2. **Translate.** To translate, we need to recall that the sum of the measures of the angles in a triangle is 180°.

Rewording:	Measure of back angle	$+$	measure of front angle	$+$	measure of peak angle	is	180°
Translating:	x	$+$	$(x + 20)$	$+$	$2x$	$=$	180

3. **Carry out.** We solve:

$$x + (x + 20) + 2x = 180$$
$$4x + 20 = 180$$
$$4x = 160$$
$$x = 40.$$

The measures for the angles appear to be:

Back angle: $x = 40°$,

Front angle: $x + 20 = 40 + 20 = 60°$,

Peak angle: $2x = 2(40) = 80°$.

4. **Check.** Consider 40°, 60°, and 80°, as listed above. The measure of the front angle is 20° greater than the measure of the back angle, the measure of the peak angle is twice the measure of the back angle, and the sum is 180°. These numbers check.

5. **State.** The measures of the angles are 40°, 60°, and 80°.   **TRY EXERCISE** 31

We close this section with some tips to aid you in problem solving.

Problem-Solving Tips

1. The more problems you solve, the more your skills will improve.
2. Look for patterns when solving problems. Each time you study an example or solve an exercise, you may observe a pattern for problems found later.
3. Clearly define variables before translating to an equation.
4. Consider the dimensions of the variables and constants in the equation. The variables that represent length should all be in the same unit, those that represent money should all be in dollars or all in cents, and so on.
5. Make sure that units appear in the answer whenever appropriate and that you completely answer the original problem.

2.5   **EXERCISE SET**

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Solve. Even though you might find the answer quickly in some other way, practice using the five-step problem-solving process in order to build the skill of problem solving.

1. Three less than twice a number is 19. What is the number?

2. Two fewer than ten times a number is 78. What is the number?

3. Five times the sum of 3 and twice some number is 70. What is the number?

4. Twice the sum of 4 and three times some number is 34. What is the number?

5. *Price of an iPod.* Kyle paid $120 for an iPod nano during a 20%-off sale. What was the regular price?

6. *Price of sneakers.* Amy paid $102 for a pair of New Balance 1122 running shoes during a 15%-off sale. What was the regular price?

7. *Price of a calculator.* Kayla paid $137.80, including 6% tax, for her graphing calculator. How much did the calculator itself cost?

8. *Price of a printer.* Laura paid $219.45, including 5% tax, for an all-in-one color printer. How much did the printer itself cost?

9. *Unicycling.* In 2005, Ken Looi of New Zealand set a record by covering 235.3 mi in 24 hr on his unicycle. After 8 hr, he was approximately twice as far from the finish line as he was from the start. How far had he traveled?
Source: *Guinness World Records* 2007

10. *Sled-dog racing.* The Iditarod sled-dog race extends for 1049 mi from Anchorage to Nome. If a musher is twice as far from Anchorage as from Nome, how many miles has the musher traveled?


11. *Indy Car racing.* In April 2008, Danica Patrick won the Indy Japan 300 with a time of 01:51:02.6739 for the 300-mi race. At one point, Patrick was 20 mi closer to the finish than to the start. How far had Patrick traveled at that point?

12. *NASCAR racing.* In June 2007, Carl Edwards won the Michigan 400 with a time of 2:42:5 for the 400-mi race. At one point, Edwards was 80 mi closer to the finish than to the start. How far had Edwards traveled at that point?

13. *Apartment numbers.* The apartments in Erica's apartment house are consecutively numbered on each floor. The sum of her number and her next-door neighbor's number is 2409. What are the two numbers?

14. *Apartment numbers.* The apartments in Brian's apartment house are numbered consecutively on each floor. The sum of his number and his next-door neighbor's number is 1419. What are the two numbers?

15. *Street addresses.* The houses on the west side of Lincoln Avenue are consecutive odd numbers. Sam and Colleen are next-door neighbors and the sum of their house numbers is 572. Find their house numbers.

16. *Street addresses.* The houses on the south side of Elm Street are consecutive even numbers. Wanda and Larry are next-door neighbors and the sum of their house numbers is 794. Find their house numbers.

17. The sum of three consecutive page numbers is 99. Find the numbers.

18. The sum of three consecutive page numbers is 60. Find the numbers.

19. *Longest marriage.* As half of the world's longest-married couple, the woman was 2 yr younger than her husband. Together, their ages totaled 204 yr. How old were the man and the woman?
Source: *Guinness World Records* 2007

20. *Oldest bride.* The world's oldest bride was 19 yr older than her groom. Together, their ages totaled 185 yr. How old were the bride and the groom?
Source: *Guinness World Records* 2007

21. *e-mail.* In 2006, approximately 125 billion e-mail messages were sent each day. The number of spam messages was about four times the number of non-spam messages. How many of each type of message were sent each day in 2006?
Source: Ferris Research

22. *Home remodeling.* In 2005, Americans spent a total of $26 billion to remodel bathrooms and kitchens. They spent $5 billion more on kitchens than on bathrooms. How much was spent on each?
Source: Joint Center for Housing Studies, Harvard University

23. *Page numbers.* The sum of the page numbers on the facing pages of a book is 281. What are the page numbers?

