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Variables and Expressions

To translate words into algebraic expressions, find words like these that tell you the operation.

add
subtract
multiply
divide
sum
difference
product
quotient
more
less
times
split
increased
decreased
per
ratio

1. Jared can type 35 words per minute. Write an expression for the number of words he can type in m minutes.

2. Mr. O'Brian's commute to work is 0.5 hour less than Miss Santos' commute. Write an expression for the length of Mr. O'Brian's commute if Miss Santos' commute is h hours.


5. Tammy's current rent is 4. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.


7. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.

8. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.


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11. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.

12. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.


15. Mrs. Knighten bought a box of 2 video games. Stan owns 7 more video games than Kenny. Write an expression for the number of video games Stan owns.

Add or subtract by drawing a model of two-color counters.

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2. Add or subtract by drawing a model of two-color counters.

3. Add or subtract by drawing a model of two-color counters.

4. Add or subtract by drawing a model of two-color counters.

5. Add or subtract by drawing a model of two-color counters.

6. Add or subtract by drawing a model of two-color counters.

7. Add or subtract by drawing a model of two-color counters.

8. Add or subtract by drawing a model of two-color counters.

9. Add or subtract by drawing a model of two-color counters.

10. Add or subtract by drawing a model of two-color counters.

11. Add or subtract by drawing a model of two-color counters.

12. Add or subtract by drawing a model of two-color counters.

13. Add or subtract by drawing a model of two-color counters.

14. Add or subtract by drawing a model of two-color counters.

15. Add or subtract by drawing a model of two-color counters.
**Review for Mastery**

### Multiplying and Dividing Real Numbers

1. Multiply or divide.
   1. Determine the sign (+ or –) for each product or quotient.
   2. Multiply the numbers if they have no signs.

**Multiplication**

- \( -5 \times -3 = 15 \)
- Different signs mean the product is negative.
- Multiply.

**Division**

- \( -2 \div (-0.5) = 4 \)
- Same signs mean the quotient is positive.
- Divide the numbers as if they have no signs.
- Divide.

Determine the sign (+ or –) for each product or quotient.

1. \(-8 \times -4 = 32\)
2. \(156 \div (-6) = -26\)
3. \(-15(4) = -60\)
4. \(6.4 \div (-4) = -1.6\)
5. \(-5(-0.4) = 2\)
6. \(29.82 \div 2.1 = 14.2\)

**Multiply or divide.**

7. \(-3 \times -7 = 21\)
8. \(-.55 \div -11 = 0.05\)
9. \(6(-4) = -24\)

10. \(-100 \div 20 = -5\)
11. \(-6(-8) = 48\)
12. \(5 \div (-2) = -2.5\)

13. \(15.3 \div -3 = -5.1\)
14. \(-8.2 \div 5 = -1.64\)
15. \(-21 \div -10 = 2.1\)

16. \(-2.7(4) = 10.8\)
17. \(4.5 \div 1.5 = 3\)
18. \(3.4 \times (-1.5) = -5.1\)

- \(10.8 \div 3 = 3.6\)
- \(3 \div -5.1 = -0.6\)

**Powers and Exponents**

A power is an expression that represents repeated multiplication of a factor. The factor is the base, and the number of times it is used as a factor is the exponent. Pay attention to parentheses, which tell you how much of the expression the exponent influences.

<table>
<thead>
<tr>
<th>Power</th>
<th>Base</th>
<th>Exponent</th>
<th>Expanded Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2^3)</td>
<td>2</td>
<td>3</td>
<td>(2 \times 2 \times 2)</td>
</tr>
<tr>
<td>(-3^2)</td>
<td>-3</td>
<td>2</td>
<td>((-3) \times (-3))</td>
</tr>
</tbody>
</table>

To evaluate a power, perform the repeated multiplication.

Evaluate \((-4)^3\).

There are parentheses, so the exponent influences the negative and the fraction.

\[ \frac{(-4)^3}{8} = \frac{64}{8} = 8 \]

Multiply two of the factors. A negative times a negative is positive.

\[ \frac{(-4)^3}{8} = \frac{-64}{8} = -8 \]

Multiply again. A positive times a positive is positive.

\[ \frac{(-4)^3}{8} = \frac{64}{8} = 8 \]

Write the expanded form of each power.

1. \(7^3 = 7 \times 7 \times 7 = 7 \times 7 \times 7 = 343\)
2. \((3)^{-3} = \frac{1}{3^3} = \frac{1}{27}\)
3. \(1^5 = 1 \times 1 \times 1 \times 1 \times 1 = 1\)
4. \((-6)^4 = (-6) \times (-6) \times (-6) \times (-6) = 1296\)

Evaluate each expression.

5. \(3^3 = 27\)
6. \(-2^3 = -8\)
7. \((-2)^3 = -8\)
8. \(9 \times 1^4 = 9\)
9. \(10 \times 0^5 = 0\)

**Review for Mastery**

### Powers and Exponents continued

Some numbers can be written as a power of a given base. For example, \(8\) is a power of \(2\) because \(2^3 = 8\).

If you know that a number is a power of a given base, you can find the exponent by doing repeated multiplication.

Write \(81\) as a power of \(-3\).

\[-3 \times (-3) = (-3)^2\]
\[-3 \times (-3)^2 = (-3)^3\]
\[-3 \times (-3)^3 = (-3)^4\]
\[-3 \times (-3)^4 = (-3)^5\]
\[-3 \times (-3)^5 = 81 = (-3)^4\]

Complete each table.

**11. Powers of \(2\)**

<table>
<thead>
<tr>
<th>Power</th>
<th>Multiplication Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2^1)</td>
<td>2</td>
</tr>
<tr>
<td>(2^2)</td>
<td>4</td>
</tr>
<tr>
<td>(2^3)</td>
<td>8</td>
</tr>
<tr>
<td>(2^4)</td>
<td>16</td>
</tr>
<tr>
<td>(2^5)</td>
<td>32</td>
</tr>
</tbody>
</table>

**12. Powers of \(3\)**

<table>
<thead>
<tr>
<th>Power</th>
<th>Multiplication Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3^1)</td>
<td>3</td>
</tr>
<tr>
<td>(3^2)</td>
<td>9</td>
</tr>
<tr>
<td>(3^3)</td>
<td>27</td>
</tr>
<tr>
<td>(3^4)</td>
<td>81</td>
</tr>
<tr>
<td>(3^5)</td>
<td>243</td>
</tr>
</tbody>
</table>

**13. Powers of \(10\)**

<table>
<thead>
<tr>
<th>Power</th>
<th>Multiplication Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10^1)</td>
<td>10</td>
</tr>
<tr>
<td>(10^2)</td>
<td>100</td>
</tr>
<tr>
<td>(10^3)</td>
<td>1,000</td>
</tr>
<tr>
<td>(10^4)</td>
<td>10,000</td>
</tr>
</tbody>
</table>

**14. Writing each number as a power of the given base.**

- \(16; base 2\)
- \(256; base 2\)
- \(64; base 5\)
- \(20.6; base 5\)

- \(2^4 = 16\)
- \(2^8 = 256\)
- \(5^4 = 625\)
- \(2^2 = 4\)

**15. Writing each number as a power of the given base.**

- \(16; base 2\)
- \(256; base 2\)
- \(64; base 5\)
- \(20.6; base 5\)

- \(2^4 = 16\)
- \(2^8 = 256\)
- \(5^4 = 625\)
- \(2^2 = 4\)
**roots and Irrational Numbers**

The square root of a number is the positive factor that you would square to get that number.

- The square root of 9 is 3 because 3 squared is 9.
- A negative square root is the negative factor that you would square to get the number.
  - The negative square root of 25 is -5 because -5 squared is 25.
  - \( \sqrt{25} = -5 \) because \((-5)^2 = (-5) \times (-5) = 25\)

To evaluate a square root, think in reverse. Ask yourself, “What number do I square?”

**Find \( \sqrt{36} \),**

\( \sqrt{36} \) Think: What negative factor do you square to get 36?

\( \sqrt{36} = 6 \)

**Find \( \sqrt{-81} \),**

Think about the numerator and denominator separately.

\( 2^2 = 4 \) Think: What number do I square to get 4?

\( \sqrt{2} \) Think: What number do I square to get \( \sqrt{81} \)?

\( \sqrt{2} \) Combine the numerator and denominator to form a positive factor.

\( \sqrt{\frac{-81}{2}} = \sqrt{-45} \)

1. Complete this table of squares.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>9</td>
<td>16</td>
<td>25</td>
<td>36</td>
<td>49</td>
<td>64</td>
<td>81</td>
<td>100</td>
</tr>
<tr>
<td>12</td>
<td>13</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Complete this table of square roots.

<table>
<thead>
<tr>
<th>( \sqrt{1} )</th>
<th>( \sqrt{9} )</th>
<th>( \sqrt{16} )</th>
<th>( \sqrt{25} )</th>
<th>( \sqrt{36} )</th>
<th>( \sqrt{49} )</th>
<th>( \sqrt{64} )</th>
<th>( \sqrt{81} )</th>
<th>( \sqrt{100} )</th>
<th>( \sqrt{121} )</th>
<th>( \sqrt{144} )</th>
<th>( \sqrt{169} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
</tr>
</tbody>
</table>

**Find each square root.**

3. \( \sqrt{121} \) = 11

4. \( \sqrt{49} \) = 7

5. \( \sqrt{9} \) = 3

6. \( \sqrt{4} \) = 2

**Write all of the classifications that apply to the real number \(-4\).**

- Real number, rational number, terminating decimal, integer, whole number, natural number
- \(-4\) can be shown on a number line. It is real.
- \(-4\) can be written as \(\frac{-4}{1}\), so it is rational.
- Its decimal representation terminates: \(\frac{-4}{1} = -4.0\).
- \(-4\) is an integer.
- \(-4\) is a negative integer. Stop. There are no more subsets in the chart below negative integers.
- \(-4\): real number, rational number, terminating decimal, integer

**Write all classifications that apply to each real number.**

9. \( 24 \)

10. \( \frac{1}{3} \)

11. \( \sqrt{5} \)

**Roots and Irrational Numbers continued**

- A set of numbers has closure under an operation if the result of the operation on any two numbers in the set is also in the set.
- The integers are closed under addition, subtraction, and multiplication.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Numbers</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>( 5 + 9 = 14 )</td>
<td>For integers ( a ) and ( b ), ( a \times b ) is an integer.</td>
</tr>
<tr>
<td>Subtraction</td>
<td>( 12 - 20 = -8 )</td>
<td>For integers ( a ) and ( b ), ( a - b ) is an integer.</td>
</tr>
<tr>
<td>Multiplication</td>
<td>( 4 \times 3 = 12 )</td>
<td>For integers ( a ) and ( b ), ( ab ) is an integer.</td>
</tr>
</tbody>
</table>

A counterexample is an example that proves a statement false.

Find a counterexample to disprove the statement “The natural numbers are closed under subtraction.”

Find two natural numbers, \( a \) and \( b \), such that their difference is not a natural number.

- \( a - b = 4 - 9 = -5 \)

Since \(-5\) is not a natural number, this is a counterexample. The statement is false.

**Find a counterexample to show that each statement is false.**

7. The whole numbers are closed under division.

   **Possible answer:** \( 5 \div 2 = 2.5 \)

8. The set of negative integers is closed under subtraction.

   **Possible answer:** \( -2 - (-3) = 1 \)

9. The rational numbers are closed under the operation of taking a square root.

   **Possible answer:** \( \sqrt{2} \)
### Review for Mastery

#### 1. Simplifying Expressions

Expressions can contain more than one operation, and then can also include grouping symbols, like parentheses ( ), brackets [ ], and braces { }. Operations must be performed in a certain order.

I. Perform operations inside grouping symbols, with the innermost group being done first.
II. Evaluate powers (exponents).
III. Perform multiplication and division in order from left to right.
IV. Perform addition and subtraction in order from left to right.

Simplify each expression.

1. \(6^2 - 3(5 - 1) = 2\)
   \(6^2 - 3 \cdot 4 + 2\) Evaluate \(5 - 1\).
   \(36 - 3 + 1 = 2\) Evaluate \(6^2\).
   \(36 - 12 = 2\) Evaluate \(-3\).
   \(24 + 2 = 20\) Add from left to right.

2. Add and subtract from left to right.

#### 2. Solving One-Step Equations

Any equation can be solved by adding the opposite. If the equation involves subtraction, it helps to first rewrite the subtraction as addition.

Solve each equation.

\(x + 4 = 10\) Find the opposite of this number.
\(x + 4 = 10\)
\(x = 6\) Add 4 to each side.

Solve: \(-5x = 8\) Find the opposite of this number.
\(-5x = 8\)
\(x = -1.6\) Subtract the coefficients only.

Rewrite each equation with addition. Then state the number that should be added to each side.

1. \(x - 7 = 12\)
   \(x + 7 = 12\)
   \(x = 19\)

2. \(x - 8 = -5\)
   \(x + 8 = -5\)
   \(\text{No solution}\)

3. \(-x = 2\)
   \(x = -2\)

Solve each equation. Check your answers.

4. \(x + 4 = -12\)
   \(x = -16\)

5. \(x = 21 - x + 2\)
   \(x = 5\)

6. \(x + 3 = 8\)
   \(x = 5\)

Solve each equation. Check your answers.

7. \(x + 10 = -6\)
   \(x = -16\)

8. \(-x = x - 2\)
   \(x = 5\)

9. \(x + 5 = -2\)
   \(x = -7\)

10. \(x = -2\)
11. \(5m = -40\)
12. \(-2x = -20\)
13. \(\frac{x}{3} = -7\)
14. \(6z = -42\)

If possible, simplify each expression by combining like terms.

\(6x^3 - 4x^2\)
\(24x^2 - 4x^2\)
\(20x^2\) Subtract the coefficients only.

Simplify 4\(x + y\) = 8\(x - 9\).
\(4x + 4y = 5x - 9\) Distribute 4.
\(4x + 5x + 4y - 9\) Use the Commutative Property.
\(9x + 4y - 9\) Add the like terms 4\(x\) and 5\(x\).
\(9x + 9y\) No other terms are like terms.

Simplify each equation.

16. \(3x + 6 \div 2\) \(27\)
17. \(7y = 2(y - 5) + y\)
\(3x + 16\)
\(10y + 10\)

State whether each pair of terms is like terms.

