

6

Solving and Graphing
Linear Inequalities

- 6.1 Solve Inequalities Using Addition and Subtraction
- 6.2 Solve Inequalities Using Multiplication and Division
- 6.3 Solve Multi-Step Inequalities
- 6.4 Solve Compound Inequalities
- 6.5 Solve Absolute Value Equations
- 6.6 Solve Absolute Value Inequalities
- 6.7 Graph Linear Inequalities in Two Variables

Before

In previous chapters, you learned the following skills, which you'll use in Chapter 6: solving equations, graphing equations, and writing equations.

Prerequisite Skills**VOCABULARY CHECK**

1. Identify one **ordered pair** that is a solution of $8x - 5y = -2$.
2. Are $7x - 4 = 10$ and $x = 3$ **equivalent equations**? *Explain.*
3. The **absolute value** of a number a is the distance between a and $\underline{\quad}$ on a number line.

SKILLS CHECK

Check whether the given number is a solution of the equation or inequality.
(Review p. 21 for 6.1–6.6.)

4. $x - 2 = 3$; 5 5. $s + 3 = 12$; 9 6. $6y > 20$; 3 7. $\frac{p-3}{5} \leq 4$; 23

Solve the equation. Check your solution. (Review pp. 134, 141, 148 for 6.1–6.6.)

8. $m + 8 = -20$ 9. $-7x = 35$ 10. $-9r - 4 = 25$ 11. $4t - 7t = 9$

For the given value of a , find $-a$ and $|a|$. (Review p. 64 for 6.5–6.6.)

12. $a = -3$ 13. $a = -5.6$ 14. $a = 14$ 15. $a = 0$

Graph the equation. (Review p. 215 for 6.7.)

16. $y = -7x + 3$ 17. $6x + 3y = -5$ 18. $x = -8$ 19. $y = 4$

@HomeTutor Prerequisite skills practice at classzone.com

Now

In Chapter 6, you will apply the big ideas listed below and reviewed in the Chapter Summary on page 414. You will also use the key vocabulary listed below.

Big Ideas

- 1 Applying properties of inequality
- 2 Using statements with *and* or *or*
- 3 Graphing inequalities

KEY VOCABULARY

- graph of an inequality, p. 356
- equivalent inequalities, p. 357
- compound inequality, p. 380
- absolute value equation, p. 390
- absolute deviation, p. 392
- linear inequality in two variables, p. 405
- graph of an inequality in two variables, p. 405

Why?

You can use inequalities to solve problems in sound amplification. For example, you can solve an inequality to determine whether an amplifier provides enough amplification for a given number of people in an audience.

Animated Algebra

The animation illustrated below for Exercise 45 on page 387 helps you answer this question: Is a 2900 watt amplifier adequate for an audience of 350 people?

You need to decide whether the amplifier is adequate for 350 people.

Total amount of amplification provided by the amplifier: $W = 2900$ watts

Size of the audience: $p = 350$ people

$y = \frac{W}{p}$ $y = \frac{\quad}{\quad}$

Click on the boxes to enter the appropriate values.

Animated Algebra at classzone.com

Other animations for Chapter 6: pages 358, 364, 382, 390, 391, 399, and 407

6.1 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS13 for Exs. 7, 15, and 33
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 29, 34, 35, and 38
- ◆ = MULTIPLE REPRESENTATIONS Ex. 37

SKILL PRACTICE

- VOCABULARY** Copy and complete: To graph $x < -8$, you draw a(n) ? circle at -8 , and you draw an arrow to the ?.
- ★ **WRITING** Are $x + 7 \geq 18$ and $x \geq 25$ equivalent inequalities? *Explain.*

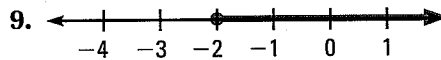
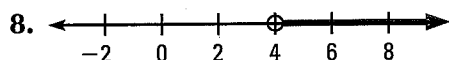
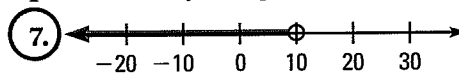
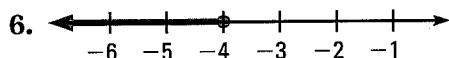
EXAMPLE 1
on p. 356
for Exs. 3–5

WRITING AND GRAPHING INEQUALITIES Write and graph an inequality that describes the situation.

- ③ The speed limit on a highway is 60 miles per hour.
- You must be at least 16 years old to go on a field trip.
- A child must be taller than 48 inches to get on an amusement park ride.

EXAMPLE 2
on p. 356
for Exs. 6–9

WRITING INEQUALITIES Write an inequality represented by the graph.



EXAMPLES 3 and 4
on pp. 357–358
for Exs. 10–23

SOLVING INEQUALITIES Solve the inequality. Graph your solution.

- | | | | |
|---|--|--------------------------------|---------------------------------|
| 10. $x + 4 < 5$ | ⑪. $-8 \leq 8 + y$ | 12. $-1\frac{1}{4} \leq m + 3$ | 13. $n + 17 \leq 16\frac{4}{5}$ |
| 14. $8.2 + v > -7.6$ | ⑮. $w + 14.9 > -2.7$ | 16. $r - 4 < -5$ | 17. $1 \leq s - 8$ |
| 18. $-1\frac{1}{3} \leq p - 8\frac{1}{3}$ | 19. $q - 1\frac{1}{3} > -2\frac{1}{2}$ | 20. $2.1 \geq c - 6.7$ | 21. $d - 1.92 > -8.76$ |

ERROR ANALYSIS Describe and correct the error in solving the inequality or in graphing the solution.

22.

$$x + 8 < -3$$

$$x + 8 - 8 < -3 + 8$$

$$x < 5$$

23.

$$-17 \leq x - 14$$

$$-17 + 14 \leq x - 14 + 14$$

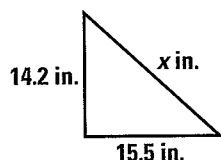
$$-3 \leq x$$

TRANSLATING SENTENCES Write the verbal sentence as an inequality. Then solve the inequality and graph your solution.

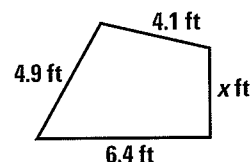
- ⑲ The sum of 11 and m is greater than -23 .
- ⑳ The difference of n and 15 is less than or equal to 37.
- ㉑ The difference of c and 13 is less than -19 .

GEOMETRY Write and solve an inequality to find the possible values of x .

27. Perimeter < 51.3 inches



28. Perimeter ≤ 18.7 feet



29. **★ WRITING** Is it possible to check all the numbers that are solutions of an inequality? Does checking one solution guarantee that you have solved an inequality correctly? *Explain* your answers.
30. **CHALLENGE** Write and graph an inequality that represents the numbers that are *not* solutions of $x - 12 \geq 5.7$.

PROBLEM SOLVING

EXAMPLE 5
on p. 358
for Exs. 31–35

31. **INTERNET** You earn points from buying items at an Internet shopping site. You would like to redeem 2350 points to get an item for free, but you want to be sure to have more than 6000 points left over. What are the possible numbers of points you can have before making a redemption?

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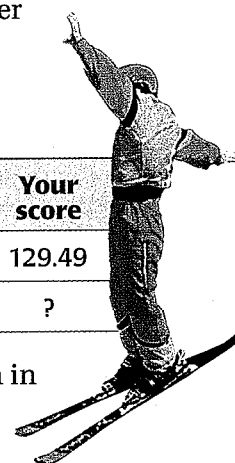
32. **SPORTS RECORDS** In 1982 Wayne Gretsky set a new record for the greatest number of hockey goals in one season with 92 goals. Suppose that a hockey player has 59 goals so far in a season. What are the possible numbers of additional goals that the player can make in order to match or break Wayne Gretsky's record?

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33. **MULTI-STEP PROBLEM** In aerial ski competitions, athletes perform two acrobatic ski jumps, and the scores on both jumps are added together. The table shows your competitor's first and second scores and your first score.

Ski jump	Competitor's score	Your score
1	127.04	129.49
2	129.98	?

- a. Write and solve an inequality to find the scores s that you can earn in your second jump in order to beat your competitor.
- b. Will you beat your competitor if you earn 128.13 points? 126.78 points? 127.53 points? *Justify* your answers.



34. **★ MULTIPLE CHOICE** You want to buy a jacket at a clothing store, and you can spend at most \$30. You have a coupon for \$3 off any item at the store. Which inequality can you use to find the original prices p of jackets that you can buy?

(A) $3 + p \geq 30$ (B) $30 + p \leq 3$ (C) $p - 3 \leq 30$ (D) $p - 30 \geq 3$

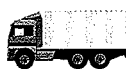
35. **★ OPEN-ENDED** Describe a real-world situation that can be modeled by the inequality $x + 14 \geq 17$. *Explain* what the solution of the inequality means in this situation.

36. **VEHICLE WEIGHTS** According to a state law for vehicles traveling on state roads, the maximum total weight of the vehicle and its contents depends on the number of axles the vehicle has.

Maximum Total Weights



2 axles
34,000 lb



3 axles
54,000 lb



4 axles
69,000 lb



5 axles
80,000 lb

For each type of vehicle, write and solve an inequality to find the possible weights w (in pounds) of a vehicle when its contents weigh 14,200 pounds. Can a vehicle that has 2 axles and weighs 20,000 pounds hold 14,200 pounds of contents? *Explain.*

37. **MULTIPLE REPRESENTATIONS** Your friend is willing to spend no more than \$17,000 for a new car. The car dealership offers \$3000 cash back for the purchase of a new car.

- a. **Making a Table** Make a table of values that gives the final price y of a car after the cash back offer is applied to the original price x . Use the following values for x : 19,459, 19,989, 20,549, 22,679, 23,999.
- b. **Writing an Inequality** Write and solve an inequality to find the original prices of the cars that your friend will consider buying.

38. **★ SHORT RESPONSE** A 4-member track team is trying to match or beat last year's winning time of 3 minutes 41.1 seconds for a 1600 meter relay race. The table shows the 400 meter times for the first three athletes.

Athlete	Time (sec)
1	53.34
2	56.38
3	57.46

- a. **Calculate** What are the possible times that the last athlete can run 400 meters in order for the team to match or beat last year's time?
- b. **Decide** So far this season the last athlete's fastest 400 meter time is 53.18 seconds, and his average 400 meter time is 53.92 seconds. In this race the last athlete expects to run faster than his slowest time this season. Is it possible for the team to fail to meet its goal? *Explain.*

39. **CHALLENGE** A public television station wants to raise at least \$72,000 in a pledge drive. The station raised an average of \$5953 per day for the first 3 days and an average of \$6153 per day for the next 3 days: What are the possible additional amounts that the station can raise to meet its goal?

MIXED REVIEW

Find the sum, difference, product, or quotient.

40. $-18 + (-27)$ (p. 74) 41. $15 - (-23)$ (p. 80) 42. $7 \cdot (-9)$ (p. 88)
43. $-11 \cdot (-12)$ (p. 88) 44. $-27 \div (-3)$ (p. 103) 45. $-30 \div (-5)$ (p. 103)

Solve the equation. (p. 134)

46. $6x = 48$ 47. $-5y = -35$ 48. $400 = -48m$
49. $\frac{n}{5} = 10$ 50. $\frac{r}{8} = -13$ 51. $\frac{s}{-2} = -15$

PREVIEW

Prepare for
Lesson 6.2
in Exs. 46–51.

6.2 Inequalities with Negative Coefficients

MATERIALS • index cards

QUESTION How do you solve an inequality with a negative coefficient?

EXPLORE Check solutions of inequalities

STEP 1 Write integers Write the integers from -5 to 5 on index cards. Place the cards face up as shown.



STEP 2 Check solutions Determine whether each integer is a solution of $4x \geq 8$. If the integer is *not* a solution, turn over the card.



STEP 3 Check solutions Turn all the cards face up. Repeat Step 2 for $-4x \geq 8$.



DRAW CONCLUSIONS Use your observations to complete these exercises

- State an operation that you can perform on both sides of $4x \geq 8$ to obtain the solutions found in Step 2. Then solve the inequality.
- Copy and complete the steps below for solving $-4x \geq 8$.
 - $-4x \geq 8$ Write original inequality.
 - ? Add $4x$ to each side.
 - ? Subtract 8 from each side.
 - ? Divide each side by 4 .
 - ? Rewrite inequality with x on the left side.
- Does dividing both sides of $-4x \geq 8$ by -4 give the solution found in Exercise 2? If not, what else must you do to the inequality when you divide by -4 ?
- Do you need to change the direction of the inequality symbol when you divide each side of an inequality by a positive number? by a negative number?

Solve the inequality.

5. $20x \geq 5$ 6. $-9x \leq 45$ 7. $-8x > 40$ 8. $7x < 21$

6.2 EXERCISES

HOMework KEY

○ = WORKED-OUT SOLUTIONS
on p. WS14 for Exs. 5, 9, and 39

★ = STANDARDIZED TEST PRACTICE
Exs. 2, 27, 34, and 41

◆ = MULTIPLE REPRESENTATIONS
Ex. 38

SKILL PRACTICE

- VOCABULARY** Which property are you using when you solve $5x \geq 30$ by dividing each side by 5?
- ★ **WRITING** Are $\frac{x}{-4} < -9$ and $x < 36$ equivalent inequalities? *Explain* your answer.

EXAMPLES

1, 2, and 3

on pp. 363–364
for Exs. 3–29

SOLVING INEQUALITIES Solve the inequality. Graph your solution.

