Tools of Algebra
(Review of Pre-Algebra)

What you will learn:

- **CA Algebra Standard 1.0**: Identify and use the arithmetic operations of integers and rational, irrational, and real numbers, including closure properties for the four basic arithmetic operations where applicable.

- **CA Algebra Standard 2.0**: Understand and use such operations as taking the square root and finding the... (Continued)

- **CA Algebra Standard 25.0**: Use properties of the number system to judge the validity of results, to complete each step of a procedure, and to verify or validate statements.
Using Variables

Vocabulary

**Variable** - A variable is a _______________, usually a ______________, that represents one or more numbers.

**Algebraic Expressions** - An algebraic expression is a _______________ _______________ that can include ________________, ________________, and _______________ ______________.

Examples:

**Showing Multiplication in Algebra** – Multiplication in algebra is shown by ________________ or by ______________ or by making numbers and variables ______________.

Example: Show “5 times a number, n” three different ways.

**Example 1: Writing an Algebraic Expression**

Write an algebraic expression for each phrase.

1. four more than a number
2. two less than a number
3. the sum of a number and 2
4. the difference of a number and 4
5. the product of seven and n
6. the quotient of n and 6
7. a number increased by four
8. a number decreased by 8

√ **Understanding Check**

1. a. the sum of 3 and a number
2. b. the product of seven and a number
3. c. the quotient of p and 2
4. d. a number increased by 3
5. e. the difference of a number and 8
6. f. six less than a number
7. g. 9 more than a number
8. h. a number decreased by 10
**Example 2: Writing an Algebraic Expression with two operations**

Define a variable and write an algebraic expression for each phrase.  

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Algebraic Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 more than eight times a number</td>
<td>a. 9 less than six times a number</td>
</tr>
<tr>
<td>7 less than three times a number</td>
<td>b. 3 more than ten times a number</td>
</tr>
<tr>
<td>9 more than twice a number</td>
<td>c. 2 less than half a number</td>
</tr>
</tbody>
</table>

**Exponents and Order of Operations**

**Vocabulary**

**Exponent** - An exponent tells how many times a number, the base, is used as a factor.

\[2^4 = \]

**Simplify:**

| Simplify | a. \(5^3\) | b. \(2^3\) | c. \(3^4\) | d. \(10^5\) |

**Order of Operations (PEMDAS)** - Mathematicians have agreed on the following order for mathematical expressions:

1. Parentheses
2. Exponents
3. Multiplication and Division
4. Addition and Subtraction

An easy way to remember the order of operations is to remember the saying: “P_____ E_____ M____ D______ A______ S_____”
Example 1: Simplifying a Numerical Expression

Simplify \( 25 - 8 \cdot 2 + 3^2 + (5 - 2) \)

\[
\begin{align*}
\text{step 1: } & \quad \underline{______________________________} \\
\text{step 2: } & \quad \underline{______________________________} \\
\text{step 3: } & \quad \underline{______________________________} \\
\text{step 4: } & \quad \underline{______________________________} \\
\text{step 5: } & \quad \underline{______________________________}
\end{align*}
\]

√ Understanding Check

a. \( 6 - 10 \div 5 \)  
   b. \( 3 \cdot 6 - 4^2 \div 2 \)  
   c. \( 4 \div 2^2 + 4 \cdot 7 \)


d. \( (5 + 3) \div 2 + (5^2 - 3) \)  
   e. \( 8 - 3(2) + 6^2 \)

Example 2: Simplifying an Expression with brackets

Simplify \( 2[(13 - 7)^2 + 3] \)

\[
\begin{align*}
\text{step 1: } & \quad \underline{______________________________} \\
\text{step 2: } & \quad \underline{______________________________} \\
\text{step 3: } & \quad \underline{______________________________} \\
\text{step 4: } & \quad \underline{______________________________}
\end{align*}
\]

√ Understanding Check

Simplify each expression.

a. \( 5[4 + 3(2^2 + 1)] \)  
   b. \( 12 + 3[18 - 5(16 - 13)] \)  
   c. \( 5 + [(2 + 1)^3 - 3] \)
Example 3: Evaluating an Algebraic Expression

Evaluate \(3a - 2^3 \div b\) for \(a = 7\) and \(b = 4\)

\[
\begin{align*}
\text{step 1:} & \quad \boxed{\phantom{0}} \\
\text{step 2:} & \quad \boxed{\phantom{0}} \\
\text{step 3:} & \quad \boxed{\phantom{0}} \\
\text{step 4:} & \quad \boxed{\phantom{0}}
\end{align*}
\]

√ Understanding Check

Evaluate each expression for \(c = 2\) and \(d = 5\)

a. \(4c - 2d \div c\)  
   b. \(d + 6c \div 4\)  
   c. \(11c - d \cdot 2\)

Example 4: Evaluating Expressions with Exponents

Evaluate each expression for \(c = 5\) and \(d = 4\)

a. \((cd)^2\)  
   b. \(cd^2\)

\[
\begin{align*}
\text{a: } (cd)^2 & \quad \leftrightsquigarrow \quad \boxed{\phantom{0}} \\
\text{b: } cd^2 & \quad \leftrightsquigarrow \quad \boxed{\phantom{0}}
\end{align*}
\]

