Algebra
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**Focused Practice for Algebra Mastery**

- Equations and inequalities
- Functions and graphing
- Rational numbers
- Answer key

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## Algebra

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Algebra Basics

Write each phrase as an algebraic expression.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. three less than x</td>
<td>n divided by seven</td>
</tr>
<tr>
<td>2. the product of 10 and 9</td>
<td>five more than a</td>
</tr>
</tbody>
</table>

Write each sentence as an equation or inequality. Use n for an unknown number.

3. The product of 3 and n is 12. Five less than n is seven.
4. Two more than n is less than 10. Eighteen divided by n is six.

Write each of the following expressions or equations in words.

5. $7 + n$  $3n + 2 = 29$

Write the expression for each statement.

6. the product of 4 and the difference between 8 and 3
7. 4 increased by the product of 5 and 3
8. the difference between 16 and the product of 4 and 2
9. the quotient of 25 and 5 increased by 3
10. the product of 6 and 2 decreased by 1

Complete or rewrite each equation using the property indicated.

11. Commutative: $9 + 8 = \underline{\phantom{0}}$  Associative: $5 \times (3 \times 4) = \underline{\phantom{0}}$
12. Identity: $91 + 0 = \underline{\phantom{0}}$  Property of Zero: $72 \times 0 = \underline{\phantom{0}}$
Algebra Basics

Find the value of each expression.

13. \((3 + 4) \times (6 + 1)\) \(=\) \(3 + 2 \times 3 + 4\) \(=\)

14. \((5 \times 3) + (4 \times 7)\) \(=\) \((3 + 2) \times (3 + 4)\) \(=\)

15. Write the letter of the point that represents \(\frac{3}{2}\) \(=\)

Solve each equation.

\(\begin{align*}
16. \quad x - 4 &= 4 \quad \quad x + 3 &= 5 \quad \quad n - 2 &= 0 \\
17. \quad \frac{a}{4} &= 4 \quad \quad a \times 4 &= 4 \quad \quad \frac{m}{5} &= 5 \\
18. \quad y \times 20 &= 30 \quad \quad \frac{x}{12} &= 3 \quad \quad b \times 7 &= 21 \\
19. \quad \frac{x}{5} &= 20 \quad \quad n \times 5 &= 25 \quad \quad \frac{x}{9} &= 1
\end{align*}\)

Solve the problems.

20. Eva spent $48 on a shirt and a pair of pants. The pants cost twice as much as the shirt. How much did each item cost?

Let \(s\) stand for the cost of the shirt.

Equation: \(\quad \quad \quad \quad \quad s = \quad \quad \quad \quad \quad \quad \quad \quad \quad\)
The shirt cost \(\quad\). The pants cost \(\quad\).

21. In Ben’s office, there are 5 more women than men. There are 23 women. How many men are there?

What is the unknown number? \(\quad\)

Equation: \(\quad \quad \quad \quad \quad n = \quad \quad \quad \quad \quad \quad\)

There are \(\quad\) men in the office.
Lesson 1.1  Expressions and Variables

A **variable** is a symbol, usually a letter of the alphabet, that stands for an unknown number, or quantity.  \( a = \text{variable} \)

An **algebraic expression** is a combination of numbers, variables, and at least one operation.  \( x + 13 \)

An **expression** is a number phrase without an equals sign.

An **algebraic expression** is a number, variable, or combination of numbers and variables, connected by a mathematical operation like addition, subtraction, multiplication, or division. For example, in the expression \( x + 5 \), \( x \) is the variable.

A **numerical expression** contains only numbers: \( 3 + 6 \)

A **variable expression** contains numbers and variables: \( 3 + b \)

All expressions express an idea.

\( 5n \) means “five times \( n \)” or “five \( n \)s.”

\( b - 3 \) means “\( b \) decreased by 3” or “\( b \) a number decreased by 3.”

In the expression \( 5n \), both 5 and \( n \) are **factors**.

