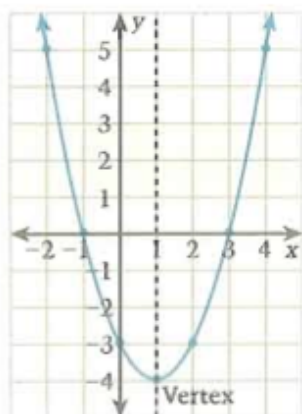
The wrench will take about 3.54 seconds to hit the ground. ■

## 9.3

Graphs of Quadratic  
Equations

Sketch the graph of  $y = x^2 - 2x - 3$ .





Sketch the graph of  $y = x^2 - 2x - 3$ .

**Solution** In standard form  $ax^2 + bx + c$ , the coefficients are  $a = 1$ ,  $b = -2$ , and  $c = -3$ . The  $x$ -coordinate of the vertex is

$$-\frac{b}{2a} = -\frac{-2}{2(1)} = 1. \quad \text{\textit{x-coordinate of vertex}}$$

Using  $x$ -values to the left and right of this  $x$ -value, construct a table of values.

	Vertex ↓						
$x$	-2	-1	0	1	2	3	4
$y = x^2 - 2x - 3$	5	0	-3	-4	-3	0	5

The vertex is  $(1, -4)$  and the axis of symmetry is  $x = 1$ . Plot the points given in the table and connect them with a U-shaped curve that opens up. ■

## 9.4

## The Quadratic Formula

Solve  $2x^2 - 3x = 8$ .

Solve  $2x^2 - 3x = 8$ .

*Solution*

$$2x^2 - 3x = 8$$

$$2x^2 - 3x - 8 = 0$$

*Rewrite original equation.*

$$a = 2, b = -3, c = -8$$

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(2)(-8)}}{2(2)}$$

$$x = \frac{3 \pm \sqrt{9 + 64}}{4} \quad \text{Simplify.}$$

$$x = \frac{3 \pm \sqrt{73}}{4} \quad \text{Solutions}$$

The equation has two solutions.

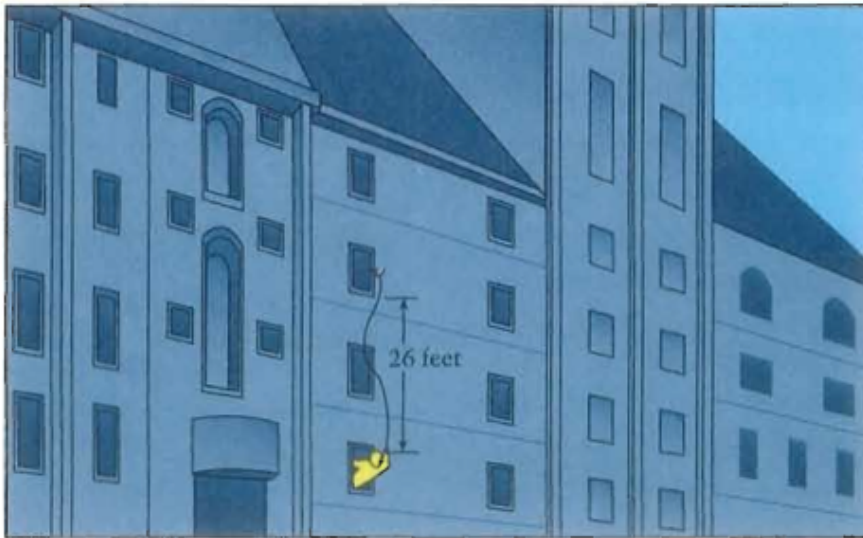
$$x = \frac{3 + \sqrt{73}}{4} \approx 2.89 \quad \text{and} \quad x = \frac{3 - \sqrt{73}}{4} \approx -1.39$$





## 9.5

### Problem Solving Using the Discriminant



*Rick is a firefighter and is leaning out of a window on the eighth floor. He is trying to throw a grappling hook to a tenth-floor window that is 26 feet above him.*



*Rick is a firefighter and is leaning out of a window on the eighth floor. He is trying to throw a grappling hook to a tenth-floor window that is 26 feet above him.*

Rick can throw the grappling hook with a maximum speed of 40 feet per second. Can he throw the grappling hook to the window above him?

### Example 2 Will the Grappling Hook Catch?

Rick can throw the grappling hook with a maximum speed of 40 feet per second. Can he throw the grappling hook to the window above him?