- | | | | |
|---------------------------|------------------------------|---------------------------|-------------------------------|
| 3. $2p \geq 14$ | 4. $\frac{x}{-3} < -10$ | 5. $-6y < -36$ | 6. $40 > \frac{w}{5}$ |
| 7. $\frac{q}{4} < 7$ | 8. $72 \leq 9r$ | 9. $\frac{g}{6} > -20$ | 10. $-11m \leq -22$ |
| 11. $-90 \geq 4t$ | 12. $\frac{n}{3} < -9$ | 13. $60 \leq -12s$ | 14. $\frac{v}{-4} \geq -8$ |
| 15. $-8.4f > 2.1$ | 16. $\frac{d}{-2} \leq 18.6$ | 17. $9.6 < -16c$ | 18. $0.07 \geq \frac{k}{7}$ |
| 19. $-1.5 \geq 6z$ | 20. $\frac{x}{-5} \leq -7.5$ | 21. $1.02 < -3j$ | 22. $\frac{y}{-4.5} \geq -10$ |
| 23. $\frac{r}{-30} < 1.8$ | 24. $1.9 \leq -5p$ | 25. $\frac{m}{0.6} > -40$ | 26. $-2t > -1.22$ |

- ★ **WRITING** How is solving $ax > b$ where $a > 0$ similar to solving $ax > b$ where $a < 0$? How is it different?

ERROR ANALYSIS Describe and correct the error in solving the inequality.

28.

$$\begin{array}{l} -15x > 45 \\ \frac{-15x}{-15} > \frac{45}{-15} \\ x > -3 \end{array}$$

29.

$$\begin{array}{l} \frac{x}{9} \leq -7 \\ 9 \cdot \frac{x}{9} \leq 9 \cdot (-7) \\ x \geq -63 \end{array}$$

TRANSLATING SENTENCES In Exercises 30–33, write the verbal sentence as an inequality. Then solve the inequality and graph your solution.

- The product of 8 and x is greater than 50.
- The product of -15 and y is less than or equal to 90.
- The quotient of v and -9 is less than -18 .
- The quotient of w and 24 is greater than or equal to $-\frac{1}{6}$.
- ★ **OPEN-ENDED** Write an inequality in the form $ax < b$ such that the solutions are all real numbers greater than 4.

35. **CHALLENGE** For the given values of a and b , tell whether the solution of $ax > b$ consists of *positive numbers*, *negative numbers*, or *both*. *Explain*.

- a. $a < 0, b > 0$ b. $a > 0, b > 0$ c. $a > 0, b < 0$ d. $a < 0, b < 0$

PROBLEM SOLVING

EXAMPLES 4 and 5

on p. 365 for
Exs. 36–39

36. **MUSIC** You have \$90 to buy CDs for your friend's party. The CDs cost \$18 each. What are the possible numbers of CDs that you can buy?

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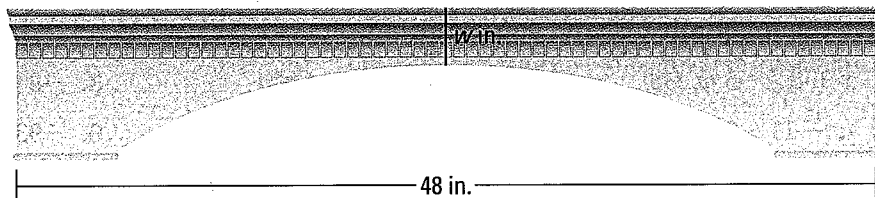
37. **JOB SKILLS** You apply for a job that requires the ability to type 40 words per minute. You practice typing on a keyboard for 5 minutes. The average number of words you type per minute must at least meet the job requirement. What are the possible numbers of words that you can type in 5 minutes in order to meet or exceed the job requirement?

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38. **MULTIPLE REPRESENTATIONS** You are stacking books on a shelf that has a height of 66 centimeters. Each book has a thickness of 4 centimeters.

- Using a Model** Use a concrete model to find the possible numbers of books that you can stack as follows: Cut strips of paper 4 centimeters wide to represent the books. Then place the strips one above the other until they form a column no taller than 66 centimeters.
- Writing an Inequality** Write and solve an inequality to find the possible numbers of books that you can stack.
- Drawing a Graph** Write and graph an equation that gives the height y of stacked books as a function of the number x of books. Then graph $y = 66$ in the same coordinate plane. To find the possible numbers of books that you can stack, identify the integer x -coordinates of the points on the first graph that lie *on or below* the graph of $y = 66$.
- Choosing a Method** Suppose the shelf has a height of 100 centimeters. Which method would you use to find the possible numbers of books, *a concrete model*, *solving an inequality*, or *drawing a graph*? *Explain*.

39. **MANUFACTURING** A manufacturer of architectural moldings recommends that the length of a piece be no more than 15 times its minimum width w (in inches) in order to prevent cracking. For the piece shown, what could the values of w be?



40. **RECREATION** A water-skiing instructor recommends that a boat pulling a beginning skier have a speed less than 18 miles per hour. Write and solve an inequality that you can use to find the possible distances d (in miles) that a beginner can travel in 45 minutes of practice time.

41. ★ **EXTENDED RESPONSE** A state agency that offers wild horses for adoption requires that a potential owner reserve 400 square feet of land per horse in a corral.
- Solve** A farmer has a rectangular corral whose length is 80 feet and whose width is 82 feet. Write and solve an inequality to find the possible numbers h of horses that the corral can hold.
 - Explain** If the farmer increases the length and width of the corral by 20 feet each, will the corral be able to hold only 1 more horse? *Explain* your answer without calculating the new area of the corral.
 - Calculate** The farmer decides to increase the length and width of the corral by 15 feet each. Find the possible numbers of horses that the corral can hold. Your answer should include the following:
 - a calculation of the new area of the corral
 - a description of your steps for solving the problem
42. **CHALLENGE** An electronics store is selling a laptop computer for \$1050. You can spend no more than \$900 for the laptop, so you wait for it to go on sale. Also, you plan to use a store coupon for 5% off the sale price. For which decreases in price will you consider buying the laptop?



MIXED REVIEW

Write an expression for the situation. (p. 15)

43. Total cost of t movie tickets if each ticket costs \$7.50
44. Distance left to travel on a 500 mile trip if you have traveled m miles

Solve the equation or inequality.

45. $9x + 6 = 7$ (p. 141) 46. $3y - 8 = 5y + 2y$ (p. 154) 47. $4(z + 1) = 6z$ (p. 154)
48. $p + 8 > 10$ (p. 356) 49. $q + 6 < -5$ (p. 356) 50. $r - 2 \geq -9$ (p. 356)

Write an equation in slope-intercept form of the line that has the given slope and y -intercept. (p. 283)

51. slope: -3 ; y -intercept: 4 52. slope: -8 ; y -intercept: $\frac{1}{4}$ 53. slope: $\frac{1}{5}$; y -intercept: $-\frac{2}{3}$

QUIZ for Lessons 6.1–6.2

Solve the inequality. Graph your solution.

1. $x + 8 \geq -5$ (p. 356) 2. $y + 6 < 14$ (p. 356) 3. $-8 \leq v - 5$ (p. 356)
4. $w - 11 > 2$ (p. 356) 5. $-40 < -5r$ (p. 363) 6. $-93 < 3s$ (p. 363)
7. $-2m \geq 26$ (p. 363) 8. $\frac{n}{-4} > -7$ (p. 363) 9. $\frac{c}{6} \leq -8$ (p. 363)

10. **FOOD PREPARATION** You need to make at least 150 sandwiches for a charity event. You can make 3 sandwiches per minute. How long will it take you to make the number of sandwiches you need? (p. 363)

PREVIEW
Prepare for
Lesson 6.3 in
Exs. 45–50.

6.3 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS14 for Exs. 5, 19, and 39
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 33, 39, 40, and 42
- ◆ = MULTIPLE REPRESENTATIONS Ex. 41

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: The inequalities $3x - 1 < 11$, $3x < 12$, and $x < 4$ are called ?.
2. ★ **WRITING** How do you know whether an inequality has no solutions? How do you know whether the solutions are all real numbers?


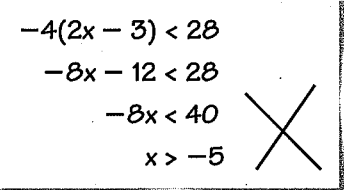
EXAMPLES 1, 2, and 3

on pp. 369–370
for Exs. 3–16

SOLVING INEQUALITIES Solve the inequality. Graph your solution.

- | | | |
|------------------------------------|--|-----------------------------------|
| 3. $2x - 3 > 7$ | 4. $5y + 9 \leq 4$ | 5. $8v - 3 \geq -11$ |
| 6. $3(w + 12) < 0$ | 7. $7(r - 3) \geq -13$ | 8. $2(s + 4) \leq 16$ |
| 9. $4 - 2m > 7 - 3m$ | 10. $8n - 2 > 17n + 9$ | 11. $-10p > 6p - 8$ |
| 12. $4 - \frac{1}{2}q \leq 33 - q$ | 13. $-\frac{2}{3}d - 2 < \frac{1}{3}d + 8$ | 14. $8 - \frac{4}{5}f > -14 - 2f$ |

ERROR ANALYSIS Describe and correct the error in solving the inequality.

- | | |
|---|--|
| <p>15.</p> $\begin{aligned} 17 - 3x &\geq 56 \\ -3x &\geq 39 \\ x &\geq -13 \end{aligned}$  | <p>16.</p> $\begin{aligned} -4(2x - 3) &< 28 \\ -8x - 12 &< 28 \\ -8x &< 40 \\ x &> -5 \end{aligned}$  |
|---|--|

EXAMPLE 4

on p. 370
for Exs. 17–28

SOLVING INEQUALITIES Solve the inequality, if possible.

- | | | |
|--------------------------------------|---|--|
| 17. $3p - 5 > 2p + p - 7$ | 18. $5d - 8d - 4 \leq -4 + 3d$ | 19. $3(s - 4) \geq 2(s - 6)$ |
| 20. $2(t - 3) > 2t - 8$ | 21. $5(b + 9) \leq 5b + 45$ | 22. $2(4c - 7) \geq 8(c - 3)$ |
| 23. $6(x + 3) < 5x + 18 + x$ | 24. $4 + 9y - 3 \geq 3(3y + 2)$ | 25. $2.2h + 0.4 \leq 2(1.1h - 0.1)$ |
| 26. $9.5j - 6 + 5.5j \geq 3(5j - 2)$ | 27. $\frac{1}{5}(4m + 10) < \frac{4}{5}m + 2$ | 28. $\frac{3}{4}(8n - 4) < -3(1 - 2n)$ |

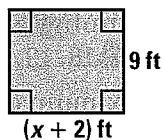
TRANSLATING PHRASES Translate the verbal phrase into an inequality. Then solve the inequality and graph your solution.

29. Four more than the product of 3 and x is less than 40.
30. Twice the sum of x and 8 is greater than or equal to -36 .
31. The sum of $5x$ and $2x$ is greater than the difference of $9x$ and 4.
32. The product of 6 and the difference of $6x$ and 3 is less than or equal to the product of -2 and the sum of 4 and $8x$.
33. ★ **MULTIPLE CHOICE** For which values of a and b are all the solutions of $ax + b > 0$ positive?

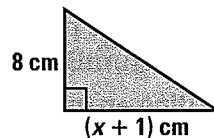
(A) $a > 0, b > 0$	(B) $a < 0, b < 0$	(C) $a > 0, b < 0$	(D) $a < 0, b = 0$
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GEOMETRY Write and solve an inequality to find the possible values of x .

34. Area > 81 square feet



35. Area ≤ 44 square centimeters



36. **CHALLENGE** For which value of a are all the solutions of $2(x - 5) \geq 3x + a$ less than or equal to 5?

PROBLEM SOLVING

EXAMPLE 5
on p. 371
for Exs. 37–40

37. **CD BURNING** A blank CD can hold 70 minutes of music. So far you have burned 25 minutes of music onto the CD. You estimate that each song lasts 4 minutes. What are the possible numbers of additional songs that you can burn onto the CD?

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38. **BUSINESS** You spend \$46 on supplies to make wooden ornaments and plan to sell the ornaments for \$8.50 each. What are the possible numbers of ornaments that you can sell in order for your profit to be positive?

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39. **★ SHORT RESPONSE** A zookeeper is designing a rectangular habitat for swans, as shown. The zookeeper needs to reserve 500 square feet for the first 2 swans and 125 square feet for each additional swan.

20 ft



50 ft

- Calculate** What are the possible numbers of swans that the habitat can hold? *Explain* how you got your answer.
- Compare** Suppose that the zookeeper increases both the length and width of the habitat by 20 feet. What are the possible numbers of additional swans that the habitat can hold?

40. **★ MULTIPLE CHOICE** A gym is offering a trial membership for 3 months by discounting the regular monthly rate by \$50. You will consider joining the gym if the total cost of the trial membership is less than \$100. Which inequality can you use to find the possible regular monthly rates that you are willing to pay?

- (A) $3x - 50 < 100$ (B) $3x - 50 > 100$
(C) $3(x - 50) < 100$ (D) $3(x - 50) > 100$

41. **MULTIPLE REPRESENTATIONS** A baseball pitcher makes 53 pitches in the first four innings of a game and plans to pitch in the next 3 innings.
- Making a Table** Make a table that gives the total number t of pitches made if the pitcher makes an average of p pitches per inning in the next 3 innings. Use the following values for p : 15, 16, 17, 18, 19.
 - Writing an Inequality** The baseball coach assigns a maximum of 105 pitches to the pitcher for the game. Write and solve an inequality to find the possible average numbers of pitches that the pitcher can make in each of the next three innings.
42. **★ EXTENDED RESPONSE** A state imposes a sales tax on items of clothing that cost more than \$175. The tax applies only to the difference of the price of the item and \$175.
- Calculate** Use the receipt shown to find the tax rate (as a percent). *Explain* how you got your answer.
 - Apply** A shopper has \$400 to spend on a winter coat. Write and solve an inequality to find the prices p of coats that the shopper can afford. Assume that $p \geq 175$.
 - Compare** Another state imposes a 4% sales tax on the entire price of an item of clothing. For which prices would paying the 4% tax be cheaper than paying the tax described above? Your answer should include the following:
 - writing and solving an inequality that describes the situation
 - checking the reasonableness of your answer using one of the solutions of the inequality
43. **CHALLENGE** Your scores in four bowling league tournaments are 157, 161, 149, and 172. After the next game, you want your average score to be at least 167. What are the possible scores that you can earn in your next tournament in order to meet your goal?