10. \(4xy\) and 3\(xy\)
11. \(2x^2\) and 5\(x^2\)
12. \(-10a\) and \(-10b\)

If possible, simplify each expression by combining like terms.

13. \(7x - 3at\)
14. \(10y^2 + 5 - 4x^2\)
15. \(12x^3 + 6x^4\)

Simplify each expression.

16. \(3x + 6 \div 2\)
17. \(7y = 2(y - 5) + y\)

\(3x + 16\)
\(10y + 10\)

### Simplifying Expressions continued

Terms can be combined only if they are like terms. Like terms can have different coefficients, but they must have the same variables raised to the same powers.

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### Simplifying Expressions continued

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Review for Mastery

Solving Two-Step Equations

When solving two-step equations, first identify the operations and the order in which they are applied to the variable. Then use inverse operations.

<table>
<thead>
<tr>
<th>Operations</th>
<th>Solve Using Inverse Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x - 3 = 15</td>
<td>x is multiplied by 4. Subtract 3 from both sides.</td>
</tr>
<tr>
<td>5 + 2 = 9</td>
<td>x is divided by 3. Add 2 to both sides.</td>
</tr>
<tr>
<td>3x - 2 = 7</td>
<td>Then 2 is added. Multiply both sides by 3.</td>
</tr>
</tbody>
</table>

The order of the inverse operations is the order of operations in reverse.

Solve each equation. Check your answers.
1. 3x - 8 = 4
2. \( \frac{2}{3} \cdot 4 - 26 \)
3. 3y + 4 = 9
4. 14 - 3x = 1

| \( \frac{3}{2} \) | 60 |
| 5 | 3 |
| x = 4 |

Review for Mastery

Solving Multi-Step Equations

Solving a multi-step equation is similar to solving a two-step equation. You use inverse operations to write an equivalent equation at each step.

<table>
<thead>
<tr>
<th>Operations</th>
<th>Solve Using Inverse Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{3x}{2} - \frac{3}{2} = 7 )</td>
<td>x is multiplied by ( \frac{3}{2} ). Then 1 is added. Divide both sides by ( \frac{3}{2} ).</td>
</tr>
<tr>
<td>2x - 2 = 12</td>
<td>Multiply both sides by 2. Add 2 to both sides.</td>
</tr>
<tr>
<td>3x = 14</td>
<td>Divide both sides by 3.</td>
</tr>
</tbody>
</table>

Solve each equation. Check your answers.
1. \( \frac{5y}{4} + 3 = 7 \)
2. \( \frac{3 + 2m}{3} = 9 \)
3. \( \frac{6x - 4}{5} = 4 \)

| \( \frac{5}{4} \) | 60 |
| \( \frac{4}{3} \) | 12 |
| \( \frac{3}{2} \) | 9 |

Review for Mastery

Sometimes you must combine like terms before you can use inverse operations to solve an equation.

<table>
<thead>
<tr>
<th>Solved Equation</th>
<th>Equivalent Equations</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>3x + 5 = 4x + 19</td>
<td>3x + 5 = 19</td>
<td>Commutative Property of Addition</td>
</tr>
<tr>
<td>16y - 6 = 11y - 2</td>
<td>16y - 6 = 2</td>
<td>Commutative Property of Addition</td>
</tr>
</tbody>
</table>

Solve each equation. Check your answers.
5. 5y + 4 - 2y = 16
6. 13m - 4 - 10m = 2

| \( \frac{4}{3} \) | 2 |
| \( \frac{3}{2} \) | 2 |

Solve each equation. Check your answers.
7. 3w - 7 = w + 5
8. 6 + 7x - 5x = 2

| \( \frac{3}{2} \) | 2 |

| \( \frac{4}{3} \) | 2 |

California Standards: Holt Algebra 1

Name: ________________________ Date: ____________ Class: ____________
Solving Equations with Variables on Both Sides

Variables must be collected on the same side of the equation before the equation can be solved.

Solve $10x + 2x = 16$.

Check:

Divide both sides by 8.

Subtract 4 from both sides.

$x = 2$.

Write the first step you would take to solve each equation.

1. $3x + 2 = 7x$
   
   Possible answers: $\frac{3}{4}x$ to each side, add $-7x$ to each side

2. $-4x - 6 = -10x$
   
   Possible answers: add $4x$ to each side, add $10x$ to each side

3. $15x + 7 = -3x$
   
   Possible answers: add $3x$ to each side, add $-15x$ to each side

Solve each equation. Check your answers.

4. $4x + 2 = 5(x + 10)$

5. $-30 + y = 30 - 30$

6. $3(y + 7) + 2 = 6y - 2 + 2y$

Solving Equations with Variables on Both Sides continued

Some equations have infinitely many solutions. These equations are true for all values of the variable. Some equations have no solutions. There is no value of the variable that will make the equation true.

Solve $-3x + 9 = 4x + 9 - 7x$.

Check any value of $x$.

Try $x = 4$.

Add $3x$ to each side.

Subtract 4 from each side.

$x = 0$

The solution is the set of all real numbers.

$-12 + 9 = 16 - 28$

There is no solution.

Solve each equation.

7. $x = 2 - x = 4$

8. $-2x + x = 4 - x = 2$

9. $y + 3 = 3y + 5$

10. $5x - 1 - 4x = x = 7$

Translate into percent

Use the form "percent of whole is part."

Find 30% of 70.

Part: 21

Whole: 70

$\frac{21}{70} = \frac{3}{10}$

Express as a percent.

30% of 70 is 21.

64.5 is 75% of 86.

You can also solve percent problems with this equation:

$\frac{\text{percent}}{100} = \frac{\text{whole}}{\text{part}}$

Solve $-3x + 9 = 4x + 9 - 7x$.

Check any value of $x$.

Try $x = 4$.

Add $3x$ to each side.

Subtract 4 from each side.

$x = 0$

The solution is the set of all real numbers.

$-12 + 9 = 16 - 28$

There is no solution.

Solve each equation.

7. $x = 2 - x = 4$

8. $-2x + x = 4 - x = 2$

9. $y + 3 = 3y + 5$

10. $5x - 1 - 4x = x = 7$

Find 30% of 70.

Part: 21

Whole: 70

$\frac{21}{70} = \frac{3}{10}$

Express as a percent.

30% of 70 is 21.

64.5 is 75% of 86.

You can also solve percent problems with this equation:

$\frac{\text{percent}}{100} = \frac{\text{whole}}{\text{part}}$

Solve $-3x + 9 = 4x + 9 - 7x$.

Check any value of $x$.

Try $x = 4$.

Add $3x$ to each side.

Subtract 4 from each side.

$x = 0$

The solution is the set of all real numbers.

$-12 + 9 = 16 - 28$

There is no solution.

Solve each equation.

7. $x = 2 - x = 4$

8. $-2x + x = 4 - x = 2$

9. $y + 3 = 3y + 5$

10. $5x - 1 - 4x = x = 7$

Find 30% of 70.

Part: 21

Whole: 70

$\frac{21}{70} = \frac{3}{10}$

Express as a percent.

30% of 70 is 21.
**Review for Mastery**

### 5.3 Solving Literal Equations for a Variable

Solving for a variable in a formula can make it easier to use that formula. The process is similar to that of solving multi-step equations. Find the operations being performed on the variable you are solving for, and then use inverse operations.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Solve Using Inverse Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A = \frac{1}{2}bh$</td>
<td>$b$ is multiplied by $\frac{2}{h}$</td>
</tr>
<tr>
<td>$V = \frac{1}{3}bh$</td>
<td>$b$ is multiplied by $\frac{3}{h}$</td>
</tr>
</tbody>
</table>

#### Example

Solve for the indicated variable.

1. $P = \frac{4}{s}$ for $s$

2. $a + b + c = 180$ for $b$

3. $P = \frac{K}{V}$ for $K$

#### Formula

The formula $A = \frac{1}{2}bh$ relates the area $A$ of a triangle to its base $b$ and height $h$. Solve the formula for $b$.

$$A = \frac{1}{2}bh$$

Multiply both sides by $\frac{2}{h}$

$$2A = bh$$

Divide both sides by $h$.

$$b = \frac{2A}{h}$$

### 5.4 Solving Absolute-Value Equations

There are three steps in solving an absolute-value equation. First use inverse operations to isolate the absolute-value expression. Then rewrite the equation as two cases that do not involve absolute values. Finally, solve these new equations.

**Step 1:** Isolate the absolute-value expression.

$$|x - 3| = 4 - 8$$

Subtract 4 from both sides.

$$|x - 3| = -4$$

**Step 2:** Rewrite the equation as two cases.

Case 1: $x - 3 = 4 - 8$

Case 2: $x - 3 = 4 + 8$

**Step 3:** Solve.

Case 1: $x = 1$

Case 2: $x = -13$

Add 3 to both sides.

Write the solution set as $\{-1, 7\}$.

#### Example

Solve each equation.

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

2. $|x + 7| + 2 = 10$

3. $4|x - 5| = 20$

4. $|2x + 1| = 7$

5. $8 + |x - 2| = 8$

6. $|x + 1| + 5 = 2$

7. $4|x - 3| - 16$

8. $3|x + 10| = 0$

### Review for Mastery

**5.4 Solving Absolute-Value Equations continued**

Some absolute-value equations have two solutions. Others have one solution or no solution. To decide how many solutions there are, first isolate the absolute-value expression.

#### Example

Solve $|x - 1| = 3 - 7$.

$|2x + 1| - 4$ is added. Absolte value cannot be negative. The solution set is the empty set, $\emptyset$.

#### Example

Solve each equation.

5. $8 + |x - 2| = 8$

6. $|x + 1| + 5 = 2$

7. $4|x - 3| - 16$

8. $3|x + 10| = 0$

### Review for Mastery

**5.4 Solving Absolute-Value Equations continued**

Any equation with two or more variables can be solved for any given variable.

Solve $x = y - z$ for $y$.

$10(x = 10)$

Multiply both sides by 10.

$10y - y - z$

Add $z$ to both sides.

$7z = 10z$

### Review for Mastery

**5.4 Solving Absolute-Value Equations continued**

Some absolute-value equations have two solutions. Others have one solution or no solution. To decide how many solutions there are, first isolate the absolute-value expression.

#### Example

Solve $|x - 1| = 3 - 7$.

$|2x + 1| - 4$ is added. Absolte value cannot be negative. The solution set is the empty set, $\emptyset$.

#### Example

Solve each equation.

5. $8 + |x - 2| = 8$

6. $|x + 1| + 5 = 2$

7. $4|x - 3| - 16$

8. $3|x + 10| = 0$

### Review for Mastery
Choose different values for \( x \). Be sure to choose positive and negative values as well as zero.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( x + 2 )</th>
<th>( x + 3 )</th>
<th>( x + 4 )</th>
<th>( x + 5 )</th>
<th>( x + 6 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Plot the points on a number line. Use \( T \) to label points that make the inequality true. Use \( F \) to label points that make the inequality false. Look for the point at which the True statements turn to False statements. Numbers less than 4 make the statement true. The solutions are all real numbers less than 4.

Test the inequalities for the values given. Then describe the solutions of the inequality.

1. \( 5x \leq 10 \)
   - For \( x = 0 \): T
   - For \( x = 1 \): T
   - For \( x = -3 \): T
   - For \( x = -4 \): F
   - For \( x = 3 \): F
   - For \( x = 1.5 \): T
   - All real numbers less than or equal to 2

2. \( m + 1 < -2 \)
   - For \( m = -2 \): F
   - For \( m = -3 \): F
   - For \( m = -4 \): T
   - All real numbers less than -3

Describe the solutions of each inequality in words.

3. \( x > 4 \) all real numbers greater than 12
4. \( g > -3 \) all real numbers less than or equal to 1

---

The method for solving one-step inequalities by adding is just like the method for solving one-step equations by adding.

\[
\begin{align*}
\text{Step 1:} & \quad \text{Write a variable and the number} \\
\text{Step 2:} & \quad \text{Look at the direction of the arrow.} \\
\text{Step 3:} & \quad \text{Draw an arrow.}
\end{align*}
\]

\[
\begin{align*}
& \quad \text{If circle is empty, use } \downarrow \text{ or } \uparrow \\
& \quad \text{If circle is filled in, use } \uparrow \\
& \quad \text{To draw arrow, } \left\{ \begin{array}{ll}
\downarrow & \text{if } \text{ direction is left} \\
\uparrow & \text{if } \text{ direction is right}
\end{array} \right.
\end{align*}
\]

\[
\begin{align*}
\text{Graph each inequality.} \\
5. \quad & \quad m \leq -3 \\
6. \quad & \quad p < 3.5
\end{align*}
\]

Write the inequality shown by the graph.

\[
\begin{align*}
8. \quad & \quad x > -4
\end{align*}
\]
### Review for Mastery

#### Solving Inequalities by Multiplying or Dividing

The inequality sign must be reversed when multiplying by a negative number.

<table>
<thead>
<tr>
<th>Multiplying by a positive number:</th>
<th>Multiplying by a negative number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2 &lt; 5$</td>
<td>$2 &lt; 5$</td>
</tr>
<tr>
<td>$2 &lt; 5$</td>
<td>$2 &lt; 5$</td>
</tr>
<tr>
<td>$3 &lt; 3 - 3$</td>
<td>$3 &lt; 3 - 3$</td>
</tr>
<tr>
<td>$3 &lt; 3 - 3$</td>
<td>$3 &lt; 3 - 3$</td>
</tr>
<tr>
<td>$x &lt; -6$</td>
<td>$x &lt; -6$</td>
</tr>
<tr>
<td>$x &lt; -6$</td>
<td>$x &lt; -6$</td>
</tr>
</tbody>
</table>

**Solve $\frac{x}{3} > -2$ and graph the solution.**

$\frac{x}{3} > -2$

**Solve each inequality.**

1. $\frac{x}{3} > -2$
2. $\frac{x}{2} < -3$
3. $5m > 10$

### Review for Mastery

#### Solving Two-Step and Multi-Step Inequalities

When solving inequalities with more than one step, use inverse operations to isolate the variable. The order of the inverse operations is the order of the operations in reverse. You can check your solution by substituting the endpoint and another point in the solution back into the original inequality.

**Solve $-5x + 3 < 23$ and graph the solutions.**

Check:

- Try $-4$.
- Try $6$.