24. *Perimeter of a triangle.* The perimeter of a triangle is 195 mm. If the lengths of the sides are consecutive odd integers, find the length of each side.

25. *Hancock Building dimensions.*   The top of the John Hancock Building in Chicago is a rectangle whose length is 60 ft more than the width. The perimeter is 520 ft. Find the width and the length of the rectangle. Find the area of the rectangle.

26. *Dimensions of a state.*   The perimeter of the state of Wyoming is 1280 mi. The width is 90 mi less than the length. Find the width and the length.


27. A rectangular community garden is to be enclosed with 92 m of fencing. In order to allow for compost storage, the garden must be 4 m longer than it is wide. Determine the dimensions of the garden.
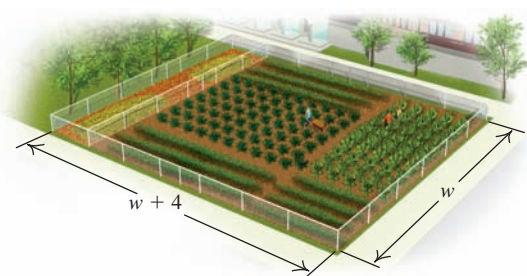

28. *Perimeter of a high school basketball court.*   The perimeter of a standard high school basketball court is 268 ft. The length is 34 ft longer than the width. Find the dimensions of the court.
Source: Indiana High School Athletic Association

29. *Two-by-four.*   The perimeter of a cross section of a "two-by-four" piece of lumber is $10\frac{1}{2}$ in. The length is twice the width. Find the actual dimensions of the cross section of a two-by-four.

$P = 10\frac{1}{2}$ in.
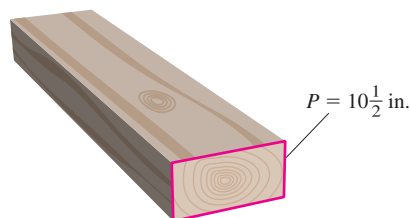
30. *Standard billboard sign.*   A standard rectangular highway billboard sign has a perimeter of 124 ft. The length is 6 ft more than three times the width. Find the dimensions of the sign.
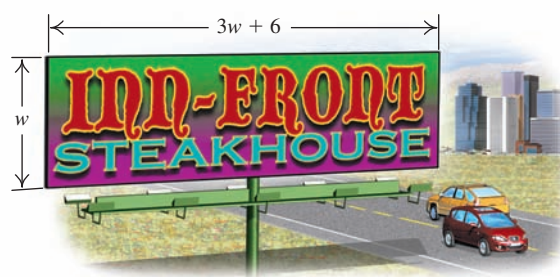
31. *Angles of a triangle.*   The second angle of an architect's triangle is three times as large as the first. The third angle is 30° more than the first. Find the measure of each angle.

32. *Angles of a triangle.*   The second angle of a triangular garden is four times as large as the first. The third angle is 45° less than the sum of the other two angles. Find the measure of each angle.

33. *Angles of a triangle.*   The second angle of a triangular kite is four times as large as the first. The third angle is 5° more than the sum of the other two angles. Find the measure of the second angle.

34. *Angles of a triangle.*   The second angle of a triangular building lot is three times as large as the first. The third angle is 10° more than the sum of the other two angles. Find the measure of the third angle.

35. *Rocket sections.*   A rocket is divided into three sections: the payload and navigation section in the top, the fuel section in the middle, and the rocket engine section in the bottom. The top section is one-sixth the length of the bottom section. The middle section is one-half the length of the bottom section. The total length is 240 ft. Find the length of each section.

240 ft
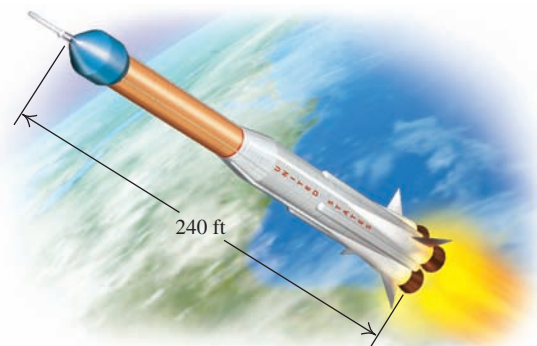
36. *Gourmet sandwiches.* Jenny, Demi, and Drew buy an 18-in. long gourmet sandwich and take it back to their apartment. Since they have different appetites, Jenny cuts the sandwich so that Demi gets half of what Jenny gets and Drew gets three-fourths of what Jenny gets. Find the length of each person's sandwich.

