In this unit, you will build on your understanding of algebra to solve problems involving linear and nonlinear functions.
GETTING DOWN TO BUSINESS

How would you like to run your own business? On this adventure, you’ll be creating your own company. Along the way you’ll come up with a company name, slogan, and product to sell to your peers at school. You’ll research the cost of materials, create advertisements, and calculate potential profits from the sales of your product. You’ll also survey your peers to find out what they would be willing to pay for your product, analyze the data, and adjust your projected profit model. It’s going to require hard work and your algebra tool kit to make this company work, so let’s get down to business!

Log on to msmath3.net/webquest to begin your WebQuest.
How is math used in skiing competitions?

In aerial skiing competitions, the total judges score is multiplied by a degree of difficulty factor and then added to the skier's current score to obtain the final score. If you know your current score, the leader's final score, and your jump's degree of difficulty, you can solve a two-step equation to determine what score you need to win a competition.

You will solve a problem about aerial skiing in Lesson 10-3.
Take this quiz to see whether you are ready to begin Chapter 10. Refer to the lesson or page number in parentheses if you need more review.

**Vocabulary Review**
Complete each sentence.

1. A(n) __ expression contains a variable, a number, and at least one operation symbol. (Lesson 1-2)
2. A sentence that compares two numbers or quantities is called a(n) __. (Lesson 1-3)

**Prerequisite Skills**
Determine whether each statement is true or false. (Lesson 1-3)

3. $10 > 4$  
4. $3 < -3$  
5. $-7 < -8$  
6. $-1 < 0$

Write an algebraic equation for each verbal sentence. (Lesson 1-7)

7. Ten increased by a number is $-8$.  
8. The difference of $-5$ and $3x$ equals $32$.  
9. Twice a number decreased by $4$ is $26$.  
10. The sum of $9$ and a number is $14$.

Solve each equation. Check your solution. (Lessons 1-8 and 1-9)

11. $n + 8 = -9$  
12. $4 = m + 19$  
13. $-4 + c = 15$  
14. $z - 6 = -10$  
15. $p - 12 = 2$  
16. $21 = y - (-3)$  
17. $3c = -18$  
18. $-2x = 18$  
19. $-42 = -6b$  
20. $\frac{w}{4} = -8$  
21. $12 = \frac{r}{7}$  
22. $\frac{a}{-3} = -5$
Algebra Tiles

In Chapter 1, you used cups and counters to model equations. In this lab and throughout the rest of this book, you will use algebra tiles. The table below shows how these two types of models are related.

<table>
<thead>
<tr>
<th>Type of Model</th>
<th>Variable x</th>
<th>Integer 1</th>
<th>Integer -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cups and Counters</td>
<td>🥤</td>
<td>🍊</td>
<td>🍊</td>
</tr>
<tr>
<td>Algebra Tiles</td>
<td>x</td>
<td>1</td>
<td>-1</td>
</tr>
</tbody>
</table>

You will use an equation mat to model and solve equations using algebra tiles in the same way as you did with cups and counters.

**Activity**

*Work with a partner.*

Use algebra tiles to model and solve $x + 3 = -2$.

1. Model the equation.

   $x + 3 = -2$

2. Add three $-1$-tiles to each side of the mat. The left side now contains zero pairs.

   $x + 3 + (-3) = -2 + (-3)$

3. Remove the zero pairs from the left side. The $x$-tile is now isolated. There are 5 negative tiles on the right side of the mat.

   $x = -5$

Therefore, $x = -5$. Since $-5 + 3 = -2$, the solution is correct.

**Your Turn** Use algebra tiles to model and solve each equation.

- a. $x + 2 = 3$
- b. $4 + x = 6$
- c. $x + 2 = -1$
- d. $-4 = x + 3$
- e. $x - 3 = 2$
- f. $x - 1 = -3$
- g. $2x = -4$
- h. $3 = 3x$
**Use the Distributive Property to simplify algebraic expressions.**

**NEW Vocabulary**
- equivalent expressions
- term
- coefficient
- like terms
- constant
- simplest form
- simplifying the expression

**Link to READING**
*Everyday Meaning of Constant:* unchanging

**Hands-On Mini Lab**

You can use algebra tiles to rewrite the algebraic expression $2(x + 3)$.

1. Choose two positive and one negative value for $x$. Then evaluate $2(x + 3)$ and $2x + 6$ for each of these values. What do you notice?
2. Use algebra tiles to rewrite the expression $3(x - 2)$. (*Hint:* Use one green $x$-tile and 2 red $-1$-tiles to represent $x - 2$.)

In Chapter 1, you learned that expressions like $2(4 + 3)$ can be rewritten using the Distributive Property and then simplified.

\[ 2(4 + 3) = 2(4) + 2(3) \quad \text{Distributive Property} \]
\[ = 8 + 6 \quad \text{Multiply. Then add.} \]

The Distributive Property can also be used to simplify an algebraic expression like $2(x + 3)$.

\[ 2(x + 3) = 2(x) + 2(3) \quad \text{Distributive Property} \]
\[ = 2x + 6 \quad \text{Multiply.} \]

The expressions $2(x + 3)$ and $2x + 6$ are equivalent expressions, because no matter what $x$ is, these expressions have the same value.

**Write Equivalent Expressions**

Use the Distributive Property to rewrite each expression.

1. $4(x + 7) = 4(x) + 4(7) = 4x + 28 \quad \text{Simplify.}$
2. $(y + 2)5 = y \cdot 5 + 2 \cdot 5 = 5y + 10 \quad \text{Simplify.}$

**Your Turn**

Use the Distributive Property to rewrite each expression.

a. $6(a + 4)$

b. $(n + 3)8$

c. $-2(x + 1)$
When a plus sign separates an algebraic expression into parts, each part is called a **term**. The numerical factor of a term that contains a variable is called the **coefficient** of the variable.

Like terms contain the same variables, such as $2x$ and $x$. A term without a variable is called a **constant**. Constant terms are also like terms.

Rewriting a subtraction expression using addition will help you identify the like terms of an expression that contains subtraction.

**Identify Parts of an Expression**

Identify the terms, like terms, coefficients, and constants in the expression $6n - 7n - 4 + n$.

$$6n - 7n - 4 + n = 6n + (-7n) + (-4) + n$$  **Definition of subtraction**

$$= 6n + (-7n) + (-4) + 1n$$  **Identity Property; $n = 1n$**

The terms are $6n$, $-7n$, $-4$, and $n$. The like terms are $6n$, $-7n$, and $n$. The coefficients are $6$, $-7$, and $1$. The constant is $-4$. 

An algebraic expression is in simplest form if it has no like terms and no parentheses. You can use the Distributive Property to combine like terms. This is called simplifying the expression.

**Equivalent Expressions** To check whether $3y + y$ and $4y$ are equivalent expressions, substitute any value for $y$ and see whether the expressions have the same value.

**FOOD** In 2002, Americans were expected to eat 26.3 million hot dogs in major league ballparks. This is enough to stretch from Dodgers’ Stadium in Los Angeles to the Pirate’s PNC Stadium in Pittsburgh. Source: www.hot-dog.org

**Simplify Algebraic Expressions**

Simplify each expression.

1. $3y + y$
   - $3y$ and $y$ are like terms.
   - $3y + y = 3y + 1y$ Identity Property; $y = 1y$
   - $= (3 + 1)y$ Distributive Property
   - $= 4y$ Simplify.

2. $-9k + 4 + 9k$
   - $-9k$ and $9k$ are like terms.
   - $-9k + 4 + 9k = -9k + 9k + 4$ Commutative Property
   - $= (-9 + 9)k + 4$ Distributive Property
   - $= 0k + 4$ $-9 + 9 = 0$
   - $= 0 + 4$ or $4$ $0k = 0 \cdot k$ or $0$

3. $5x - 2 - 7x + 6$
   - $5x$ and $-7x$ are like terms. $-2$ and $6$ are also like terms.
   - $5x - 2 - 7x + 6 = 5x + (-2) + (-7x) + 6$ Definition of subtraction
   - $= 5x + (-7x) + (-2) + 6$ Commutative Property
   - $= [5 + (-7)]x + (-2) + 6$ Distributive Property
   - $= -2x + 4$ Simplify.

**Your Turn**

Simplify each expression.

g. $4z - z$

h. $6 + 3n - 8n$

i. $2g - 3 + 11 - 2g$

**Translate Phrases into Expressions**

**FOOD** At a baseball game, you buy some hot dogs that cost $3 each and the same number of soft drinks for $2.50 each. Write an expression in simplest form that represents the total amount of money spent on food and drinks.

If $x$ represents the number of hot dogs you buy, then $x$ also represents the number of drinks you buy. To find the total amount spent, multiply the cost of each item by the number of items purchased. Then add the expressions.

- $3x + 2.50x = (3 + 2.50)x$ Distributive Property
  - $= 5.50x$ Simplify.

The expression $5.50x$ represents the total amount of money spent on food and drink, where $x$ is the number of hot dogs or drinks.
1. Define like terms.

2. **OPEN ENDED** Write an expression that has four terms and simplifies to $3n + 2$. Identify the coefficient(s) and constant(s) in your expression.

3. **Which One Doesn’t Belong?** Identify the expression that is not equivalent to the other three. Explain your reasoning.

|x - 3 + 4x| 5(x - 3)| 6 + 5x - 9| 5x - 3|

Use the Distributive Property to rewrite each expression.

4. $5(x + 4)$
5. $-3(a + 9)$
6. $-6(g - 2)$

Identify the terms, like terms, coefficients, and constants in each expression.

7. $8a + 4 - 6a$
8. $7 - 3d - 8 + d$
9. $5n - n + 3 - 2n$

Simplify each expression.

10. $5x + 2x$
11. $8n + n$
12. $10y - 17y$
13. $12c - c$
14. $4p - 7 + 6p$
15. $11x - 12 - 6x + 9$

Use the Distributive Property to rewrite each expression.