Translate each phrase into an algebraic expression.

\[
\begin{array}{ll}
\text{a} & \text{b} \\
1. & x \text{ increased by 2} & 4 \text{ less than 11} \\
2. & \text{the product of 9 and 8} & r \text{ added to 10} \\
3. & b \text{ divided by 5} & \text{three 7s} \\
4. & s \text{ decreased by 1} & 6 \text{ more than 12} \\
\end{array}
\]

Write the following expressions in words.

5. \( d + 2 \)

6. \( 3 \times n \)
Lesson 1.2 Equations and Inequalities

A term is a number, variable, product, or quotient in an algebraic expression. In $3a + 5$, $3a$ is a term and 5 also is a term.

The term $3a$ means $3 \times a$. The number 3 is the coefficient of $a$. A coefficient is a number that multiplies a variable. In the expression $x + 5$, the coefficient of $x$ is understood to be 1.

An equation is a mathematical sentence that states that two expressions are equal. It contains an equals sign.

$2 + 5 = 7$

An inequality is a mathematical sentence that states that two expressions are not equal. It shows how two numbers or expressions compare to one another.

$2 + 5 > 6 \quad 2 + 5 < 9$

Like expressions, equations and inequalities may contain only numerals, or they may also contain variables.

$2 + c = 7$

For each term below, identify the coefficient and the variable.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $3x$ coefficient ____ variable ____</td>
<td>4y coefficient ____ variable ____</td>
</tr>
<tr>
<td>2. $z$ coefficient ____ variable ____</td>
<td>5n coefficient ____ variable ____</td>
</tr>
</tbody>
</table>

Translate each sentence into an equation or inequality. Use $n$ for an unknown number.

3. five more than $n$ _________ the product of $n$ and 11 _________

Translate each sentence into an equation or inequality. Use $n$ for an unknown number.

4. The product of $n$ and three is greater than twenty-seven. _________

5. Ten divided by $n$ equals two. _________

Write each equation or inequality in words.

6. $x \div 3 = 12$ ________________________________

7. $7n + 3 < 31$ ________________________________

Spectrum Algebra
Grades 6–8
Lesson 1.2
Algebra Basics

4
Lesson 1.3 Properties

The **Commutative Properties of Addition and Multiplication** state that the order in which numbers are added or multiplied does not change the result.

\[
\begin{align*}
    a + b &= b + a \\
    2 + 3 &= 5 \\
    3 + 2 &= 5 \\
    a \times b &= b \times a \\
    5 \times 2 &= 10 \\
    2 \times 5 &= 10
\end{align*}
\]

The **Associative Properties of Addition and Multiplication** state that the way in which addends and factors are grouped does not change the result.

\[
\begin{align*}
    (a + b) + c &= a + (b + c) \\
    (2 + 3) + 4 &= 2 + (3 + 4) \\
    5 + 4 &= 2 + 7 \\
    9 &= 9 \\
    (a \times b) \times c &= a \times (b \times c) \\
    (2 \times 4) \times 5 &= 2 \times (4 \times 5) \\
    8 \times 5 &= 2 \times 20 \\
    40 &= 40
\end{align*}
\]

The **Identity Property of Addition** states that the sum of an addend and 0 is the addend.

\[
\begin{align*}
    a + 0 &= a \\
    5 + 0 &= 5
\end{align*}
\]

The **Identity Property of Multiplication** states that the product of a factor and 1 is the factor.

\[
\begin{align*}
    a \times 1 &= a \\
    4 \times 1 &= 4
\end{align*}
\]

The **Properties of Zero** state that the product of a factor and 0 is 0. They also state that the quotient of zero and any non-zero divisor is 0.

\[
\begin{align*}
    a \times 0 &= 0 \\
    5 \times 0 &= 0 \\
    0 \div a &= 0 \\
    0 \div 5 &= 0
\end{align*}
\]

Name the property shown by each statement.