37. *Taxi rates.* In Chicago, a taxi ride costs $2.25 plus $1.80 for each mile traveled. Debbie has budgeted $18 for a taxi ride (excluding tip). How far can she travel on her $18 budget?
**Source:** City of Chicago

38. *Taxi fares.* In New York City, taxis charge $2.50 plus $2.00 per mile for off-peak fares. How far can Ralph travel for $17.50 (assuming an off-peak fare)?
Source: New York City Taxi and Limousine Commission

39. *Truck rentals.* Truck-Rite Rentals rents trucks at a daily rate of $49.95 plus 39¢ per mile. Concert Productions has budgeted $100 for renting a truck to haul equipment to an upcoming concert. How far can they travel in one day and stay within their budget?

40. *Truck rentals.* Fine Line Trucks rents an 18-ft truck for $42 plus 35¢ per mile. Judy needs a truck for one day to deliver a shipment of plants. How far can she drive and stay within a budget of $70?

41. *Complementary angles.* The sum of the measures of two *complementary* angles is 90°. If one angle measures 15° more than twice the measure of its complement, find the measure of each angle.

Complementary
angles
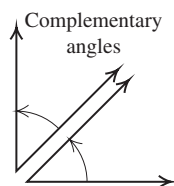
42. *Complementary angles.* Two angles are complementary. (See Exercise 41.) The measure of one angle is $1\frac{1}{2}$ times the measure of the other. Find the measure of each angle.

43. *Supplementary angles.* The sum of the measures of two *supplementary* angles is 180°. If the measure of one angle is $3\frac{1}{2}$ times the measure of the other, find the measure of each angle.

Supplementary
angles
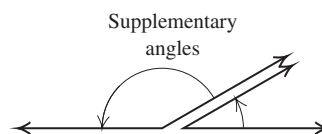
44. *Supplementary angles.* Two angles are supplementary. (See Exercise 43.) If one angle measures 45° less than twice the measure of its supplement, find the measure of each angle.

45. *Copier paper.* The perimeter of standard-size copier paper is 99 cm. The width is 6.3 cm less than the length. Find the length and the width.

46. *Stock prices.* Sarah's investment in Jet Blue stock grew 28% to $448. How much did she originally invest?

47. *Savings interest.* Janeka invested money in a savings account at a rate of 6% simple interest. After 1 yr, she has $6996 in the account. How much did Janeka originally invest?

48. *Credit cards.* The balance in Will's Mastercard® account grew 2%, to $870, in one month. What was his balance at the beginning of the month?

49. *Scrabble®.* In a single game on October 12, 2006, Michael Cresta and Wayne Yorra set three North American Scrabble records: the most points in one game by one player, the most total points in the game, and the most points on a single turn. Cresta scored 340 points more than Yorra, and together they scored 1320 points. What was the winning score?
Source: www.slate.com

50. *Color printers.* The art gallery in Example 3 decides to raise its budget to $5000 for the 2-month period. How many brochures can they print for $5000?

51. *Selling a home.* The Brannons are planning to sell their home. If they want to be left with $117,500 after paying 6% of the selling price to a realtor as a commission, for how much must they sell the house?

52. *Budget overruns.* The massive roadworks project in Boston known as The Big Dig cost approximately $14.6 billion. This cost was 484% more than the original estimate. What was the original estimate of the cost of The Big Dig?
Sources: Taxpayers for Common Sense; www.msnbc.cmsn.com

53. *Cricket chirps and temperature.* The equation $T = \frac{1}{4}N + 40$ can be used to determine the temperature T, in degrees Fahrenheit, given the number of times N a cricket chirps per minute. Determine the number of chirps per minute for a temperature of 80°F.

54. *Race time.* The equation $R = -0.028t + 20.8$ can be used to predict the world record in the 200-m dash, where R is the record in seconds and t is the number of years since 1920. In what year will the record be 18.0 sec?

55. Sean claims he can solve most of the problems in this section by guessing. Is there anything wrong with this approach? Why or why not?

56. When solving Exercise 20, Beth used a to represent the bride's age and Ben used a to represent the groom's age. Is one of these approaches preferable to the other? Why or why not?

Skill Review

To prepare for Section 2.6, review inequalities (Section 1.4).