THE STYLE STORE	
Item:	Price: \$ 300.00
Suit	Tax: \$ 6.25
	Total: \$ 306.25

MIXED REVIEW

44. Using the positive integers less than 10, draw a Venn diagram where set A consists of factors of 30 and set B consists of odd numbers. Then tell whether this statement is *true* or *false*: "If a positive integer less than 10 is odd, then it is a factor of 30." *Explain* your reasoning. (p. 930)

Simplify the expression.

45. $11(-y)(-y)$ (p. 88) 46. $\frac{3}{4} \cdot (-16y)$ (p. 88) 47. $-2(x + 1) - 7x$ (p. 96)
48. $5x + 4 - 3x$ (p. 96) 49. $8(x + 6) - 5$ (p. 96) 50. $\frac{-15x + 18}{-6}$ (p. 103)

Solve the inequality. Graph your solution.

51. $x + 7 < 8$ (p. 356) 52. $y - 4 \geq -2$ (p. 356) 53. $9 \leq z + 13$ (p. 356)
54. $4.8 > m - 7.4$ (p. 356) 55. $\frac{n}{4} < -1$ (p. 363) 56. $4p \geq 52$ (p. 363)

PREVIEW

Prepare for
Lesson 6.4
in Exs. 51–56.

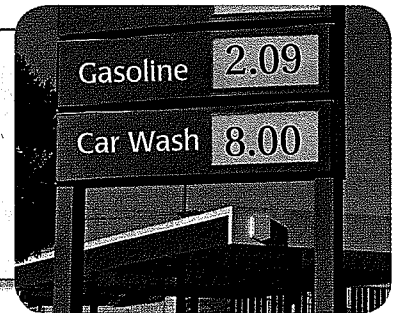
Another Way to Solve Example 5, page 371



MULTIPLE REPRESENTATIONS In Example 5 on page 371, you saw how to solve a problem about buying gasoline using an inequality. You can also solve the problem by working backward or by using a graph.

PROBLEM

CAR WASH Use the sign shown. A gas station charges \$.10 less per gallon of gasoline if a customer also gets a car wash. What are the possible amounts (in gallons) of gasoline that you can buy if you also get a car wash and can spend at most \$20?



METHOD 1

Work backward One alternative approach is to work backward.

STEP 1 Read the problem. It gives you the following information:

- amount you can spend: up to \$20
- price of a car wash: \$8
- regular price per gallon of gasoline: \$2.09
- discount per gallon of gasoline when you get a car wash: \$.10

Because you are getting a car wash, gasoline costs $\$2.09 - \$.10$, or \$1.99, per gallon.

STEP 2 Work backward.

- Start with the amount you have to spend: \$20.
- Subtract the cost of a car wash: $\$20 - \$8 = \$12$.
- Make a table of values showing the amount of money you have left after buying various amounts of gasoline.

Gasoline (gal)	Amount of money left
0	\$12.00
1	\$10.01
2	\$8.02
3	\$6.03
4	\$4.04
5	\$2.05
6	\$.06

$\left. \begin{array}{l} \leftarrow - \$1.99 \\ \leftarrow - \$1.99 \\ \leftarrow - \$1.99 \\ \leftarrow - \$1.99 \\ \leftarrow - \$1.99 \\ \leftarrow - \$1.99 \end{array} \right\}$

► You can buy up to slightly more than 6 gallons of gasoline.

METHOD 2

Using a graph Another alternative approach is to use a graph.

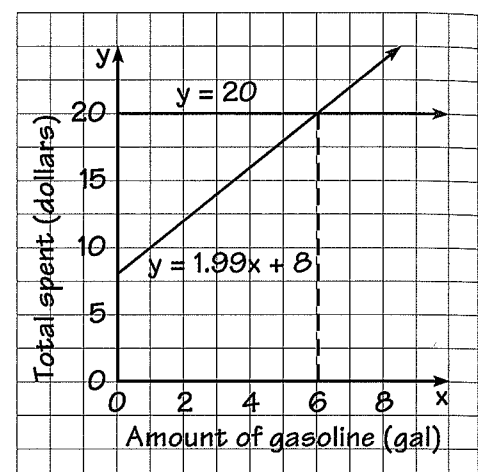
STEP 1 Write a verbal model. Then write an equation that gives the total amount of money y (in dollars) that you spend as a function of the amount x (in gallons) of gasoline that you buy.

Total spent (dollars)	=	Price of gasoline (dollars/gallon)	•	Amount of gasoline (gallons)	+	Price of car wash (dollars)
↓		↓		↓		↓
y	=	1.99	•	x	+	8

STEP 2 Graph $y = 1.99x + 8$.

STEP 3 Graph $y = 20$ in the same coordinate plane. This equation gives the maximum amount of money that you can spend for gasoline and a car wash.

STEP 4 Analyze the graphs. The point of intersection shows that you can buy slightly more than 6 gallons of gasoline when you spend \$20. Because you can spend *at most* \$20, the solutions are the x -coordinates of the points on the graph of $y = 1.99x + 8$ that lie *on or below* the graph of $y = 20$.



► You can buy up to slightly more than 6 gallons of gasoline.

PRACTICE

1. **BAKING** You need to bake at least 100 cookies for a bake sale. You can bake 12 cookies per batch of dough. What are the possible numbers of batches that will allow you to bake enough cookies? Solve this problem using two different methods.
4. **MONEY** You need to have at least \$100 in your checking account to avoid a low balance fee. You have \$247 in your account, and you make withdrawals of \$20 per week. What are the possible numbers of weeks that you can withdraw money and avoid paying the fee? Solve this problem using two different methods.
2. **VIDEO GAMES** A video game console costs \$259, and games cost \$29 each. You saved \$400 to buy a console and games. What are the possible numbers of games that you can buy? Solve this problem using two different methods.
5. **RUNNING TIMES** You are running a 10 mile race. You run the first 3 miles in 24.7 minutes. Your goal is to finish the race in less than 1 hour 20 minutes. What should your average running time (in minutes per mile) be for the remaining miles?
3. **WHAT IF?** In Exercise 2, suppose that you saved \$500 and decide to buy a video game console that costs \$299. What are the possible numbers of games that you can buy?

Extension

Use after Lesson 6.3

Solve Linear Inequalities by Graphing

GOAL Use graphs to solve linear inequalities.

So far in Chapter 6 you have seen how to solve linear inequalities algebraically. You can also solve linear inequalities graphically.

KEY CONCEPT

For Your Notebook

Solving Linear Inequalities Graphically

STEP 1 Write the inequality in one of the following forms: $ax + b < 0$, $ax + b \leq 0$, $ax + b > 0$, or $ax + b \geq 0$.

STEP 2 Write the related equation $y = ax + b$.

STEP 3 Graph the equation $y = ax + b$.

- The solutions of $ax + b > 0$ are the x -coordinates of the points on the graph of $y = ax + b$ that lie above the x -axis.
- The solutions of $ax + b < 0$ are the x -coordinates of the points on the graph of $y = ax + b$ that lie below the x -axis.
- If the inequality symbol is \leq or \geq , then the x -intercept of the graph is also a solution.

EXAMPLE 1 Solve an inequality graphically

Solve $3x + 2 > 8$ graphically.

Solution

STEP 1 Write the inequality in the form $ax + b > 0$.

$$3x + 2 > 8 \quad \text{Write original inequality.}$$

$$3x - 6 > 0 \quad \text{Subtract 8 from each side.}$$

STEP 2 Write the related equation $y = 3x - 6$.

STEP 3 Graph the equation $y = 3x - 6$.

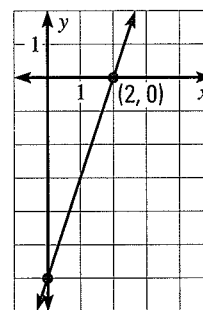
The inequality in Step 1 is in the form $ax + b > 0$, and the x -intercept of the graph in Step 3 is 2. So, $x > 2$.

► The solutions are all real numbers greater than 2. Check by substituting a number greater than 2 in the original inequality.

CHECK $3x + 2 > 8$ Write original inequality.

$$3(4) + 2 \stackrel{?}{>} 8 \quad \text{Substitute 4 for } x.$$

$$14 > 8 \checkmark \quad \text{Solution checks.}$$



EXAMPLE 2 Approximate a real-world solution

CELL PHONES Your cell phone plan costs \$49.99 per month for a given number of minutes. Each additional minute or part of a minute costs \$.40. You budgeted \$55 per month for phone costs. What are the possible additional minutes x that you can afford each month?

Solution

STEP 1 Write a verbal model. Then write an inequality.

Rate for additional time (dollars/minute)	•	Additional time (minutes)	+	Cost of phone plan (dollars)	≤	Amount budgeted (dollars)
↓		↓		↓		↓
0.40	•	x	+	49.99	≤	55

Write the inequality in the form $ax + b \leq 0$.

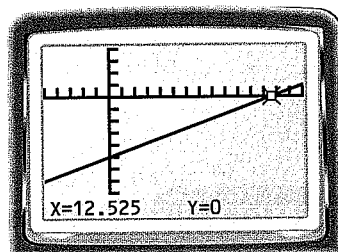
$$0.40x + 49.99 \leq 55 \quad \text{Write original inequality.}$$

$$0.40x - 5.01 \leq 0 \quad \text{Subtract 55 from each side.}$$

STEP 2 Write the related equation $y = 0.40x - 5.01$.

STEP 3 Graph the equation $y = 0.40x - 5.01$ on a graphing calculator.

Use the *trace* feature of the graphing calculator to find the x -intercept of the graph.



The inequality in Step 1 is in the form $ax + b \leq 0$, and the x -intercept is about 12.5. Because a part of a minute costs \$.40, round 12.5 down to 12 to be sure that you stay within your budget.

► You can afford up to 12 additional minutes.

PRACTICE

EXAMPLES 1 and 2

on pp. 377–378
for Exs. 1–4

Solve the inequality graphically.

1. $2x + 5 > 11$

2. $\frac{1}{2}x + 6 \leq 13$

3. $0.2x - 15.75 < 27$

4. **CABLE COSTS** Your family has a cable television package that costs \$40.99 per month. Pay-per-view movies cost \$3.95 each. Your family budgets \$55 per month for cable television costs. What are the possible numbers of pay-per-view movies that your family can afford each month?

6.4 Statements with *And* and *Or*

MATERIALS • paper and pencil

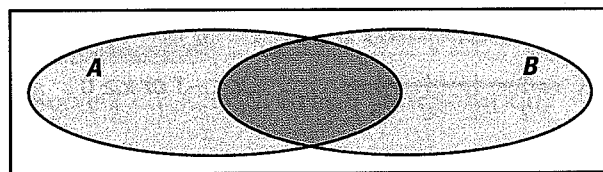
QUESTION What is the difference between a statement with *and* and a statement with *or*?

EXPLORE Use a Venn diagram to answer questions about a group

STEP 1 Answer questions Copy the questions below and write your answers beside them.

1. Are you taking an art class?
2. Are you taking a foreign language class?

STEP 2 Complete a Venn diagram Form a group with 3 or 4 classmates. Draw a Venn diagram, like the one shown below, where set *A* consists of students taking an art class, and set *B* consists of students taking a foreign language class. Then write the name of each student in the appropriate section of the diagram.



DRAW CONCLUSIONS Use your observations to complete these exercises

In Exercises 1–3, use your Venn diagram to list the students who belong in the given set.

1. Set *A*
2. Set *B*
3. Set *A and set B*
4. The students who belong in set *A or set B* are all of the students who belong only in set *A*, only in set *B*, or in set *A and set B*. List the students in your group who belong in set *A or set B*.
5. **OPEN-ENDED** Write a statement with *and* so that the statement is true for all students in your group.
6. **OPEN-ENDED** Write a statement with *or* so that the statement is true for all students in your group.

REASONING Tell whether the statement is *true* or *false*.

7. If a student belongs in set *A and set B*, then the student belongs in set *A or set B*.
8. If a student belongs in set *A or set B*, then the student belongs in set *A and set B*.

6.4 EXERCISES

HOMWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS14 for Exs. 7, 11, and 41
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 27, 39, and 45
- ◆ = MULTIPLE REPRESENTATIONS Ex. 43

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: A(n) ? is an inequality that consists of two inequalities joined by *and* or *or*.

2. ★ **WRITING** Describe the difference between the graphs of $-6 \leq x \leq -4$ and $x \leq -6$ or $x \geq -4$.

EXAMPLE 1

on p. 380
for Exs. 3–6

TRANSLATING VERBAL PHRASES Translate the verbal phrase into an inequality. Then graph the inequality.

3. All real numbers that are less than 6 *and* greater than 2
4. All real numbers that are less than or equal to -8 *or* greater than 12
5. All real numbers that are greater than or equal to -1.5 *and* less than 9.2
6. All real numbers that are greater than or equal to $-7\frac{1}{2}$ *or* less than or equal to -10

EXAMPLE 2

on p. 381
for Exs. 7–8

WRITING AND GRAPHING INEQUALITIES Write and graph an inequality that describes the situation.

7. The minimum speed on a highway is 40 miles per hour, and the maximum speed is 60 miles per hour.
8. The temperature inside a room is uncomfortable if the temperature is lower than 60°F or higher than 75°F .

EXAMPLES 3, 4, and 5

on pp. 381–382
for Exs. 9–22

SOLVING COMPOUND INEQUALITIES Solve the inequality. Graph your solution.