16. $3(x + 8)$
17. $7(m + 6)$
18. $-8(b + 5)$
19. $-7(n + 2)$
20. $-4(k + 8)$
21. $(c - 8)(-8)$
22. $-5(a - 9)$
23. $(x - 6)(-4)$
24. $2(a + b)$
25. $4(x - y)$
26. $3(2y + 1)$
27. $-4(3x + 5)$

**GEOMETRY** Write two equivalent expressions for the area of each figure.

28. $x + 5$
29. $x - 7$
30. $x + 4$
31. $x - 3$

Identify the terms, like terms, coefficients, and constants in each expression.

32. $2 + 3a + 9a$
33. $7 - 5x + 1$
34. $4 + 5y - 6y + y$
35. $n + 4n - 7n - 1$
36. $-3d + 8 - d - 2$
37. $9 - z + 3 - 2z$

Simplify each expression.

38. $4y + 7y$
39. $n + 5n$
40. $12x - 5x$
41. $4k - 7k$
42. $10k - k$
43. $5x + 4 + 9x$
44. $2 + 3d + d$
45. $6 - 4c + c$
46. $2m + 5 - 8m$
47. $3r + 7 - 3r$
48. $9y - 4 - 11y + 7$
49. $3x + 2 - 10 - 3x$
For Exercises 50–53, write an expression in simplest form that represents the total amount in each situation.

50. **MOVIES** You buy 2 drinks that each cost $x$ dollars, a large bag of popcorn for $3.50, and a chocolate bar for $1.50.

51. **PHYSICAL EDUCATION** Each lap around the school track is a distance of $y$ yards. You ran 2 laps on Monday, 3\( \frac{1}{2} \) laps on Wednesday, and 100 yards on Friday.

52. **SHOPPING** You buy $x$ shirts that each cost $15.99, the same number of jeans for $34.99 each, and a pair of sneakers for $58.99.

53. **FUND-RAISING** You have sold $t$ tickets for a school fund-raiser. Your friend has sold 24 more than you.

54. **CRITICAL THINKING** Is $2(x - 1) + 3(x - 1) = 5(x - 1)$ a true statement? If so, explain your reasoning. If not, give a counterexample.

55. **SHORT RESPONSE** Write an expression in simplest form for the perimeter of the figure.

56. **MULTIPLE CHOICE** Dustin is 3 years younger than his older sister. If his older sister is $y$ years old, which expression represents the sum of their ages?

- $2y - 3$
- $y - 3$
- $y^2 - 3$
- $2y + 3$

**TECHNOLOGY** For Exercises 61 and 62, refer to the graphs at the right. (Lesson 9-7)

61. Which graph gives the impression that the number of DVD players sold in 2001 was more than 5 times the amount sold in 1999?

62. About how many times more DVD’s were sold in 2001 than in 1999?

**PREREQUISITE SKILL** Solve each equation. Check your solution. (Lessons 1-8 and 1-9)

63. $x + 8 = 2$
64. $y - 5 = -9$
65. $32 = -4n$
66. $\frac{a}{3} = -15$
Solve Two-Step Equations

**BOOK SALE** Linda bought four books at a book sale benefiting a local charity. The handwritten receipt she received was missing the cost for the hardback books she purchased.

1. Explain how you could use the work backward strategy to find the cost of each hardback book. Then find the cost.

The solution to this problem can also be found by solving the equation $3x + 1 = 7$, where $x$ is the cost per hardback book. This equation can be modeled using algebra tiles.

A *two-step equation* contains two operations. In the equation $3x + 1 = 7$, $x$ is multiplied by 3 and then 1 is added. To solve two-step equations, undo each operation in reverse order.

**EXAMPLE** Solve a Two-Step Equation

**Solve $3x + 1 = 7$.**

**Method 1** Use a model.

Remove one 1-tile from the mat.

![Algebra tiles showing $3x + 1 = 7$](image)

Separate the remaining tiles into 3 equal groups.

![Algebra tiles showing $3x = 6$](image)

There are 2 tiles in each group. The solution is 2.

**Method 2** Use symbols.

**Write the equation.**

$3x + 1 = 7$

**Subtract 1 from each side.**

$3x = 6$

**Divide each side by 3.**

$x = 2$

**Simplify.**

$x = 2$
Solve Two-Step Equations

Solve each equation. Check your solution.

4x - 3 = 25

Method 1 Vertical Method

Write the equation.

4x - 3 = 25

Add 3 to each side.

4x = 28

Divide each side by 4.

\[ \frac{4x}{4} = \frac{28}{4} \]

\[ x = 7 \]

Check

4x - 3 = 25

Replace x with 7 and check to see if the sentence is true.

25 = 25 ✔

The solution is 7.

Method 2 Horizontal Method

4x - 3 = 25

4x = 28

\[ \frac{4x}{4} = \frac{28}{4} \]

\[ x = 7 \]


Some two-step equations have a term with a negative coefficient.

Equations with Negative Coefficients

Solve 6 - 3x = 21.

Write the equation.

6 + (-3x) = 21

Subtract 6 from each side.

-3x = 15

Divide each side by -3.

\[ \frac{-3x}{-3} = \frac{15}{-3} \]

\[ x = -5 \]

Check this solution.

Common Error
A common mistake when solving the equation in Example 4 is to divide each side by 3 instead of -3. Remember that you are dividing by the coefficient of the variable, which in this instance is a negative number.

Your Turn
Solve each equation. Check your solution.

a. \( \frac{n}{-3} - 2 = -18 \)

b. 19 = 3x - 2

c. 5 - 2n = -1
Sometimes it is necessary to combine like terms before solving an equation.

**Combine Like Terms Before Solving**

**Solve** \(-2y + y - 5 = 11\). Check your solution.

\[-2y + y - 5 = 11\]  Write the equation.
\[-2y + 1y - 5 = 11\]  Identity Property; \(y = 1y\)
\[-y - 5 = 11\]  Combine like terms; \(-2y + 1y = (-2 + 1)y\) or \(-y\).
\[-y - 5 + 5 = 11 + 5\]  Add 5 to each side.
\[-y = 16\]  Simplify.
\[-\frac{1y}{-1} = \frac{16}{-1}\]  \(-y = -1y\); divide each side by \(-1\).
\[y = -16\]  Simplify.

**Check**  
\[-2y + y - 5 = 11\]  Write the equation.
\[-2(-16) + (-16) - 5 = 11\]  Replace \(y\) with \(-16\).
\[32 + (-16) - 5 = 11\]  Multiply.
\[11 = 11\]  ✔  The statement is true.

The solution is \(-16\).

**Your Turn** Solve each equation. Check your solution.

d. \(x + 4x = 45\)

e. \(10 = 2a + 13 - a\)

f. \(-3 = 6 - 5w + 2w\)

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1. **Explain** how you can use the work backward problem-solving strategy to solve a two-step equation.

2. **OPEN ENDED** Write a two-step equation that can be solved by using the Addition and Division Properties of Equality.

3. **FIND THE ERROR** Alexis and Tomás are solving the equation \(2x + 7 = 16\). Who is correct? Explain.

   **Alexis**  
   \(2x + 7 = 16\)
   \(\frac{2x}{2} + \frac{7}{2} = \frac{16}{2}\)
   \(x + \frac{7}{2} = 8\)
   \(x = 4.5\)

   **Tomás**  
   \(2x + 7 = 16\)
   \(2x + 7 - 7 = 16 - 7\)
   \(2x = 9\)
   \(\frac{2x}{2} = \frac{9}{2}\)
   \(x = 4.5\)

---

**GUIDED PRACTICE** Solve each equation. Check your solution.

4. \(6x + 5 = 29\)
5. \(9m - 11 = -2\)
6. \(1 = 2p + 13\)
7. \(10 = \frac{a}{4} + 3\)
8. \(\frac{c}{2} - 4 = 3\)
9. \(3 - 5y = -37\)
10. \(4 - d = 11\)
11. \(7 = -2n + 1\)
12. \(6k - 10k = 16\)
Solve each equation. Check your solution.

13. \( 2h + 9 = 21 \)
14. \( 11 = 2b + 17 \)
15. \( 5 = 4a - 7 \)
16. \( 6p - 5 = -17 \)
17. \( 2g - 3 = -19 \)
18. \( 16 = 5x - 9 \)
19. \( 3 + 8c = 35 \)
20. \( 13 + 3d = -8 \)
21. \( 13 = \frac{8}{3} + 4 \)
22. \( 5 + \frac{y}{8} = -3 \)
23. \( -\frac{1}{2}x - 7 = -11 \)
24. \( -\frac{1}{4}w + 15 = 28 \)

25. **SCHOOL TRIP** At a theme park, each student is given $19. This covers the cost of 2 meals at \( x \) dollars each plus $7 worth of snacks. Solve \( 2x + 7 = 19 \) to find the amount each student can spend per meal.

26. **SHOPPING** You receive a $75 online gift to a music site. You want to purchase CDs that cost $14 each. There is a $5 shipping and handling fee. Solve \( 14n + 5 = 75 \) to find the number of CDs you can purchase.

Solve each equation. Check your solution.

27. \( 5 - 3c = 14 \)
28. \( 9 - 5y = 19 \)
29. \( -6 = 4 - 2x \)
30. \( 2 = 18 - 4d \)
31. \( 8 - k = 17 \)
32. \( -7 - p = -15 \)
33. \( 12 = 6 - x \)
34. \( -2 = 4 - t \)
35. \( 5w - 8w = -12 \)
36. \( 28 = 3m - 7m \)
37. \( y + 5y + 11 = 35 \)
38. \( 3 - 6x + 8x = 9 \)
39. \( -21 = 9a - 15 - 3a \)
40. \( 26 = g + 10 - 3g \)
41. \( 8x + 5 - x = -2 \)
42. \( 6h + 5 + h = -30 \)
43. \( -n + 9 - 2n - 1 = -13 \)
44. \( 10 = 6a + 4 - 9a + a \)

45. **CRITICAL THINKING** Work backward to write a two-step equation whose solution is \(-5\).

46. **MULTIPLE CHOICE** If \( 3x + 10 = 4 \), what is the value of \( 2 + 5x \)?