**Solve each inequality.**

1. $-3a - 10 > -4$
2. $\frac{e}{2} + 8 > 11$
3. $15 < 3 - 4s$

### Review for Mastery

#### Solving Inequalities by Multiplying or Dividing continued

The inequality sign must also be reversed when dividing by a negative number.

<table>
<thead>
<tr>
<th>Dividing by a negative number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$8 &gt; 6$</td>
</tr>
</tbody>
</table>

**Solve each inequality and graph the solutions.**

5. $-5p > -10$
6. $4x < -16$

**Solve each inequality.**

7. $-x < 5$
8. $30 > -10a$
Solving Compound Inequalities

Compound inequalities using AND require you to find solutions so that both inequalities will be satisfied at the same time.

Solve each compound inequality.

1. \(-3 < x < 10\)
2. \(8 \leq m < 15\)
3. \(-2 \leq w < 6\)

Write the two inequalities that must be solved in order to solve each compound inequality.

1. \(-3 < x < 10\) AND \(x < 4 \leq 10\)
2. \(8 \leq m + 4 \leq 15\) AND \(m + 4 \leq 15\)
3. \(-2 \leq w < 6\) AND \(w < 6\)

Solve each compound inequality and graph the solutions.

1. \(-3 < x < 10\)
2. \(8 \leq m + 4 \leq 15\)
3. \(-2 \leq w < 6\)

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Holt Algebra 1

Review for Mastery

Solving Inequalities with Variables on Both Sides

Variables must be collected on the same side of an inequality before the inequality can be solved. If you collect the variables so that the variable term is positive, you will not have to multiply or divide by a negative number.

Solve \(x > 8(x - 7)\).

Collect the variables on the left.

\[x > 8(x - 7)\]

Collect the variables on the right.

\[x > 8x - 56\]

Distribute.

\[-7x > -56\]

Divide both sides by \(-7\).

\[x < 8\]

Reverse the sign.

\[8 > x\]

Notice that if you want to have the variable on the left to make graphing solutions easier, you may still need to switch the inequality sign, even if you did not multiply or divide by a negative number.

Write the first step you would take to solve each inequality if you wanted to keep the variable positive.

1. \(6y < 10y + 1\) add \(-6y\) to both sides
2. \(4p - 2 > 3p\) add \(-3p\) to both sides
3. \(5 - 3x > 6\) add \(3x\) to both sides

Solve each inequality.

1. \(8c + 4 > 4(c - 3)\)
2. \(5x - 11 < 3x + 10 - 8x\)
3. \(-8 - 4a - 12 > 2a + 10\)

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Holt Algebra 1

Review for Mastery

Solving Compound Inequalities

Compound inequalities using OR require you to find solutions that satisfy either inequality.

Solve \(4x > 12\) OR \(3x \leq -15\) and graph the solutions.

The two inequalities are: \(4x > 12\) OR \(3x \leq -15\).

Solve \(4x > 12\).

\[x > 3\]

Divide both sides by 4.

Graph \(x > 3\).

Graph \(x < 5\).

Graph \(-1 < x < 5\).

Write the compound inequality shown by each graph.

1. \(x < 0\) OR \(x \geq 4\)
2. \(x < -6\) OR \(x > -3\)
3. \(x \geq 3\) OR \(x < -4\)
4. \(b \geq 7\) OR \(b \leq -1\)

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Holt Algebra 1
Ivy is selling bracelets. Each bracelet costs $1.50.

Solve each inequality and graph the solutions.

1. \(|x - 2| = 16\)
   
   Add 2 to both sides.
   
   \(|x| = 18\)
   
   \(x = 18\) or \(x = -18\)

2. \(|x - 1| = 5 > 0\)
   
   Add 1 to both sides.
   
   \(|x| = 6\)
   
   \(x = 6\) or \(x = -6\)

3. \(7|x| < 21\)
   
   Divide both sides by 7.
   
   \(|x| < 3\)
   
   \(-3 < x < 3\)

4. \(|x + 4| - 3 < -2\)
   
   Add 3 to both sides.
   
   \(|x + 4| < 1\)
   
   \(-1 < x + 4 < 1\)
   
   \(-5 < x < -3\)

5. \(4 + |x| = 5\)
   
   Add -4 to both sides.
   
   \(|x| = 1\)
   
   \(x = 1\) or \(x = -1\)

6. \(2|x - 2| > 6\)
   
   Divide both sides by 2.
   
   \(|x - 2| > 3\)
   
   \(x - 2 > 3\) or \(x - 2 < -3\)
   
   \(x > 5\) or \(x < -1\)

Graph the solutions as shown.

Graphs are a way to turn words into pictures. Be sure to read the graphs from left to right.

Increasing: gained, rose, grew
Decreasing: lost, diminished, fell
Stays the same: same, continuous

Other descriptions: fell steadily, leveled off, fell again, and then increased sharply.

Sketch a graph of each situation. Tell whether the graph is continuous or discrete.

4. The heart rate of someone walking, then running, then resting.

5. Ivy is selling bracelets. Each bracelet costs $1.50. She has 6 bracelets to sell.
Review for Mastery

Relations and Functions

A relation is a set of ordered pairs. The relation can be in the form of a table, graph, or mapping diagram. The domain is all the x-values. The range is all the y-values.

Find the domain and range.

1. \( x \): \(-2, 0, 1, 4 \) \( y \): \(-1, 0, 1, 2 \)

\( \text{Domain: } \{ -2, 0, 1, 4 \} \text{ Range: } \{ -1, 0, 1, 2 \} \)

2. \( x \): \((-2, 5, 6) \) \( y \): \((-5, 0, 3) \)

\( \text{Domain: } \{ -2, 5, 6 \} \text{ Range: } \{ -5, 0, 3 \} \)

3. \( x \): \((-4, 0, 3, 4) \) \( y \): \((-3, 0, 2, 4) \)

\( \text{Domain: } \{ -4, 0, 3, 4 \} \text{ Range: } \{ -3, 0, 2, 4 \} \)

4. \( x \): \((-3, 1, 2, 3) \) \( y \): \((-1, 3, 5, 9) \)

\( \text{Domain: } \{ -3, 1, 2, 3 \} \text{ Range: } \{ -1, 3, 5, 9 \} \)

5. \( x \): \((-4, 2, 3, 5) \) \( y \): \((-2, 0, 3, 6) \)

\( \text{Domain: } \{ -4, 2, 3, 5 \} \text{ Range: } \{ -2, 0, 3, 6 \} \)

6. \( x \): \((-2, 2, 3, 4) \) \( y \): \((-1, 2, 3, 4) \)

\( \text{Domain: } \{ -2, 2, 3, 4 \} \text{ Range: } \{ -1, 2, 3, 4 \} \)

7. \( x \): \((-4, 0, 3, 6) \) \( y \): \((-3, 0, 4, 6) \)

\( \text{Domain: } \{ -4, 0, 3, 6 \} \text{ Range: } \{ -3, 0, 4, 6 \} \)

8. \( x \): \((-3, 1, 2, 3) \) \( y \): \((-1, 3, 5, 9) \)

\( \text{Domain: } \{ -3, 1, 2, 3 \} \text{ Range: } \{ -1, 3, 5, 9 \} \)

Find the domain and range of each relation.

1. \( x \): \(-2, -1, 0, 1 \) \( y \): \(-4, 1, 0, 4 \)

\( \text{Domain: } \{ -2, -1, 0, 1 \} \text{ Range: } \{ -4, 1, 0, 4 \} \)

2. \( x \): \((-2, 5, 6) \) \( y \): \((-5, 0, 3) \)

\( \text{Domain: } \{ -2, 5, 6 \} \text{ Range: } \{ -5, 0, 3 \} \)

3. \( x \): \((-4, 0, 3, 4) \) \( y \): \((-3, 0, 2, 4) \)

\( \text{Domain: } \{ -4, 0, 3, 4 \} \text{ Range: } \{ -3, 0, 2, 4 \} \)

4. \( x \): \((-3, 1, 2, 3) \) \( y \): \((-1, 3, 5, 9) \)

\( \text{Domain: } \{ -3, 1, 2, 3 \} \text{ Range: } \{ -1, 3, 5, 9 \} \)

Review for Mastery

Graph each function.

1. \( y = 2x + 3 \)

\( \text{Domain: } \{ 1, 2, 3 \} \text{ Range: } \{ 5, 7, 9 \} \)

2. \( y = \frac{1}{2}x - 3 \)

\( \text{Domain: } \{ -2, -1, 0 \} \text{ Range: } \{ -4, -3, -2 \} \)

3. \( y = \frac{1}{3}x^3 \)

\( \text{Domain: } \{ -4, -2, 0 \} \text{ Range: } \{ -5, -2, 0 \} \)

4. \( y = \frac{1}{4}x - 3 \)

\( \text{Domain: } \{ -2, -1, 0 \} \text{ Range: } \{ -4, -3, -2 \} \)

5. \( y = 3x + 2 \)

\( \text{Domain: } \{ -3, -1, 1 \} \text{ Range: } \{ -7, -1, 5 \} \)

6. \( y = \frac{1}{2}x^2 + 4 \)

\( \text{Domain: } \{ -3, -1, 1 \} \text{ Range: } \{ -1, 1, 9 \} \)

7. \( y = \frac{1}{3}x^3 - 3 \)

\( \text{Domain: } \{ -4, -2, 0 \} \text{ Range: } \{ -11, -5, -3 \} \)

8. \( y = \frac{1}{4}x - 3 \)

\( \text{Domain: } \{ -2, -1, 0 \} \text{ Range: } \{ -4, -3, -2 \} \)

9. \( y = \frac{1}{2}x^2 + 4 \)

\( \text{Domain: } \{ -3, -1, 1 \} \text{ Range: } \{ -1, 1, 9 \} \)

10. \( y = \frac{1}{3}x^3 - 3 \)

\( \text{Domain: } \{ -4, -2, 0 \} \text{ Range: } \{ -11, -5, -3 \} \)

Review for Mastery

Equal and Proportional Relationships

Functions have dependent and independent variables. The dependent variable will always depend on the independent variable.

Rewrite each situation using the word depends. Then identify the dependent and the independent variables.

An employee who works longer hours will receive a larger amount on her paycheck.

Rewrite sentence:

The amount of a paycheck depends on the number of hours worked.

Identify the dependent and independent variables.

Dependent: amount of paycheck Independent: number of hours worked

Tell whether the relation is a function. Explain.

1. No; several domain values are paired with more than one range value.

2. Yes; each domain value is paired with exactly one range value.

3. No; 3 is paired with both 2 and 3.

4. 6 is paired with 2 and 3.

5. 3 is paired with 4 and 6.

6. 6 is paired with 7 and 10.

Identify the dependent and independent variables for each situation below. Write the function using cost of admission as the dependent variable.

A computer support company charges $56.67 for the first hour plus $23.50 for each additional hour.

Cost of admission = total charge

Function: \( f(x) = 23.50x + 56.67 \)

Evaluate for \( x = 2 \): \( f(2) = 23.50(2) + 56.67 = 63.67 \)

Evaluate for \( x = 3 \): \( f(3) = 23.50(3) + 56.67 = 90.67 \)

A car rental company charges $70.00 per day plus $0.25 per mile.

Cost of rental = daily charge + mileage charge

Function: \( f(x) = 70.00 + 0.25x \)

Evaluate for \( x = 100 \): \( f(100) = 70.00 + 0.25(100) = 100.00 \)

Evaluate for \( x = 200 \): \( f(200) = 70.00 + 0.25(200) = 150.00 \)
Based on the relationship, predict ... Simplify.

Substitute the term number.

Identify the correlation you would expect to see between the number of grams of fat and the number of calories in different kinds of pizzas. When you increase the amount of fat in a food, you also increase calories. So you would expect to see a positive correlation.

Identify the correlation you would expect to see between each pair of data sets. Explain.
1. the number of knots tied in a rope and the length of the rope
   Negative correlation; each knot decreases the length of the rope

2. the height of a woman and her score on an algebra test
   No correlation; there is no relationship between height and algebra skill

Describe the correlation illustrated by each scatter plot.

3. negative correlation
   positive correlation

4. positive correlation
   negative correlation

Determine whether each sequence is an arithmetic sequence. If so, find the common difference and the next three terms.

5. 0, 6, 12, 18, ... The difference between terms is constant. This sequence is an arithmetic sequence. The common difference is 6. Use the difference of 6 to find three more terms.

6. 6, 12, 18, 24, 30, ... Find how much you add or subtract to move from term to term. The first term is 6. Use the common difference to find the next three terms in each arithmetic sequence.

7. 3, 7, 11, 15, 19, 23, 27, ... Use the common difference to find the next three terms in each arithmetic sequence.

8. 5, 11, 17, 23, 29, 35, ... Determine whether each sequence is an arithmetic sequence. If so, find the common difference and the next three terms.

9. 12, 15, 18, 21, ... yes; 2, 5, 11, 15, 19, 23

With the common difference you found, write the general form for each arithmetic sequence.

First, write the rule.

10. aₙ = a₁ + (n - 1)d

Write the general form for the rule.

11. aₙ = a₁ + (n - 1)d

Substitute the first term and common difference.

12. aₙ = 5 + (n - 1)1.2

Substitute the term number.

13. aₙ = 5 + (n - 1)1.2

Simplify.

14. aₙ = 5 + (n - 1)1.2

The 50th term is 53.8.

Find how much you add or subtract to move from term to term. The common difference is -1.2.

Use the first term and common difference to write the rule for each arithmetic sequence.

15. aₙ = 10 + (n - 1)4

Write the general form for the rule.

16. aₙ = 5 + (n - 1)1.2

17. aₙ = -5 + (n - 1)5

18. aₙ = 6 + (n - 1)(3)

Find the indicated term of each arithmetic sequence.

19. First term: a₁ = 5, common difference: d = 5

20. aₙ = 10 + (n - 1)(4)

21. aₙ = 5 + (n - 1)1.2

22. aₙ = -5 + (n - 1)5

23. aₙ = 6 + (n - 1)(3)

24. aₙ = 5 + (n - 1)1.2

25. aₙ = -5 + (n - 1)5

26. aₙ = 6 + (n - 1)(3)

27. aₙ = 5 + (n - 1)1.2

28. aₙ = -5 + (n - 1)5

29. aₙ = 6 + (n - 1)(3)
The volleyball team is traveling to a game 120 miles away.