- | | |
|---|--|
| 9. $6 < x + 5 \leq 11$ | 10. $-7 > y - 8 \geq -12$ |
| 11. $-1 \leq -4m \leq 16$ | 12. $-6 < 3n + 9 < 21$ |
| 13. $-15 \leq 5(3p - 2) < 20$ | 14. $7 > \frac{2}{3}(6q + 18) \geq -9$ |
| 15. $2r + 3 < 7$ or $-r + 9 \leq 2$ | 16. $16 < -s - 6$ or $2s + 5 \geq 11$ |
| 17. $v + 13 < 8$ or $-8v < -40$ | 18. $-14 > w + 3$ or $5w - 13 > w + 7$ |
| 19. $9g - 6 > 12g + 1$ or $4 > -\frac{2}{5}g + 8$ | 20. $-2h - 7 > h + 5$ or $\frac{1}{4}(h + 8) \geq 9$ |

ERROR ANALYSIS Describe and correct the error in solving the inequality or in graphing the solution.

21.

$$\begin{aligned} 4 &< -2x + 3 < 9 \\ 4 &< -2x < 6 \\ -2 &> x > -3 \end{aligned}$$

22.


$$\begin{aligned} x - 2 &> 5 \text{ or } x + 8 < -2 \\ x &> 7 \text{ or } x < -10 \end{aligned}$$

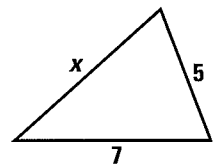
TRANSLATING SENTENCES Write the verbal sentence as an inequality. Then solve the inequality and graph your solution.

23. Five more than x is less than 8 or 3 less than x is greater than 5.
24. Three less than x is greater than -4 and less than -1 .
25. Three times the difference of x and 4 is greater than or equal to -8 and less than or equal to 10.
26. The sum of $-2x$ and 8 is less than or equal to -5 or 6 is less than $-2x$.
27. ★ **MULTIPLE CHOICE** Consider the compound inequality $a > 3x + 8$ or $a > -4x - 1$. For which value of a does the solution consist of numbers greater than -6 and less than 5?
- (A) 16 (B) 19 (C) 23 (D) 26

REASONING In Exercises 28 and 29, tell whether the statement is *true* or *false*. If it is false, give a counterexample.

28. If a is a solution of $x < 5$, then a is also a solution of $x < 5$ and $x \geq -4$.
29. If a is a solution of $x > 5$, then a is also a solution of $x > 5$ or $x \leq -4$.
30. Is the converse of the statement in Exercise 28 *true* or *false*? Explain.
31. Is the converse of the statement in Exercise 29 *true* or *false*? Explain.

32.  **GEOMETRY** The sum of the lengths of any two sides of a triangle is greater than the length of the third side.
- a. Write and solve three inequalities for the triangle shown.
- b. Use the inequalities that you wrote in part (a) to write one inequality that describes all the possible values of x .
- c. Give three possible lengths for the third side of the triangle.




CHALLENGE Solve the inequality, if possible. Graph your solution.

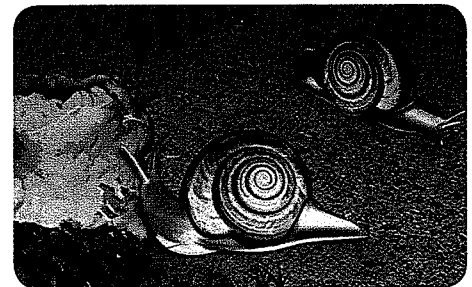
33. $-18 < x - 23$ and $x - 16 < -22$
34. $-3y + 7 \leq 11$ and $y + 4 > 11$
35. $2m - 1 \geq 5$ or $5m > -25$
36. $n + 19 \geq 10$ or $-5n + 3 > 33$

PROBLEM SOLVING

EXAMPLE 2
on p. 381
for Exs. 37, 39,
40


37. **SLITSNAILS** Slitsnails are large mollusks that live in deep waters. Slitsnails have been found at elevations from -2600 feet to -100 feet. Write and graph a compound inequality that represents the elevations at which slitsnails have been found.

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EXAMPLE 6
on p. 383
for Exs. 38,
41–43

38. **ICEBERGS** The temperature inside an iceberg off the coast of Newfoundland, Canada, ranges from -20°C to -15°C . Write and graph a compound inequality that describes the possible temperatures (in degrees Fahrenheit) of the iceberg's interior.

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39. ★ **MULTIPLE CHOICE** The euro is the currency in several countries in Europe. In 2003, the dollar value of one euro ranged from \$1.0361 to \$1.2597. Which inequality represents the dollar values v that the euro was *not* worth during the year?

- (A) $1.0361 < v < 1.2597$ (B) $v < 1.0361$ or $v > 1.2597$
 (C) $1.0361 \leq v \leq 1.2597$ (D) $v \leq 1.0361$ or $v \geq 1.2597$

40. **CURRENCY** On October 25, 1865, the steamship *S.S. Republic* sank along with a cargo of gold and silver coins. The list gives the prices of several recovered gold coins. Use the least price and greatest price to write a compound inequality that describes the prices p of the coins.

Prices of Recovered Gold Coins

\$9,098	\$20,995	\$9,798	\$33,592	\$12,597
\$16,796	\$9,798	\$10,498	\$5,319	\$73,486
\$11,897	\$32,895	\$7,349	\$6,578	\$29,395



41. **ANIMALS** A deer can eat 2% to 4% of its body weight in food per day. The percent p of the deer's body weight eaten in food is given by the equation $p = \frac{f}{d}$ where f is the amount (in pounds) of food eaten and d is the weight (in pounds) of the deer. Find the possible amounts of food that a 160 pound deer can eat per day.

42. **SKIS** A ski shop sells recreational skis with lengths ranging from 150 centimeters to 220 centimeters. The shop recommends that recreational skis be 1.16 times the skier's height (in centimeters). For which heights of skiers does the shop *not* provide recreational skis?
43. **MULTIPLE REPRESENTATIONS** Water can exist as either a solid, a liquid, or a gas. The table shows the temperatures (in degrees Celsius) at which water can exist in each state.

State of water	Solid	Liquid	Gas
Temperatures (°C)	Less than 0	0 to 100	Greater than 100

- a. **Writing an Inequality** Write and solve a compound inequality to find the temperatures (in degrees Fahrenheit) at which water is *not* a liquid.
- b. **Making a Table** Make a table that gives the temperature (in degrees Celsius) when the temperature (in degrees Fahrenheit) of water is 23°F, 86°F, 140°F, 194°F, and 239°F. For which temperatures in the table is water *not* a liquid?
44. **WEATHER** Wind chill temperature describes how much colder it feels when the speed of the wind is combined with air temperature. At a wind speed of 20 miles per hour, the wind chill temperature w (in degrees Fahrenheit) can be given by the model $w = -22 + 1.3a$ where a is the air temperature (in degrees Fahrenheit). What are the possible air temperatures if the wind chill temperature ranges from -9°F to -2.5°F at a wind speed of 20 miles per hour?

45. ★ **EXTENDED RESPONSE** Some musicians use audio amplifiers so that everyone in the audience can hear the performance. The amount y of amplification per person is given by the equation $y = \frac{w}{p}$ where w is the total amount (in watts) of amplification provided by the amplifier and p is the number of people in the audience.
- Solve** Each person requires 8 watts to 10 watts of amplification. Write and solve an inequality to find the possible total amounts of amplification that an amplifier would need to provide for 300 people.
 - Decide** Will an amplifier that provides 2900 watts of amplification be strong enough for an audience of 350 people? 400 people? *Explain.*
 - Justify** Your band usually performs before an audience of 500 to 600 people. What is the least amount of amplification that your amplifier should provide? *Justify* your answer.

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46. **CHALLENGE** You and three friends are planning to eat at a restaurant, and all of you agree to divide the total cost of the meals and the 15% tip equally. Each person agrees to pay at least \$10 but no more than \$20. How much can you spend altogether on meals before the tip is applied?

MIXED REVIEW

Evaluate the expression.

47. $14x$ when $x = 3$ (p. 2)

48. $6d^3$ when $d = 4$ (p. 8)

49. $|m|$ when $m = -1$ (p. 64)

50. $-8t$ when $t = -5$ (p. 88)

Solve the equation.

51. $8x - 14 = -16$ (p. 134)

52. $2y + 8 + 5y = -1$ (p. 141)

53. $4(f - 3) = -28$ (p. 148)

54. $6r - 2 = 5r - 3$ (p. 154)

55. **MUSEUMS** You and some friends are taking a trip to a museum. Parking costs \$15, and the price of a ticket is \$14.50. Write an equation that gives the total cost C (in dollars) of the trip as a function of the number p of people who are going. (p. 283)

PREVIEW

Prepare for
Lesson 6.5
in Exs. 51–54.

QUIZ for Lessons 6.3–6.4

Solve the inequality, if possible. Graph your solution.

1. $-\frac{1}{5}(x - 5) > x - 9$ (p. 369)

2. $\frac{1}{2}y - 8 \geq -2y + 3$ (p. 369)

3. $-4r + 7 \leq r + 10$ (p. 369)

4. $-2(s + 6) \leq -2s + 8$ (p. 369)

5. $a - 4 \geq -1$ or $3a < -24$ (p. 380)

6. $22 > -3c + 4 > 14$ (p. 380)

7. $-27 \leq 9m \leq -18$ (p. 380)

8. $5n + 2 > -18$ or $-3(n + 4) > 21$ (p. 380)

6.4 Solve Compound Inequalities

QUESTION How can you use a graphing calculator to display the solutions of a compound inequality?

EXAMPLE Display the solutions of a compound inequality on a graphing calculator

Display the solutions of $12 \leq 3x \leq 21$ on a graphing calculator.

STEP 1 Rewrite inequality

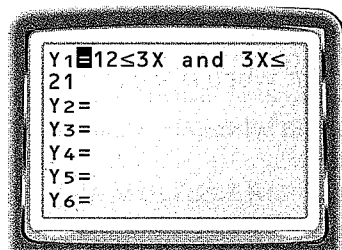
Rewrite $12 \leq 3x \leq 21$ as two separate inequalities joined by *and*.

$12 \leq 3x \leq 21$ Write original inequality.

$12 \leq 3x$ and $3x \leq 21$ Write as two inequalities joined by *and*.

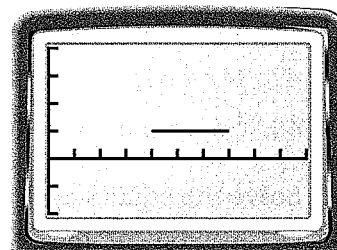
STEP 2 Enter inequalities

Press **Y=** and enter the two inequalities, as shown. Inequality signs can be found in the TEST menu, and *and* and *or* can be found in the LOGIC menu.



STEP 3 Display solutions

Press **GRAPH** to display the solutions of $12 \leq 3x$ and $3x \leq 21$. For each value of x that makes the inequality true, the calculator assigns a value of 1 to y and plots the point $(x, 1)$. For each value of x that makes the inequality false, the calculator assigns a value of 0 to y and plots the point $(x, 0)$.



The screen in Step 3 shows the graph of $y = 1$ over the interval $4 \leq x \leq 7$. This suggests that the solutions are all real numbers greater than or equal to 4 and less than or equal to 7.

DRAW CONCLUSIONS

1. Display the solutions of $12 < 3x < 21$ on a graphing calculator. Then compare the graph of $12 < 3x < 21$ with the graph of $12 \leq 3x \leq 21$.
2. When displaying the solutions of an inequality on a graphing calculator, how do you know which inequality symbols you should use in your solution?

Display the solutions of the inequality on a graphing calculator.

3. $9 \leq 3x \leq 21$

4. $4 < 4x < 8$

5. $2 \leq \frac{1}{4}x \leq 12$

6. $-6x > 18$ or $9x > 45$

7. $4x \leq 18$ or $5x \geq 25$

8. $8x \leq 16$ or $3x \geq 30$



Lessons 6.1–6.4

1. **MULTI-STEP PROBLEM** A nanotube thermometer is so tiny that it is invisible to the human eye. The thermometer can measure temperatures from 50°C to 500°C .
 - a. Write and solve a compound inequality to find the temperatures (in degrees Fahrenheit) that the thermometer can measure.
 - b. Graph your solution of the inequality.
 - c. Can the thermometer measure a temperature of 1000°F ? *Explain.*

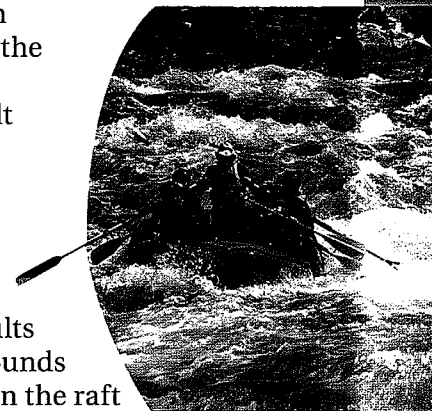
2. **SHORT RESPONSE** You earned the following scores on five science tests: 75, 82, 90, 84, and 71. You want to have an average score of at least 80 after you take the sixth test.
 - a. Write and solve an inequality to find the possible scores that you can earn on your sixth test in order to meet your goal.
 - b. The greatest score that you can earn on a test is 100. Is it possible for you to have an average score of 90 after the sixth test? *Explain* your reasoning.

3. **GRIDDED ANSWER** You need at least 34 eggs to make enough chiffon cakes for a bake sale. Your grocery store sells cartons of eggs only by the dozen. Of all the possible numbers of cartons that you can buy, which is the least number?

4. **MULTI-STEP PROBLEM** You have a \$300 gift card to use at a sporting goods store.
 - a. You want to use your card to buy 2 pairs of shoes for \$85 each and several pairs of socks. Write and solve an inequality to find the possible amounts of money that you can spend on socks using your card.
 - b. Suppose that socks cost \$4.75 per pair. Write and solve an inequality to find the possible numbers of socks that you can buy using the card.

5. **OPEN-ENDED** *Describe* a real-world situation that can be modeled by the inequality $17x \leq 240$. *Explain* what the solution of the inequality means in this situation.

