

## 5.8

## Exercise Set

FOR EXTRA HELP

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Solve.

- The square of a number plus the number is 132. Find all such numbers.  $-12, 11$
- A number is 30 less than its square. Find all such numbers.  $-5, 6$
- Parking-Space Numbers.** The product of two consecutive parking spaces is 110. Find the parking-space numbers.  $10, 11$
- Page Numbers.** The product of the page numbers on two facing pages of a book is 420. Find the page numbers.  $20, 21$
- Construction.** The front porch on Trent's new home is five times as long as it is wide. If the area of the porch is  $180 \text{ ft}^2$ , find the dimensions. Length:  $30 \text{ ft}$ ; width:  $6 \text{ ft}$



- Furnishings.** The work surface of Anita's desk is a rectangle that is twice as long as it is wide. If the area of the desktop is  $18 \text{ ft}^2$ , find the length and the width of the desk. Length:  $6 \text{ ft}$ ; width:  $3 \text{ ft}$

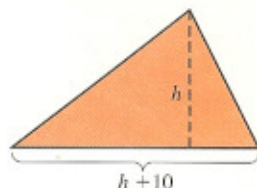


- A photo is  $5 \text{ cm}$  longer than it is wide. Find the length and the width if the area is  $84 \text{ cm}^2$ . Length:  $12 \text{ cm}$ ; width:  $7 \text{ cm}$
- An envelope is  $4 \text{ cm}$  longer than it is wide. The area is  $96 \text{ cm}^2$ . Find the length and the width. Length:  $12 \text{ cm}$ ; width:  $8 \text{ cm}$
- Dimensions of a Sail.** The height of the jib sail on a Lightning sailboat is  $5 \text{ ft}$  greater than the length of its

"foot." If the area of the sail is , find the length of the foot and the height of the sail.

Foot:  $7 \text{ ft}$ ; height:  $12 \text{ ft}$ 

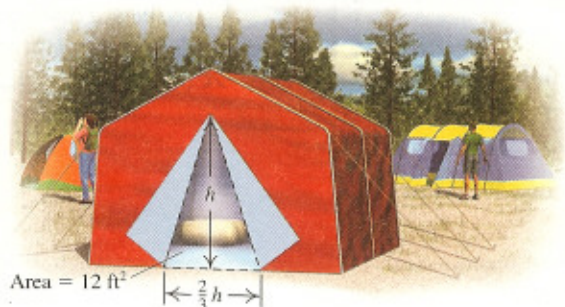
- Dimensions of a Triangle.** A triangle is  $10 \text{ cm}$  wider than it is tall. The area is  $48 \text{ cm}^2$ . Find the height and the base. Base:  $16 \text{ cm}$ ; height:  $6 \text{ cm}$



- Road Design.** A triangular traffic island has a base half as long as its height. Find the base and the height if the island has an area of  $64 \text{ ft}^2$ . Base:  $8 \text{ ft}$ ; height:  $16 \text{ ft}$



- Tent Design.** The triangular entrance to a tent is  $\frac{2}{3}$  as wide as it is tall. The area of the entrance is  $12 \text{ ft}^2$ . Find the height and the base. Height:  $6 \text{ ft}$ ; base:  $4 \text{ ft}$



**Games in a League's Schedule.** In a sports league of  $x$  teams in which all teams play each other twice, the total number  $N$  of games played is given by

$$x^2 - x = N.$$

Use this formula for Exercises 13 and 14.

13. The Colchester Youth Soccer League plays a total of 240 games, with all teams playing each other twice. How many teams are in the league? **16 teams**

14. The teams in a women's softball league play each other twice, for a total of 132 games. How many teams are in the league? **12 teams**

15. **Medicine.** For many people suffering from constricted bronchial muscles, the drug Albuterol is prescribed. The number of micrograms  $A$  of Albuterol in a person's bloodstream  $t$  minutes after 200 micrograms have been inhaled can be approximated by

$$A = -50t^2 + 200t.$$

How long after an inhalation will there be about 150 micrograms of Albuterol in the bloodstream?