Step 1: Write the ordered pairs in a table.
Step 2: Find the amount of change in each variable. Determine if the amounts are constant.
Step 3: Using the x-values show a constant change, the y-values do not. Therefore, this set of ordered pairs does not represent a linear function.

Identify whether the function \( y = 5x - 2 \) is a linear function.

Try to write the equation in standard form \((Ax + By = C)\).

In standard form, \( x \) and \( y \) are not multiplied together.

Conclusion: Because the function can be written in standard form, \((Ax + By = C)\), the function is a linear function.

Tell whether each graph, set of ordered pairs, or equation represents a linear function. Write yes or no.

1. no 2. yes 3. yes
4. \((-3, 5), (-2, 8), (-1, 12)\) 5. \(2y = -3x^2\) 6. \(y = 4x - 7\)

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Find the slope of the line that contains \((-1, 3)\) and \((2, 0)\).

**Step 1:** Name the ordered pairs. (It does not matter which is first and which is second.)

<table>
<thead>
<tr>
<th>first ordered pair</th>
<th>((-1, 3))</th>
<th>second ordered pair</th>
<th>((2, 0))</th>
</tr>
</thead>
</table>

**Step 2:** Label each number in the ordered pairs.

\((-1, 3), (2, 0)\)

**Step 3:** Substitute the ordered pairs into the slope formula.

\[ m = \frac{y_2 - y_1}{x_2 - x_1} \]

\[ m = \frac{0 - 3}{2 - (-1)} \]

\[ m = \frac{-3}{3} \]

\[ m = -1 \]

The slope of the line that contains \((-1, 3)\) and \((2, 0)\) is \(-1\).

---

**Review for Mastery**

**Direct Variation**

A direct variation is a special type of linear relationship. It can be written in the form \(y = kx\) where \(k\) is a nonzero constant called the constant of variation.

**Tell whether \(2x + 4y = 0\) is a direct variation. If so, identify the constant of variation.**

First, put the equation in the form \(y = kx\).

\[ 2x + 4y = 0 \]

\[ 4y = -2x \]

\[ y = -\frac{1}{2}x \]

The constant of variation is \(-\frac{1}{2}\). This is a direct variation.

**Tell whether the relationship is a direct variation. If so, identify the constant of variation.**

- **1.** \(x + y = 7\)
  - **2.** \(4x - 3y = 0\)
  - **3.** \(-8y = 24x\)

  **4.** \(x = 4, y = 2, 10\)
  - **5.** \(x = 5, y = 12, 8\)
  - **6.** \(x = 6, y = 8, 10\)

  **yes; \(\frac{4}{3}\)**
  - **yes; \(-3\)**
  - **yes; \(-\frac{1}{2}\)**

**Find the slope of each linear relationship.**

- **1.**
  - **2.**
  - **3.** The line contains \((5, -2)\) and \((7, 6)\).

**Review for Mastery**

**Direct Variation continued**

If you know one ordered pair that satisfies a direct variation, you can find and graph other ordered pairs that will also satisfy the direct variation.

**Tell whether each equation or relationship is a direct variation. If so, identify the constant of variation.**

- **1.** \(x + y = 7\)
  - **2.** \(4x - 3y = 0\)
  - **3.** \(-8y = 24x\)

  **4.** \(x = 4, y = 2, 10\)
  - **5.** \(x = 5, y = 12, 8\)
  - **6.** \(x = 6, y = 8, 10\)

  **yes; \(\frac{4}{3}\)**
  - **yes; \(-3\)**
  - **yes; \(-\frac{1}{2}\)**
5. The ordered pair \((3, 1)\) is on the line. Write the equation in slope-intercept form.

Step 1: Find the slope.

\[
y = mx + b
\]

\[
y = 2x + b
\]

Substitute the given value for \(m\) and the value you found for \(b\).

\[
y = mx + b
\]

\[
y = 2x - 5
\]

Substitute the given values for \(x\) and \(y\) if it is written as:

\[
y = \frac{1}{4}x + 3
\]

\[
y = -5x
\]

\[
y = 7x - 2
\]

\[
y = 3x - 6
\]

\[
y = \frac{3}{2}x + 9
\]

\[
y = -x + 3
\]

Write the following equations in slope-intercept form.

7. \(5x + y = 30\)

8. \(x - y = 7\)

9. \(-4x + 3y = 12\)

\[
y = -5x + 30
\]

\[
y = x - 7
\]

\[
y = \frac{4}{3}x + 4
\]

10. Write an equation in point-slope form for the line through the points \((4, 2)\) and \((6, 12)\).

\[
y - y_1 = m(x - x_1)
\]

\[
y - 2 = \frac{1}{2}(x - 4)
\]

\[
y = \frac{1}{2}x + 1
\]

\[
y = 4x
\]

Write an equation in slope-intercept form for the line with the given slope that contains the given point.

7. \(m = -3\); \((1, 2)\)

8. \(m = \frac{1}{2}; (8, 3)\)

9. \(m = 4; (2, 8)\)

\[
y = -3x + 5
\]

\[
y = \frac{1}{2}x + 1
\]

\[
y = 4x
\]

Write an equation in slope-intercept form for the line through the two points.

10. \((1, 2)\) and \((3, 12)\)

11. \((6, 2)\) and \((-2, -2)\)

12. \((4, 1)\) and \((1, 4)\)

\[
y = 5x - 3
\]

\[
y = \frac{1}{2}x - 1
\]

\[
y = -x + 5
\]
Tell whether the ordered pair is a solution of the given system.

3. \((3, 9)\) and \((2, 5)\) are solutions of the system.

Step 1: Substitute \((3, 9)\) into each equation.
\[\begin{align*}
3x + 2y & = 37 \\
2x + 5y & = 73
\end{align*}\]

Step 2: Substitute \((2, 5)\) into each equation. The ordered pair is not a solution of the system.
\[\begin{align*}
3x + 2y & = 37 \\
2x + 5y & = 73
\end{align*}\]

Tell whether the ordered pair is a solution of the given system.

5. \((1, 9)\) is a solution of the system.

Step 1: Substitute \((1, 9)\) into each equation. The ordered pair makes both equations true. So \((1, 9)\) is a solution of the system.
\[\begin{align*}
3x + y & = 12 \\
2x + 5y & = 12
\end{align*}\]
LESSON 2

Solving Systems by Substitution

Review for Mastery

You can use substitution to solve a system of equations if one of the equations is already solved for a variable.

\[ \begin{align*}
3x + y &= 10 \\
x &= y + 2
\end{align*} \]

Step 1: Choose the equation to use as the substitute.

The first equation \( y = x - 2 \) because it is already solved for a variable.

Step 2: Solve by substitution.

\[ \begin{align*}
3x + y &= 10 \\
3x + (x + 2) &= 10 \\
x + 2 &= 10 \\
\end{align*} \]

Step 3: Now substitute \( x + 2 \) back into one of the original equations to find the value of \( y \).

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

Step 4: Substitute \( x = 3 \) into both equations.

\[ \begin{align*}
y &= x - 2 \\
y &= 3 - 2 \\
y &= 1
\end{align*} \]

Step 5: The solution is \( (3, 1) \).

Solve each system by substitution. Check your answer.

1. \( \begin{align*}
x &= y - 1 \\
x &= 2y - 8
\end{align*} \)

2. \( \begin{align*}
y &= x + 2 \\
x &= 2x - 5
\end{align*} \)

3. \( \begin{align*}
y &= x + 5 \\
3x &= y - 11
\end{align*} \)

4. \( \begin{align*}
x &= y + 10 \\
x &= 2y + 3
\end{align*} \)

5. \( \begin{align*}
x &= y - 3 \\
2x &= 12 - y
\end{align*} \)

6. \( \begin{align*}
y &= 8 \\
5x &= 2y - 9
\end{align*} \)

Solving Systems by Elimination

Review for Mastery

Elimination can be used to solve a system of equations by adding terms vertically. This will cause one of the variables to be eliminated. It may be necessary to multiply one or both equations by some number to use this method.

I. Elimination may require no change to either equation.

\[ \begin{align*}
3x + y &= 6 \\
5x - y &= 10
\end{align*} \]

Adding vertically will eliminate \( y \).

\[ \begin{align*}
3x + y &= 6 \\
5x - y &= 10 \\
8x &= 16 \\
x &= 2
\end{align*} \]

II. Elimination may require multiplying one equation by an appropriate number.

\[ \begin{align*}
2x + 5y &= 9 \\
x - 3y &= 10
\end{align*} \]

Multiply bottom equation by \(-2\): \( \begin{align*}
2x + 5y &= 9 \\
-2(2x + 3y) &= -2(10) \\
0 - 11y &= -11
\end{align*} \)

III. Elimination may require multiplying both equations by different numbers.

\[ \begin{align*}
5x + 3y &= 2 \\
4x + 2y &= 10
\end{align*} \]

Multiply the top by \(-2\) and the bottom by \(3\):

\[ \begin{align*}
-10x + 6y - 4 \\
12x + 6y &= 30 \\
2x + 0 &= 26
\end{align*} \]

Solve each system by elimination.

1. \( \begin{align*}
2x + 3y &= 20 \\
3x &= 2y - 19
\end{align*} \)

2. \( \begin{align*}
3x &= 2y - 10 \\
3x &= 2y - 14
\end{align*} \)

3. \( \begin{align*}
x &= y - 12 \\
2x + y &= 6
\end{align*} \)

4. \( \begin{align*}
3x &= 2y - 2 \\
8x + 2y &= 4
\end{align*} \)

5. \( \begin{align*}
x &= y + 3 \\
-2x + y &= -4
\end{align*} \)

6. \( \begin{align*}
x &= y + 3 \\
2x - y &= 4
\end{align*} \)

7. \( \begin{align*}
x &= y + 3 \\
3x &= 5y - 5
\end{align*} \)

Solving Systems by Elimination continued

A system of equations can be solved by graphing, substitution, or elimination.

- Use graphing if both equations are solved for \( y \) or if you want an estimate of the solution.
- Use substitution if either equation is solved for a variable, or has a variable with a coefficient of 1 or -1.
- Use elimination if both equations have the same variable with the same or opposite coefficients.

It may be necessary to manipulate your equations to get them in any of the three forms above.

\[ \begin{align*}
y &= 3x - 4 \\
2x + 3y &= -6
\end{align*} \]

One equation is solved for a variable. Use substitution.

\[ \begin{align*}
x &= 1 \\
2x &= 3
\end{align*} \]

Substitute \( x = 3 \) into one of the original equations to find the value of \( y \).

\[ \begin{align*}
x &= 3 \\
3x &= y - 1
\end{align*} \]

The equations have the same variable with opposite coefficients. Use elimination.

\[ \begin{align*}
x &= 3 \\
x &= 3 - y
\end{align*} \]

The solution is \( (3, 0) \).

The solution is \( (-1, 7) \).

Solve each system by any method.

5. \( \begin{align*}
y &= x + 3 \\
-2x + y &= -4
\end{align*} \)

6. \( \begin{align*}
x &= y + 10 \\
-2x - y &= 4
\end{align*} \)

7. \( \begin{align*}
x &= y + 8 \\
3x &= 5y - 5
\end{align*} \)

8. \( \begin{align*}
x &= y + 3 \\
2x - y &= 4
\end{align*} \)

The solution is \( (7, 10) \).

The solution is \( (-7, 18) \).

The solution is \( (5, -2) \).
California Standards: 8.0, 15.0

Review for Mastery

Solving Special Systems

When solving equations in one variable, it is possible to have one solution, no solutions, or infinitely many solutions. The same results can occur when graphing systems of equations.

1. \(4x + 2y = 2\)
2. \(3x + y = 4\)

Multiply the second equation by \(-2\) will eliminate the \(x\) terms.

\[
\begin{align*}
4x + 2y & = 2 \\
-8x - 2y & = -4
\end{align*}
\]

The solution is \((0, 3)\).

The equation is a contradiction. There is no solution.

The equation is true for all values of \(x\) and \(y\). There are infinitely many solutions.

Solve each system of linear equations algebraically.

1. \(y = 3x - 2\)
2. \(y = -2x + 5\)
3. \(3x = 2y - 9\)

3. \(y = 3x - 2\)
4. \(y = -2x + 5\)
5. \(3x + y = 4\)

The slopes and \(y\)-intercepts are the same. These are the same line.

There are infinitely many solutions.

Classify each system and give the number of solutions. If there is one solution, provide it.

4. \(y = 3x - 2\)
5. \(y = -2x + 5\)
6. \(3x + y = 4\)

Consistent and independent: one solution

no solutions

inconsistent:

one solution: \((0, 8)\)

No solutions

inconsistent:

one solution: \((0, 8)\)

The solution is \((29, 10)\).

Write a system of equations by reading each row of the table:

1. \(a = b = 300\)
2. \(a = b = 300\)
3. \(a = b = 300\)
4. \(a = b = 300\)

Write a system of equations for each mixture problem. Then solve the problem.

1. Jenny mixes a 30% saline solution with a 50% saline solution to make 800 milliliters of a 40% saline solution. How many milliliters of each solution does she use?

2. A pharmacist wants to mix a medicine that is 10% aspirin with a medicine that is 25% aspirin to make 10 grams of a medicine that is 16% aspirin. How many grams of each medicine should the pharmacist mix together?

3. Peanuts cost $1.60 per pound and raisins cost $2.40 per pound. Brad wants to make 8 pounds of a peanut-raisin mixture that costs $2.20 per pound. How many pounds of peanuts and raisins should he use?

4. Miguel has some quarters and dimes. There are 38 coins altogether and the total value of the coins is $8.80. How many quarters and how many dimes does he have?

5. The drawer of a cash register contains 55 bills. All of the bills are either $10 bills or $20 bills. The total value of the bills is $810. How many $10 bills and $20 bills are in the drawer?

6. Kenisha is selling tickets to a school play. Adult tickets cost $12 and student tickets cost $6. Kenisha sells a total of 48 tickets and collects a total of $336. How many of each type of ticket does she sell?
**Review for Mastery**

**Solving Linear Inequalities**

When graphing an equation, the solutions are all the points on the line. When graphing an inequality, the solutions are all the points above or below the line (and may include the line).