6. **SHORT RESPONSE** A rafting guide plans to take 6 adults on a rafting trip. The raft can hold up to 1520 pounds. The guide weighs 180 pounds and estimates that each adult will bring 10 pounds of baggage.
 - a. Write and solve an inequality to find the possible average weights of an adult such that the raft will not exceed its maximum weight capacity.
 - b. Suppose that the weights of the adults range from 105 pounds to 200 pounds. Can the raft accommodate all the people and the baggage at one time? *Justify* your answer.



7. **EXTENDED RESPONSE** In 1862 the United States imposed a tax on annual income in order to pay for the expenses of the Civil War. The table shows the tax rates for different incomes.

Annual income	Tax rate
\$600 to \$10,000	3% of income
Greater than \$10,000	3% of the first \$10,000 plus 5% of income over \$10,000

- a. Write a compound inequality that represents the possible taxes paid by a person whose annual income was at least \$600 but not greater than \$10,000.
- b. For people whose taxes ranged from \$400 to \$750, tell whether their annual incomes were greater than \$10,000 or less than \$10,000. *Explain* how you know. Then find the possible annual incomes of those people.
- c. Suppose that the tax rate had been 4% of the total income for people whose annual incomes were greater than \$10,000. For which incomes would paying the 4% rate have resulted in less taxes than paying the tax rate described above? *Explain.*

6.5 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS
on p. WS14 for Exs. 11, 23, and 45
- ★ = STANDARDIZED TEST PRACTICE
Exs. 2, 32, 44, 48, and 49

SKILL PRACTICE

- VOCABULARY** Copy and complete: The equation $|x - 7| = 0.15$ is an example of a(n) ?.
- ★ **WRITING** Given $|x - 9| = 5$, describe the relationship between x , 9, and 5 using absolute deviation.

EXAMPLES

1, 2, and 3
on pp. 390–391
for Exs. 3–20

SOLVING EQUATIONS Solve the equation.

- | | | |
|------------------------------------|-------------------------|-----------------------------------|
| 3. $ x = 5$ | 4. $ y = 36$ | 5. $ v = 0.7$ |
| 6. $ w = 9.2$ | 7. $ r = \frac{1}{2}$ | 8. $ s = \frac{7}{4}$ |
| 9. $ m + 3 = 7$ | 10. $ 4n - 5 = 18$ | 11. $ 3p + 7 = 4$ |
| 12. $ q + 8 = 2$ | 13. $ 2d + 7 = 11$ | 14. $ f - 8 = 14$ |
| 15. $3 13 - 2t = 15$ | 16. $4 b - 1 - 7 = 17$ | 17. $\frac{1}{3} 2c - 5 + 3 = 7$ |
| 18. $\frac{7}{4} 3j + 5 + 1 = 15$ | 19. $4 2k + 3 - 2 = 6$ | 20. $-3 5g + 1 - 6 = -9$ |

ERROR ANALYSIS Describe and correct the error in solving the absolute value equation.

21. $|x + 4| = 13$
 $x + 4 = 13$
 $x = 9$

22. $|x - 6| = -2$
 $x - 6 = -2$ or $x - 6 = 2$
 $x = 4$ or $x = 8$

EXAMPLE 4

on p. 392
for Exs. 23–31

SOLVING EQUATIONS Solve the equation, if possible.

- | | | |
|----------------------------|------------------------------------|----------------------------------|
| 23. $ x - 1 + 5 = 2$ | 24. $ y - 4 + 8 = 6$ | 25. $ m + 5 + 1.5 = 2$ |
| 26. $-4 8 - 5n = 13$ | 27. $-3 1 - \frac{2}{3}v = -9$ | 28. $-5 \frac{4}{5}w + 6 = -10$ |
| 29. $-10 14 - r - 2 = -7$ | 30. $-2 \frac{1}{3}s - 5 + 3 = 8$ | 31. $-9 4p + 2 - 8 = -35$ |

32. ★ **MULTIPLE CHOICE** Which number is a solution of $|4x - 1| + 2 = 1$?
- (A) $-\frac{1}{2}$ (B) 0 (C) 1 (D) There is no solution.

EXAMPLE 5

on p. 392
for Exs. 33–36

USING ABSOLUTE DEVIATION Find the values of x that satisfy the definition of absolute deviation for the given value and the given absolute deviation.

- | | |
|--|--|
| 33. Given value: 5;
absolute deviation: 8 | 34. Given value: 20;
absolute deviation: 5 |
| 35. Given value: -9.1 ;
absolute deviation: 1.6 | 36. Given value: -3.4 ;
absolute deviation: 6.7 |

37. **SOLVING AN EQUATION** Interpreted geometrically, the equation $|x - a| = b$ means that the distance between x and a on a number line is b . Solve $|x - 3| = 7$ both geometrically and algebraically. Compare your solutions.

TRANSLATING SENTENCES In Exercises 38 and 39, write the verbal sentence as an absolute value equation. Then solve the equation.

38. Four more than the absolute deviation of x from 3 is 8.
39. Five times the absolute deviation of $2x$ from -9 is 15.
40. **REASONING** Is $a|x|$ equivalent to $|ax|$ when a is positive? when a is negative? when a is 0? Give examples to support your answers.
41. **CHALLENGE** How many solutions does the equation $a|x + b| + c = d$ have if $a > 0$ and $c = d$? if $a < 0$ and $c > d$?

PROBLEM SOLVING

EXAMPLE 5
on p. 392
for Exs. 42–46

42. **GUARDRAILS** A safety regulation requires that the height of a guardrail be 42 inches with an absolute deviation of 3 inches. Find the minimum and maximum heights of a guardrail.

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43. **CHEERLEADING** A cheerleading team is preparing a dance program for a competition. The program must last 4 minutes with an absolute deviation of 5 seconds. Find the least and greatest possible times (in seconds) that the program can last.

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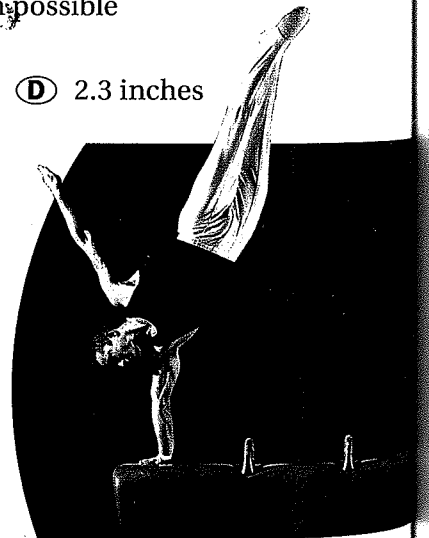
44. **★ MULTIPLE CHOICE** The diameter of a billiard ball must be 2.25 inches with an absolute error of 0.005 inch. What is the maximum possible diameter that a billiard ball can have?

(A) 2.2 inches (B) 2.245 inches (C) 2.255 inches (D) 2.3 inches

45. **SPORTS** In gymnastics meets last year, the mean of your friend's least and greatest scores was 54.675 points. The absolute deviation of his least and greatest scores from the mean was 2.213 points.

- a. What were the least and greatest scores that he earned?
- b. This year the mean of his least and greatest scores is 56.738 points, and the absolute deviation of the least and greatest scores from the mean is 0.45 point. How many points more than last year's greatest score is this year's greatest score?

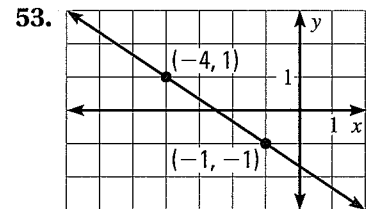
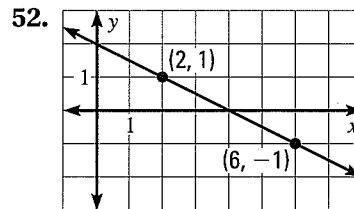
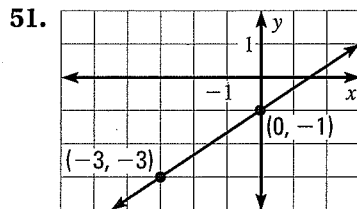
46. **JEWELRY** A jewelry store advertisement states that a certain diamond bracelet weighs 12 carats, but the actual weight can vary by as much as 5% of the advertised weight. Find the minimum and maximum possible weights of the bracelet.



47. **CONTESTS** You currently have 450 points in an academic contest. You choose the value p of the question you want to answer. The value p represents the absolute deviation of your new score s from 450.
- Write an absolute value equation that gives p in terms of s .
 - If you choose a question worth 150 points, what are the possible new scores that you can have after answering the question?
48. **★ EXTENDED RESPONSE** The percent p of United States residents who were foreign born, or born outside of the United States, during the period 1910–2000 can be modeled by the equation $p = 0.165|t - 60| + 4.8$ where t is the number of years since 1910.
- Approximate** During the period 1910–2000, in approximately what year did foreign-born residents account for 13% of all residents?
 - Predict** If the model holds for years after 2000, predict the year in which foreign-born residents will again account for 13% of all residents.
 - Decide** According to the model, did foreign-born residents account for 4% of all residents at any time during the period 1910–2000? Explain your answer.
49. **★ SHORT RESPONSE** A stock's average price p (in dollars) during the period February 2005 to October 2005 can be modeled by the equation $p = 2.3|m - 7| + 9.57$ where m is the number of months since February 2005.
- Approximate** In approximately what month and year was the average price \$16.15? If the model holds for months after October 2005, predict the month and year in which the average price will again be \$16.15.
 - Justify** Is it possible to use the model to estimate the stock's lowest average price during this period? Justify your answer.
50. **CHALLENGE** In a recent Olympics, swimmers in a men's 200 meter butterfly event finished with times from 1 minute 54.04 seconds to 1 minute 57.48 seconds. Let t represent the slowest or fastest time (in seconds). Write an absolute value equation that describes the situation.

MIXED REVIEW

Write an equation of the line shown. (p. 283)



Solve the inequality. Graph your solution.

54. $r + 7 \geq 28$ (p. 356)

55. $-\frac{1}{2}s > -8$ (p. 363)

56. $-6t + 7 \leq 15$ (p. 369)

57. $-5(v - 2) < -16$ (p. 369)

58. $-14 < 1 - 5w < 12$ (p. 380)

59. $-3x > 9$ or $4x \geq 8$ (p. 380)

PREVIEW

Prepare for
Lesson 6.6
in Exs. 54–59.

Extension

Use after Lesson 6.5

Graph Absolute Value Functions

GOAL Graph absolute value functions.

Key Vocabulary

- absolute value, p. 66

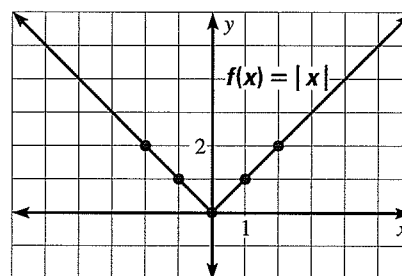
The function $f(x) = |x|$ is an example of an *absolute value function* and is the parent function for all absolute value functions. You can graph absolute value functions by using a table of values, as shown below for $f(x) = |x|$.

KEY CONCEPT

For Your Notebook

Graph of Parent Function for Absolute Value Functions

x	$f(x) = x $
-2	$ -2 = 2$
-1	$ -1 = 1$
0	$ 0 = 0$
1	$ 1 = 1$
2	$ 2 = 2$



EXAMPLE 1 Graph $g(x) = |x - h|$ and $g(x) = |x| + k$

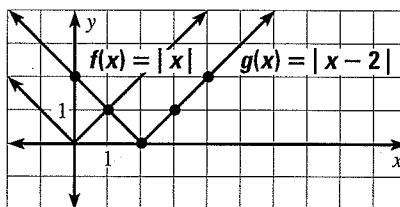
Graph each function. Compare the graph with the graph of $f(x) = |x|$.

a. $g(x) = |x - 2|$

STEP 1 Make a table of values.

x	0	1	2	3	4
$g(x)$	2	1	0	1	2

STEP 2 Graph the function.



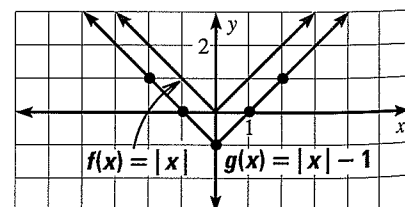
STEP 3 Compare the graphs of g and f . The graph of $g(x) = |x - 2|$ is 2 units to the right of the graph of $f(x) = |x|$.

b. $g(x) = |x| - 1$

STEP 1 Make a table of values.

x	-2	-1	0	1	2
$g(x)$	1	0	-1	0	1

STEP 2 Graph the function.



STEP 3 Compare the graphs of g and f . The graph of $g(x) = |x| - 1$ is 1 unit below the graph of $f(x) = |x|$.

APPLY TRANSFORMATIONS

The two graphs in Example 1 are translations of the graph of $f(x) = |x|$. The graph in part (a) is a horizontal translation. The graph in part (b) is a vertical translation.

EXAMPLE 2 Graph $g(x) = a|x|$

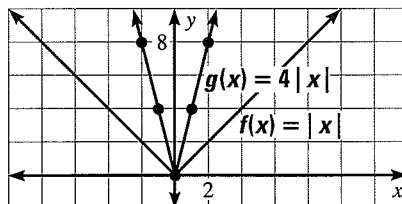
Graph each function. Compare the graph with the graph of $f(x) = |x|$.

a. $g(x) = 4|x|$

STEP 1 Make a table of values.

x	-2	-1	0	1	2
$g(x)$	8	4	0	4	8

STEP 2 Graph the function.



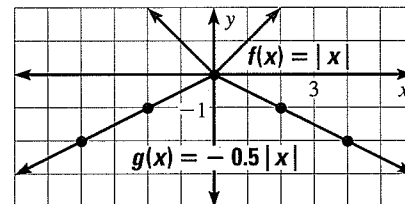
STEP 3 Compare the graphs of g and f . The graph of $g(x) = 4|x|$ opens up and is narrower than the graph of $f(x) = |x|$.

b. $g(x) = -0.5|x|$

STEP 1 Make a table of values.

x	-4	-2	0	2	4
$g(x)$	-2	-1	0	-1	-2

STEP 2 Graph the function.