- A  \(-14\)
- B  \(-8\)
- C  \(-2\)
- D  \(12\)

47. **SHORT RESPONSE** Write an equation for the given diagram. Then find the value of \( x \).

Use the Distributive Property to rewrite each expression. (Lesson 10-1)

48. \( 6(a + 6) \)
49. \( -3(x + 5) \)
50. \( (y - 8)4 \)
51. \( -8(p - 7) \)

52. Find \( [6 \quad 3 \quad -1] - [2 \quad 8 \quad 9] \). If there is no difference, write *impossible*. (Lesson 9-8)

**PREREQUISITE SKILL** Write an algebraic equation for each verbal sentence. (Lesson 1-7)

53. Four times a number increased by 5 is 17.
54. 8 less than twice a number equals 10.
Write two-step equations that represent real-life situations.

**HOME ENTERTAINMENT** Your parents offer to loan you the money to buy a $600 sound system. You give them $125 as a down payment and agree to make monthly payments of $25 until you have repaid the loan.

1. Let \( n \) represent the number of payments. Write an expression that represents the amount of the loan paid after \( n \) payments.

2. Write and solve an equation to find the number of payments you will have to make in order to pay off your loan.

3. What type of equation did you write for Exercise 2? Explain your reasoning.

In Chapter 1, you learned how to write verbal sentences as one-step equations. Some verbal sentences translate to two-step equations.

**EXAMPLES**

**Translate Sentences into Equations**

Translate each sentence into an equation.

**Sentence**  
Eight less than three times a number is \(-23\).  
Thirteen is 7 more than twice a number.  
The quotient of a number and 4, decreased by 1, is equal to 5.

**Equation**  
\(3n - 8 = -23\)  
\(13 = 2n + 7\)  
\(\frac{n}{4} - 1 = 5\)

Translate each sentence into an equation.

**Your Turn**

a. Fifteen equals three more than six times a number.

b. If 10 is increased by the quotient of a number and 6, the result is 5.

c. The difference between 12 and twice a number is 18.
Translate and Solve an Equation

 Nine more than four times a number is 21. Find the number.

<table>
<thead>
<tr>
<th>Words</th>
<th>Nine more than four times a number is 21.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Let ( n ) = the number.</td>
</tr>
<tr>
<td>Equation</td>
<td>( 4n + 9 = 21 )</td>
</tr>
</tbody>
</table>

\[
4n + 9 = 21 \quad \text{Write the equation.}
\]

\[
4n + 9 - 9 = 21 - 9 \quad \text{Subtract 9 from each side.}
\]

\[
4n = 12 \quad \text{Simplify.}
\]

\[
n = 3 \quad \text{Mentally divide each side by 4.}
\]

Therefore, the number is 3.

In many real-life situations, you start with a given amount and then increase it at a certain rate. These situations can be represented by two-step equations.

Write and Solve a Two-Step Equation

**FUND-RAISING** Your Class Council needs $600 for the Spring Dance. With only $210 in their treasury, the Council decides to raise the rest by selling donuts for a profit of $1.50 per dozen. How many dozen donuts will they need to sell?

The council already has $210 and will sell donuts for a profit of $1.50 per dozen until they have $600. Organize the data for the first few dozen donuts sold into a table and look for a pattern.

<table>
<thead>
<tr>
<th>Dozens</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>210.00</td>
</tr>
<tr>
<td>1</td>
<td>211.50</td>
</tr>
<tr>
<td>2</td>
<td>213.00</td>
</tr>
<tr>
<td>3</td>
<td>214.50</td>
</tr>
</tbody>
</table>

Write an equation to represent the situation. Let \( d \) represent the number of dozens.

\[
210 + 1.50d = 600 \quad \text{Write the equation.}
\]

\[
210 - 210 + 1.50d = 600 - 210 \quad \text{Subtract 210 from each side.}
\]

\[
1.50d = 390 \quad \text{Simplify.}
\]

\[
\frac{1.50d}{1.50} = \frac{390}{1.50} \quad \text{Divide each side by 1.50.}
\]

\[
d = 260 \quad \text{Simplify.}
\]

They need to sell 260 dozen donuts.
1. **NUMBER SENSE** Identify the operation indicated by the word *twice*.

2. **OPEN ENDED** Write two different statements that translate into the same two-step equation.

Translate each sentence into an equation. Then find each number.

3. One more than three times a number is 7.
4. Seven less than twice a number is $-1$.
5. The quotient of a number and 5, less 10, is 3.
6. **FINES** You return a book that is 5 days overdue. Including a previous unpaid overdue balance of $1.30, your new balance is $2.05. Write and solve an equation to find the fine for a book that is one day overdue.

Translate each sentence into an equation. Then find each number.

7. Four less than five times a number is equal to 11.
8. Fifteen more than twice a number is 9.
9. Eight more than four times a number is $-12$.
10. Six less than seven times a number is equal to $-20$.
11. Nine more than the quotient of a number and 3 is 14.
12. The quotient of a number and $-7$, less 4, is $-11$.
13. The difference between three times a number and 10 is 17.
14. The difference between twice a number and 1 is $-21$.

Solve each problem by writing and solving an equation.

15. **VACATION** While on vacation, you purchase 4 identical T-shirts for some friends and a watch for yourself, all for $75. You know that the watch cost $25. How much did each T-shirt cost?

16. **PERSONAL FITNESS** Angelica joins a local gym called Fitness Solutions. If she sets aside $1,000 in her annual budget for gym costs, use the ad at the right to determine how many hours she can spend with a personal trainer.

17. **PHONE SERVICE** A telephone company advertises long distance service for 7¢ per minute plus a monthly fee of $3.95. If your bill one month was $12.63, find the number of minutes you used making long distance calls.

18. **GAMES** You and two friends share the cost of renting a video game system for 5 nights. Each person also rents one video game for $6.33. If each person pays $11.33, what is the cost of renting the system?
19. **SKIING** In aerial skiing competitions, the total judges score is multiplied by the jump’s degree of difficulty and then added to the skier’s current score to obtain their final score. The table shows the first-round scores of a competition. After her second jump, Toshiro’s final score is 216.59. The degree of difficulty for Martin’s second jump is 4.45. Write and solve an equation to find what the judge’s score for Martin’s jump must be in order for her to tie Toshiro for first.

20. **WRITE A PROBLEM** Write about a real-life situation that can be solved using a two-step equation. Then write the equation and solve the problem.

21. **CRITICAL THINKING** Student Council has a total of $200 to divide among the top class finishers in a used toy drive. Second place will receive twice as much as third place. First place will receive $15 more than second place. Write and solve an equation to find how much each winning class will receive.

22. **MULTIPLE CHOICE** Ms. Anderson receives a weekly base salary of $325 plus 7% of her weekly sales. At the end of one week, she earned $500. Which equation can be used to find her sales $s$ for that week?

   - A. $325 + 0.07s = 500$
   - B. $325 + 7s = 500$
   - C. $325 + 0.7s = 500$
   - D. $325 + 0.07s = 500$

23. **GRID IN** Find the value of $x$ in the parallelogram at the right.

**SHORT RESPONSE** For Exercises 24 and 25, use the following information.

In a basketball game, 2 points are awarded for making a regular basket, and 1 point is awarded for making a foul shot. Emeril scored 21 points during one game. Three of those points were for foul shots. The rest were for regular goals.

24. Write an equation to find the number of regular baskets $b$ Emeril made during the game.

25. Solve the equation to find the number of regular baskets he made.

Solve each equation. Check your solution. *(Lesson 10-2)*

26. $5x + 2 = 17$
27. $-7b + 13 = 27$
28. $\frac{n}{8} + 1 = -6$
29. $-15 = -4p + 9$

Determine the number of significant digits in each measure. *(Lesson 7-9)*

30. 140 ft
31. 7.0 L
32. 9.04 s
33. 1,000.2 mi

**PREREQUISITE SKILL** Simplify each expression. *(Lesson 10-1)*

34. $5x + 6 - x$
35. $8 - 3n + 3n$
36. $7a - 7a - 9$
37. $3 - 4y + 9y$
Equations with Variables on Each Side

You can also use algebra tiles to solve equations that have variables on each side of the equation.

**ACTIVITY**

Work with a partner.

Use algebra tiles to model and solve $3x + 1 = x + 5$.

1. Identify the property of equality that allows you to remove a 1-tile or $-1$-tile from each side of an equation mat.

2. Explain why you can remove an $x$-tile from each side of the mat.

Therefore, $x = 2$. Since $3(2) + 1 = 2 + 5$, the solution is correct.

**Your Turn**

Use algebra tiles to model and solve each equation.

- a. $x + 2 = 2x + 1$
- b. $2x + 7 = 3x + 4$
- c. $2x - 5 = x - 7$
- d. $8 + x = 3x$
- e. $4x = x - 6$
- f. $2x - 8 = 4x - 2$

**Writing Math**

1. **Identify** the property of equality that allows you to remove a 1-tile or $-1$-tile from each side of an equation mat.

2. **Explain** why you can remove an $x$-tile from each side of the mat.
Lesson 10-4a  Hands-On Lab: Equations with Variables on Each Side

Use algebra tiles to model and solve \( x - 4 = 2x + 2 \).

\[ \begin{align*}
   x - 4 & = 2x + 2 \\
   x - x - 4 & = 2x - x + 2 \\
   -4 + (-2) & = x + 2 + (-2) \\
   -6 & = x \\
\end{align*} \]

Therefore, \( x = -6 \). Since \(-6 - 4 = 2(-6) + 2\), the solution is correct.

Use algebra tiles to model and solve each equation.

- **g.** \( x + 6 = 3x - 2 \)
- **h.** \( 3x + 3 = x - 5 \)
- **i.** \( 2x + 1 = x - 7 \)
- **j.** \( x - 4 = 2x + 5 \)
- **k.** \( 3x - 2 = 2x + 3 \)
- **l.** \( 2x + 5 = 4x - 1 \)

**Writing Math**

3. Solve \( x + 4 = 3x - 4 \) by removing 1-tiles first. Then solve the equation by removing x-tiles first. Does it matter whether you remove x-tiles or 1-tiles first? Is one way more convenient? Explain.