**Graph** $y = x + 4$.

**Graph** $y < x + 4$.

One method of determining which side to shade is to choose a point anywhere on the graph (except on the line). Then substitute to determine if it makes the inequality true.

The boundary line for the inequality $y > -x + 5$ is graphed below. Shade the correct side.

**Step 1:** Choose a point.

**Step 2:** Substitute $(0, 0)$ in the inequality $y > -x + 5$.

$y > -x + 5$

$0 > -0 + 5$

The statement is false.

**Step 3:** Because $(0, 0)$, which is below the line, resulted in a false statement, it is not a solution. Shade above the line.

The boundary lines for each inequality are graphed below. Shade the correct side.

1. $y > 5x + 7$
2. $y < -2x - 9$
3. $x > 3$

**Graph** $x < 3$.

**Graph of**

**Possible Answers:**

- Sol: $(3, 4)$
- Sol: $(5, -2)$
- Sol: $(5, 2)$
- Sol: $(3, -2)$

**Graph each system of linear inequalities.**

1. $y > x - 3$
2. $y < 2x + 3$
3. $y > -x + 6$
4. $y < x$

**Graph the solutions of each linear inequality.**

5. $x + y = 0$
6. $y = x + 3$
7. $y = x - 5$
Review for Mastery

Integer Exponents

Remember that \(2^3\) means \(2 \times 2 \times 2\). The base is 2, the exponent is positive 3. Exponents can also be 0 or negative.

<table>
<thead>
<tr>
<th>Zero Exponents</th>
<th>Negative Exponents</th>
<th>Negative Exponents in the Denominator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>For any nonzero number (x, x^0 = 1).</td>
<td>For any nonzero number (x, x^{-n} = \frac{1}{x^n}).</td>
</tr>
<tr>
<td>Examples</td>
<td>(5^0 = 1)</td>
<td>(2^{-1} = \frac{1}{2})</td>
</tr>
</tbody>
</table>

Simplify \(4^{-3}\).

\[4^{-3} = \frac{1}{4^3} = \frac{1}{64}\]

Fill in the blanks to simplify each expression.

1. \(2^{-3} \times 10^2\)
2. \(10^{-3} \times 10^2\)
3. \(\frac{1}{2} \times 10^1\)

Simplify \(\frac{5}{y^3} \times \frac{y}{5}\).

\[\frac{5}{y^3} \times \frac{y}{5} = \frac{5y}{5y^3} = \frac{1}{y^2}\]

Evaluate each expression for the given values of the variables.

10. \(x^2y^2\) for \(x = 2\) and \(y = 5\)
11. \(a^3b^2\) for \(a = 4\) and \(b = 2\)
12. \(z^2\) for \(z = 3\) and \(y = 5\)
13. \(a^2b^{-1}\) for \(a = 2\) and \(b = -1\)
14. \(m^{-2}\) for \(m = 6\) and \(n = 2\)
15. \((-u)^3v^{-2}\) for \(u = -2\) and \(v = 2\)

Powers of 10 and Scientific Notation

Powers of 10 are used to write large numbers in a simple way. The exponent will tell you how many places to move the decimal when finding the value of a power of 10.

1. **Find the value of** \(10^3\). **Step 1:** Start with the number 1. **Step 2:** Move the decimal 3 places to the right.
   \[1000 = 10^3\]
   \[1000000000 = 10^8\]

2. **Write 100,000,000 as a power of 10.**
   \[1000000000 = 10^9\]
   \[0.000001 = 10^{-6}\]

3. **Write each number as a power of 10.**
   - **100,000**
   - **0.01**
   - **10,000**

4. **First determine whether the decimal point will move to the right or to the left.**
   - **Then find the value of each power of 10.**
     1. \(10^0\)
     2. \(10^{-1}\)
     3. \(10^1\)

First determine whether the exponent will be positive or negative when each number is written as a power of 10.

4. \(1000\)
5. \(0.0001\)
6. \(10,000,000\)

First determine whether the exponent will be positive or negative when each number is written as a power of 10.

4. \(10^3\)
5. \(10^{-1}\)
6. \(10^1\)

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Holt Algebra 1
Review for Mastery

**Multiplication Properties of Exponents**

You can multiply a power by a power by expanding each factor.

**Simplify** 
\[(a^n)(a^m)\]
\[= a^{n+m}\]

**Review for Mastery**

**Division Properties of Exponents**

The Quotient of Powers Property can be used to divide terms with exponents.

**Simplify**
\[\frac{a^n}{a^m} = a^{n-m}\]

You can use the Power of a Quotient Property to find a power raised to another power.

**Simplify**
\[\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}\]

**Review for Mastery**

**Division Properties of Exponents continued**

You can divide quotients raised to a negative power by using the Negative Power of a Quotient Property.

**Rewrite with a positive exponent**
\[\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n\]

**Review for Mastery**

**Division Properties of Exponents continued**

Fill in the blanks below.

10.

11.

12.

**Review for Mastery**

**Multiplication Properties of Exponents continued**

In the Power of a Product Property, each factor is raised to that power.

\[(ab)^n = a^nb^n\]

**Review for Mastery**

**Division Properties of Exponents continued**

\[\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n\]
Polynomials

A monomial is a number, a variable, or a product of numbers and variables with whole-number exponents. A polynomial is a monomial or a sum or difference of monomials.

The degree of the monomial is the sum of the exponents in the monomial.

Find the degree of $8x^2y^3z^2$.

8x^2y^3 The exponents are 2 and 3.

The degree of the monomial is 2 + 3 = 5.

The standard form of a polynomial is written with the terms in order from the greatest degree to the least degree. The coefficient of the first term is the leading coefficient.

Write $3x^2y + 4x^2y^2 + z^4$ in standard form.

$3x^2y + 4x^2y^2 + z^4$ The first term is the leading term.

Find the degree of each monomial.

1. $7m^3n^2$
2. $6x^2y$
3. $4xy^2$

Write each polynomial in standard form. Then give the leading coefficient.

4. $x^2 - 5x^2 - 6x$
5. $2x + 5x^2 - x^3$
6. $8x + 7x - 1$

Find the degree of each term.

7. $-x^2 + 3x - 2$
8. $-8 + 3x^2 - 6x$
9. $4x^4 + 6x^3 - 5x^2$

Write each polynomial in standard form. Then give the leading coefficient.

10. $7x^3 - 5x$
11. $b^4 + 2b^2 - 4b + 1$

A root of a polynomial is a value of the variable for which the polynomial is equal to 0.

Tell whether 4 is a root of $-16x^2 + 65x - 4$.

Substitute 4 for $x$.

Follow the order of operations to simplify.

Classify each polynomial according to its degree and number of terms.

12. 5
13. 1
14. 2

no no yes
Determine whether the following are like terms. Explain.

10. $2x^2 + 3x + 2$ and $3x^3 + 4x^2 + 5x + 6$

Add $3x^2 + 4x = 5x^2 + 6x$.

Add $[5x^2 + 7y + 2] + (4y^2 + y + 8)$.

Add $3x^2 + 5x + 4 + 4x^3 + 6x$.

Add $3y^2 + 4x = 5y^2 + 2z$.

Add $2x^2 + 3 + (4y^2 + y + 8)$.

Add $3y^2 + 5x + 4 + 4x^3 + 6x$.

Identify like terms.

Identify like terms.

Identify like terms.

Identify like terms.

Identify like terms.

Rewrite subtraction as addition of the opposite.

Find the opposite of each polynomial.

Find the opposite of each term in the polynomial.

Rewrite subtraction as addition of the opposite.

Find the opposite of each term in the polynomial.

Rewrite subtraction as addition of the opposite.

Find the opposite of each polynomial.

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Rewrite subtraction as addition of the opposite.

Find the opposite of each polynomial.

Rewrite subtraction as addition of the opposite.

Find the opposite of each polynomial.
Square

1. State whether each product will result in a perfect-square trinomial.
   a. \((x + 5)^2\)  
   b. \((x - 3)^2\)  
   c. \((5x - 6)^2\)

2. Fill in the blanks. Then write the perfect-square trinomial.
   a. \((x + 7)^2\)  
   b. \((x - 1)^2\)  
   c. \((2x + 10)^2\)

3. Find the prime factorization of 30.
   a. Choose any prime number that is a factor of 30. Then divide.
   b. \(\text{Repeat the process with the quotient.}\)
   c. The prime factorization of 30 is 2 \cdot 3 \cdot 5.

4. Find the prime factorization of 84.
   a. \(\text{Check by multiplying:}\)
   b. The prime factorization of 84 is 2 \cdot 2 \cdot 3 \cdot 7 or 2^2 \cdot 3 \cdot 7.

5. Write the prime factorization of each number.
   a. 99  
   b. 75  
   c. 84

6. California Standards Prep for 11.0
   a. Review for Mastery
   b. Factors and Greatest Common Factors
   c. Find the prime factorization of the given numbers.
   d. 1. \(2^2 \cdot 11\)
   e. 2. \(2^3 \cdot 7\)
   f. 3. \(3^4\)

7. Find the GCF of 28 and 44 by following the steps below.
   a. Find the factors of 28.
   b. Find the factors of 44.
   c. Find the GCF of 28 and 44.

8. Find the GCF of each pair of numbers.
   a. 10 and 20  
   b. 16 and 28  
   c. 24 and 60

9. Find the GCF of each pair of monomials.
   a. 4a and 10a  
   b. 15x and 21x^2  
   c. 5y^5 and 6y

10. Multiply \((x + 4)(x - 4)\).
   a. \((x^2 - 16)\)
   b. \((7 + 4x)(7 - 4x)\)
   c. \((x^2 - 49)\)
   d. \((2a)(3x)(y)\)

11. Multiply \((x + 2)(x - 2)\).
   a. \((x^2 - 4)\)
   b. \((2x + 8)(x - 4)\)
   c. \((x^2 - 4x)\)
   d. \((2a)(3x)(y)\)

12. Multiply \((x - 2)^2\).
   a. \((x^2 - 4x + 4)\)
   b. \((2x - 4)(x + 4)\)
   c. \((x^2 - 4)\)
   d. \((2a)(3x)(y)\)
Factor each polynomial.
1. 20x^2 - 15x
2. 44a^2 + 11a
3. 24y - 36x

Factor each expression.
4. 5x(x + 7) + 2(x + 7)
5. 3a(4 + 1) - 2(a - 4)
6. 4y(y + 1) + (y + 1)

Factor each trinomial.
7. x^2 + 7x + 10
8. 4x^2 + 4x + 1
9. 2x^2 + 4x + 2

Factor each polynomial filling in the blanks.
10. 3x^2 + 2x + 1

Factor each polynomial by grouping.
11. 21x^2 + 12x + 4
12. 10x^2 - 50x + 12x - 15

Factor each polynomial by filling in the blanks.
13. x^2 + 10x + 16
14. x^2 + 9x + 20

Factor each polynomial continuing.
15. x^2 + 3x + 2
16. x^2 - 5x - 24

Factor each polynomial continued.
17. 2x^2 + 3x - 2
18. 4x^2 - 9x - 5

Factor each polynomial filling in the blanks continued.
19. x^2 + 6x + 5
20. 4x^2 - 11x + 6

Factor each polynomial by grouping continued.
21. 4x^2 + 20x + 5
22. 10x^2 + 40x + 20

Factor each polynomial by filling in the blanks continued.
23. x^2 + 13x + 36
24. x^2 + 15x + 50

Factor each trinomial.
25. (x + 12)(x + 1)
26. (x + 10)(x + 5)
27. (x - 9)(x - 4)

Factor each trinomial continuing.
28. (x - 3)(x + 6)
29. (x - 7)(x + 2)
30. (x - 5)(x + 9)

Factor each trinomial continued.
31. (x + 4)(x + 2)
32. (x + 3)(x + 1)
33. (x - 4)(x + 5)
34. (x - 3)(x - 4)

Factor each trinomial by grouping.
35. 6x^2 + 13x - 5
36. 10x^2 - 15x - 4

Factor each trinomial by grouping continued.
37. 8x^2 + 10x - 3
38. 12x^2 + 11x - 6

Factor each trinomial by filling in the blanks.
39. x^2 + 7x + 6
40. x^2 + 10x + 25

Factor each trinomial by filling in the blanks continued.
41. (x + 10)(x + 5)
42. (x - 10)(x - 5)
43. (x + 5)(x + 9)

Factor each trinomial continued.
44. (x - 5)^2
45. (x + 3)^2
46. (x - 2)(x + 4)

Factor each trinomial by grouping.
47. 4x^2 + 20x + 5
48. 10x^2 + 40x + 20

Factor each trinomial by grouping continued.
49. 6x^2 + 13x - 5
50. 10x^2 - 15x - 4

Factor each trinomial by filling in the blanks.
51. x^2 + 7x + 6
52. x^2 + 10x + 25

Factor each trinomial by filling in the blanks continued.
53. (x + 10)(x + 5)
54. (x - 10)(x - 5)
55. (x + 5)(x + 9)

Factor each trinomial continued.
56. (x - 5)^2
57. (x + 3)^2
58. (x - 2)(x + 4)
### Factoring Special Products

**If a polynomial is a perfect square trinomial, the polynomial can be factored using a pattern.**

\[ a^2 + 2ab + b^2 = (a + b)^2 \]

Determine whether \(4x^2 + 20x + 25\) is a perfect square trinomial. If so, factor it.

**Step 1:** Find \(a\) and \(b\), then find the GCF of \(a\) and \(b\).

- \(a = 2x\)
- \(b = x\)

**Step 2:** Substitute expressions for \(a\) and \(b\) into \(a^2 + 2ab + b^2\).

\[(2x)^2 + 2(2x)(x) + x^2 = 4x^2 + 20x + 25\]

Therefore, \(4x^2 + 20x + 25\) is a perfect square trinomial.

**Factoring each trinomial.**

<table>
<thead>
<tr>
<th>Trinomial</th>
<th>Factors of (a)</th>
<th>Factors of (b)</th>
<th>Factors of (a + b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(9x^2 + 25x + 36)</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>(3x^2 + 7x + 4)</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>(2x^2 + 13x + 21)</td>
<td>2</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

**Conclusion:**
- \(9x^2 + 25x + 36\) is a perfect square trinomial.
- \(3x^2 + 7x + 4\) is not a perfect square trinomial.
- \(2x^2 + 13x + 21\) is not a perfect square trinomial.
Complete each table and then graph the quadratic function.