**Solution** You don't know Rick's present height. In the vertical motion model, however, you can let his present height be  $s = 0$ . Use an initial velocity of  $v = 40$  feet per second. To reach the window, Rick must be able to throw the grappling hook to a height of 26 feet.

$$h = -16t^2 + 40t + 0 \quad \text{Vertical motion model}$$

$$26 = -16t^2 + 40t \quad \text{Substitute 26 for } h.$$

$$16t^2 - 40t + 26 = 0 \quad \text{Standard form}$$

Using  $a = 16$ ,  $b = -40$ , and  $c = 26$ , the discriminant is

$$b^2 - 4ac = (-40)^2 - 4(16)(26) = -64.$$

Because the discriminant is negative, the equation  $16t^2 - 40t + 26 = 0$  has no solution. This means that Rick cannot throw the grappling hook to the window above him. ■

## 0.6

Solving Quadratic Equations  
by FactoringSolve  $3x^2 + 5x = 12$ .

1st  $\Rightarrow 3x^2 + 5x - 12 = 0$

2nd  $ac = -36 \mid b = 5$

1 · -36
2 · -18
3 · -12
<del>4 · -9</del>
-4 · 9

3rd

	$x$	3
$3x$	$3x^2$	$9x$
-4	$-4x$	$-12$

4th  $(3x - 4)(x + 3) = 0$

5th use Z.P.P. to solve  
 $3x - 4 = 0$  &  $x + 3 = 0$   
 $\Rightarrow x = \frac{4}{3}$        $\Rightarrow x = -3$

Solve  $3x^2 + 5x = 12$ .

*Solution*

$$3x^2 + 5x = 12$$

$$3x^2 + 5x - 12 = 0$$

$$(3x - 4)(x + 3) = 0$$

$$3x - 4 = 0$$

$$\text{or } x + 3 = 0$$

$$x = \frac{4}{3}$$

$$\text{or } x = -3$$

*Rewrite original equation.*

*Write in standard form.*

*Factor.*

*Set factors equal to 0.*

*Solve for x.*

The equation has two solutions:  $\frac{4}{3}$  and  $-3$ . Check these solutions in the original equation. ■

## 10.7

Solving Quadratic Equations  
by Completing the Square

Solve  $2x^2 - x - 2 = 0$  by completing the square.

Solve  $2x^2 - x - 2 = 0$  by completing the square.

**Solution**

$$2x^2 - x - 2 = 0$$

$$2x^2 - x = 2$$

$$x^2 - \frac{1}{2}x = 1$$

$$x^2 - \frac{1}{2}x + \left(-\frac{1}{4}\right)^2 = 1 + \frac{1}{16}$$

$$\underbrace{\hspace{1.5cm}}_{\uparrow}$$

$$\left(\text{half of } -\frac{1}{2}\right)^2$$

$$\left(x - \frac{1}{4}\right)^2 = \frac{17}{16}$$

$$x - \frac{1}{4} = \pm \frac{\sqrt{17}}{4}$$

$$x = \frac{1}{4} \pm \frac{\sqrt{17}}{4}$$

*Rewrite original equation.*

*Subtract  $-2$  from both sides.*

*Divide both sides by 2.*

*Add  $\left(-\frac{1}{4}\right)^2$ , or  $\frac{1}{16}$ , to both sides.*

*Binomial squared*

*Find square roots.*

*Solve for  $x$ .*

The equation has two solutions,  $x = \frac{1}{4} + \frac{\sqrt{17}}{4}$  and  $x = \frac{1}{4} - \frac{\sqrt{17}}{4}$ .  
As a check, you can use the quadratic formula on the original equation. ■



A hawk, flying at a height of 50 feet, spots a rat on the ground. If he dives down to catch the rat at a speed of 45 feet per second, how long will it take him to catch the rat?

$$h = -16t^2 + vt + S$$

Diagram illustrating the variables in the equation  $h = -16t^2 + vt + S$ :

- $h$ : height you want
- $t$ : time in seconds
- $v$ : velocity  
+  $\Rightarrow$  up  
-  $\Rightarrow$  down
- $S$ : start height



Hint  $0 = -16t^2 - 45t + 50$

A hawk, flying at a height of 50 feet, spots a rat on the ground. If he dives down to catch the rat at a speed of 45 feet per second, how long will it take him to catch the rat?

and  $a = -16$   
 $b = -45$   
 $c = 50$

$x = \frac{45 \pm \sqrt{(-45)^2 - 4(-16)(50)}}{2(-16)}$

$= \frac{45 \pm \sqrt{5225}}{-32}$

$\frac{45 + \sqrt{5225}}{-32}$  or  $\frac{45 - \sqrt{5225}}{-32}$

$\approx -3.67$  seconds?  
 This solution does  
 not make sense

$\approx .85$  seconds

4th

***Integrated Review***

In Exercises 49–54, solve the equation.