4. In the set of algebra tiles, \(-x\) is represented by \( -\square \). **Make a conjecture** and explain how you could use \(-x\)-tiles and other algebra tiles to solve \(-3x + 4 = -2x - 1\).
Solving Equations with Variables on Each Side

SPORTS You and your friend are having a race. You give your friend a 15-meter head start. During the race, you average 6 meters per second and your friend averages 5 meters per second.

1. Copy the table. Continue filling in rows to find how long it will take you to catch up to your friend.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Friend’s Distance (m)</th>
<th>Your Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 + 5(0) = 15</td>
<td>6(0) = 0</td>
</tr>
<tr>
<td>1</td>
<td>15 + 5(1) = 20</td>
<td>6(1) = 6</td>
</tr>
<tr>
<td>2</td>
<td>15 + 5(2) = 25</td>
<td>6(2) = 12</td>
</tr>
<tr>
<td>3</td>
<td>15 + 5(3) = 30</td>
<td>6(3) = 18</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

2. Write an expression for your distance after \( x \) seconds.
3. Write an expression for your friend’s distance after \( x \) seconds.
4. What is true about the distances you and your friend have gone when you catch up to your friend?
5. Write an equation that could be used to find how long it will take for you to catch up to your friend.

Some equations, like \( 15 + 5x = 6x \), have variables on each side of the equals sign. To solve these equations, use the Addition or Subtraction Property of Equality to write an equivalent equation with the variables on one side of the equals sign. Then solve the equation.

### Example
**Equations with Variables on Each Side**

Solve \( 15 + 5x = 6x \). Check your solution.

1. Write the equation.
2. Subtract \( 5x \) from each side.

\[
15 + 5x - 5x = 6x - 5x \\
15 = x
\]

To check your solution, replace \( x \) with 15 in the original equation.

Check \( 5x + 15 = 6x \)

\[
5(15) + 15 \overset{?}{=} 6(15) \\
90 = 90 \checkmark
\]

The solution is 15.
Alternate Method
The problem in Example 2 could have also been solved by first subtracting 6n from each side.

\[
6n - 1 = 4n - 5
\]

\[
-6n = -6n
\]

\[
-1 = -2n - 5
\]

Notice that this method results in a term with a negative coefficient, but the solution is the same.

Equations with Variables on Each Side

Solve \(6n - 1 = 4n - 5\).

Write the equation.

\[
6n - 1 = 4n - 5
\]

Subtract 4n from each side.

\[
2n - 1 = -5
\]

Simplify.

\[
2n - 1 + 1 = -5 + 1
\]

Add 1 to each side.

\[
2n = -4
\]

Simplify.

\[
2n = -2
\]

Mentally divide each side by 2.

The solution is \(-2\). Check this solution.

Your Turn
Solve each equation. Check your solution.

a. \(8a = 5a + 21\)  

b. \(3x - 7 = 8x + 23\)  

c. \(7g - 12 = 3 + 2g\)

Use an Equation to Solve a Problem

GRID-IN TEST ITEM Find the value of \(x\) so that polygons have the same perimeter.

Read the Test Item You need to find the value of \(x\) that will make the perimeter of the triangle equal to the perimeter of the rectangle.

Solve the Test Item Write expressions for the perimeter of each figure. Then set the two expressions equal to each other and solve for \(x\).

Triangle

\((x + 5) + (x + 4) + (x + 8) = 3x + 17\)

Rectangle

\((2x + 3) + (2x + 3) + (x + 5) + (x + 5) = 6x + 16\)

\[
\frac{\text{Perimeter of Triangle}}{3x + 17} = \frac{\text{Perimeter of Rectangle}}{6x + 16}
\]

\[
3x - 3x + 17 = 6x - 3x + 16
\]

\[
17 = 3x + 16
\]

\[
17 - 16 = 3x + 16 - 16
\]

\[
1 = 3x
\]

\[
\frac{1}{3} = \frac{3x}{3}
\]

\[
\frac{1}{3} = x
\]
1. **Name** the property of equality that allows you to add $3x$ to each side of the equation $1 - 3x = 5x - 7$.

2. **OPEN ENDED** Write an equation that has variables on each side. Then list the steps you would use to isolate the variable.

---

**Guided Practice**

Solve each equation. Check your solution.

3. $5n + 9 = 2n$  
4. $3k + 14 = k$  
5. $10x = 3x - 28$

6. $7y - 8 = 6y + 1$  
7. $2a + 21 = 8a - 9$  
8. $-4p - 3 = 2 + p$

9. Eighteen less than three times a number is twice the number. Define a variable, write an equation, and solve to find the number.

---

**Practice and Applications**

Solve each equation. Check your solution.

10. $7a + 10 = 2a$  
11. $11x = 24 + 8x$

12. $9g - 14 = 2g$  
13. $m - 18 = 3m$

14. $5p + 2 = 4p - 1$  
15. $8y - 3 = 6y + 17$

16. $15 - 3n = n - 1$  
17. $3 - 10b = 2b - 9$

18. $-6f + 13 = 2f - 11$  
19. $2z - 31 = -9z + 24$

20. $2.5h - 15 = 4h$  
21. $21.6 - d = 5d$

22. $1 - 3c = 9c + 7$  
23. $7k + 12 = 8 - 9k$

24. $13.4w + 17 = 5w - 4$  
25. $8.1a + 2.3 = 5.1a - 3.1$

26. $\frac{2}{3}x + 5 = \frac{1}{3}x + 14$  
27. $\frac{1}{2}a - 3 = 7 - \frac{3}{4}a$

---

Define a variable and write an equation to find each number. Then solve.

28. Twice a number is 42 less than five times a number. What is the number?

29. Two more than 4 times a number is the number less 7. What is the number?

Write an equation to find the value of $x$ so that each pair of polygons has the same perimeter. Then solve.

30. 

31. 

---

32. **MOVIES** For an annual fee of $30, you can join a movie club that will allow you to purchase tickets for $5.50 each at your local theater. If the theater charges $8 for movie tickets, write and solve an equation to determine how many movie tickets you will have to buy through the movie club for the cost to equal that of buying regularly priced tickets.
33. **DISCOUNTS** Band members are selling the coupons shown at the right for $14 each. Write and solve an equation to determine how much money you would have to spend on food and drinks for the cost to equal that of buying the concessions without the discount.

34. **FOOD DRIVES** The seventh graders at your school have collected 345 cans for the canned food drive and are averaging 115 cans per day. The eighth graders have collected 255 cans, but vow to win the contest by collecting an average of 130 cans per day. If both grades continue collecting at these rates, after how many days will the number of cans they have collected be equal?

35. **CRAFT FAIRS** The Art Club is selling handcrafted mugs at a local craft fair. Vendors at the fair must pay $5 for a booth plus 10% of their sales. It costs $8 in materials to make each mug. If the club sells each mug for $10, write and solve an equation to find how many mugs they must sell to break even. (Hint: Total cost must equal total income.)

36. **CRITICAL THINKING** Find the area of the parallelogram at the right.

37. **MULTIPLE CHOICE** Phone company A charges $28.25 a month plus 18¢ per minute for local calls. Company B charges $19.85 per month plus 32¢ per minute for local calls. Which equation can be used to find the number of minutes for which the companies’ plans cost the same?

38. **SHORT RESPONSE** Find the value of x so that the two figures at the right have the same area.

Translate each sentence into an equation. Then find each number. **(Lesson 10-3)**

39. Eight more than four times a number is 60.

40. Five less than the quotient of a number and 3 equals −9.

Solve each equation. Check your solution. **(Lesson 10-2)**

41. $7r + 10 = -11$

42. $3g - 7 = 8$

43. $8 - p = -10$

44. $2 + \frac{a}{-5} = 6$

**PREREQUISITE SKILL** Determine whether each statement is true or false. **(Lesson 1-3)**

45. $8 > 11$

46. $3 \geq -6$

47. $-5 \geq -5$

48. $-2 < -9$
What You’ll Learn
Solve problems using the guess and check strategy.

Guess and Check

Wow! The Fall Carnival was really a success! We collected 150 tickets at the Balloon Pop and Bean-Bag Toss booths alone.

But how many came from each booth? They are all mixed together. We can guess and check to figure this out.

Explore
The Bean-Bag Toss was 3 tickets, and the Balloon Pop was 2 tickets. The person running the Bean-Bag Toss said 10 more games were played at her booth than at the Balloon Pop.

Plan
Let’s make a guess and check to see if it is correct. Remember, the number we guess for the Bean-Bag Toss must be 10 more than the number we guess for the Balloon Pop.

Solve
We need to find the combination that gives us 150 total tickets. In our list, \( p \) is the number of Balloon Pop games, and \( t \) is the number of Bean-Bag Toss games.

<table>
<thead>
<tr>
<th>( p )</th>
<th>( t )</th>
<th>( 3p + 2t )</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>22</td>
<td>3(12) + 2(22) = 80</td>
<td>too low</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
<td>3(30) + 2(40) = 170</td>
<td>too high</td>
</tr>
<tr>
<td>28</td>
<td>38</td>
<td>3(28) + 2(38) = 160</td>
<td>still too high</td>
</tr>
<tr>
<td>26</td>
<td>36</td>
<td>3(26) + 2(36) = 150</td>
<td>correct</td>
</tr>
</tbody>
</table>

So 3(26) or 78 tickets were from the Balloon Pop and 2(36) or 72 tickets were from the Bean-Bag Toss.

Examine
36 Balloon Pop games is 10 more than 26 Bean-Bag Toss games. Since 78 tickets plus 72 tickets is 150 tickets, the guess is correct.

1. Describe how to solve a problem using the guess and check strategy.
2. Explain why it is important to make an organized list of your guesses and their results when using the guess and check strategy.
3. Write a problem that could be solved by guessing and checking. Then write the steps you would take to find the solution to your problem.
Solve. Use the guess and check strategy.