Write a true sentence using either $<$ or $>$. [1.4]

57. -8 ☐ 1

58. -2 ☐ -5

59. $\frac{1}{2}$ ☐ 0

60. -3 ☐ -1

Write a second inequality with the same meaning. [1.4]

61. $x \geq -4$

62. $x < 5$

63. $5 > y$

64. $-10 \leq t$

Synthesis

65. Write a problem for a classmate to solve. Devise it so that the problem can be translated to the equation $x + (x + 2) + (x + 4) = 375$.

66. Write a problem for a classmate to solve. Devise it so that the solution is "Audrey can drive the rental truck for 50 mi without exceeding her budget."

67. *Discounted dinners.* Kate's "Dining Card" entitles her to $10 off the price of a meal after a 15% tip has been added to the cost of the meal. If, after the discount, the bill is $32.55, how much did the meal originally cost?

68. *Test scores.* Pam scored 78 on a test that had 4 fill-in questions worth 7 points each and 24 multiple-choice questions worth 3 points each. She had one fill-in question wrong. How many multiple-choice questions did Pam get right?

69. *Gettysburg Address.* Abraham Lincoln's 1863 Gettysburg Address refers to the year 1776 as "four *score* and seven years ago." Determine what a score is.

70. One number is 25% of another. The larger number is 12 more than the smaller. What are the numbers?

71. A storekeeper goes to the bank to get $10 worth of change. She requests twice as many quarters as half dollars, twice as many dimes as quarters, three times as many nickels as dimes, and no pennies or dollars. How many of each coin did the storekeeper get?

72. *Perimeter of a rectangle.* The width of a rectangle is three fourths of the length. The perimeter of the rectangle becomes 50 cm when the length and the width are each increased by 2 cm. Find the length and the width.

73. *Discounts.* In exchange for opening a new credit account, Macy's Department Stores® subtracts 10% from all purchases made the day the account is established. Julio is opening an account and has a coupon for which he receives 10% off the first day's reduced price of a camera. If Julio's final price is $77.75, what was the price of the camera before the two discounts?

74. *Sharing fruit.*   Apples are collected in a basket for six people. One third, one fourth, one eighth, and one fifth of the apples are given to four people, respectively. The fifth person gets ten apples, and one apple remains for the sixth person. Find the original number of apples in the basket.

75. *eBay purchases.*   An eBay seller charges $9.99 for the first DVD purchased and $6.99 for all others. For shipping and handling, he charges the full shipping fee of $3 for the first DVD, one half of the shipping charge for the second item, and one third of the shipping charge per item for all remaining items. The total cost of a shipment (excluding tax) was $45.45. How many DVDs were in the shipment?

76. *Winning percentage.*   In a basketball league, the Falcons won 15 of their first 20 games. In order to win 60% of the total number of games, how many more games will they have to play, assuming they win only half of the remaining games?

77. *Taxi fares.*   In New York City, a taxi ride costs $2.50 plus 40¢ per $\frac{1}{5}$ mile and 40¢ per minute stopped in traffic. Due to traffic, Glenda's taxi took 20 min to complete what is usually a 10-min drive. If she is charged $18.50 for the ride, how far did Glenda travel?
Source: New York City Taxi and Limousine Commission

78. *Test scores.*   Ella has an average score of 82 on three tests. Her average score on the first two tests is 85. What was the score on the third test?

79. A school purchases a piano and must choose between paying $2000 at the time of purchase or $2150 at the end of one year. Which option should the school select and why?

80. Annette claims the following problem has no solution: "The sum of the page numbers on facing pages is 191. Find the page numbers." Is she correct? Why or why not?

Aha!

81. The perimeter of a rectangle is 101.74 cm. If the length is 4.25 cm longer than the width, find the dimensions of the rectangle.

82. The second side of a triangle is 3.25 cm longer than the first side. The third side is 4.35 cm longer than the second side. If the perimeter of the triangle is 26.87 cm, find the length of each side.

2.6   Solving Inequalities

Solutions of Inequalities   •   Graphs of Inequalities   •   Solving Inequalities Using the Addition Principle
•   Solving Inequalities Using the Multiplication Principle   •   Using the Principles Together

Many real-world situations translate to *inequalities*. For example, a student might need to register for *at least* 12 credits; an elevator might be designed to hold *at most* 2000 pounds; a tax credit might be allowable for families with incomes of *less than* $25,000; and so on. Before solving applications of this type, we must adapt our equation-solving principles to the solving of inequalities.

Solutions of Inequalities

Recall from Section 1.4 that an inequality is a number sentence containing $>$ (is greater than), $<$ (is less than), $\geq$ (is greater than or equal to), or $\leq$ (is less than or equal to). Inequalities like

$$-7 > x, \qquad t < 5, \qquad 5x - 2 \geq 9, \quad \text{and} \quad -3y + 8 \leq -7$$

are true for some replacements of the variable and false for others.