Source: Based on information in Chohan, Naina, Rita M. Doyle, and Patricia Nayle (eds.), *Nursing Handbook*, 21st ed. Springhouse, PA: Springhouse Corporation, 2001

**1 min, 3 min**

16. **Medicine.** For adults with certain heart conditions, the drug Primacor (milrinone lactate) is prescribed. The number of milligrams  $M$  of Primacor in the bloodstream of a 132-lb patient  $t$  hours after a 3-mg dose has been injected can be approximated by

$$M = -\frac{1}{2}t^2 + \frac{5}{2}t.$$

How long after an injection will there be about 2 mg in the bloodstream? **1 hr, 4 hr**

Source: Based on information in Chohan, Naina, Rita M. Doyle, and Patricia Nayle (eds.), *Nursing Handbook*, 21st ed. Springhouse, PA: Springhouse Corporation, 2001

17. **Wave Height.** The height of waves in a storm depends on the speed of the wind. Assuming the wind has no obstructions for a long distance, the maximum wave height  $H$  for a wind speed  $x$  can be approximated by

$$H = 0.006x^2 + 0.6x.$$

Here  $H$  is in feet and  $x$  is in knots (nautical miles per hour). For what wind speed would the maximum wave height be 6.6 ft? **10 knots**

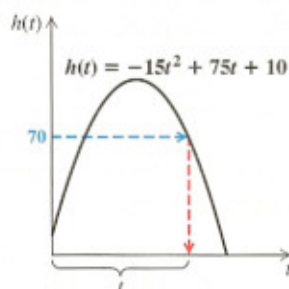
Source: Based on information from cimss.ssec.wisc.edu

18. **Cabinet Making.** Dovetail Woodworking determines that the revenue  $R$ , in thousands of dollars, from the sale of  $x$  sets of cabinets is given by  $R(x) = 2x^2 + x$ . If the cost  $C$ , in thousands of dollars, of producing  $x$  sets of cabinets is given by  $C(x) = x^2 - 2x + 10$ , how many sets must be produced and sold in order for the company to break even? **2 sets**

19. **Prize Tee Shirts.** During a game's intermission, a team mascot launches tightly rolled tee shirts into the stands. The height  $h(t)$ , in feet, of an airborne tee shirt  $t$  seconds after being launched can be approximated by

$$h(t) = -15t^2 + 75t + 10.$$

After peaking, a rolled-up tee shirt is caught by a fan 70 ft above ground level. For how long was the tee shirt in the air? **4 sec**

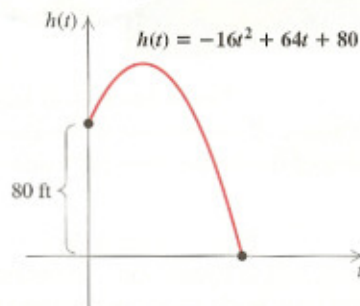


20. **Prize Tee Shirts.** Using the model in Exercise 19, determine how long a tee shirt has been airborne if it is caught on the way up by a fan 100 ft above ground level. **2 sec**

21. **Fireworks Displays.** Fireworks are typically launched from a mortar with an upward velocity (initial speed) of about 64 ft/sec. The height  $h(t)$ , in feet, of a "weeping willow" display,  $t$  seconds after having been launched from an 80-ft high rooftop, is given by

$$h(t) = -16t^2 + 64t + 80.$$

After how long will the cardboard shell from the fireworks reach the ground? **5 sec**



22. **Safety Flares.** Suppose that a flare is launched upward with an initial velocity of 80 ft/sec from a height of 224 ft. Its height  $h(t)$ , in feet, after  $t$  seconds is given by

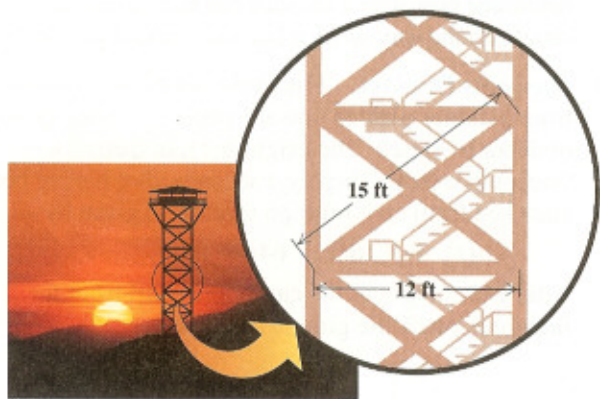
$$h(t) = -16t^2 + 80t + 224.$$

After how long will the flare reach the ground? **7 sec**

23. **Geometry.** If each of the sides of a square is lengthened by 4 m, the area becomes 49 m<sup>2</sup>. Find the length of a side of the original square. **3 m**