4. **NUMBER THEORY** The product of a number and its next two consecutive whole numbers is 60. Find the number.

5. **MONEY MATTERS** Adam has exactly $2 in quarters, dimes, and nickels. If he has 12 coins, how many of each coin does he have?

Solve. Use any strategy.

6. **DESIGN** Edu-Toys is designing a new package to hold a set of 30 alphabet blocks like the one shown. Give two possible dimensions for the box.

7. **RECREATION** During a routine, ballet dancers are evenly spaced in a circle. If the sixth person is directly opposite the sixteenth person, how many people are in the circle?

8. **TECHNOLOGY** The average Internet user spends $6\frac{1}{2}$ hours online each week. What percent of the week does the average user spend online?

9. **READING** Terrence is reading a 255-page book. He needs to read twice as many pages as he has already read to finish the book. How many pages has he read so far?

10. **DINING** The cost of your meal comes to $8.25. If you want to leave a 15% tip, would it be more reasonable to expect the tip to be about $1.25 or about $1.50?

11. **GEOMETRY** The length $\ell$ of the rectangle below is longer than its width $w$. List the possible whole number dimensions for the rectangle, and identify the possibility that gives the smallest perimeter.

**FOOD** For Exercises 12 and 13, use the following information.
The school cafeteria surveyed 36 students about their dessert preference. The results are listed below.

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Preference of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>cake</td>
</tr>
<tr>
<td>20</td>
<td>ice cream</td>
</tr>
<tr>
<td>15</td>
<td>pie</td>
</tr>
<tr>
<td>2</td>
<td>all three</td>
</tr>
<tr>
<td>1</td>
<td>no desserts</td>
</tr>
<tr>
<td>15</td>
<td>cake or ice cream</td>
</tr>
<tr>
<td>8</td>
<td>pie or cake</td>
</tr>
<tr>
<td>3</td>
<td>ice cream only</td>
</tr>
</tbody>
</table>

12. How many students prefer only pie?
13. How many prefer either pie or ice cream?

14. **NUMBER SENSE** Find the product of $1 - \frac{1}{2}$, $1 - \frac{1}{3}$, $1 - \frac{1}{4}$, ..., $1 - \frac{1}{48}$, $1 - \frac{1}{49}$, and $1 - \frac{1}{50}$.

15. **STANDARDIZED TEST PRACTICE** SOL Practice
At a souvenir shop, a mug costs $3, and a pin costs $2. Chase bought either a mug or a pin for each of his 11 friends. If he spent $30 on these gifts and bought at least one of each type of souvenir, how many of each did he buy?

- **A** 7 mugs, 4 pins
- **B** 8 mugs, 3 pins
- **C** 9 mugs, 2 pins
- **D** 10 mugs, 1 pin
1. Explain what is meant by like terms. Then give an example of two terms that are considered like terms and two that are not. (Lesson 10-1)

2. OPEN ENDED Write a two-step equation whose solution is 12. (Lesson 10-2)

3. Use the Distributive Property to rewrite each expression. (Lesson 10-1)
   3. $3(x + 2)$
   4. $-2(a - 3)$
   5. $5(3c - 7)$

4. Identify the terms, like terms, coefficients, and constants in the expression $5 - 4x + x - 3$. (Lesson 10-1)

5. Simplify each expression. (Lesson 10-1)
   7. $2a - 13a$
   8. $6b + 5 - 6b$
   9. $7x + 2 - 8x + 5$

6. Solve each equation. Check your solution. (Lessons 10-2 and 10-4)
   10. $3m + 5 = 14$
   11. $11 = \frac{1}{3}a + 2$
   12. $-2k + 7 = -3$
   13. $3x + 7 = 2x$
   14. $7p - 6 = 4p$
   15. $3y - 5 = 5y + 7$

7. Two less than 5 times a number is 23. Write and solve an equation to find the number. (Lesson 10-3)

8. CAR RENTALS A rental car company charges $52 per day and $0.32 per mile to rent a car. Ms. Misel was charged $202.40 for a 3-day rental. Write and solve an equation to determine how many miles she drove. (Lesson 10-3)

9. GEOMETRY Write and solve an equation to find the value of $x$ so that the polygons have the same perimeter. (Lesson 10-4)

10. MULTIPLE CHOICE Which expression is equivalent to $2(3x + 1 - x - 5)$? (Lesson 10-1)
    - A $6x - 8$
    - B $4x - 8$
    - C $4x - 4$
    - D $7x - 4$

11. SHORT RESPONSE The length of a rectangular room is 3 feet more than twice its width. If the perimeter of the room is 78 feet, find its width. (Lesson 10-2)
**Math-O**

**GET READY!**

**Players:** two, three, or four  
**Materials:** 52 index cards and 4 different colored markers

**GET SET!**

- Make a set of four cards by using the markers to put a different-colored stripe at the top of each card.
- Then write a different two-step equation on each card. The solution of each equation should be 1.
- Continue to make sets of four cards having equations with solutions of 2, 3, 4, 5, 6, \(-1\), \(-2\), \(-3\), \(-4\), \(-5\) and \(-6\).
- Mark the remaining set of four cards “Wild”.

**GO!**

- The dealer shuffles the cards and deals five to each person. The remaining cards are placed in a pile facedown in the middle of the table. The dealer turns the top card faceup.
- The player to the left of the dealer plays a card with the same color or solution as the faceup card. Wild cards can be played any time. If the player cannot play a card, he or she takes a card from the pile and plays it, if possible. If it is not possible to play, the player places the card in his or her hand, and it is the next player’s turn.
- **Who Wins?** The first person to play all cards in his or her hand is the winner.
Inequalities

am I ever going to use this?

SIGNS The first highway sign at the right indicates that trucks more than 10 feet 6 inches tall cannot pass. The second sign indicates that a speed of 45 miles per hour or less is legal.

1. Name three truck heights that can safely pass on a road where the first sign is posted. Can a truck that is 10 feet 6 inches tall pass? Explain.
2. Name three speeds that are legal according to the second sign. Is a car traveling at 45 miles per hour driving at a legal speed? Explain.

In Chapter 1, you learned that a mathematical sentence that contains > or < is called an inequality. When used to compare a variable and a number, inequalities can describe a range of values.

Write Inequalities with < or >

Write an inequality for each sentence.

SAFETY A package must weigh less than 80 pounds.
Let \( w \) = package’s weight.
\( w < 80 \)

AGE You must be over 55 years old to join.
Let \( a \) = person’s age.
\( a > 55 \)

Some inequalities use the symbols \( \leq \) or \( \geq \). They are combinations of the symbol < or > with part of the equals sign. The symbol \( \leq \) is read is less than or equal to, while the symbol \( \geq \) is read is greater than or equal to.

Write Inequalities with \( \leq \) or \( \geq \)

Write an inequality for each sentence.

VOTING You must be 18 years of age or older to vote.
Let \( a \) = person’s age.
\( a \geq 18 \)

DRIVING Your speed must be 65 miles per hour or less.
Let \( s \) = car’s speed.
\( s \leq 65 \)
Inequalities with variables are open sentences. When the variable in an open sentence is replaced with a number, the inequality may be true or false.

### Determine the Truth of an Inequality

For the given value, state whether each inequality is true or false.

- For the given value, state whether each inequality is true or false.
  - **a.** \(a + 2 > 8, a = 5\)
    - Write the inequality. \(a + 2 > 8\)
    - Replace \(a\) with 5. \(5 + 2 > 8\)
    - Simplify. \(7 > 8\)
    - Since 7 is not greater than 8, \(7 > 8\) is false.
  - **b.** \(10 \leq 7 - x, x = -3\)
    - Write the inequality. \(10 \leq 7 - x\)
    - Replace \(x\) with \(-3\). \(10 \leq 7 - (-3)\)
    - Simplify. \(10 \leq 10\)
    - While 10 < 10 is false, 10 = 10 is true, so 10 \(\leq\) 10 is true.

### Graph an Inequality

Graph each inequality on a number line.

- **n < 3**
  - Place an open circle at 3.
  - Then draw a line and an arrow to the left.
  - The open circle means the number 3 is not included in the graph.

- **n \(\geq\) 3**
  - Place a closed circle at 3.
  - Then draw a line and an arrow to the right.
  - The closed circle means the number 3 is included in the graph.

**Your Turn**

Graph each inequality on a number line.

- **d.** \(x > 2\)
- **e.** \(x < 1\)
- **f.** \(x \leq 5\)
- **g.** \(x \geq -4\)
1. **OPEN ENDED** Write an inequality using $\leq$ or $\geq$. Then give a situation that can be represented by the inequality.

2. **NUMBER SENSE** Integers that are greater than or equal to zero are classified as what types of numbers? Represent this classification of numbers using an inequality.

Write an inequality for each sentence.

3. **RESTAURANTS** Children under the age of 6 eat free.

4. **TESTING** You are allowed a maximum of 45 minutes to complete one section of a standardized test.

For the given value, state whether each inequality is true or false.

5. $x - 11 < 9, x = 20$
6. $42 \geq 6a, a = 8$
7. $\frac{n}{3} + 1 \leq 6; n = 15$

Graph each inequality on a number line.

8. $n > 4$
9. $p \leq 2$
10. $x \geq 0$
11. $a < 7$

Write an inequality for each sentence.

12. **MOVIES** Children under 13 are not permitted without an adult.
13. **SHOPPING** You must spend more than $100 to receive a discount.
14. **ELEVATORS** An elevator’s maximum load is 3,400 pounds.
15. **FITNESS** You must run at least 4 laps around the track.
16. **GRADES** A grade of no less than 70 is considered passing.
17. **MONEY** The cost can be no more than $25.

For the given value, state whether each inequality is true or false.

18. $12 + a < 20, a = 9$
19. $15 - k > 6, k = 8$
20. $-3y < 21; y = 8$
21. $32 \leq 2x, x = 16$
22. $\frac{n}{4} \geq 5, n = 12$
23. $\frac{-18}{x} > 9, x = -2$

Graph each inequality on a number line.