STEP 3 Compare the graphs of g and f . The graph of $g(x) = -0.5|x|$ opens down and is wider than the graph of $f(x) = |x|$.

APPLY TRANSFORMATIONS

The graph in part (a) of Example 2 is a vertical stretch of the graph of $f(x) = |x|$. The graph in part (b) is a vertical shrink with a reflection in the x -axis of the graph of $f(x) = |x|$.

KEY CONCEPT

For Your Notebook

Comparing Graphs of Absolute Value Functions with the Graph of $f(x) = |x|$

$$g(x) = |x - h|$$

If $h > 0$, the graph of g is $|h|$ units to the right of the graph of $f(x) = |x|$.

If $h < 0$, the graph of g is $|h|$ units to the left of the graph of $f(x) = |x|$.

$$g(x) = |x| + k$$

If $k > 0$, the graph of g is $|k|$ units above the graph of $f(x) = |x|$.

If $k < 0$, the graph of g is $|k|$ units below the graph of $f(x) = |x|$.

$$g(x) = a|x|$$

If $|a| > 1$, the graph of g is narrower than the graph of $f(x) = |x|$.

If $0 < |a| < 1$, the graph of g is wider.

If $a > 0$, the graph of g opens up. If $a < 0$, the graph opens down.

PRACTICE

EXAMPLES 1 and 2

on pp. 396–397
for Exs. 1–6

Graph the function. Compare the graph with the graph of $f(x) = |x|$.

1. $g(x) = |x + 3|$

2. $g(x) = |x| + 5$

3. $g(x) = |x| - 7$

4. $g(x) = 2|x|$

5. $g(x) = 0.6|x|$

6. $g(x) = -3|x|$

7. Make a table of values for $g(x) = 2|x - 3| + 4$. Use the following values for x : 1, 2, 3, 4, 5. Then graph the function and compare the graph with the graph of $f(x) = |x|$.

6.6 EXERCISES

HOMEWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS15 for Exs. 9, 15, and 37
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 21, 22, 37, and 40
- ◆ = MULTIPLE REPRESENTATIONS Ex. 38

SKILL PRACTICE

EXAMPLES

1, 2, and 3
on pp. 398–399
for Exs. 3–24

1. **VOCABULARY** Copy and complete: The inequalities $|x| > 8$ and $x > 8$ or $x < -8$ are ?.

2. **★ WRITING** Describe the difference between solving $|x| \leq 5$ and solving $|x| \geq 5$.

SOLVING INEQUALITIES Solve the inequality. Graph your solution.

3. $|x| < 4$

4. $|y| \geq 3$

5. $|h| > 4.5$

6. $|p| < 1.3$

7. $|t| \leq \frac{3}{5}$

8. $|j| \geq 1\frac{3}{4}$

9. $|d + 4| \geq 3$

10. $|b - 5| < 10$

11. $|14 - m| > 6$

12. $|2s - 7| < 1$

13. $|4c + 5| \geq 7$

14. $|9 - 4n| \leq 5$

15. $5\left|\frac{1}{2}r + 3\right| > 5$

16. $\left|\frac{4}{3}s - 7\right| - 8 > 3$

17. $-3\left|2 - \frac{5}{4}u\right| \leq -18$

18. $2|3w + 8| - 13 < -5$

19. $2\left|\frac{1}{4}v - 5\right| - 4 > 3$

20. $\frac{2}{7}|4f + 6| - 2 \geq 10$

21. **★ MULTIPLE CHOICE** Which inequality is equivalent to $x < 1$ or $x > 5$?

(A) $|x + 8| - 2 > 10$

(B) $3|6 - 2x| > 12$

(C) $|5x + 9| < 10$

(D) $|7 - 4x| - 9 < 8$

22. **★ WRITING** How can you tell whether an absolute value inequality is equivalent to a compound inequality with *and* or to a compound inequality with *or*?

ERROR ANALYSIS Describe and correct the error in solving the inequality.

23.

$$|x + 4| > 13$$

$$13 > x + 4 > -13$$

$$9 > x > -17$$



24.

$$|x - 5| < 20$$

$$x - 5 < 20$$

$$x < 25$$



TRANSLATING SENTENCES Write the verbal sentence as an inequality. Then solve the inequality and graph your solution.

25. The absolute deviation of x from 6 is less than or equal to 4.

26. The absolute deviation of $2x$ from -7 is greater than or equal to 15.

27. Three more than the absolute deviation of $-4x$ from 7 is greater than 10.

28. Four times the absolute deviation of x from 9 is less than 8.


REASONING Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

29. If a is a solution of $|x + 3| \leq 8$, then a is also a solution of $x + 3 \geq -8$.
30. If a is a solution of $|x + 3| > 8$, then a is also a solution of $x + 3 > 8$.
31. If a is a solution of $|x + 3| \geq 8$, then a is also a solution of $x + 3 \leq -8$.
32. If a is a solution of $x + 3 \leq -8$, then a is also a solution of $|x + 3| \geq 8$.
33. **CHALLENGE** Solve $|x - 3| < 4$ and $|x + 2| > 8$. Describe your steps.
34. **CHALLENGE** If $|ax + b| < c$ where $c < 0$, what is the solution of the inequality? If $|ax + b| > c$ where $c < 0$, what is the solution of the inequality? Explain your answers.


PROBLEM SOLVING

EXAMPLE 4
on p. 400
for Exs. 35–38

35. **ESSAY CONTEST** An essay contest requires that essay entries consist of 500 words with an absolute deviation of at most 30 words. What are the possible numbers of words that the essay can have?

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36. **SWIMMING POOL** The saturation index for a pool measures the balance between the acid level and the amount of minerals in pool water. Balanced water has an index value of 0. Water is highly corrosive or highly scale forming if the absolute deviation of the index value from 0 is greater than 0.5. Find the index values for which pool water is highly corrosive or highly scale forming.

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37. **★ SHORT RESPONSE** You are preheating an oven to 350°F before you bake muffins. Several minutes later, the oven thermometer reads 346°F . The measured temperature has an absolute deviation of at most 2°F . Write and solve an inequality to find the possible temperatures in the oven. Should you continue to preheat the oven, or should you start baking the muffins? Explain your choice.



38. **◆ MULTIPLE REPRESENTATIONS** Softball compression measures the hardness of a softball and affects the distance that the softball can travel upon contact with a bat. A softball organization requires that the compression of a softball be 350 pounds but allows an absolute deviation of at most 50 pounds.
- a. **Making a Table** Make a table that shows the absolute deviation from the required compression when the measured compression of a softball is p pounds. Use the following values for p : 275, 325, 375, 425, 475.
- b. **Writing an Inequality** Write and solve an inequality to find the softball compressions that the organization will allow. Which values of p in the table are solutions of the inequality?

39. **MULTI-STEP PROBLEM** In a physics class, 7 groups of students experimentally determine the acceleration (in meters per second per second) of an object in free fall. The table below shows the value calculated by each group.

Group	1	2	3	4	5	6	7
Calculated value (m/sec ²)	10.50	9.52	9.73	9.86	9.78	10.90	9.86

- a. **Calculate** Find the mean of the measured values given in the table. Round to the nearest hundredth.
- b. **Solve** When writing up their lab reports, the students wanted to state that the absolute deviation of each measured value x from the mean was at most d . What is the value of d in this situation?
40. **★ EXTENDED RESPONSE** *Relative absolute deviation* of a number from a given value is the absolute deviation expressed as a percent of the given value. A wildlife biologist estimates that the number of pronghorn antelope in Nevada is 18,000 with a relative absolute deviation of at most 20%.
- a. **Calculate** Find the absolute deviation from the estimated population of pronghorn antelope by multiplying the estimated population by the relative absolute deviation.
- b. **Solve** Write and solve an inequality to find the possible numbers of pronghorn antelope in Nevada.
- c. **Explain** If the relative absolute deviation were 25%, could you conclude that the actual population is necessarily greater than if the relative absolute deviation were 20%? *Explain* your reasoning.
41. **CHALLENGE** According to the rules for a women's figure skating event, a skater should finish a routine in an ideal time of 3 minutes 30 seconds. The skater receives a 0.1 point penalty if the absolute deviation of the finishing time from the ideal time is greater than 10 seconds *and* less than or equal to 20 seconds. Write and solve an inequality to find the finishing times for which the skater receives a 0.1 penalty point.



MIXED REVIEW

PREVIEW

Prepare for
Lesson 6.7
in Exs. 42–53.

Graph the equation. (p. 215)

42. $y = -5.5$

43. $x = 10$

44. $3x + y = 3$

45. $y = 2x + 7$

46. $y = -5x + 2$

47. $5 = -\frac{1}{2}x - y$

Check whether the ordered pair is a solution of the equation. (p. 215)

48. $x - y = 1$; (2, 1)

49. $-x + 2y = -12$; (3, 0)

50. $x = -9$; (-9, 3)

51. $y = -1$; (-1, 10)

52. $-4y - x = -1$; (-2, -8)

53. $6y + 5x = 10$; (-4, 8)

6.7 Linear Inequalities in Two Variables

MATERIALS • set of tangram pieces • 4 tangram puzzles • stopwatch

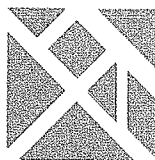
QUESTION How can you use inequalities to describe an overestimate or an underestimate?

EXPLORE Conduct an experiment

To solve a tangram puzzle, you use seven pieces to create a figure. Each piece must lie flat and touch at least one other piece, and the pieces cannot overlap.

STEP 1 Predict a time

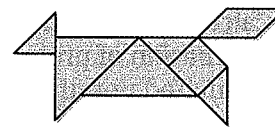
Have your partner give you a tangram puzzle, such as the dog shown below. Predict how long it will take you to create the figure.



Predicted time:
50 seconds

STEP 2 Create figure

Use the tangrams to create the figure. Your partner will use a stopwatch to record the actual time it takes you to finish.



Actual time:
73 seconds

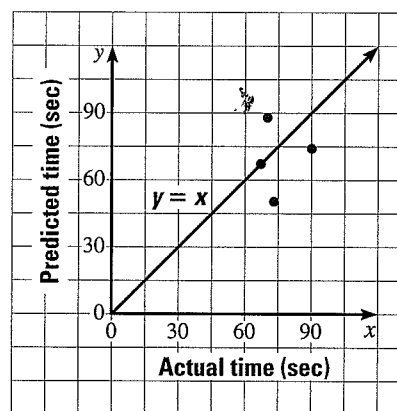
STEP 3 Record times

Record the actual time x and the predicted time y in a table, as below. Repeat Steps 1–3 for three more puzzles. Then switch roles with your partner.

Figure	Actual time x (sec)	Predicted time y (sec)
1	73	50
2	67	67
3	70	88
4	90	74

STEP 4 Plot points

Graph $y = x$ in Quadrant I. Then plot the points (x, y) from the table.



DRAW CONCLUSIONS Use your observations to complete these exercises

- Describe the points that represent an *overestimate* of the actual finishing time. Then write an inequality that describes the location of the points in the coordinate plane.
- Describe the points that represent an *underestimate* of the actual finishing time. Then write an inequality that describes the location of the points in the coordinate plane.

6.7 EXERCISES

HOMWORK KEY

- = WORKED-OUT SOLUTIONS on p. WS15 for Exs. 5, 19, and 57
- ★ = STANDARDIZED TEST PRACTICE Exs. 2, 15, 16, 39, 56, 59, and 60
- ◆ = MULTIPLE REPRESENTATIONS Ex. 55

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: The ordered pair $(2, -4)$ is a(n) ? of $3x - y > 7$.

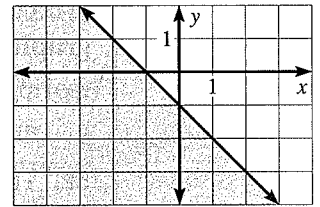
2. ★ **WRITING** Describe the difference between graphing a linear inequality in two variables and graphing a linear equation in two variables.

CHECKING SOLUTIONS Tell whether the ordered pair is a solution of the inequality.

- | | | |
|------------------------------------|--|--|
| 3. $x + y < -4$; $(0, 0)$ | 4. $x - y \leq 5$; $(8, 3)$ | 5. $y - x > -2$; $(-1, -4)$ |
| 6. $2x + 3y \geq 14$; $(5, 2)$ | 7. $4x - 7y > 28$; $(-2, 4)$ | 8. $-3y - 2x < 12$; $(5, -6)$ |
| 9. $2.8x + 4.1y \leq 1$; $(0, 0)$ | 10. $0.5y - 0.5x > 3.5$; $(6, 2)$ | 11. $x \geq -3$; $(-4, 0)$ |
| 12. $y \leq 8$; $(-9, -7)$ | 13. $\frac{3}{4}x - \frac{1}{3}y < 6$; $(-8, 12)$ | 14. $\frac{2}{5}x + y \geq 2$; $(1, 2)$ |
15. ★ **MULTIPLE CHOICE** Which ordered pair is *not* a solution of $x + 5y < 15$?
- (A) $(-1, -3)$ (B) $(-1, 3)$ (C) $(1, 3)$ (D) $(3, 2)$

16. ★ **MULTIPLE CHOICE** The graph of which inequality is shown?

- (A) $x + y \leq -1$ (B) $x + y \geq -1$
 (C) $x - y \leq -1$ (D) $x - y \geq -1$

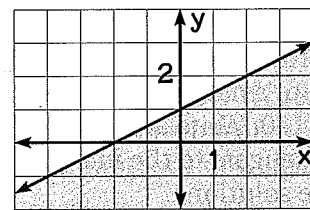


GRAPHING INEQUALITIES Graph the inequality.