24. **Geometry.** If each of the sides of a square is lengthened by 6 cm, the area becomes 144 cm<sup>2</sup>. Find the length of a side of the original square. **6 cm**

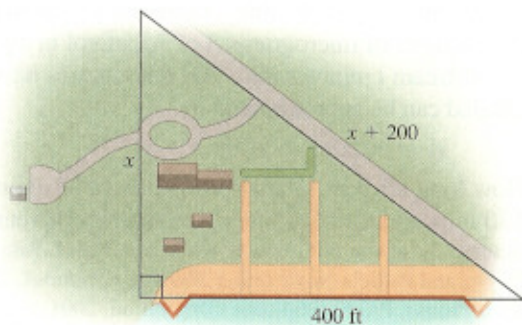
25. **Framing a Picture.** A picture frame measures 12 cm by 20 cm, and  $84 \text{ cm}^2$  of picture shows. Find the width of the frame. **3 cm**
26. **Framing a Picture.** A picture frame measures 14 cm by 20 cm, and  $160 \text{ cm}^2$  of picture shows. Find the width of the frame. **2 cm**
27. **Landscaping.** A rectangular lawn measures 60 ft by 80 ft. Part of the lawn is torn up to install a sidewalk of uniform width around it. The area of the new lawn is  $2400 \text{ ft}^2$ . How wide is the sidewalk? **10 ft**
28. **Landscaping.** A rectangular garden is 30 ft by 40 ft. Part of the garden is removed in order to install a walkway of uniform width around it. The area of the new garden is one-half the area of the old garden. How wide is the walkway? **5 ft**
29. **Construction.** The diagonal braces in a lookout tower are 15 ft long and span a horizontal distance of 12 ft. How high does each brace reach vertically? **9 ft**



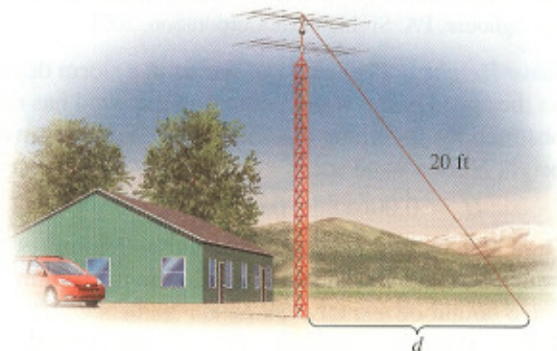
30. **Reach of a Ladder.** Twyla has a 26-ft ladder leaning against her house. If the bottom of the ladder is 10 ft from the base of the house, how high does the ladder reach? **24 ft**
31. **Roadway Design.** Elliott Street is 24 ft wide when it ends at Main Street in Brattleboro, Vermont. A 40-ft long diagonal crosswalk allows pedestrians to cross Main Street to or from either corner of Elliott Street (see the figure). Determine the width of Main Street. **32 ft**



32. **Aviation.** Engine failure forced Robbin to pilot her Cessna 150 to an emergency landing. To land, Robbin's plane glided 17,000 ft over a 15,000-ft stretch of deserted highway. From what altitude did the descent begin? **8000 ft**
33. **Archaeology.** Archaeologists have discovered that the 18th-century garden of the Charles Carroll House in Annapolis, Maryland, was a right triangle. One leg of the triangle was formed by a 400-ft long sea wall. The hypotenuse of the triangle was 200 ft longer than the other leg. What were the dimensions of the garden? **300 ft by 400 ft by 500 ft**  
Source: [www.bsos.umd.edu](http://www.bsos.umd.edu)