24. $x > 6$
25. $a > 0$
26. $y < 8$
27. $h < 2$
28. $w \leq 3$
29. $p \geq 7$
30. $n \geq 1$
31. $d \leq 4$
32. $-5 > b$
33. $-3 \leq y$

Write an inequality for each sentence.

34. A number increased by 5 is at most 15.
35. Eight times a number is no less than 24.
36. Sixteen is more than the quotient of number and 2.
37. Four less than a number is less than 12.
TELEVISION For Exercises 38 and 39, use the information in the graphic.

38. Rashid decides that he spends at least 100 more hours than the average time spent by kids watching television each year. Write an inequality for Rashid’s TV viewing time.

39. Gabriela determines that she spends at most the same amount of time watching TV each year as the average amount of time kids spend attending school. Write an inequality to represent Gabriela’s TV viewing time.

EQUIVALENT INEQUALITIES The inequality $3 < x$ is equivalent to $x > 3$. Write an equivalent inequality for each of the following.

40. $14 \leq a$  
41. $-2 > n$  
42. $-5 \geq y$

43. RESEARCH Use the Internet or another resource to find who first used the symbols $<$ for less than and $>$ for greater than.

44. CRITICAL THINKING Determine whether the following statement is sometimes, always, or never true. Explain your reasoning. If $x$ is a real number, then $x \geq x$.

45. MULTIPLE CHOICE What inequality is graphed below?

- $x < -3$
- $x \leq -3$
- $x > -3$
- $x \geq -3$

46. MULTIPLE CHOICE Which inequality represents a number is at least 24?

- $n \geq 24$
- $n < 24$
- $n \leq 24$
- $n > 24$

Solve each equation. Check your solution. (Lesson 10-4)

47. $2x + 16 = 6x$  
48. $5y - 1 = 3y + 11$  
49. $4a - 9 = 7a + 6$  
50. $n + 0.8 = -n + 1$

51. WEATHER The temperature is $-3^\circ F$. It is expected to rise $6^\circ$ each hour for the next several hours. Write and solve an equation to find in how many hours the temperature will be $21^\circ F$. (Lesson 10-3)

PREREQUISITE SKILL Solve each equation. (Lesson 1-8)

52. $y + 15 = 31$  
53. $n + 4 = -7$  
54. $a - 8 = 25$  
55. $-12 = x - 3$
Solve Inequalities by Adding or Subtracting

**Virginia SOL** Standard 8.15 The student will solve two-step equations and inequalities in one variable, using concrete materials, pictorial representations, and paper and pencil.

**What You’ll Learn**
- Solve inequalities by using the Addition or Subtraction Properties of Inequality.

**FAMILY** The table shows the age of each member of Victoria’s family. Notice that Victoria is younger than her brother, since $13 < 16$. Will this be true 10 years from now?

1. Add 10 to each side of the inequality $13 < 16$. Write the resulting inequality and decide whether it is true or false.

2. Was Victoria’s dad younger or older than Victoria’s mom 13 years ago? Explain your reasoning using an inequality.

The examples above demonstrate properties of inequality.

**Key Concept**

**Addition and Subtraction Properties of Inequality**

<table>
<thead>
<tr>
<th>Words</th>
<th>When you add or subtract the same number from each side of an inequality, the inequality remains true.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbols</td>
<td>For all numbers $a$, $b$, and $c$,</td>
</tr>
<tr>
<td>1.</td>
<td>if $a &gt; b$, then $a + c &gt; b + c$ and $a - c &gt; b - c$.</td>
</tr>
<tr>
<td>2.</td>
<td>if $a &lt; b$, then $a + c &lt; b + c$ and $a - c &lt; b - c$.</td>
</tr>
<tr>
<td>Examples</td>
<td>$2 &gt; -3$, $2 + 5 &gt; -3 + 5$, $7 &gt; 2$, $3 &lt; 8$, $3 - 4 &lt; 8 - 4$, $-1 &lt; 4$</td>
</tr>
</tbody>
</table>

These properties are also true for $a \geq b$ and $a \leq b$.

Solving an inequality means finding values for the variable that make the inequality true.

**EXAMPLE**

**Solve an Inequality Using Addition**

Solve $n - 8 < 15$. Check your solution.

$n - 8 < 15$ Write the inequality.

$n - 8 + 8 < 15 + 8$ Add 8 to each side.

$n < 23$ Simplify.

**Check**

$n - 8 < 15$ Write the inequality.

$22 - 8 \leq 15$ Replace $n$ with a number less than 23, such as 22.

$14 < 15$ ✓ This statement is true.

Any number less than 23 will make the statement true, so the solution is $n < 23$. 

---

Family Age

<table>
<thead>
<tr>
<th>Member</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dad</td>
<td>43</td>
</tr>
<tr>
<td>Mom</td>
<td>41</td>
</tr>
<tr>
<td>Brother</td>
<td>16</td>
</tr>
<tr>
<td>Victoria</td>
<td>13</td>
</tr>
</tbody>
</table>
**Solve an Inequality Using Subtraction**

**Example**

Solve \(-4 \geq a + 7\). Check your solution.

1. Write the inequality.
   \[-4 \geq a + 7\]
2. Subtract 7 from each side.
   \[-4 - 7 \geq a + 7 - 7\]
   \[-11 \geq a\] or \(a \leq -11\)

**Check** Replace \(a\) in the original inequality with \(-11\) and then with a number less than \(-11\).

The solution is \(a \leq -11\).

**Graph the Solutions of an Inequality**

**Example**

Solve \(y - \frac{1}{3} \leq 5\). Then graph the solution on a number line.

1. Write the inequality.
   \[y - \frac{1}{3} \leq 5\]
2. Subtract \(\frac{1}{3}\) from each side.
   \[y - \frac{1}{3} + \frac{1}{3} \leq 5 + \frac{1}{3}\]
   \[y \leq 5\frac{1}{3}\]

The solution is \(y \leq 5\frac{1}{3}\).

**Your Turn**

Solve each inequality and check your solution. Then graph the solution on a number line.

a. \(t + 3 > 12\)  
   \(t > 9\)

b. \(2 > p - 5\)  
   \(p < 7\)

c. \(n + \frac{1}{2} \geq 4\)  
   \(n \geq \frac{7}{2}\)

**Use an Inequality to Solve a Problem**

**Example**

Suppose a South American manatee weighs 968 pounds. Use the information at the left to determine how much more weight this manatee might gain.

1. The phrase *up to* means *less than or equal to*. So, the manatee’s current weight plus any weight gained must be less than or equal to 1,300 pounds.
2. Let \(w\) = weight gained by the manatee.
3. \[\text{manatee’s current weight} \quad \text{plus} \quad \text{weight gained} \quad \text{must be less than or equal to} \quad 1,300 \quad \text{pounds}\]

   \[968 + w \leq 1,300\]
4. Write the inequality.
5. \[968 - 968 + w \leq 1,300 - 968\]
   \[w \leq 332\]
   Simplify.

The manatee might gain up to 332 more pounds.
1. Explain how solving an inequality by using subtraction is similar to solving an equation by using subtraction.

2. OPEN ENDED Write an inequality whose solution is \( n > 5 \) that can be solved by using the Addition or Subtraction Property of Equality.

Solve each inequality. Check your solution.

3. \( b + 5 > 9 \)
4. \( 12 + n \leq 4 \)
5. \( -6 \leq 7 + g \)
6. \( x - 4 < 10 \)
7. \( k - 9 \geq -2 \)
8. \( 8 > y - 8 \)

Solve each inequality and check your solution. Then graph the solution on a number line.

9. \( c + 9 < 7 \)
10. \( m - 1 \geq 3 \)
11. \( a - \frac{1}{2} > 3 \)

Write an inequality and solve each problem.

30. Five more than a number is at least 13.
31. The difference between a number and 11 is less than 8.
32. Nine less than a number is more than 4.
33. The sum of a number and 17 is no more than 6.

Solve each inequality and check your solution. Then graph the solution on a number line.

34. \( c + 1 < 4 \)
35. \( n + 8 > 12 \)
36. \( 2 \leq 7 + p \)
37. \( -10 \geq x + 6 \)
38. \( a - 3 \leq 5 \)
39. \( -11 > g - 4 \)
40. \( -12 < k - 9 \)
41. \( h - 6 \geq -4 \)
42. \( y - 1.5 < 2 \)
43. \( b - 0.75 \leq 7 \)
44. \( t + \frac{2}{3} > 8 \)
45. \( w + 5\frac{1}{3} < 10 \)

46. INSECTS There are more than 250,000 species of beetles. A science museum has a collection representing 320 of these species. Write and solve an inequality to find how many beetle species are not represented.
HEALTH  For Exercises 47 and 48, use the diagram at the right.

47. An adult is considered to have a high fever if his or her temperature goes above 101°F. Suppose Mr. Herr has a temperature of 99.2°F. Write and solve an inequality to find how much his temperature must increase before he is considered to have a high fever.

48. Hypothermia occurs when a person’s body temperature falls below 95°F. Write and solve an inequality that describes how much lower the body temperature of a person with hypothermia will be than a person with a normal body temperature of 98.6°F.

49. GEOMETRY  The base of the rectangle shown is greater than its height. Write and solve an inequality to find the possible values of $x$.

50. WRITE A PROBLEM  Write about a real-life situation that can be solved by using an addition inequality. Then write an inequality and solve the problem.

51. CRITICAL THINKING  Is it sometimes, always, or never true that $x > x + 1$? Explain your reasoning.

52. MULTIPLE CHOICE  Adriana has $30 to spend on food and rides at a carnival. She has already spent $12 on food. Which inequality represents how much money she can spend on rides?