1. \( y = -2x^2 + 1 \)

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-7</td>
</tr>
<tr>
<td>-1</td>
<td>-1</td>
</tr>
<tr>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>2</td>
<td>-7</td>
</tr>
</tbody>
</table>

2. \( y = \frac{1}{3}x^2 - 2 \)

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-6</td>
</tr>
<tr>
<td>-1</td>
<td>-2</td>
</tr>
<tr>
<td>0</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Review for Mastery

Characteristics of Quadratic Functions

You find the axis of symmetry of a parabola by averaging the two zeros. If there is only one zero or no zeros, use the x-value of the vertex.

Find the axis of symmetry of each parabola.

1. 
   - The zeros are -3 and 5. The axis of symmetry is x = 1.

2. 
   - The zeros are -3 and 5. The axis of symmetry is x = -6.

3. 
   - There are no zeros. The axis of symmetry is x = 0.

4. 
   - The zeros are -3 and 5. The axis of symmetry is x = 2.

Characteristics of Quadratic Functions

You find the axis of symmetry of a quadratic function with this formula:

\[ x = \frac{-b}{2a} \]

Find the axis of symmetry of the graph of \( y = -2x^2 + 8x - 5 \).

1. Find the axis of symmetry.
2. Substitute a and b into the formula.
3. The axis of symmetry is x = 2.
4. The axis of symmetry always passes through the vertex. Once you know the axis of symmetry, you can find the vertex.
5. Find the vertex of \( y = -2x^2 + 8x - 5 \).
6. The vertex is (2, 3).

Graphing Quadratic Functions

You can use the axis of symmetry, vertex, and y-intercept to graph a quadratic function.

Graph \( y = x^2 + 6x + 8 \).

1. **Step 1:** Identify the coefficients.
   - a = 1
   - b = 6
   - c = 8

2. **Step 2:** Complete the square.
   - \( y = x^2 + 6x + 9 - 1 \)
   - \( y = (x + 3)^2 - 1 \)

3. **Step 3:** Find the vertex.
   - The vertex is (-3, -1).

Graph \( x^2 + 4x - 12 \) by completing the following.

1. Find and graph the axis of symmetry.
   - x = -2
2. Find and graph the vertex.
   - (-2, -16)
3. Find and graph the y-intercept.
   - (0, -12)
4. Find and graph two more points.
   - (-1, -15), (1, -7)
5. Reflect the points and draw the graph.

Characteristics of Quadratic Functions

You find the axis of symmetry of a function's graph.

5. \( y = x^2 - 10x + 25 \)
6. \( y = -3x^2 + 6x + 5 \)

The vertex is (x = 5).

7. \( y = x^2 - 10x + 25 \)
8. \( y = -3x^2 + 6x + 5 \)

The vertex is (x = 0).

9. Find the vertex of \( y = -2x^2 + 12x - 9 \).
   - The vertex is (-3, -27).

Characteristics of Quadratic Functions

You find the axis of symmetry of a parabola by averaging the two zeros. If there is only one zero or no zeros, use the x-value of the vertex.

Find the axis of symmetry of each parabola.

1. 
   - The zeros are -3 and 5. Average the zeros:
   - \( -\frac{-3 + 5}{2} = 1 \)
   - The axis of symmetry is x = 1.

2. 
   - The zeros are -3 and 5. Average the zeros:
   - \( -\frac{-3 + 5}{2} = -1 \)
   - The axis of symmetry is x = -1.

Characteristics of Quadratic Functions

You find the axis of symmetry of a quadratic function with this formula:

\[ x = \frac{-b}{2a} \]

Find the axis of symmetry of the graph of \( y = -2x^2 + 8x - 5 \).

1. Identify the coefficients.
2. Substitute a and b into the formula.
3. The axis of symmetry is x = 2.
4. The axis of symmetry always passes through the vertex. Once you know the axis of symmetry, you can find the vertex.
5. Find the vertex of \( y = -2x^2 + 8x - 5 \).
6. The vertex is (2, 3).

Characteristics of Quadratic Functions

You find the axis of symmetry of a function's graph.

5. \( y = x^2 - 10x + 25 \)
6. \( y = -3x^2 + 6x + 5 \)

The vertex is (x = 5).

7. \( y = x^2 - 10x + 25 \)
8. \( y = -3x^2 + 6x + 5 \)

The vertex is (x = 0).

9. Find the vertex of \( y = -2x^2 + 12x - 9 \).
   - The vertex is (-3, -27).
You can find solutions to a quadratic equation by looking at the graph of the related function.

Find the solutions of \( x^2 + x - 6 = 0 \) from the graph of the related function.

Solutions occur where the graph crosses the \( x \)-axis.

\[
\begin{align*}
\text{Graph} & \quad \text{Solution} \\
\hline
\text{Intersection} & \quad \text{Roots} \\
(2,0) & \quad x = -3 \text{ and } x = 2
\end{align*}
\]

The solutions appear to be \(-3\) and \(2\).

Find the solutions from each graph below. Then check your answers.

1. \( 3x^2 + 9x = 0 \)
   - \( x = 0 \) or \( x = -3 \)
2. \( x^2 - 4x = 4 = 0 \)
   - \( x = 2 \) or \( x = 0 \)
3. \(-2x^2 + 6x = 0 \)
   - \( x = 3 \) or \( x = 0 \)

**Check:**

\[
\begin{align*}
\text{Check:} & \quad x = -3 \\
(2,0) & \quad \text{Solution:} \\
\end{align*}
\]

The firework is launched from the ground. The quadratic function \( y = -15x^2 + 56x \) models the rocket's height above the ground after \( x \) seconds. About how long is the rocket in the air?

1. \( x = 5 \) or \( x = 2 \)
2. \( y = 0 \) or \( y = 0 \)
3. \( x = 0 \) or \( x = 0 \)

**Solution:**

\[
\begin{align*}
\text{Solution} & \quad x = 0 \\
4 & \quad \text{Solution:} \\
\end{align*}
\]

The firework is in the air for about 0.6 seconds.

**Use your graphing calculator to estimate each answer. Check your answer by plugging it back into the quadratic equation.**

4. A rocket is launched from the ground. The quadratic function \( y = -16x^2 + 96x \) models the rocket's height above the ground after \( x \) seconds. About how long is the rocket in the air?

5. About 3.5 seconds

6. About 5.5 seconds

**Step 1:** Write the related function.

**Step 2:** Graph the function by using a graphing calculator.

**Step 3:** Use trace to estimate the zeros.

The solutions appear to be \(0\) and \(0.5\).

The dancer is in the air for about 0.5 seconds.

**Remember that using the trace key gives an estimate of the solutions.**

**Review for Mastery**

**California Standards:** 21.0, 23.0

**Holt Algebra 1**

**Review for Mastery**

**California Standards:** 14.0, 23.0

**Holt Algebra 1**
**Review for Mastery**

**Review of Mastery**

1. California Standards 2.0, 14.0, 23.0

### Solving Quadratic Equations by Using Square Roots

- **Solve using square roots.**
  - 1. \( x^2 = 81 \)
  - 2. \( x^2 = 9 \)
  - 3. \( x^2 = -64 \)
  - 4. \( x^2 + 44 = 188 \)
  - 5. \( x^2 - 12 = 37 \)
  - 6. \( x^2 + 10 = 131 \)
  - 7. \( 3x^2 = 25 - 73 \)
  - 8. \( 5x^2 = 9 - 116 \)
  - 9. \( -4x^2 + 42 = -102 \)
  - 10. \( 4x^2 - 11 = 25 \)

**Check:**
- \( x = 9 \) or \( x = -3 \)
- \( x = 7 \) or \( x = -7 \)
- \( x = 6 \) or \( x = -6 \)
- \( x = 5 \) or \( x = -5 \)
- \( x = 3 \) or \( x = -3 \)
- \( x = 4 \) or \( x = -4 \)

### Completing the Square

- **Complete the square to form a perfect square trinomial.**
  - 1. \( x^2 + 14x = -7 \)
  - 2. \( x^2 - 12x = -18 \)
  - 3. \( x^2 + 20x = 100 \)

**Check:**
- \( x = 7 \) or \( x = -7 \)
- \( x = 6 \) or \( x = -6 \)
- \( x = 10 \) or \( x = -10 \)

### Review for Mastery**

- **Solve using square roots.**
  - 1. \( x^2 = 81 \)
  - 2. \( x^2 = 9 \)
  - 3. \( x^2 = -64 \)

**Check:**
- \( x = 9 \) or \( x = -3 \)
- \( x = 7 \) or \( x = -7 \)
- \( x = 6 \) or \( x = -6 \)

### Completing the Square

- **Complete the square to form a perfect square trinomial.**
  - 1. \( x^2 + 14x = -7 \)
  - 2. \( x^2 - 12x = -18 \)
  - 3. \( x^2 + 20x = 100 \)

**Check:**
- \( x = 7 \) or \( x = -7 \)
- \( x = 6 \) or \( x = -6 \)
- \( x = 10 \) or \( x = -10 \)
Review for Mastery

LESSON 9-8

The Discriminant

The discriminant of a quadratic equation is \( b^2 - 4ac \). The discriminant will indicate the number of solutions of a quadratic equation.

If \( b^2 - 4ac > 0 \), the equation has 2 real solutions.

If \( b^2 - 4ac = 0 \), the equation has 1 real solution.

If \( b^2 - 4ac < 0 \), the equation has no real solutions.

Find the number of solutions of \( 4x^2 - 8x + 5 = 0 \) using the discriminant.

Step 1: Identify a, b, and c.

\( a = 4, \quad b = -8, \quad c = 5 \)

Step 2: Substitute into \( b^2 - 4ac \).

\( b^2 - 4ac = (-8)^2 - 4(4)(5) = 64 - 80 = -16 \)

Step 3: Simplify.

\( b^2 - 4ac = -16 \)

\( b^2 - 4ac \) is negative. \( b^2 - 4ac \) is negative. There are no real solutions. There are two real solutions.

Find the number of solutions of each equation using the discriminant by filling in the boxes below.

1. \( 4x^2 + 20x + 25 = 0 \)

\( a = 4, \quad b = 20, \quad c = 25 \)

\( b^2 - 4ac = (20)^2 - 4(4)(25) = 400 - 400 = 0 \)

1 solution

2 solutions

Find the number of solutions of each equation using the discriminant.

3. \( x^2 + 9x - 36 = 0 \)

\( b^2 - 4ac = (9)^2 - 4(1)(-36) = 81 + 144 = 225 \)

2 solutions

4. \( 25x^2 - 4 = 0 \)

\( b^2 - 4ac = (0)^2 - 4(25)(-4) = 0 + 400 = 400 \)

2 solutions

no real solutions

Review for Mastery

LESSON 9-9

The Quadratic Formula

The Quadratic Formula is the only method that can be used to solve any quadratic equation.

Solve \( 2x^2 - 5x - 12 = 0 \) using the quadratic formula.

\( a = 2, \quad b = -5, \quad c = -12 \)

\( x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\
= \frac{5 \pm \sqrt{(-5)^2 - 4(2)(-12)}}{2(2)} \\
= \frac{5 \pm \sqrt{25 + 96}}{4} \\
= \frac{5 \pm \sqrt{121}}{4} \\
= \frac{5 \pm 11}{4} \\
= \frac{5 + 11}{4}, \frac{5 - 11}{4} \\
= \frac{16}{4}, \frac{-6}{4} \\
= 4, -1.5 \\
\)

Solve each equation using any method. Tell which method you used.

5. \( x^2 - 7x - 8 = 0 \)

Possible answer: Factoring

\( x^2 - 7x - 8 = (x - 8)(x + 1) = 0 \)

\( x = 8, -1 \)

6. \( x^2 - 16 = 0 \)

Possible answer: Graphing

\( x^2 - 16 = (x - 4)(x + 4) = 0 \)

\( x = 4, -4 \)

Review for Mastery

LESSON 9-10

The Discriminant continued

You can use the discriminant to determine the number of \( x \)-intercepts of a quadratic function.

Find the number of \( x \)-intercepts of \( f(x) = 2x^2 - 2x + 3 \) by using the discriminant.

\( a = 2, \quad b = -2, \quad c = 3 \)

\( b^2 - 4ac = (-2)^2 - 4(2)(3) = 4 - 24 = -20 \)

The discriminant is negative, so there are no real solutions.

Therefore, the graph does not intersect the \( x \)-axis and there are no \( x \)-intercepts.

Check by graphing:

\( y = 2x^2 - 2x + 3 \)

None

Find the number of \( x \)-intercepts of each function by using the discriminant.

5. \( y = x^2 - x - 2 \)

Two

6. \( y = 4x^2 - 4x + 1 \)

One

7. \( y = 3x^2 - 2x - 7 \)

None

8. \( y = 6x^2 + 7x - 3 \)

Two
Let Fill in the table of values and graph.

Multiply.


Write the inverse variation equation.

: Write the inverse variation when and .

: Write the inverse variation when and .

: Write the inverse variation when and .

Write and graph the inverse variation when .

Write the product rule for inverse variation.

Find

11. Write the inverse variation equation.

Step 1: Find .

Step 2: Write the inverse variation equation.

Step 3: Make a table of values and graph.

9. Write and graph the inverse variation when and .

a. Find .

b. Write the inverse variation .

c. Fill in the table of values and graph.

10. Write and graph the inverse variation when and .

a. Find .

b. Write the inverse variation .

c. Fill in the table of values and graph.

Identify the asymptotes.

Sketch each function.

Identify the asymptotes.

Sketch each function.

Sketch each function.
Simplifying Rational Expressions

A rational expression is an algebraic expression whose numerator and denominator are polynomials.

Excluded values are any values from a rational expression that make the denominator equal zero.

Find any excluded value of \( \frac{6x}{x^2 - 5x} \).

Simplify \( x^2 + 4 \), if possible. Identify any excluded values.

Divide out common factors.

The excluded values are 0 and 5.

Identify any excluded values.

1. \( \frac{3}{4x} \)
2. \( \frac{5x}{3x^2 + 15x} \)
3. \( \frac{x - 4}{x^2 - 5x} \)

Simplify each rational expression, if possible. Identify any excluded values.

Divide out common factors.

Identify each excluded rational expression, if possible.

Simplify each rational expression, if possible.