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>63 \times 1 = 63</td>
<td>0 \times b = 0</td>
</tr>
<tr>
<td>2.</td>
<td>3 \times (5 \times 7) = (3 \times 5) \times 7</td>
<td>91 + 0 = 91</td>
</tr>
<tr>
<td>3.</td>
<td>9 \times 8 = 8 \times 9</td>
<td>0 \div 2 = 0</td>
</tr>
</tbody>
</table>

Complete or rewrite each equation using the property indicated.

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Identity: 0 + y =</td>
<td>Associative: 6 \times (7 \times 8) =</td>
</tr>
<tr>
<td>5.</td>
<td>Commutative: 5 + 4 =</td>
<td>Properties of Zero: 0 \times 10 =</td>
</tr>
<tr>
<td>6.</td>
<td>Associative: 7 + (b + 9) =</td>
<td>Commutative: 10 \times 3 =</td>
</tr>
</tbody>
</table>

Spectrum Algebra
Grades 6–8
Lesson 1.4  Order of Operations

If an expression contains two or more operations, they must be completed in a specified order. The **order of operations** is as follows:

1. Do all operations within parentheses and/or brackets (innermost first).
2. Do all multiplications and divisions, in order from left to right.
3. Do all additions and subtractions, in order from left to right.

\[ 3 \times (4 + 5) + 6 ÷ 3 \quad \text{Do the operation within the parentheses first.} \]
\[ 3 \times 9 + 6 ÷ 3 \quad \text{Multiply and divide from left to right.} \]
\[ 27 + 2 \quad \text{Add.} \]
\[ 29 \]

Describe the steps necessary to find the value of the expression.

1. \[ 2[5 + 6 ÷ 2 - (4 + 3)] \]

_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

Find the value of each expression.

\[ \text{a} \quad \text{b} \]
\[ 2. \quad (8 - 3) \times 2 \quad 8 - (3 \times 2) \]
\[ 3. \quad 10 - (5 + 2) \quad 10 - 5 + 2 \]
\[ 4. \quad (2 + 3) \times (4 + 5) \quad 2 + 3 \times 4 + 5 \]
\[ 5. \quad (9 \times 3) + (9 \times 2) \quad [9 \times (6 - 3)] \times 2 \]

Find the value of each expression if \( a = 2 \) and \( b = 3 \).

6. \[ 5a + 2 - 1 \quad (b + 6) \times 4 \]
7. \[ (4a + 3b) - 2 \quad (3a + 3) ÷ b \]
Lesson 1.5 Coordinate Systems, Ordered Pairs, and Relations

A coordinate plane is formed by two intersecting number lines. The horizontal line is called the x-axis. The vertical line is called the y-axis. This two-axis system is called the coordinate system.

The coordinates of a point are represented by the ordered pair \((x, y)\). This shows the distance the point is from the origin \((0, 0)\), in the domain (the set of x coordinates) and the range (the set of y coordinates). A set of ordered pairs is called a relation.

In the graph at right, Point A is located at \((4, 2)\). Point B is located at \((-5, -3)\).

When two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes. The coordinates of Point C differ from the coordinates of Point B by only the sign of the x-coordinate. So Point C, located at \((5, -3)\), is a reflection of Point B across the y-axis.

Write the ordered pair for each lettered point on the grid.

1. A ________ B ________
2. C ________ D ________
3. G ________ H ________

Write the ordered pair for Point I and Point J if they are reflected across the x-axis.

4. I ________ J ________

Plot each ordered pair on the grid. Label the points.

5. K \((2, 1)\)  
   L \((2, -5)\)  
   M \((-2, -7)\)  
   N \((-6, 6)\)  
   O \((4, 6)\)  
   P \((3, -2)\)  
   Q \((-4, -6)\)  
   R \((-7, 8)\)  
   S \((5, 8)\)  
   T \((-3, 2)\)
Lesson 1.5  Coordinate Systems, Ordered Pairs, and Relations

You can graph data using ordered pairs. For example, Jim has a summer job mowing lawns. He is paid $10 per hour. The amount he can earn in five hours is shown in the table below and in the graph to the right. Hours are shown on the x-axis, and dollars are shown on the y-axis.