49.  $x^2 = 16$

50.  $x^2 + 3 = 7$

51.  $x^2 + 4 = 29$

52.  $\frac{1}{7}x^2 + 8 = 15$

53.  $2x^2 - 7 = 11$

54.  $3x^2 - 8 = 100$

The following pages are extra practice taken from your packets; the solutions can be found in the document folder

In Exercises 29–43, use the most convenient method to solve the equation. Explain why you made your choice.

29.  $x^2 - 3x - 1 = 0$

32.  $4x^2 - 25 = 0$

35.  $3x^2 - 5x = 0$

38.  $4x^2 + 4x + 1 = 0$

41.  $8x^2 - 10x + 3 = 0$

30.  $4x^2 - 12 = 0$

33.  $x^2 + 7x + 10 = 0$

36.  $y^2 + 2y - 26 = 0$

39.  $7x^2 - 14x = 0$

42.  $7x^2 - 14 = 0$

31.  $y^2 + 6y - 24 = 0$

34.  $u^2 + 5u + 2 = 0$

37.  $9z^2 + 10z - 4 = 0$

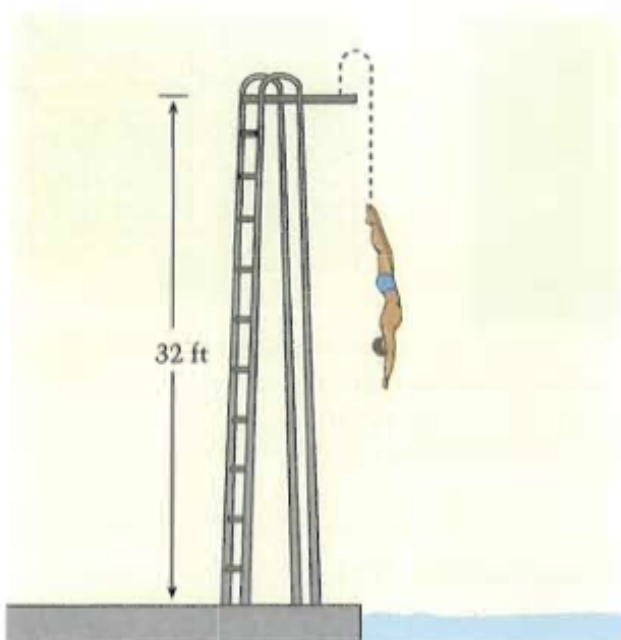
40.  $4x^2 - 13x + 3 = 0$

43.  $y^2 + 20y + 10 = 0$

58. *Height of a Diver* A diver jumps from a diving board that is 32 feet above the water. The height of the diver is given by

$$\text{Height} = -16(t - 2)(t + 1)$$

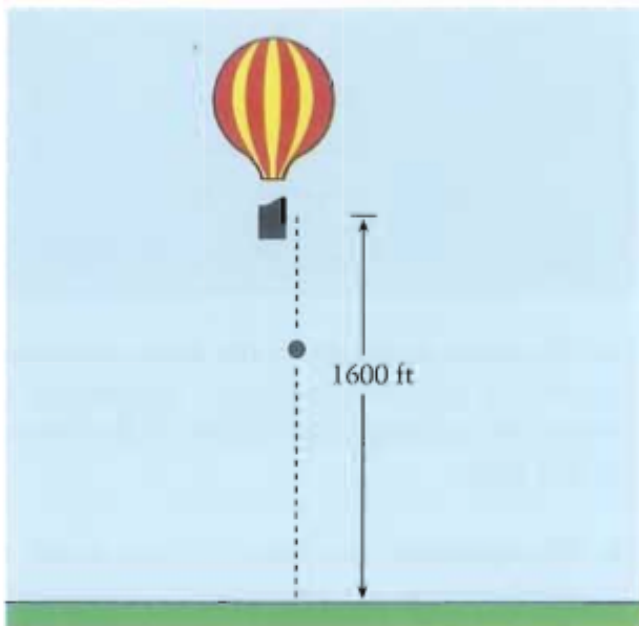
where the height is measured in feet, and the time,  $t$ , is measured in seconds. When will the diver hit the water? Can you see a quick way to find the answer? Explain.