Rational expressions with binomials, trinomials, and opposite binomials can also be simplified.

If \( a, b, c, \) and \( d \) are nonzero polynomials, then \( \frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c} \).

You can make any expression rational by writing it with a denominator of 1.

Multiply \( \frac{x + 1}{5x} \) by \( \frac{5x}{x + 1} \).

Multiply \( (3x + 12) \cdot \frac{1}{x - 20} \) and simplify your answer.

Divide \( x^2 - 4 \) by \( x - 2 \).

Multiply \( \frac{4x + 24}{x^2 - 36} \) and simplify your answer.

Add \( \frac{x}{x + 1} + \frac{1}{x + 1} \) and simplify your answer.

Divide \( \frac{4x - 5}{x^2 - 20} \) and simplify your answer.
### Review for Mastery

**Adding and Subtracting Rational Expressions**

The rules for adding and subtracting rational expressions are the same as the rules for adding and subtracting fractions.

Add: \( \frac{5x + 10}{x - 16} - \frac{10}{x - 16} \)

Simplify your answer.

\[ \frac{(5x + 10) - 10}{x - 16} = \frac{5x}{x - 16} \]

Add like terms.

\[ \frac{5x}{x - 16} \]

**Factor**.

\[ (5x - 5) \]

Simplify.

\[ \frac{5(x - 1)}{x - 16} \]

**Review for Mastery** continued

Like fractions, you may need to multiply by a form of 1 to obtain common denominators.

Add: \( \frac{3x + 4}{10x^2} \)

Simplify your answer.

\[ \frac{3x + 4}{10x^2} \]

Add like terms.

\[ \frac{3x + 4}{10x^2} \]

Combine like terms.

\[ \frac{3x + 4}{10x^2} \]

**Factor**.

\[ \frac{3}{5}x^2 + \frac{4}{10x} \]

**Review for Mastery** continued

1. Add or subtract. Simplify your answer.
   - \( \frac{x - 2}{x^2 - 100} + \frac{8}{x - 100} \)
   - \( \frac{x - 3}{x + 6} - \frac{3y}{x + 8} \)
   - \( \frac{3x + 30}{5x + 30} - \frac{5x + 30}{30} \)
   - \( \frac{1}{10x} - \frac{3}{x + 5} + \frac{1}{x - 2} \)

2. \( \frac{x^2 - 18}{x + 6} \)  
   - Rewrite as a rational expression.
   - \( \frac{x^2 - 18}{x + 6} \)

3. \( \frac{x}{x + 6} + \frac{3}{x + 8} \)
   - Factor the numerators.
   - \( \frac{x}{x + 6} + \frac{3}{x + 8} \)

4. \( \frac{x}{3} \)
   - Divide each term by 3x.
   - \( \frac{x}{3x} \)

5. \( \frac{16x^2 - 12}{17 + 17} \)
   - Divide out common factors.
   - \( \frac{x - 5}{3} \)

6. **Simplify**

   - \( 4x + 3 \)

7. **Identify the LCD** of \( \frac{3}{8x^2} \) and \( \frac{13}{20x} \)

8. \( \frac{40x^2}{5(x + 7)} \)

9. Add or subtract. Simplify your answer.
   - \( \frac{2x + 5}{6x} + \frac{3}{12x} \)
   - \( \frac{5x + 3}{12x^2} \)

10. Add or subtract. Simplify your answer.
    - \( \frac{3x + 6}{x + 4} - \frac{2}{x - 2} \)
    - \( \frac{x}{x + 3} \)

### Review for Mastery

**Dividing Polynomials**

To divide a polynomial by a monomial, first write the division as a rational expression.

Divide: \( (12x^2 + 9x) ÷ 3x \)

**Rewrite as a rational expression.**

\( \frac{12x^2 + 9x}{3x} \)

**Factor the numerators.**

\( \frac{(12x^2 + 9x)}{3x} \)

**Divide out common factors.**

\( \frac{12x^2 + 9x}{3x} \)

### Review for Mastery continued

11. **Identify the LCD** of \( \frac{3}{8x} \) and \( \frac{-x}{x + 7} \)

12. Add or subtract. Simplify your answer.
    - \( \frac{2x + 14}{3x + 12} \)
    - \( 1 - \frac{1}{x} \)

13. **Identify the LCD** of \( \frac{3}{8x} \) and \( \frac{-x}{x + 7} \)

### Review for Mastery

**Dividing Polynomials** continued

You can use long division to divide a polynomial by a binomial.

Divide: \( (2x^2 - 2 + 7) ÷ (x - 3) \)

**Use a zero coefficient if the polynomial is missing a term.**

\( x - 3 \)

**Write in long division form.**

\( x + 2 \)

**Use 2x.**

\( -2x + 2 \)

**Use -4.**

\( -4x + 7 \)

**Use -12.**

\( -12x + 19 \)

**Use -2.**

\( -2x - 4 \)

**Use -4.**

\( -4x - 7 \)

**Use -2.**

\( -2x - 4 \)

Divide using long division.

7. \( (x^2 - 4x - 12) ÷ (x - 2) \)

8. \( (x^2 + 6x + 3) ÷ (x + 4) \)

### Review for Mastery continued

Dividing Polynomials continued

**Divide using long division.**

\( x - 6 \)

**Add or subtract. Simplify your answer.**

\( x + 2 + \frac{-5}{x + 4} \)

9. \( (x^2 - 25) ÷ (x - 5) \)

10. **Use a zero coefficient if the polynomial is missing a term.**

**Write in long division form.**

\( x - 5 \)

**Use 2x.**

\( -2x + 10 \)

**Use -4.**

\( -4x + 12 \)

**Use -2.**

\( -2x + 4 \)

**Use -4.**

\( -4x - 7 \)

**Use -2.**

\( -2x - 4 \)

**Use -4.**

\( -4x - 7 \)
Solving Rational Equations

A rational equation is an equation that contains one or more rational expressions. Some rational equations are proportions and can be solved using cross products. Solutions to all rational equations must be checked.

Solve: \( \frac{4}{x-3} = 2 \).

\( \frac{4}{x-3} = 2 \)

Multiply. 

\( 4 = 2(x-3) \)

Add 6 to both sides. 

\( x = 8 \)

Check: 
\( \frac{4}{5} = 2 \)

Yes. The solution is 8.

Solve: \( \frac{x-4}{x-2} = \frac{2}{3} \).

\( \frac{x-4}{x-2} = \frac{2}{3} \)

Cross multiply. 

\( 3(x-4) = 2(x-2) \)

Add 2 to both sides. 

\( x = 10 \)

Check: 
\( \frac{6}{8} = \frac{2}{3} \)

Yes. The solution is 10.

Solve: \( \frac{x}{x-2} = \frac{5}{x-1} \).

\( \frac{x}{x-2} = \frac{5}{x-1} \)

Cross multiply. 

\( x(x-1) = 5(x-2) \)

Add 2 to both sides. 

\( x = 10 \)

Check: 
\( \frac{10}{9} = \frac{5}{7} \)

Yes. The solution is 10.

You can use these steps to solve work problems. Kyle and Jemma can paint the living room in their apartment in 3 hours. Kyle can prepare sandwiches for an office party in 3 hours. Jemma can prepare sandwiches for the same party in 4 hours. How long will it take them to do the job together?

Step 1: Choose a variable for the time it takes them to do the job together. Kyle: \( \frac{1}{3} \) hour, Jemma: \( \frac{1}{4} \) hour.

Step 2: Make a table.

<table>
<thead>
<tr>
<th>Kyle’s Part</th>
<th>Jemma’s Part</th>
<th>Whole Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{3} )</td>
<td>( \frac{1}{4} )</td>
<td>( \frac{1}{12} )</td>
</tr>
</tbody>
</table>

Step 3: Write an equation based on the table.

\( \frac{1}{3} \) + \( \frac{1}{4} \) = \( \frac{1}{12} \)

Step 4: Solve the equation.

\( \frac{4}{12} + \frac{3}{12} = \frac{7}{12} \) \( \frac{7}{12} \) hours

Solve each problem.

1. Zack can wash all the windows in his house in 3 hours. His brother Cory can do the same job in 5 hours. How long will it take them to wash all the windows if they work together?

\( \frac{1}{3} + \frac{1}{5} = \frac{8}{15} \) \( \frac{8}{15} \) hours

2. Brenda and Leonard work in a sandwich shop. Brenda can prepare sandwiches for an office party in 40 minutes. Leonard can prepare sandwiches for the same party in 50 minutes. How long will it take them to prepare the sandwiches if they work together?

\( \frac{1}{40} + \frac{1}{50} = \frac{9}{200} \) \( \frac{9}{200} \) minutes

3. At an aquarium, two different pipes can be used to fill one of the large tanks. Pipe A can fill the tank in 7 hours. Pipe B can fill the tank in 9 hours. The aquarium’s manager would like to fill the tank in less than 4 hours. Is it possible to do this by using both pipes at the same time? Explain your answer.

Yes. Working together, both pipes take 3.5 hours to fill the tank.

4. A chemist has 300 mL of a solution that is 25% acid. She wants to make a solution that is 40% acid. How much acid should she add to the original solution?

\( \frac{25}{100} \times 300 = 75 \) mL

\( \frac{40}{100} \times x = 120 \) mL

5. A cook at a restaurant has 20 quarts of soup. The soup is 10% chicken stock. The cook wants to make a soup that is 20% chicken stock. How much chicken stock should he add to the original soup?

\( \frac{1}{10} \times 20 = 2 \) quarts

\( \frac{1}{2} \times x = 10 \)

6. LaTonya has 20 ounces of trail mix that contains 20% raisins. She wants to make a mix that contains 40% raisins. How many ounces of raisins should she add to the original trail mix?

\( \frac{1}{5} \times 20 = 4 \) ounces

\( \frac{2}{5} \times x = 8 \) ounces

7. Jay has 1 liter of a solution that is 30% alcohol. He needs a solution that is 50% alcohol. How many milliliters of alcohol should he add to the original solution?

\( \frac{3}{10} \times 1 = 0.3 \) liters

\( \frac{1}{2} \times x = 0.8 \) liters

\( x = 160 \) mL
11.1 Square-Root Functions

A square-root function is a function in which the independent variable is under the square-root sign.

<table>
<thead>
<tr>
<th>Product Property</th>
<th>Quotient Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sqrt{ab} = \sqrt{a}\sqrt{b} ) where ( a \geq 0 ) and ( b \geq 0 )</td>
<td>( \frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}} ) where ( b \neq 0 )</td>
</tr>
</tbody>
</table>

Determine whether \( y = \sqrt{x} \pm 5 \) is a square-root function. Explain.

Because \( x \) is under the square-root sign, this is a square-root function.

Find the domain of \( y = \sqrt{x} \pm 5 \).

- \( x \geq 0 \)

The domain is the set of all real numbers greater than or equal to 0.

Graph each square-root function.

9. \( y = \sqrt{x} \)
10. \( y = \sqrt{x} + 3 \)
11. \( y = \sqrt{2x + 6} \)

Domain: \( x \geq 0 \)
Domain: \( x \geq -3 \)
Domain: \( x \geq -3 \)

Graph \( f(x) = 3\sqrt{x} - 6 \).

Step 1: Find the domain of the function.

- \( 3x - 6 \geq 0 \)
- \( x \geq 2 \)

The domain is the set of all real numbers greater than or equal to 2.

Step 2: Choose \( x \)-values greater than or equal to 2 to generate ordered pairs.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( f(x) = 3\sqrt{x} - 6 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>

11.2 Radical Expressions

A radical expression is an expression that contains a radical sign.

\( \sqrt[3]{a} \) is under the radical sign.

A radical expression is in simplest form if:

- the radicand has no perfect square factors other than 1
- the radicand has no fractions
- there are no square roots in the denominator

Product Property of Square Roots
Quotient Property of Square Roots

\( \sqrt{ab} = \sqrt{a}\sqrt{b} \) where \( a \geq 0 \) and \( b \geq 0 \)

\( \frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}} \) where \( b \neq 0 \)

Simplify \( \sqrt{50} \).

\( = 5\sqrt{2} \)

Simplify \( \sqrt{\frac{28}{25}} \).

\( = \frac{\sqrt{28}}{\sqrt{25}} \)

\( = \frac{\sqrt{28}}{5} \)

Simplify, All variables represent nonnegative numbers.

1. \( \sqrt{25} \)
2. \( \sqrt{300} \)
3. \( \sqrt{4x^2} \)

4. \( \sqrt{\frac{7}{8}} \)
5. \( \sqrt{\frac{10}{9}} \)
6. \( \sqrt{\frac{9x^2}{25}} \)

7. \( \sqrt{\frac{1}{4}} \)
8. \( \sqrt[3]{\frac{288}{25}} \)

Simplify by filling in the blanks below. All variables represent nonnegative numbers.

7. \( \sqrt[3]{\frac{1}{4}} \)
8. \( \sqrt[3]{\frac{288}{25}} \)

Simplify. All variables represent nonnegative numbers.

9. \( \frac{1}{8} \)
10. \( \frac{\sqrt{6}}{4} \)
11. \( \frac{\sqrt{5}}{3} \)

12. \( \frac{\sqrt{2}}{9} \)
13. \( \frac{3\sqrt{2}}{7} \)
14. \( \frac{5\sqrt{2}}{3} \)

Review for Mastery

Graph each square-root function.

9. \( y = \sqrt{x} \)
10. \( y = \sqrt{x} + 3 \)
11. \( y = \sqrt{2x + 6} \)

Domain: \( x \geq 0 \)
Domain: \( x \geq -3 \)
Domain: \( x \geq -3 \)

Graph \( f(x) = 3\sqrt{x} - 6 \).

Step 1: Find the domain of the function.

- \( 3x - 6 \geq 0 \)
- \( x \geq 2 \)

The domain is the set of all real numbers greater than or equal to 2.

Step 2: Choose \( x \)-values greater than or equal to 2 to generate ordered pairs.

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<th>( f(x) = 3\sqrt{x} - 6 )</th>
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<tbody>
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</table>

Review for Mastery

Graph each square-root function.

9. \( y = \sqrt{x} \)
10. \( y = \sqrt{x} + 3 \)
11. \( y = \sqrt{2x + 6} \)

Domain: \( x \geq 0 \)
Domain: \( x \geq -3 \)
Domain: \( x \geq -3 \)
**Review for Mastery**

### Adding and Subtracting Radical Expressions
You can add and subtract radical expressions just like you add and subtract expressions with variables.