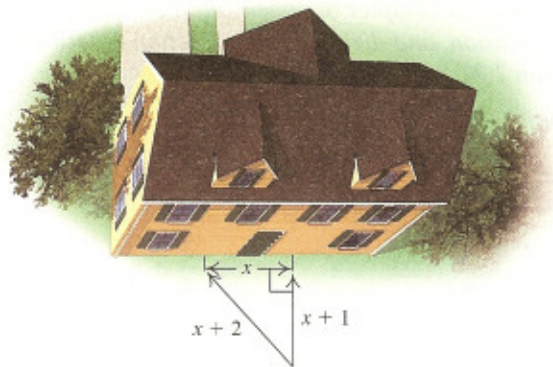


34. One leg of a right triangle is 7 cm shorter than the other leg. The length of the hypotenuse is 13 cm. Find the length of each side. **5 cm, 12 cm, 13 cm**
35. **Antenna Wires.** A wire is stretched from the ground to the top of an antenna tower. The wire is 20 ft long. The height of the tower is 4 ft greater than the distance  $d$  from the tower's base to the bottom of the wire. Find the distance  $d$  and the height of the tower. **Distance  $d$ : 12 ft; tower height: 16 ft**



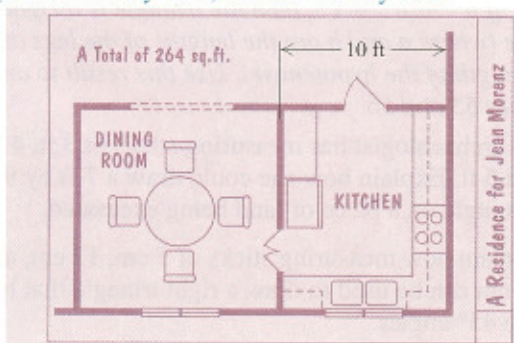
36. **Parking Lot Design.** A rectangular parking lot is 50 ft longer than it is wide. Determine the dimensions of the parking lot if it measures 250 ft diagonally.  
**Length: 200 ft; width: 150 ft**
37. **Carpentry.** In order to build a deck at a right angle to their house, Lucinda and Felipe place a stake in the ground a precise distance from the back wall of their

house. This stake will combine with two marks on the house to form a right triangle. From a course in geometry, Lucinda remembers that there are three consecutive integers that can work as sides of a right triangle. Find the sides of that triangle. 3, 4, 5



38. **Ladder Location.** The foot of an extension ladder is 9 ft from a wall. The height that the ladder reaches on the wall and the length of the ladder are consecutive integers. How long is the ladder? 41 ft

39. **Architecture.** An architect has allocated a rectangular space of  $264 \text{ ft}^2$  for a square dining room and a 10-ft wide kitchen, as shown in the figure. Find the dimensions of each room.  
Dining room: 12 ft by 12 ft; kitchen: 12 ft by 10 ft



40. **Design.** A window panel for a sun porch consists of a 7-ft high rectangular window stacked above a square window. The windows have the same width. If the total area of the window panel is  $18 \text{ ft}^2$ , find the dimensions of each window. Rectangular window: 2 ft by 7 ft; square window: 2 ft by 2 ft



41. **Health-Care Costs.** The table below lists the average annual percentage change in national prescription drug expenditures.

Year	Number of Years After 1990, $x$	Average Annual Percentage Change in Prescription Drug Expenditures, $P$
1996	6	13
1998	8	14
2000	10	15
2002	12	14
2004	14	8
2006	16	9

Source: Kaiser Family Foundation calculations using National Health Expenditure historical data from Centers for Medicare & Medicaid Services

- Use regression to find a quartic function  $P$  that can be used to estimate the average annual percentage change in prescription drug expenditures  $x$  years after 1990. Round coefficients to five decimal places. □
- Estimate the average annual percentage change in prescription drug expenditures in 2005. 7%
- In what years did the average prescription drug expenditures increase 12%? 2003 and 2007

42. **Fuel Economy.** The table below lists the average fuel economy of motor vehicles at various speeds.