59. **Balloon Drop** An object is dropped from a hot-air balloon 1600 feet above the ground. The height of the object is given by

$$\text{Height} = -16(t - 10)(t + 10)$$

where the height is measured in feet, and the time,  $t$ , is measured in seconds. When will the object hit the ground? Can you see a quick way to find the answer? Explain.



**11.**  $x^2 + 5x - 6 = 0$

**13.**  $2x^2 + 5x + 3 = 0$

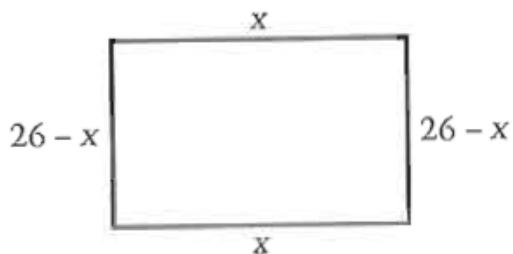
**15.**  $3x^2 + 7x + 2 = 0$

**12.**  $3x^2 + 11x - 4 = 0$

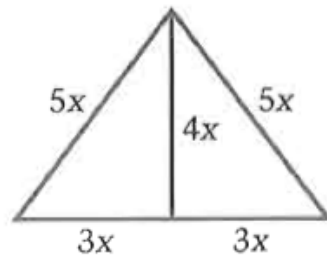
**14.**  $6x^2 + 13x + 5 = 0$

**16.**  $12x^2 - 5x - 3 = 0$

15. **Geometry** Is it possible for a rectangle with a perimeter of 52 centimeters to have an area of 148.75 square centimeters? Explain.



16. **Geometry** The area of the isosceles triangle is 192 square meters. What is its perimeter?

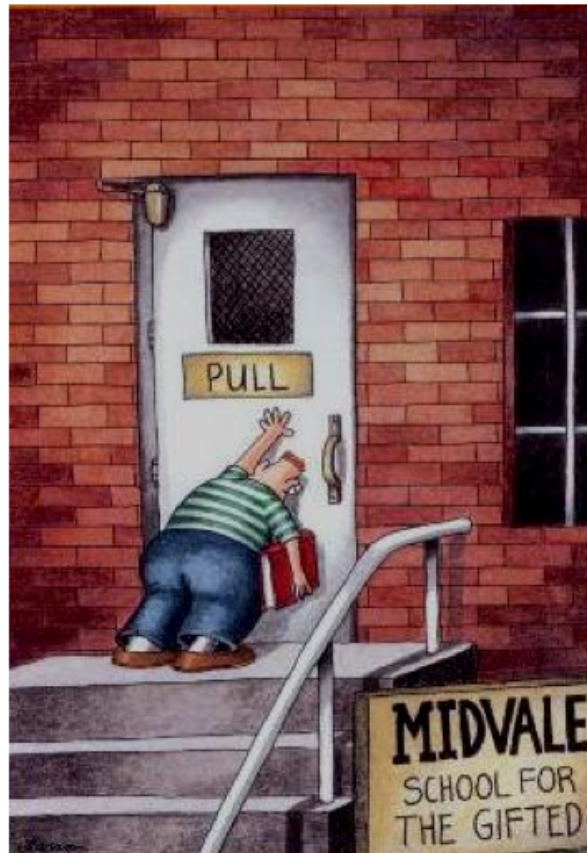




**Dunking the Ball** In Exercises 17 and 18, use the vertical motion model:  $h = -16t^2 + vt + s$ .

Chun and R.J. are playing basketball. Chun can jump with an initial velocity of 13 feet per second and needs to jump 2.6 feet to dunk the basketball. R.J. can jump with an initial velocity of 15 feet per second and needs to jump 3.6 feet to dunk the ball.

17. Can Chun dunk the ball? Can R.J.? Justify your answers.
18. Suppose that Chun can jump with an initial velocity of 12.5 feet per second and R.J. can jump with an initial velocity of 15.5 feet per second. How, if at all, would this change your answers to Exercise 17?



**"Abandon blame and map your contribution."**

**-from Difficult Conversations**