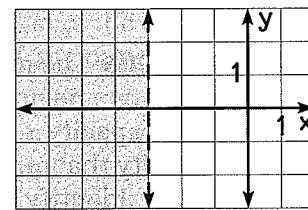
- | | | | |
|------------------------|----------------------------|-----------------------------------|--------------------------------------|
| 17. $y > x + 3$ | 18. $y \leq x - 2$ | 19. $y < 3x + 5$ | 20. $y \geq -2x + 8$ |
| 21. $x + y < -8$ | 22. $x - y \leq -11$ | 23. $x + 8y > 16$ | 24. $5x - y \geq 1$ |
| 25. $2(x + 2) > 7y$ | 26. $y - 4 < x - 6$ | 27. $-4y \leq 16x$ | 28. $6(2x) \geq -24y$ |
| 29. $y < -3$ | 30. $x \geq 5$ | 31. $x > -2$ | 32. $y \leq 4$ |
| 33. $3(x - 2) > y + 8$ | 34. $x - 4 \leq -2(y + 6)$ | 35. $\frac{1}{2}(x + 2) + 3y < 8$ | 36. $2(x + 1) \geq \frac{1}{4}y - 1$ |

ERROR ANALYSIS Describe and correct the error in graphing the inequality.

37. $2y - x \geq 2$



38. $x \leq -3$



EXAMPLE 1
on p. 405
for Exs. 3–15

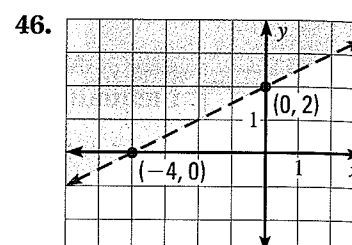
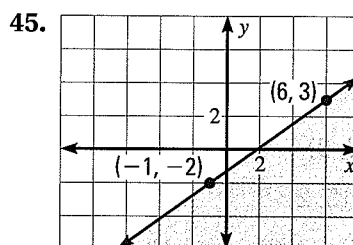
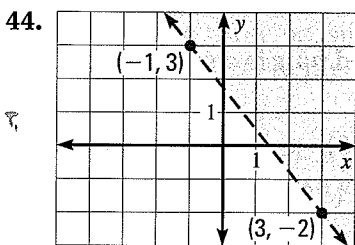
EXAMPLES 2, 3, 4, and 5
on pp. 406–407
for Exs. 16–38

39. ★ **WRITING** Can you use $(0, 0)$ as a test point when graphing $2x > -5y$? Explain your reasoning.

TRANSLATING SENTENCES Write the verbal sentence as an inequality. Then graph the inequality.

40. Four less than x is greater than or equal to y .
 41. The product of -2 and y is less than or equal to the sum of x and 6 .
 42. The quotient of y and 2 is greater than the difference of 7 and x .
 43. The sum of x and the product of 4 and y is less than -3 .

USING A GRAPH Write an inequality of the graph shown.



WRITING INEQUALITIES Write an inequality whose graph contains only the points in the given quadrants.

47. Quadrants I and II
 48. Quadrants II and III
 49. Quadrants III and IV
 50. Quadrants I and IV


CHALLENGE In Exercises 51 and 52, write and graph an inequality whose graph is described by the given information.

51. The points $(2, 5)$ and $(-3, -5)$ lie on the boundary line. The points $(6, 5)$ and $(-2, -3)$ are solutions of the inequality.
 52. The points $(-7, -16)$ and $(1, 8)$ lie on the boundary line. The points $(-7, 0)$ and $(3, 14)$ are *not* solutions of the inequality.


PROBLEM SOLVING

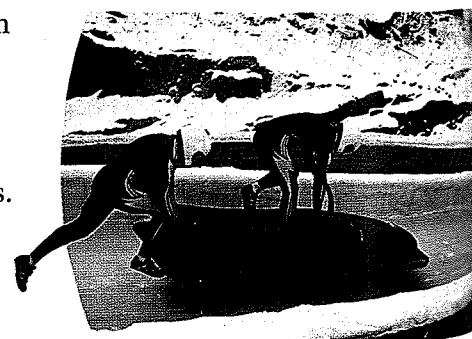
EXAMPLE 6
 on p. 408
 for Exs. 53–57

53. **BOBSLEDS** In a two-man bobsled competition, the sum of the weight x (in pounds) of the bobsled and the combined weight y (in pounds) of the athletes must not exceed 860 pounds. Write and graph an inequality that describes the possible weights of the bobsled and the athletes. Identify and interpret one of the solutions.

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54. **ELEVATORS** The number y of passengers riding an elevator can be no greater than the elevator's maximum weight capacity x (in pounds) divided by 150. Write and graph an inequality that relates the number of passengers to the maximum weight capacity. Identify and interpret one of the solutions.

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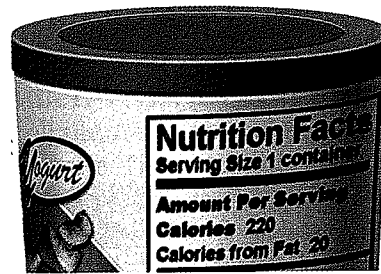
55. **◆ MULTIPLE REPRESENTATIONS** You tutor Spanish for \$15 per hour and French for \$10 per hour. You want to earn at least \$100 per week.
- Writing an Inequality** Write an inequality that describes your goal in terms of hours spent tutoring Spanish and hours spent tutoring French.
 - Drawing a Graph** Graph the inequality. Then give three possible combinations of hours that meet your goal.
 - Making a Table** Make a table that gives the amount of money that you will earn for each combination of hours given in part (b).

56. **★ MULTIPLE CHOICE** To compete in a piano competition, you need to perform two musical pieces whose combined duration is no greater than 15 minutes. Which inequality describes the possible durations x and y (in minutes) of the pieces?

(A) $x + y < 15$ (B) $x + y \leq 15$ (C) $x + y > 15$ (D) $x + y \geq 15$

57. **Ⓜ MULTI-STEP PROBLEM** You are making muffins and loaves of bread for a bake sale. You need $\frac{1}{6}$ batch of batter per muffin and $\frac{1}{2}$ batch of batter per loaf of bread. You have enough ingredients to make up to 12 batches of batter.
- Write and graph an inequality that describes the possible combinations of muffins m and loaves l of bread that you can make.
 - You make 4 loaves of bread. What are the possible numbers of muffins that you can make?

58. **NUTRITION** A nutritionist recommends that the fat calories y consumed per day should be at most 30% of the total calories x consumed per day.
- Write and graph an inequality that relates the number of fat calories consumed to the total calories consumed.
 - Use the nutrition labels below. You normally consume 2000 calories per day. So far today you have eaten 6 crackers and 1 container of yogurt. What are the possible additional fat calories that you can consume today?



59. **★ SHORT RESPONSE** You need to bring a duffel and a bedroll for a trip in the mountains. The sum of the weight x (in pounds) of the duffel and the weight y (in pounds) of the bedroll cannot exceed 30 pounds.
- Graph and Apply** Write and graph a linear inequality that describes the possible weights of the duffel and bedroll. Then give three possible combinations of weights of the duffel and bedroll.
 - Interpret** Are $(0, 30)$ and $(30, 0)$ solutions of the inequality in part (a)? Do these ordered pairs make sense for this situation? *Explain.*

60. ★ **EXTENDED RESPONSE** A financial advisor suggests that if a person is an aggressive investor, the percent y of money that the person invests in stocks should be greater than the difference of 110 and the person's age x .
- Graph** Write and graph a linear inequality that relates the percent of money invested in stocks to an aggressive investor's age.
 - Calculate** If an aggressive investor is 30 years old, what are the possible percents that the investor can invest in stocks? *Explain* your answer.
 - Justify** Are there any ages for which none of the solutions of the inequality makes sense for this situation? *Justify* your answer.
61. **CHALLENGE** The formula $m = dV$ gives the mass m of an object in terms of the object's density d and its volume V . Water has a density of 1 gram per cubic centimeter. An object immersed in water will sink if its density is greater than the density of water. An object will float in water if its density is less than the density of water.
- For an object that sinks, write and graph an inequality that relates its mass (in grams) to its volume (in cubic centimeters). For an object that floats, write and graph an inequality that relates its mass (in grams) to its volume (in cubic centimeters).
 - A cylindrical can has a radius of 5 centimeters, a height of 10 centimeters, and a mass of 2119.5 grams. Will the can sink or float in water? *Explain* your answer.

MIXED REVIEW

Solve the equation or inequality.

- | | | |
|--|-----------------------------------|---|
| 62. $-4a = 20$ (p. 134) | 63. $3c + 8 = 17$ (p. 141) | 64. $6m - 5 = -8m + 2$ (p. 154) |
| 65. $\frac{n}{5} = \frac{n+1}{3}$ (p. 168) | 66. $p - 9 \geq -15$ (p. 356) | 67. $-2s + 3 < -4$ (p. 369) |
| 68. $2x \geq 8$ or $5x < 10$ (p. 380) | 69. $-2 < 9y - 2 \leq 5$ (p. 380) | 70. $ \frac{1}{3}g - 7 \geq 15$ (p. 398) |

Graph the equation. (p. 225)

- | | | |
|-------------------|----------------------|---------------------|
| 71. $x - y = 8$ | 72. $-6x + 2y = -12$ | 73. $12x + 3y = -9$ |
| 74. $y = -7x + 1$ | 75. $y = 5x + 2$ | 76. $y = 0.5x - 5$ |

PREVIEW
Prepare for
Lesson 7.1 in
Exs. 71–76.

QUIZ for Lessons 6.5–6.7

Solve the equation. (p. 390)

- | | | |
|--------------|-------------------|---------------------|
| 1. $ x = 5$ | 2. $ c - 8 = 24$ | 3. $-2 r - 5 = -6$ |
|--------------|-------------------|---------------------|

Solve the inequality. Graph your solution. (p. 398)

- | | | |
|--------------|-------------------|---------------------------|
| 4. $ y > 4$ | 5. $ 2t - 5 < 3$ | 6. $4 3s + 7 - 5 \geq 7$ |
|--------------|-------------------|---------------------------|

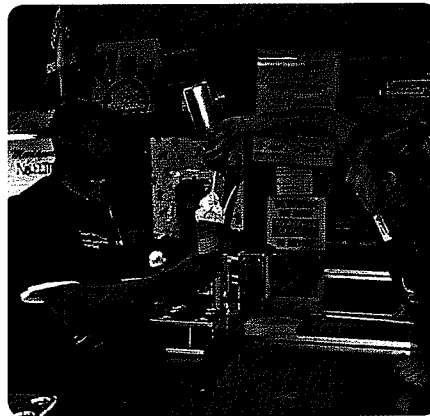
Graph the inequality. (p. 405)

- | | | |
|-------------------|------------------------|--------------------|
| 7. $x + y \geq 3$ | 8. $\frac{5}{7}x < 10$ | 9. $2y - x \leq 8$ |
|-------------------|------------------------|--------------------|

Lessons 6.5–6.7

1. **MULTI-STEP PROBLEM** You gathered 36 apples from your backyard apple tree in order to make apple pies and applesauce. You use 7 apples to make one apple pie and 5 apples to make one pint of applesauce.
 - a. Write an inequality that describes the possible numbers of apple pies and pints of applesauce that you can make.
 - b. Graph the inequality.
 - c. Give three possible combinations of apple pies and pints of applesauce that you can make.

2. **SHORT RESPONSE** You are scooping ice cream as part of your training at an ice cream shop. The weight of a scoop must be 4 ounces with an absolute deviation of at most 0.5 ounce.
 - a. Write an inequality to find the possible weights (in ounces) of each scoop.
 - b. You make 10 scoops. You can start working at the shop if at least 80% of the scoops meet the weight requirement. The list shows the weights (in ounces) of your scoops.
3.8, 4.2, 3.9, 4.5, 3.7, 4.6, 4.1, 3.3, 4.3, 4.2
Can you start working at the shop? *Explain* your reasoning.



3. **GRIDDED ANSWER** You will be making a presentation in your history class. Your teacher gives you a time limit of 15 minutes with an absolute deviation of 1.5 minutes. What is the maximum possible duration (in minutes) of your presentation?

4. **OPEN-ENDED** Describe a real-world situation that can be modeled by the equation $|x - 50| = 10$. Explain what the solution of the equation means in this situation.

5. **EXTENDED RESPONSE** A tour operator recommends that a river rafter wear a protective suit under the temperature conditions described below.

- a. Write and graph an inequality that describes the possible air temperatures and water temperatures for which a protective suit is recommended.
 - b. If the water temperature is 40°F, for which air temperatures is a protective suit recommended?
 - c. How would you change the graph in part (a) in order to describe the situations in which a protective suit is required? *Explain* your answer.
6. **MULTI-STEP PROBLEM** You are buying a new cell phone and see eight phones listed on a website. The prices of the phones are shown.
\$139, \$249, \$229, \$199, \$179, \$359, \$199, \$209
 - a. Find the mean price of the phones.
 - b. You are willing to purchase a phone that has the mean price with an absolute deviation of at most \$50. Write and solve an inequality to find the prices of phones that you will consider.
 - c. How many of the phones on the website will you consider buying?

BIG IDEAS

For Your Notebook

Big Idea 1

Applying Properties of Inequality

You can apply the properties of inequality to solve inequalities. The properties listed below are also true for inequalities involving \leq and \geq .

Property	If $a < b$, then ...	If $a > b$, then ...
Addition property of inequality	$a + c < b + c$.	$a + c > b + c$.
Subtraction property of inequality	$a - c < b - c$.	$a - c > b - c$.
Multiplication property of inequality	$ac < bc$ if $c > 0$. $ac > bc$ if $c < 0$.	$ac > bc$ if $c > 0$. $ac < bc$ if $c < 0$.
Division property of inequality	$\frac{a}{c} < \frac{b}{c}$ if $c > 0$. $\frac{a}{c} > \frac{b}{c}$ if $c < 0$.	$\frac{a}{c} > \frac{b}{c}$ if $c > 0$. $\frac{a}{c} < \frac{b}{c}$ if $c < 0$.

Big Idea 2

Using Statements with *And* or *Or*

An absolute value equation can be rewritten as two equations joined by *or*. An absolute value inequality can be rewritten as a compound inequality with *and* or *or*. In the statements below, $<$ can be replaced by \leq , and $>$ can be replaced by \geq .