- $m < 18$
- $m \leq 18$
- $m > 18$
- $m \geq 18$

53. MULTIPLE CHOICE  If $x - 6 > 17$, then $x$ could be which of the following values?

- $11$
- $22$
- $23$
- $24$

For the given value, state whether each inequality is true or false. (Lesson 10-5)

54. $18 - n > 4, n = 11$
55. $13 + x < 21, x = 8$
56. $34 \leq 5p, p = 7$
57. \( \frac{a}{-4} \geq 3, a = -12 \)

58. CAR RENTAL  Suppose you can rent a car for either $35 a day plus $0.40 a mile or for $20 a day plus $0.55 per mile. Write and solve an equation to find the number of miles that results in the same cost for one day. (Lesson 10-4)

59. If $\angle F$ and $\angle G$ are supplementary and $m\angle G = 47^\circ$, find $m\angle F$. (Lesson 6-1)

PREREQUISITE SKILL  Solve each equation. (Lesson 1-9)

60. $3y = -15$
61. $-18 = -2a$
62. \( \frac{w}{4} = 12 \)
63. $20 = \frac{x}{-5}$
Solve inequalities by using the Multiplication or Division Properties of Inequality.

SHOPPING The table shows the prices of the same brand name of shoes at a sports apparel store. Notice that walking shoes cost less than cross-training shoes, since $80 < 150$. Will this inequality be true if the store sells both pairs of shoes at half price?

1. Divide each side of the inequality $80 < 150$ by 2. Write the resulting inequality and decide whether it is true or false.

2. Would the cost of three pairs of basketball shoes be greater or less than the cost of three pairs of running shoes all sold at the regular price? Explain your reasoning using an inequality.

The examples above demonstrate additional properties of inequality.

### Key Concept

**Multiplication and Division By a Positive Number**

**Words**
When you multiply or divide each side of an inequality by a positive number, the inequality remains true.

**Symbols**
For all numbers $a$, $b$, and $c$, where $c > 0$,

1. if $a > b$, then $ac > bc$ and $\frac{a}{c} > \frac{b}{c}$.
2. if $a < b$, then $ac < bc$ and $\frac{a}{c} < \frac{b}{c}$.

**Examples**

- $5 < 8$
- $4(5) < 4(8)$
- $20 < 32$
- $2 > -10$
- $\frac{2}{2} > \frac{-10}{2}$
- $1 > -5$

These properties also hold true for $a \geq b$ and $a \leq b$.

### Example

**Divide by a Positive Number**

Solve $7y > -42$. Check your solution.

1. $7y > -42$
   Write the inequality.
2. $\frac{7y}{7} > \frac{-42}{7}$
   Divide each side by 7.
3. $y > -6$
   Simplify.

The solution is $y > -6$. You can check this solution by substituting numbers greater than $-6$ into the inequality.
What happens when each side of an inequality is multiplied or divided by a negative number?

Graph 3 and 5 on a number line. Multiply each number by -1.

Since 3 is to the left of 5, \(3 < 5\). Since \(-3\) is to the right of \(-5\), \(-3 > -5\).

Notice that the numbers being compared switched positions as a result of being multiplied by a negative number. In other words, their order reversed. These and other examples suggest the following properties.

### Key Concept: Multiplication and Division By a Negative Number

**Words**
When you multiply or divide each side of an inequality by a negative number, the direction of the inequality symbol must be reversed for the inequality to remain true.

**Symbols**
For all numbers \(a\), \(b\), and \(c\), where \(c < 0\),

1. if \(a > b\), then \(ac < bc\) and \(\frac{a}{c} < \frac{b}{c}\).
2. if \(a < b\), then \(ac > bc\) and \(\frac{a}{c} > \frac{b}{c}\).

**Examples**

\[
\begin{align*}
8 &> 5 & -3 &< 9 \\
-1(8) &< -1(5) & -\frac{3}{3} &> -\frac{9}{3} \\
-8 &< -5 & 1 &> -3
\end{align*}
\]

These properties also hold true for \(a \geq b\) and \(a \leq b\).
Some inequalities involve more than one operation. To solve, work backward to undo the operations as you did in solving two-step equations.

**Multiply or Divide by a Negative Number**

1. Solve \( \frac{a}{-2} \geq 8 \). Check your solution.

   \[
   \frac{a}{-2} \geq 8 \quad \text{Write the inequality.}
   \]

   \[
   -2 \left( \frac{a}{-2} \right) \leq -2(8) \quad \text{Multiply each side by } -2 \text{ and reverse the inequality symbol.}
   \]

   \[
   a \leq -16 \quad \text{Simplify.}
   \]

   The solution is \( a \leq -16 \). You can check this solution by replacing \( a \) in the original inequality with \( -16 \) and a number less than \( -16 \).

2. Solve \( -6n < -24 \). Then graph the solution on a number line.

   \[
   -6n < -24 \quad \text{Write the inequality.}
   \]

   \[
   \frac{-6n}{-6} > \frac{-24}{-6} \quad \text{Divide each side by } -6 \text{ and reverse the inequality symbol.}
   \]

   \[
   n > 4 \quad \text{Check this result.}
   \]

   Graph the solution, \( n > 4 \).

**Your Turn**

Solve each inequality and check your solution. Then graph the solution on a number line.

- d. \( \frac{c}{7} < -14 \)
- e. \( -5d \geq 30 \)
- f. \( -3 \leq \frac{w}{-8} \)

**REAL-LIFE MATH**

If you are 14 or 15 and have a part-time job, you can work no more than 3 hours on a school day, 8 hours in a school week, 8 hours on a nonschool day, or 40 hours in a nonschool week.

**Source:** www.youthrules.dol.gov

**Examples**

**Solve a Two-Step Inequality**

**WORK** Jason wants to earn at least $30 this week to go to the state fair. His dad will pay him $12 to mow the lawn. For washing their cars, his neighbors will pay him $8 per car. If Jason mows the lawn, write and solve an inequality to find how many cars he needs to wash to earn at least $30.

The phrase *at least* means *greater than or equal to*. Let \( c \) = the number of cars he needs to wash. Then write an inequality.

\[
\begin{align*}
12 & \quad \text{plus} \quad 8c \quad \text{is greater than or equal to} \quad 30 \\
12 + 8c & \geq 30 \\
12 - 12 + 8c & \geq 30 - 12 \\
8c & \geq 18 \\
\frac{8c}{8} & \geq \frac{18}{8} \\
c & \geq 2.25
\end{align*}
\]

Since he will not get paid for washing a fourth of a car, Jason must wash at least 3 cars.
1. **OPEN ENDED** Write an inequality that can be solved using the Multiplication Property of Equality where the inequality symbol needs to be reversed.

2. **FIND THE ERROR** Olivia and Lakita each solved $8a \leq -56$. Who is correct? Explain.

   **Olivia**
   
   $8a \leq -56$
   
   $\frac{8a}{8} \leq \frac{-56}{8}$
   
   $a \leq -7$

   **Lakita**

   $8a \leq -56$
   
   $\frac{8a}{8} \geq \frac{-56}{8}$
   
   $a \geq -7$

---

**GUIDED PRACTICE**

Solve each inequality and check your solution. Then graph the solution on a number line.

3. $8x \leq -72$
4. $-4y > 32$
5. $-56 \leq -7p$
6. $\frac{h}{4} \geq -6$
7. $\frac{8}{-2} < -7$
8. $\frac{d}{-3} \geq -3$

---

Solve each inequality. Check your solution.

9. $2a - 8 < -24$
10. $-4k + 3 > -13$
11. $\frac{m}{-3} + 7 \leq -2$

---

**Practice and Applications**

Solve each inequality and check your solution. Then graph the solution on a number line.

12. $5x < 15$
13. $9n \leq 45$
14. $14k \geq -84$
15. $-12 > 3g$
16. $-100 \leq 50p$
17. $2y < -22$
18. $-4w \geq 20$
19. $-3r > 9$
20. $-72 < -12h$
21. $-6c \geq -6$
22. $\frac{v}{-4} > 4$
23. $\frac{a}{-3} \geq 5$
24. $\frac{x}{9} \leq -3$
25. $\frac{n}{7} < -14$
26. $\frac{m}{-2} < -7$
27. $\frac{t}{-5} \leq -2$
28. $-8 \leq \frac{v}{0.2}$
29. $-\frac{1}{2}k > -10$

30. **BUS TRAVEL** A city bus company charges $2.50 per trip. They also offer a monthly pass for $85.00. Write and solve an inequality to find how many times a person should use the bus so that the pass is less expensive than buying individual tickets.

31. **BABY-SITTING** You want to buy a pair of $42 inline skates with the money you make baby-sitting. If you charge $5.25 an hour, write and solve an inequality to find how many whole hours you must baby-sit to buy the skates.
For Exercises 32 and 33, use the information in the graphic at the right.

32. Write and solve an inequality to find the approximate circumference of Earth.

33. Write and solve an inequality to find the approximate distance from Earth to the moon and back.

Solve each inequality. Check your solution.

34. \(5y - 2 > 13\)
35. \(8k + 3 \leq -5\)
36. \(-3g + 8 \geq -4\)
37. \(7 + \frac{n}{3} < 4\)
38. \(\frac{4}{8} - 4 \leq -5\)
39. \(-\frac{c}{4} + 8 < 1\)
40. \(3a - 8 < 5a\)
41. \(10 - 3x \geq 25 + 2x\)

Write an inequality for each sentence. Then solve the inequality.

42. Three times a number is less than \(-60\).
43. The quotient of a number and \(-5\) is at most 7.
44. The quotient of a number and 3 is at least \(-12\).
45. The product of \(-2\) and a number is greater than \(-18\).

46. CRITICAL THINKING You have scores of 88, 92, 85, and 87 on four tests. What number of points must you get on your fifth test to have a test average of at least 90?

47. MULTIPLE CHOICE Which number is a possible base length of the triangle if its area is greater than 45 square yards?

   - A 3
   - B 4
   - C 5
   - D 6

48. MULTIPLE CHOICE As a salesperson, you are paid $60 per week plus $5 per sale. This week you want your pay to be at least $120. Which inequality can be used to find the number of sales you must make this week?