<table>
<thead>
<tr>
<th>Hours (x values)</th>
<th>Dollars (y values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
</tbody>
</table>

1. An 8th-grade class is selling tubs of cookie dough. They earn a $5 profit from each tub sold. Make a table and graph to show how much profit they will earn if they sell 100, 200, 300, and 400 tubs of cookie dough. Be sure to label the x and y axes in your graph.

<table>
<thead>
<tr>
<th>Tubs (x values)</th>
<th>Dollars (y values)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Refer to the data for cookie dough sales in problem 1. How many tubs will they need to sell to earn $3,000? Represent your answer with a point on the number line. Label all values.
Algebra Answers

Chapter 1

Check What You Know, page 1

1. \( \frac{x}{3} \) \( \frac{3}{n} \)
2. \( 10 \times 9 \) \( a + 5 \)
3. \( 3 \times n = 12 \) \( n - 5 = 7 \)
4. \( n + 2 < 10 \) \( 18 \div n = 6 \)
5. seven increased by \( n \) Three times \( n \), plus two, is twenty-nine.
6. \( 4 \times (8 - 3) \)
7. \( 4 + (5 \times 3) \)
8. \( 16 - (4 \times 2) \)
9. \( 25 \div (5 + 3) \)
10. \( 6 \times (2 - 1) \)
11. \( 8 + 9 \) \( (5 \times 3) \times 4 \)
12. \( 91 \) 0

Check What You Know, page 2

13. \( 49 \) \( 13 \)
14. \( 43 \) \( 35 \)
15. \( A \)
16. 8 2 2
17. 16 1 25
18. \( \frac{1}{2} \) \( 36 \) \( 3 \)
19. \( 100 \) 5 9
20. \( 3s = 48; \$16; \$16, \$32 \)
21. the number of men; \( 23 - n = 5 \) or \( n + 5 = 23 \); 18

Lesson 1.1, page 3

1. \( x + 2 \) \( 11 - 4 \)
2. \( 9 \times 8 \) \( 10 + r \)
3. \( b + 5 \) \( 3 \times 7 \)
4. \( s - 7 \) \( 12 + 6 \)
5. two more than \( d \), or two added to \( d \), or \( d \) increased by two, or a number increased by two
6. three times \( n \), or three \( n \), or the product of three \( n \), or the product of three and a number

Lesson 1.2, page 4

1. \( 3; x \) \( 4; y \)
2. \( 1; z \) \( 5; n \)
3. \( n + 5 \) \( 11 \times n \)
4. \( n \times 3 > 27 \)
5. \( 10 \div n = 2 \)
6. \( x \) divided by three is twelve, or a number divided by three is twelve.
7. Seven times \( n \), plus three, is less than thirty-one; or seven times a number, plus three, is less than thirty-one.

Lesson 1.3, page 5

1. identity property of zero
2. associative property of zero
3. commutative property of zero
4. \( y \)
5. \( 4 + 5 \)
6. \( (7 + b) + 9 \)

Lesson 1.4, page 6

1. Perform the operation inside parentheses first, \( 2[5 + 6 + 2 - (7)] \). Then, perform division, \( 2[5 + 3 - 7] \). Finally, multiply the difference by the factor of 2, \( 2[1] = 2 \).

Lesson 1.5, page 7

1. \( A (2, 2) \); \( B (-2, -5) \)
2. \( C (3, 6) \); \( D (3, 6) \)
3. \( G (4, -3) \); \( H (4, -4) \)
4. \( I (5, 8) \); \( J (5, -8) \)
5. \( \text{Grid 1} \)

Lesson 1.5, page 8

1. \[
\begin{array}{c|c}
\text{Tubs} & \text{Dollars} \\
\hline
x \text{ values} & y \text{ values} \\
\hline
100 & 500 \\
200 & 1,000 \\
300 & 1,500 \\
400 & 2,000 \\
\end{array}
\]