Absolute value equation or inequality	Equivalent statement with <i>and</i> or <i>or</i>
$ ax + b = c, c \geq 0$	$ax + b = c$ or $ax + b = -c$
$ ax + b < c, c \geq 0$	$-c < ax + b < c$
$ ax + b > c, c \geq 0$	$ax + b < -c$ or $ax + b > c$

Big Idea 3

Graphing Inequalities

You use a number line to graph an inequality in one variable. Similarly, you use a coordinate plane to graph a linear inequality in two variables (including cases where one of the variables has a coefficient of 0, such as $0x + y < 1$, or $y < 1$).

Graphing inequalities in one variable	Graphing linear inequalities in two variables
Graph simple inequalities: 1. Solve for the variable. 2. Draw an open circle for $<$ or $>$ and a closed circle for \leq or \geq . Draw an arrow in the appropriate direction. Graph compound inequalities: 1. Solve the compound inequality. 2. Use the union of graphs of simple inequalities for <i>or</i> . Use the intersection for <i>and</i> .	1. Graph the boundary line. Use a solid line for \leq or \geq and a dashed line for $<$ or $>$. 2. Test a point that does not lie on the boundary line. 3. Shade the half-plane containing the point if the ordered pair is a solution of the inequality. Shade the other half-plane if the ordered pair is <i>not</i> a solution.

REVIEW KEY VOCABULARY

- graph of an inequality, p. 356
- absolute value equation, p. 390
- solution of an inequality in two variables, p. 405
- equivalent inequalities, p. 357
- absolute deviation, p. 392
- graph of an inequality in two variables, half-plane, p. 405
- compound inequality, p. 380
- linear inequality in two variables, p. 405

VOCABULARY EXERCISES

1. Translate the verbal sentence into an absolute value equation: "The absolute deviation of x from 19 is 8."
2. Identify three ordered pairs that are solutions of $2x - 3y \geq -10$.
3. **WRITING** When you graph a linear inequality in two variables, how do you know whether the boundary line is a solid line or a dashed line? How do you know which half-plane to shade?

REVIEW EXAMPLES AND EXERCISES

Use the review examples and exercises below to check your understanding of the concepts you have learned in each lesson of Chapter 6.

6.1 Solve Inequalities Using Addition and Subtraction

pp. 356–361

EXAMPLE

Solve $x - 2.1 \leq 1.4$. Graph your solution.

$$x - 2.1 \leq 1.4$$

Write original inequality.

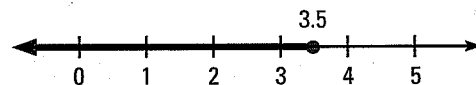
$$x - 2.1 + 2.1 \leq 1.4 + 2.1$$

Add 2.1 to each side.

$$x \leq 3.5$$

Simplify.

▶ The solutions are all real numbers less than or equal to 3.5.



EXERCISES

4. **GEOGRAPHY** The lowest elevation in Mexico is -10 meters at Laguna Salada. Write and graph an inequality that describes all elevations in Mexico that are greater than the lowest elevation.

Solve the inequality. Graph your solution.

5. $x + 5 > -13$

6. $m - 9 \geq -4$

7. $s + 3.7 < 1$

EXAMPLES
1, 2, 3, and 4
on pp. 356–358
for Exs. 4–7

6

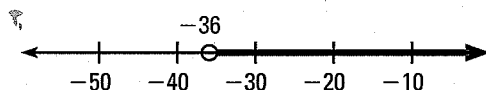
CHAPTER REVIEW

6.2 Solve Inequalities Using Multiplication and Division pp. 363–368**EXAMPLE**Solve $\frac{x}{-4} < 9$. Graph your solution.

$$\frac{x}{-4} < 9 \quad \text{Write original inequality.}$$

$$-4 \cdot \frac{x}{-4} > -4 \cdot 9 \quad \text{Multiply each side by } -4. \text{ Reverse inequality symbol.}$$

$$x > -36 \quad \text{Simplify.}$$

▶ The solutions are all real numbers greater than -36 .**EXERCISES**

Solve the inequality. Graph your solution.

8. $\frac{p}{2} \leq 5$

9. $\frac{n}{-4.5} < -8$

10. $-3x > 27$

11. $2y \geq 18$

12. **GYMNASTICS** In men's gymnastics, an athlete competes in 6 events. Suppose that an athlete's average score per event is at most 9.7 points. Write and solve an inequality to find the possible total scores for the athlete.

EXAMPLES
1, 2, 3, 4, and 5
on pp. 363–365
for Exs. 8–12

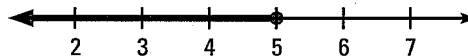
6.3 Solve Multi-Step Inequalities pp. 369–374**EXAMPLE**Solve $4x + 7 \geq -13$. Graph your solution.

$$-4x + 7 \geq -13 \quad \text{Write original inequality.}$$

$$-4x \geq -20 \quad \text{Subtract 7 from each side.}$$

$$x \leq 5 \quad \text{Divide each side by } -4. \text{ Reverse inequality symbol.}$$

▶ The solutions are all real numbers less than or equal to 5.

**EXERCISES**

Solve the inequality, if possible. Graph your solution.

13. $2g + 11 < 25$

14. $\frac{2}{3}r - 4 \geq 1$

15. $1 - 3x \leq -14 + 2x$

16. $3(q + 1) < 3q + 7$

17. $8(t - 1) > -8 + 8t$

18. $-3(2n - 1) \geq 1 - 8n$

19. **TICKET PURCHASES** You can order discount movie tickets from a website for \$7 each. You must also pay a shipping fee of \$4. You want to spend no more than \$40 on movie tickets. Find the possible numbers of movie tickets that you can order.

EXAMPLES
1, 2, 3, and 4
on pp. 369–370
for Exs. 13–19

6.4 Solve Compound Inequalities

pp. 380–387

EXAMPLE

Solve $-1 < -2x + 7 < 9$. Graph your solution.

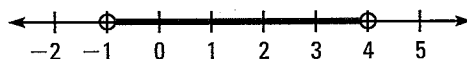
$$-1 < -2x + 7 < 9 \quad \text{Write original inequality.}$$

$$-8 < -2x < 2 \quad \text{Subtract 7 from each expression.}$$

$$4 > x > -1 \quad \text{Divide each expression by } -2. \text{ Reverse both inequality symbols.}$$

$$-1 < x < 4 \quad \text{Rewrite in the form } a < x < b.$$

► The solutions are all real numbers greater than -1 and less than 4 .



EXERCISES

Solve the inequality. Graph your solution.

20. $-6 \leq 2t - 5 \leq -3$

21. $-3 < -3x + 8 < 11$

22. $9s - 6 < 12$ or $3s + 1 > 13$

23. $-4w + 12 \geq 10$ or $5w - 14 > -4$

EXAMPLES 3, 4, and 5

on pp. 381–382
for Exs. 20–23

6.5 Solve Absolute Value Equations

pp. 390–395

EXAMPLE

Solve $4|5x - 3| + 6 = 30$.

First, rewrite the equation in the form $|ax + b| = c$.

$$4|5x - 3| + 6 = 30 \quad \text{Write original equation.}$$

$$4|5x - 3| = 24 \quad \text{Subtract 6 from each side.}$$

$$|5x - 3| = 6 \quad \text{Divide each side by 4.}$$

Next, solve the absolute value equation.

$$5x - 3 = 6 \quad \text{or} \quad 5x - 3 = -6 \quad \text{Rewrite as two equations.}$$

$$5x = 9 \quad \text{or} \quad 5x = -3 \quad \text{Add 3 to each side.}$$

$$x = 1.8 \quad \text{or} \quad x = -0.6 \quad \text{Divide each side by 5.}$$

► The solutions are -0.6 and 1.8 .

EXERCISES

Solve the equation, if possible.

24. $|r| = 7$

25. $|a + 6| = 2$

26. $|2c + 5| = 21$

27. $2|x - 3| + 1 = 5$

28. $3|2q + 1| - 5 = 1$

29. $4|3p - 2| + 5 = 11$

30. **BOWLING** In tenpin bowling, the height of each bowling pin must be 15 inches with an absolute deviation of 0.03125 inch. Find the minimum and maximum possible heights of a bowling pin.

EXAMPLES 1, 2, 3, 4, and 5

on pp. 390–392
for Exs. 24–30

6

CHAPTER REVIEW

6.6 Solve Absolute Value Inequalities

pp. 398–403

EXAMPLE

Solve $3|2x + 11| + 2 \leq 17$. Graph your solution.

$$3|2x + 11| + 2 \leq 17$$

Write original inequality.

$$3|2x + 11| \leq 15$$

Subtract 2 from each side.

$$|2x + 11| \leq 5$$

Divide each side by 3.

$$-5 \leq 2x + 11 \leq 5$$

Rewrite as compound inequality.

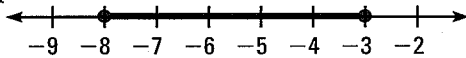
$$-16 \leq 2x \leq -6$$

Subtract 11 from each expression.

$$-8 \leq x \leq -3$$

Divide each expression by 2.

► The solutions are all real numbers greater than or equal to -8 and less than or equal to -3 .



EXERCISES

Solve the inequality. Graph your solution.

31. $|m| \geq 8$

32. $|6k + 1| \geq 2$

33. $|3g - 2| < 5$

34. $6|3x + 5| \leq 14$

35. $|2j - 9| - 2 > 10$

36. $5|d + 8| - 7 > 13$

EXAMPLES
1, 2, and 3
on pp. 398–399
for Exs. 31–36

6.7 Graph Linear Inequalities in Two Variables

pp. 405–412

EXAMPLE

Graph the inequality $y < 3x - 1$.

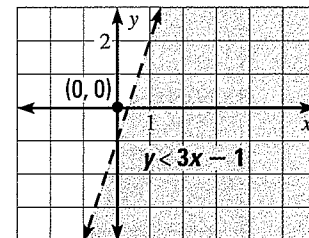
STEP 1 Graph the equation $y = 3x - 1$. The inequality is $<$, so use a dashed line.

STEP 2 Test $(0, 0)$ in $y < 3x - 1$.

$$0 \stackrel{?}{<} 3(0) - 1$$

$$0 < -1 \quad \times$$

STEP 3 Shade the half-plane that does not contain $(0, 0)$, because $(0, 0)$ is *not* a solution of the inequality.



EXERCISES

Tell whether the ordered pair is a solution of $-3x + 2y \geq 16$.

37. $(-2, 8)$

38. $(-1, -1)$

39. $(-2, 10)$

40. $(9, -5)$

Graph the inequality.

41. $y > 2x + 3$

42. $y \leq \frac{1}{2}x - 1$

43. $3x - 2y < 12$

44. $y \geq 3$

EXAMPLES
1, 2, 3, 4, and 5
on pp. 405–407
for Exs. 37–44

CHAPTER TEST

Translate the verbal phrase into an inequality. Then graph the inequality.

1. All real numbers that are less than 5
2. All real numbers that are greater than or equal to -1
3. All real numbers that are greater than -2 and less than or equal to 7
4. All real numbers that are greater than 8 or less than -4

Solve the inequality, if possible. Graph your solution.

- | | | |
|------------------------------|-----------------------------------|---|
| 5. $x - 9 \geq -5$ | 6. $-2 > 5 + y$ | 7. $-0.8 \leq z + 7.7$ |
| 8. $5m \geq 35$ | 9. $\frac{n}{6} < -1$ | 10. $\frac{r}{-3} \leq 4$ |
| 11. $-4s < 6s + 1$ | 12. $4t - 7 \leq 13$ | 13. $-8 > 5 - v$ |
| 14. $3(5w + 4) < 12w - 11$ | 15. $4p - 3 > 2(2p + 1)$ | 16. $9q - 12 \geq 3(3q - 4)$ |
| 17. $-2 \leq 4 - 3a \leq 13$ | 18. $-7 < 2c - 1 < 10\frac{1}{2}$ | 19. $-5 \leq 2 - h$ or $6h + 5 \geq 71$ |
| 20. $ 2d + 8 > 3$ | 21. $2 3f - 7 + 5 < 11$ | 22. $ j - 7 - 1 \leq 3\frac{5}{6}$ |

Solve the equation, if possible.

- | | | |
|---|-------------------------|-------------------------|
| 23. $-\frac{3}{4} x - 3 = \frac{1}{4}$ | 24. $ 3y + 1 - 6 = -2$ | 25. $4 2z + 5 + 9 = 5$ |
|---|-------------------------|-------------------------|

Check whether the ordered pair is a solution of the inequality.

- | | | |
|----------------------------|---------------------------------|---------------------------|
| 26. $2x - y < 4$; (2, -1) | 27. $y + 3x \geq -5$; (-3, -4) | 28. $y \leq -3$; (4, -7) |
|----------------------------|---------------------------------|---------------------------|

Graph the inequality.

- | | | |
|-----------------|---------------------|-----------------|
| 29. $y < x + 4$ | 30. $y \geq 2x - 5$ | 31. $y \geq -6$ |
|-----------------|---------------------|-----------------|

32. **BUSINESS** Your friend is starting a small business baking and decorating cakes and wants to make a profit of at least \$250 for the first month. The expenses for the first month are \$155. What are the possible revenues that your friend can earn in order to meet the profit goal?

33. **BICYCLES** A manufacturer of bicycle parts requires that a bicycle chain have a width of 0.3 inch with an absolute error of at most 0.0003 inch. Find the possible widths of bicycle chains that the manufacturer will accept.

34. **HORSES** You are planning to ride a horse to a campsite. The sum of your weight x (in pounds) and the combined weight y (in pounds) of your camping supplies can be at most 20% of the weight of the horse.

- a. Suppose that the horse weighs 1000 pounds. Write and graph an inequality that describes the possible combinations of your weight and the combined weight of the camping supplies.
- b. Identify and interpret one of the solutions of the inequality in part (a).