   - A \(60 + 5x \geq 120\)
   - B \(60 + 5x \leq 120\)
   - C \(60x + 5 \geq 120\)
   - D \(60x + 5 \leq 120\)

Solve each inequality. Check your solution. (Lesson 10-6)

49. \(y + 7 < 9\)
50. \(a - 5 \leq 2\)
51. \(j - 8 \geq -12\)
52. \(-14 > 8 + n\)

Write an inequality for each sentence. (Lesson 10-5)

53. HEALTH Your heart beats over 100,000 times a day.
54. BIRDS A peregrine falcon can spot a pigeon up to 8 kilometers away.
Vocabulary and Concept Check

Choose the letter of the term that best matches each statement or phrase.

1. terms that contain the same variables
   a. constant
   b. coefficient
   c. two-step equation
   d. like terms
   e. term
   f. simplest form

Lesson-by-Lesson Exercises and Examples

10-1 Simplifying Algebraic Expressions (pp. 469–473)

Use the Distributive Property to rewrite each expression.
7. \(4(a + 3)\)  
8. \(-6(x + 7)\)
9. \((n - 5)(-7)\)  
10. \(-2(6x - 3)\)

Simplify each expression.
11. \(p + 6p\)
12. \(6b + 7b - 3 + 5\)

Example 1 Use the Distributive Property to rewrite \(-8(x - 9)\).

\[-8(x - 9) = -8[x + (-9)]\]
\[= -8x + 72\]

Example 2 Solve \(5h + 8 = -12\).

\[5h + 8 = -12\]
\[5h = -8\]
\[h = -4\]

The solution is \(-4\).
10-3 Writing Two-Step Equations  (pp. 478–481)

Translate each sentence into an equation. Then find the number.

19. Six more than twice a number is \(-4\).
20. Three less than 2 times a number equals 11.
21. The quotient of a number and 8, less 2, is 5.

Example 3 Translate the following sentence into an equation.

6 less than 4 times a number is 10.

\[ 6 - 4n = 10 \]

Solve each equation. Check your solution.

22. \[ 11x = 20x + 18 \]
23. \[ 4n + 13 = n - 8 \]
24. \[ 3a + 5 = 2a + 7 \]
25. \[ 7b - 3 = -2b + 24 \]
26. \[ 9 - 2y = 8y - 6 \]

Example 4 Solve \[ 7x + 5 = 6x - 19 \].

\[ 7x + 5 = 6x - 19 \]
\[ 7x - 6x + 5 = 6x - 6x - 19 \]
\[ x + 5 = -19 \]
\[ x = -24 \]

10-4 Solving Equations with Variables on Each Side  (pp. 484–487)

Solve each equation. Check your solution.

22. \[ 11x = 20x + 18 \]
23. \[ 4n + 13 = n - 8 \]
24. \[ 3a + 5 = 2a + 7 \]
25. \[ 7b - 3 = -2b + 24 \]
26. \[ 9 - 2y = 8y - 6 \]

Example 4 Solve \[ 7x + 5 = 6x - 19 \].

\[ 7x + 5 = 6x - 19 \]
\[ 7x - 6x + 5 = 6x - 6x - 19 \]
\[ x + 5 = -19 \]
\[ x = -24 \]

10-5 Inequalities  (pp. 492–495)

Write an inequality. Then graph the inequality on a number line.

27. GRADES a grade of 92 or better
28. SPORTS qualifying time must be less than 2 minutes

Example 5 Graph \[ a < -4 \].

Place an open circle at \(-4\). Then draw a line and an arrow to the left.

10-6 Solving Inequalities by Adding or Subtracting  (pp. 496–499)

Solve each inequality. Check your solution.

29. \[ y + 7 \leq 5 \]
30. \[ x - 2 < 7 \]
31. \[ 18 < 4 + d \]
32. \[ a - 6 > -2 \]

Example 6 Solve \[ k + 2 > -5 \].

\[ k + 2 > -5 \]
\[ k + 2 - 2 > -5 - 2 \]
\[ k > -7 \]

Simplify. Check this result.

10-7 Solving Inequalities by Multiplying or Dividing  (pp. 500–504)

Solve each inequality. Check your solution.

33. \[ 13c \leq -26 \]
34. \[ -2a \geq -10 \]
35. \[ -6m > 18 \]
36. \[ 22 \geq -3x - 2 \]

Example 7 Solve \[ -9n < 54 \].

\[ -9n < 54 \]
\[ \frac{-9n}{-9} > \frac{54}{-9} \]
\[ n > -6 \]

Divide each side by \(-9\) and reverse the inequality symbol.

Simplify. Check this result.
1. **Explain** how you determine whether or not an expression is in simplest form.

2. **Give** three examples of phrases that indicate the inequality symbol ≤.

**Skills and Applications**

3. Use the Distributive Property to rewrite the expression −7(x − 10).

4. Simplify the expression 9a − a + 15 − 10a − 6.

**Solve each equation. Check your solution.**

5. 3n + 18 = 6

6. \( \frac{k}{2} - 11 = 5 \)

7. −23 = 3p + 5 + p

8. 4x − 6 = 5x

9. −3a − 2 = 2a + 3

10. −2y + 5 = y − 1

11. Translate the quotient of a number and 6, plus 3, is 11 into an equation. Then find the number.

12. **FUND-RAISER** The band buys coupon books for a one-time fee of $60 plus $5 per book. If they sell the books for $10 each, write and solve an equation to find how many books they must sell to break even.

13. **COMPUTERS** A disk can hold at most 1.38 megabytes of data. Write an inequality. Then graph the inequality on a number line.

**Solve each inequality and check the solution. Then graph the solution on a number line.**

14. \( x + 5 \geq 3 \)

15. 5 > a − 2

16. −3d ≤ 18

17. −4 > \( \frac{c}{9} \)

18. −2g + 15 > 45

19. \( \frac{m}{-5} + 4 \geq 1 \)

**20. MULTIPLE CHOICE** The perimeter of the parallelogram at the right is no more than 44 inches. Which of the following inequalities represents all possible values for x?

- A: x ≤ 3
- B: x ≥ 3
- C: x ≤ 7.4
- D: x ≥ 7.4
Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. On Saturday Jennifer rode her bike to Robert’s house. They then biked together to the library. Finally, Jennifer rode home alone from the library. If each unit on the grid represents 1 mile, what was the total distance that Jennifer biked on Saturday? (Lesson 3-6)
   - about 3.5 mi
   - about 8.5 mi
   - about 15.5 mi
   - about 20.5 mi

2. The data below was collected from four different remote-controlled car tests.

<table>
<thead>
<tr>
<th>Car</th>
<th>Distance Traveled (ft)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedster</td>
<td>45</td>
<td>9</td>
</tr>
<tr>
<td>Turbo</td>
<td>31</td>
<td>5</td>
</tr>
<tr>
<td>Cruiser</td>
<td>33</td>
<td>6</td>
</tr>
<tr>
<td>Hurricane</td>
<td>51</td>
<td>8 1/2</td>
</tr>
</tbody>
</table>

Which car traveled at the fastest rate? (Lesson 4-1)
   - Speedster
   - Turbo
   - Cruiser
   - Hurricane

3. In 1990, the number of students attending a school was 865. In 2000, the number was 680. By what percent did the number decrease from 1990 to 2000? (Lesson 5-7)
   - 20%
   - 21%
   - 43%
   - 79%

4. What is the volume of paint in a can that has a diameter of 10 inches and a height of 12 inches? (Lesson 7-5)
   - 188.4 in³
   - 376.8 in³
   - 942 in³
   - 1,884 in³

5. The graph shows the results of the election for club president. Which statement is supported by the information on the graph? (Lesson 9-2)
   - The total number of votes was 190.
   - Isaac received 30% of the votes.
   - The ratio of Angel’s votes to Isaac’s votes was 5 to 6.
   - Jacqueline received half the votes.

6. Find the value of x so that the isosceles trapezoid at the right has a perimeter of 200 inches. (Lesson 10-3)
   - 35
   - 40
   - 55
   - 80

7. The number line below is the graph of which inequality? (Lesson 10-7)
   - 4y ≤ −12
   - −5y ≤ 15
   - 5y > −15
   - −4y > 12
8. You are serving soup to 7 people. Each serving is \( \frac{3}{4} \) of a cup. If each can of soup contains \( \frac{3}{2} \) cups, how many cans do you need in order to give every person a full serving? (Lessons 2-3 and 2-4)

9. Draw the figure that results from rotating the figure at the right 90° counterclockwise about its center and then reflecting it over the indicated vertical axis. (Lessons 6-7 and 6-9)

10. Santiago is running the duck pond at the youth carnival. Each duck has a number on the bottom indicating the level of the prize awarded. The table shows how many ducks of each prize level are currently in the pond.

<table>
<thead>
<tr>
<th>Prize Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Ducks</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>?</td>
</tr>
</tbody>
</table>

How many prize-level-4 ducks should Santiago place in the pond so that the chances of randomly selecting one of these ducks is \( \frac{1}{2} \)? (Lesson 8-1)

11. The statistics below were listed on the board at the end of the grading period for a class of 9 students.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>mean: 87</td>
<td>median: 88</td>
<td>range: 15</td>
<td></td>
</tr>
</tbody>
</table>

List a possible set of grades for the students in this class. (Lesson 9-4)

12. Write an expression with four terms, two of which are constants. The other terms should be like terms, one with a coefficient of \(-2\) and the other with a coefficient of 6. Then simplify your expression. (Lesson 10-1)

13. If \( 8 + 5w = 11 \), find the value of \( 2w \). (Lesson 10-2)

14. A restaurant has \( s \) small tables that will seat 4 people each. They also have \( \ell \) large tables that will seat 10 people each. Write an inequality representing the number of people \( p \) that can be seated at this restaurant. (Lesson 10-5)

15. Write an equation to find the number of games \( g \) for which the total cost to bowl at each alley would be equal.

16. Explain how you would solve the equation you wrote in Question 15.

17. How many games would you have to play for the cost to bowl at each alley to be equal?

18. Write an inequality giving the number of games \( g \) for which Bowling Alley X would be cheaper.

19. Write an inequality giving the number of games \( g \) for which Bowling Alley Y would be cheaper.