Speed $x$ (in miles per hour)	Fuel Economy $c$ , (in miles per gallon)
5	11
25	27
35	29
45	30
55	31
65	28
75	23

Source: Based on data from the U.S. Department of Energy

- Use regression to find a quartic function  $c$  that can be used to estimate the average fuel economy at a speed of  $x$  miles per hour. Round coefficients to six decimal places. □ About 22 mpg
- Estimate the average fuel economy at 15 mph.
- For what speeds is the average fuel economy 25 mpg? 21 mph and 72 mph

- 43. Olympics.** The table below lists the number of female athletes participating in the summer Olympic games for various years.

Year	Number of Years After 1900, $x$	Number of Female Athletes in the Summer Olympic Games, $F$
1960	60	611
1976	76	1260
1992	92	2704
2000	100	4069
2008	108	4746

Source: olympic.org  $F(x) = -0.03587x^3 + 10.35169x^2 - 871.97543x + 23423.45189$

- a) Use regression to find a cubic polynomial function  $F$  that can be used to estimate the number of female athletes competing in the summer Olympic games  $x$  years after 1900. Round coefficients to five decimal places.
- b) Estimate the number of female athletes competing in 2012. **5220 athletes**
- c) In what year will 6000 female athletes compete in the summer Olympic games? **2024;  $x = 122$ , which gives 2022; the first games after 2022 will be in 2024**
- 44. Life Insurance Premiums.** The table below lists monthly life insurance premiums for a \$500,000 policy for females of various ages.

Age	Monthly Premium for \$500,000 Life Insurance Policy for Females
35	\$ 14
40	18
45	24
50	33
55	48
60	70
65	110
70	188

$L(x) = 0.007899x^3 - 1.040519x^2 + 46.472655x - 678.484848$

- a) Use regression to find a cubic polynomial function  $L$  that can be used to estimate the monthly life insurance premium for a female of age  $x$ . Round coefficients to six decimal places.
- b) Estimate the monthly premium for a female of age 58. **About \$58**
- c) For what age is the monthly premium \$100? **About 64**
- 45.** Tyler disregards any negative solutions that he finds when solving applied problems. Is this approach correct? Why or why not?

- 46.** Write a chart of the population of two imaginary cities. Devise the numbers in such a way that one city has linear growth and the other has nonlinear growth.

## SKILL REVIEW

To prepare for Chapter 6, review addition, subtraction, multiplication, and division using fraction notation (Section 1.2).

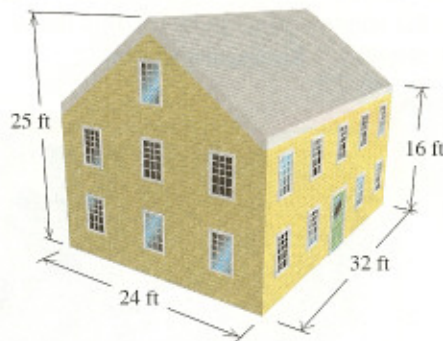
Simplify.

47.  $-\frac{3}{5} \cdot \frac{4}{7}$  [1.2]  $-\frac{12}{35}$
48.  $-\frac{3}{5} \div \frac{4}{7}$  [1.2]  $-\frac{21}{20}$
49.  $-\frac{5}{6} - \frac{1}{6}$  [1.2]  $-1$
50.  $\frac{3}{4} + \left(-\frac{5}{2}\right)$  [1.2]  $-\frac{7}{4}$
51.  $-\frac{3}{8} \cdot \left(-\frac{10}{15}\right)$  [1.2]  $\frac{1}{4}$
52.  $\frac{-8}{15} \div \frac{-2}{3}$  [1.2]  $\frac{4}{5}$
53.  $\frac{5}{24} + \frac{3}{28}$  [1.2]  $\frac{53}{168}$
54.  $\frac{5}{6} - \left(-\frac{2}{9}\right)$  [1.2]  $\frac{19}{18}$

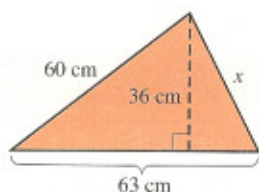
## SYNTHESIS

The converse of the Pythagorean theorem is also true. That is, if  $a^2 + b^2 = c^2$ , then the triangle is a right triangle (where  $a$  and  $b$  are the lengths of the legs and  $c$  is the length of the hypotenuse). Use this result to answer Exercises 55 and 56.