- **Combine radicals only if they are like radicals.**
  - $\sqrt{2x} + 2\sqrt{2x} = 3\sqrt{2x}$
  - $\sqrt{3y} - \sqrt{3y} = 0$

**Add $8\sqrt{10 + 5\sqrt{10}}$.**

$$8\sqrt{10 + 5\sqrt{10}} = \sqrt{160 + 50\sqrt{10}}$$

**Add $4\sqrt{x^2 + x^3}$.**

$$4\sqrt{x^2 + x^3} = 4x\sqrt{x + 1}$$

**Simplify each expression by filling in the boxes below.**

- $\sqrt{x + 2}$
- $\sqrt{27 - \sqrt{3}}$
- $\sqrt{125 + \sqrt{5}}$

**State whether the expressions can be added. If yes, find the sum.**

1. $\sqrt{3} + \sqrt{2}$
2. $2\sqrt{5} + \sqrt{2}$
3. $\sqrt{2} - \sqrt{3}$
4. $\sqrt{2} + 2\sqrt{3}$
5. $\sqrt{2} - 2\sqrt{3}$

**Add or subtract. All variables represent nonnegative numbers.**

- $\sqrt{12} + \sqrt{10}$
- $\sqrt{2} - 3\sqrt{2}$
- $\sqrt{2} + \sqrt{3}$
- $\sqrt{3} - \sqrt{2}$
- $\sqrt{2} + \sqrt{3}$

**Simplify.**

- $\sqrt{2} + \sqrt{3}$
- $\sqrt{2} - \sqrt{3}$
- $\sqrt{2} \cdot \sqrt{3}$
- $\sqrt{2} \div \sqrt{3}$
- $\sqrt{2} \cdot \sqrt{3}$

**Multiply and Dividing Radical Expressions**

Use the Product and Quotient Properties to multiply and divide radical expressions.

- **Product Property of Square Roots**
  - $\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$, where $a \geq 0$ and $b \geq 0$

- **Quotient Property of Square Roots**
  - $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$, where $a \geq 0$, $b > 0$

**Multiply $\sqrt{6} \cdot \sqrt{5}$.**

$$\sqrt{30}$$

**Multiply:**

- $\sqrt{3} \cdot \sqrt{2}$
- $\sqrt{3} \cdot \sqrt{10}$
- $\sqrt{8} \cdot \sqrt{15}$

**Rationalize the denominator of each quotient. Then simplify.**

- $\frac{\sqrt{2}}{\sqrt{3}}$
- $\frac{\sqrt{8}}{\sqrt{15}}$
- $\frac{\sqrt{3}}{\sqrt{5}}$

**Multiply:**

- $\sqrt{2} \cdot \sqrt{10}$
- $\sqrt{3} \cdot \sqrt{5}$

**Simplify:**

- $\sqrt{30}$
- $\sqrt{6}$

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**Review for Mastery**

**Solving Equations**

A radical equation is an equation that contains a variable within a radical.

You can solve both sides of an equation, and the resulting equation is still true.

\[
\sqrt{x} = 7, \quad \sqrt{x} = 7
\]

\[
(x) = 7^2 \quad \text{square both sides:} \quad x = 49 \quad \text{Substitute 49 for } x \text{ in the original equation.}
\]

Sometimes you first need to isolate the variable.

\[
4x = 20, \quad \frac{4x}{4} = \frac{20}{4} \quad \text{divide both sides by 4:} \quad x = 5
\]

Sometimes a solution will not check in the original equation. This is an extraneous solution.

\[
x + 3 = 1, \quad x + 3 = 1
\]

\[
-3 - 3 = 0 \quad \text{add } -3 \text{ to both sides:} \quad x + 3 = 1
\]

\[
x + 3 = 1 \quad \text{square both sides:} \quad x = 4
\]

The solution is extraneous.

The equation has no solution.

\[
\sqrt{x} = 2, \quad \sqrt{x} = 2
\]

\[
x = 4 \quad \text{square both sides:} \quad x = 4
\]

\[
x = 20 \quad \text{solve for } x \text{ in the original equation.}
\]

Sometimes you first need to isolate the variable.

\[
4x = 20, \quad 4x = 20
\]

\[
\frac{4x}{4} = \frac{20}{4} \quad \text{divide both sides by 4:} \quad x = 5
\]

\[
x = 25 \quad \text{solve for } x \text{ in the original equation.}
\]

\[
3 \cdot 3 \cdot 3 = 27 \quad \text{multiply by 3 seven times:} \quad x = 25
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 = 81 \quad \text{multiply by 3 eight times:} \quad x = 81
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 243 \quad \text{multiply by 3 nine times:} \quad x = 243
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 729 \quad \text{multiply by 3 ten times:} \quad x = 729
\]

The common ratio is 3.

The equation has no solution.

\[
\sqrt{x} = 2, \quad \sqrt{x} = 2
\]

\[
x = 4 \quad \text{square both sides:} \quad x = 4
\]

\[
x = 20 \quad \text{solve for } x \text{ in the original equation.}
\]

Sometimes you first need to isolate the variable.

\[
4x = 20, \quad 4x = 20
\]

\[
\frac{4x}{4} = \frac{20}{4} \quad \text{divide both sides by 4:} \quad x = 5
\]

\[
x = 25 \quad \text{solve for } x \text{ in the original equation.}
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 = 27 \quad \text{multiply by 3 seven times:} \quad x = 25
\]

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3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 81 \quad \text{multiply by 3 eight times:} \quad x = 81
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 243 \quad \text{multiply by 3 nine times:} \quad x = 243
\]

\[
3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 729 \quad \text{multiply by 3 ten times:} \quad x = 729
\]

The common ratio is 3.

The equation has no solution.
An exponential function has the independent variable as the exponent. $y = 3^x$ and $y = -2.5^{0.1t}$ are exponential functions.

A set of ordered pairs satisfies an exponential function if the y-values are multiplied by a constant amount as the x-values change by a constant amount.

**Tell whether the following ordered pairs satisfy an exponential function.**

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>

Think 4 = 2 × 2 = 8.

Think 2 × 2 × 2 = 8.

Think 2 × 2 × 2 × 2 = 8.

This is an exponential function. This is not an exponential function.

The population of a school can be described by the function $f(x) = 1500(1.02)^x$, where x represents the number of years since the school was built. What will be the population of the school in 12 years?

$f(12) = 1500(1.02)^{12}$

Substitute 12 for x.

Round to the nearest whole number.

$18,657$.

**Tell whether the ordered pairs satisfy an exponential function.**

1. $y = 2(0.5)^t$
2. $y = 1(1.5)^t$
3. $y = 3(0.5)^t$

yes no yes

If a rubber ball is dropped from a height of 10 feet, the function $f(x) = 20.06^x$ gives the height in feet of each bounce, where $x$ is the bounce number. What will be the height of the 5th bounce? Round to the nearest tenths of a foot.

1.6 feet

A population of pigs is expected to increase at a rate of 4% each year. If the original population is 1000, the function $f(x) = 1000(1.04)^x$ gives the population in x years. What will be the population in 12 years?

$f(12) = 1000(1.04)^{12}$

Round to the nearest whole number.

$1601$.

**Exponential Growth and Decay**

In the exponential growth and decay formulas, $y$ = final amount, $a$ = original amount, $r$ = rate of growth or decay, and $t$ = time.

Exponential growth: $y = a(1 + r)^t$

Exponential decay: $y = a(1 - r)^t$

The population of a city is increasing at a rate of 4% each year. In 2000 there were 236,000 people in the city. Write an exponential growth function to model this situation. Then find the population in 2009.

Step 1: Identify the variables.

$y = 236,000(1.04)^t$

Step 2: Substitute for a and r.

$236,000(1.04)^t$

Step 3: Substitute for t.

$y = 236,000(1.04)^{0.9}$

Growth greater than 1.

The population will be about 335,902. The population will be about 16,657.

Write an exponential growth function to model each situation. Then find the value of the function after the given amount of time.

1. Annual sales at a company are $372,000 and increasing at a rate of 5% per year. 5 years

$y = 372,000(1.05)^5$

2. The population of a town is 4200 and increasing at a rate of 3% per year. 7 years

$y = 4200(1.03)^7$

3. Monthly car sales for a certain type of car are $550,000 and are decreasing at a rate of 3% per month. 6 months

$y = 550,000(0.97)^6$

4. An internet chat room has 1200 participants and is decreasing at a rate of 2% per year. 5 years

$y = 1200(0.98)^5$

Write an exponential decay function to model each situation. Then find the value of the function after the given amount of time.

1. $577,000 invested at 3%, compounded quarterly; 8 years

$A = 577,000(1 + 0.03/4)^{8 	imes 4}$

2. $155,000 invested at 6%, compounded quarterly; 5 years

$A = 155,000(1 + 0.06/4)^{5 	imes 4}$

3. $42,000 invested at 8%, compounded quarterly; 15 years

$A = 42,000(1 + 0.08/4)^{15 	imes 4}$

4. $25,000 invested at 9%, compounded annually; 10 years

$A = 25,000(1 + 0.09)^{10}$

A special type of exponential decay involves finding compound interest. Write a compound interest function to model $15,000 invested at a rate of 3% compounded quarterly. Then find the balance after 6 years.

$A = 15,000(1 + 0.03/4)^{6 	imes 4}$

Compound interest function

$A = 15,000(1 + 0.03)^{6} = 16,657$

The balance after 6 years is $19,051.67.

If the original population is 1000, the function $f(x) = 1000(1.04)^x$ gives the population in x years. What will be the population in 12 years?

$f(12) = 1000(1.04)^{12}$

Round to the nearest whole number.

$1601$.

A special type of exponential decay involves the half-life of substances. Write a compound interest function to model compound interest for 60 days. Find the amount of iodine-122 left from a 25 gram sample after 300 seconds.

$A = 15500(1 + 0.03/4)^{60}$

Step 1: Find $t = 300 = 5$

Step 2: Substitute for $P$ and $t$.

$A = 15500(1 + 0.03/4)^{5}$

$A = 15500(1 + 0.03)^{5} = 19051.67$

The balance after 6 years is $19,051.67.

Smuth-212 has a half-life of approximately 60 seconds. Find the amount of iodine-212 left from a 25 gram sample after 300 seconds.

$A = 25(1 + 0.03/4)^{300}$

Write a compound interest function to model each situation. Then find the balance after the given number of years.

1. $17,000 invested at 3%, compounded annually; 9 years

$A = 17000(1 + 0.03)^{9}$

2. $23,000 invested at 2%, compounded quarterly; 8 years

$A = 23000(1 + 0.02/4)^{8 	imes 4}$

Write an exponential decay function to model each situation. Then find the value of the function after the given amount of time.

1. A 30 gram sample of lead-131 has a half-life of about 8 days; 4 days

$A = 30(1 + 0.03/4)^{8}$

2. A 40 gram sample of Sodium-24 has a half-life of 15 hours; 60 hours

$A = 40(1 + 0.03/4)^{15}$
Look for a pattern in each data set to determine which kind of model best describes the data.

1. \((-2, -4), (-1, -2), (0, 0), (1, 2), (2, 4)\)
2. \((-1, -4), (0, 2), (1, 1), (2, \frac{5}{2}), (3, \frac{3}{2})\)
3. \((0, 6), (1, 12), (2, 24), (3, 48)\)
4. \((0, 0), (1, 10), (2, 28), (3, 40)\)
5. \((0, 3), (1, 4), (2, 9), (3, 12)\)

Graph each data set. Which kind of model best describes the data?

Graph: constant 1st differences.

Graph: constant 2nd differences.

Graph: variable 1st differences.

Graph: variable 2nd differences.

Graph each data set. Which kind of model best describes the data?

1. \((-2, -4), (-1, -2), (0, 0), (1, 2), (2, 4)\)
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3. \((0, 6), (1, 12), (2, 24), (3, 48)\)
4. \((0, 0), (1, 10), (2, 28), (3, 40)\)
5. \((0, 3), (1, 4), (2, 9), (3, 12)\)

Connect the points. The data appear to be quadratic.

Connect the points. The data appear to be quadratic.

Connect the points. The data appear to be quadratic.

Connect the points. The data appear to be quadratic.

You can also look at patterns in data to determine the correct model.

Linear functions have constant 1st differences. Quadratic functions have constant 2nd differences. Exponential functions have a constant ratio.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>80</td>
</tr>
<tr>
<td>1</td>
<td>72.00</td>
</tr>
<tr>
<td>2</td>
<td>64.80</td>
</tr>
<tr>
<td>3</td>
<td>58.32</td>
</tr>
</tbody>
</table>

First differences are not constant. Second differences are not constant.

Check ratio:

1. \(0.9\)
2. \(0.9\)
3. \(0.9\)
4. \(0.9\)
5. \(0.9\)

Ratio is constant. Use an exponential model.

Use the data in the table to describe how the software’s cost is changing. Then write a function to model the data.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>80.00</td>
</tr>
<tr>
<td>1</td>
<td>72.00</td>
</tr>
<tr>
<td>2</td>
<td>64.80</td>
</tr>
<tr>
<td>3</td>
<td>58.32</td>
</tr>
</tbody>
</table>

Step 1: Determine whether data is linear, quadratic, or exponential.

Check differences:

<table>
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<tr>
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<th>y</th>
</tr>
</thead>
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<tr>
<td>0</td>
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</tr>
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<td>1</td>
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<td>64.80</td>
</tr>
<tr>
<td>3</td>
<td>58.32</td>
</tr>
</tbody>
</table>

Ratio is constant. Use an exponential model.

Step 2: Write the function.

Use \(y = ab^x\)

Substitute the constant ratio 0.9 for \(b\).

\(80 = a(0.9)^0\) Substitute the ordered pair \((0, 80)\) for \(x\) and \(y\).

\(80 = a\) Simplify. \((0.9)^0 = 1\).

\(80 = a\) The value of \(a\) is 80.

\(y = 80(0.9)^x\) Write the function.

Describe the model that best fits the data below. Then write a function to model the data.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
</tr>
</tbody>
</table>

Exponential model: \(y = 1(4)^x\)

Linear function: \(y = 3x + 7\)


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