- 55.** An archaeologist has measuring sticks of 3 ft, 4 ft, and 5 ft. Explain how she could draw a 7-ft by 9-ft rectangle on a piece of land being excavated.
- 56.** Explain how measuring sticks of 5 cm, 12 cm, and 13 cm can be used to draw a right triangle that has two  $45^\circ$  angles.
- 57. Roofing.** A square of shingles covers  $100 \text{ ft}^2$  of surface area. How many squares will be needed to reshingle the house shown? **10 squares**



58. Solve for
- $x$
- . 39 cm



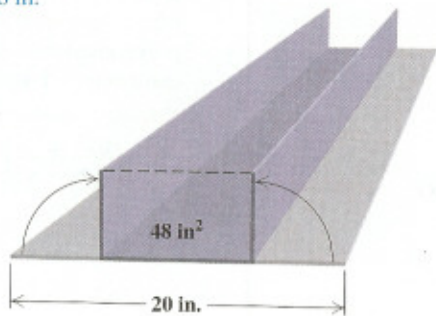
- Medicine.** For certain people with acid reflux, the drug Pepcid (famotidine) is used. The number of milligrams  $N$  of Pepcid in an adult's bloodstream  $t$  hours after a 20-mg tablet has been swallowed can be approximated by

$$N(t) = -0.009t(t - 12)^3.$$

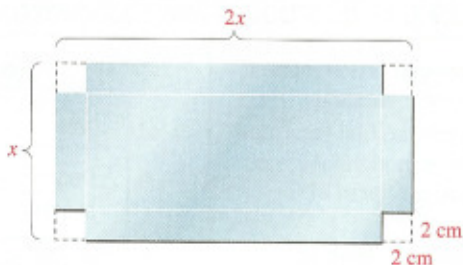
Use a graphing calculator with the window  $[-1, 13, -1, 25]$  to answer Exercises 59–61.

Source: Based on information in Chohan, Naina, Rita M. Doyle, and Patricia Nayle (eds.), *Nursing Handbook*, 21st ed. Springhouse, PA: Springhouse Corporation, 2001

59. Approximately how long after a tablet has been swallowed will there be 18 mg in the bloodstream? **2 hr, 4.2 hr**
60. Approximately how long after a tablet has been swallowed will there be 10 mg in the bloodstream? **0.8 hr, 6.4 hr**
61. Approximately how long after a tablet has been swallowed will the peak dosage in the bloodstream occur? **3 hr**
62. **Folding Sheet Metal.** An open rectangular gutter is made by turning up the sides of a piece of metal 20 in. wide, as shown. The area of the cross section of the gutter is  $48 \text{ in}^2$ . Find the possible depths of the gutter. **4 in., 6 in.**



63. **Box Construction.** A rectangular piece of tin is twice as long as it is wide. Squares 2 cm on a side are cut out of each corner, and the ends are turned up to make a box whose volume is  $480 \text{ cm}^3$ . What are the dimensions of the piece of tin? **Length: 28 cm; width: 14 cm**



64. **Navigation.** A tugboat and a freighter leave the same port at the same time at right angles. The freighter travels 7 km/h slower than the tugboat. After 4 hr, they are 68 km apart. Find the speed of each boat. **Tugboat: 15 km/h; freighter: 8 km/h**
65. **Skydiving.** During the first 13 sec of a jump, a skydiver falls approximately  $11.12t^2$  feet in  $t$  seconds. A small heavy object (with less wind resistance) falls about  $15.4t^2$  feet in  $t$  seconds. Suppose that a skydiver jumps from 30,000 ft, and 1 sec later a camera falls out of the airplane. How long will it take the camera to catch up to the skydiver? **About 5.7 sec**

**Try Exercise Answers: Section 5.8**

3. 10, 11    9. Foot: 7 ft; height: 12 ft    15. 1 min, 3 min  
 25. 3 cm    33. 300 ft by 400 ft by 500 ft  
 41. (a)  $P(x) = 0.01823x^4 - 0.77199x^3 + 11.62153x^2 - 73.65807x + 179.76190$ ; (b) 7%; (c) 2003 and 2007