√ Understanding Check

Evaluate each expression for \(r = 6\) and \(t = 3\)

a. \(rt^2\)  
   b. \(r^2t\)  
   c. \((rt)^2\)
Example 5: Application

A neighborhood association turned a vacant lot into a park. The park is shaped like the trapezoid below. Use the formula $A = h \left( \frac{b_1 + b_2}{2} \right)$ to find the area of the lot for:

$h = 12$ ft and bases $b_1 = 100$ ft and $b_2 = 40$ ft.

step 1: _______________________________
step 2: _______________________________
step 3: _______________________________
step 4: _______________________________

√ Understanding Check
1. Find the area of a trapezoid with height $h = 4$ ft and bases $b_1 = 20$ ft and $b_2 = 10$ ft, using the formula.

$$A = h \left( \frac{b_1 + b_2}{2} \right)$$

2. Find the area of a triangle with height $h = 8$ ft and a base $b_1 = 6$ ft, using the formula.

$$A = \frac{1}{2} (bh)$$
Exploring Real Numbers

Vocabulary

**Natural Numbers** – Natural numbers are the _______________ counting numbers you learned when you were three years old.

**Whole Numbers** – Whole numbers are the natural numbers and ____________.

**Integers** – Integers are the whole numbers and the ________________ numbers.

**Rational Numbers** – A rational number is any number that you can write in the form \( \frac{a}{b} \), where \( a \) and \( b \) are ______________ and \( b \neq 0 \). A rational number in decimal form is either ______________, such as 6.27, or ______________, such as 8.2222... which you can write as _______.

\[ \checkmark \text{Understanding Check} \]

What kind of number is each of the following (a number can be more than one kind.)

- a. 5
- b. -3
- c. 0
- d. 5\( \frac{3}{2} \)
Adding Real Numbers

Vocabulary

Identity Property of Addition – For every real number n, ___________________ and ___________________

Example:

Inverse Property of Addition – For every real number n, there is an _______________ _________________ (−n) such that ___________________

Example:

Example 1: Using a Number Line Model

Simplify each expression:

a. 2 + 6
b. 2 + (−6)
c. −2 + 6
d. −2 + (−6)

Example 2: Adding Integers with Symbols

a. 5 + 2
b. −5 + (−2)
c. 7 + (−3)
d. −8 + 6

√ Understanding Check

1. 3 + (−6)  5. −9 + 2
2. −7 + −11  6. −3 + 3
3. −8 + 10  7. −1 + 5
4. −2 + (−6)  8. −4 + 0

Which problem above is an example of identity property of addition? _____
And which is an example of inverse property of addition? ______
Example 3: Application
A football team gains 2 yd and then loses 7 yd in two plays. You express a loss of 7 yd as \(-7\). Use addition to find the result of the two plays.

√ Understanding Check
The temperature falls 15 degrees and then rises 18 degrees. Use addition to find the change in temperature. (Show your work.)

Subtracting Real Numbers

Example 1: Using a Number Line Model

a. \(7 - 2\)

b. \(1 - 4\)

c. \(-2 - 5\)

Example 2: Subtracting Real Numbers

Both \(2 + (-6)\) and \(2 - 6\) have the ____________ _____________, \(-4\). This illustrates the following rule for subtracting real numbers:

Rule: To subtract a number, ____________________________.

Examples: \(3 - 5 = \) 4 \(-(-9) = \)

Simplify each expression by adding the opposite. (Show your changes!)

a. \(5 - 11\)  b. \(-3 - 7\)  c. \(-8 - 5\)  d. \(-4 - (-9)\)

√ Understanding Check

a. \(-6 - 2\)  b. \(8 - (-4)\)  c. \(3 - 4\)  d. \(-5 - (-7)\)
Example 3: Applying Subtraction – Evaluating Expressions

Evaluate \(-a - b\) for \(a = -3\) and \(b = -5\)

\[
\begin{align*}
\text{step 1} & : \quad \quad \\
\text{step 2} & : \quad \quad \\
\text{step 3} & : \quad \quad \\
\end{align*}
\]

√ Understanding Check
Evaluate each expression for \(r = 7\) and \(t = -2\)

\[
\begin{align*}
a. r - t & \quad b. t - r \\
c. -t - r & \quad d. -r - (-t)
\end{align*}
\]

Multiplying and Dividing Real Numbers

Vocabulary

Identity Property of Multiplication – For every real number \(n\), ____________.
Examples:

Multiplication Property of Zero – For every real number \(n\), ____________.
Examples:

Multiplication Property of \(-1\) – For every real number \(n\), ____________.
Examples:

Example 1: Multiplying Real Numbers

Rule: The product of two positive numbers or two negative numbers is _____________. (In other words, same signs make a positive.)
Examples: \(5 \cdot 2 = \quad -5(-2) = \)

Rule: The product of a positive number and a negative number, or a negative number and a positive number, is _______________. (In other words, different signs make a negative.)
Examples: \(3(-6) = \quad -3 \cdot 8 = \)
Example 1: Simplify

a. $9(-4.2)$  
b. $-5\left(-\frac{2}{3}\right)$

√ Understanding Check

a. $4(-6) $  
b. $-10(-5) $  
c. $-4(-8.1) $  
d. $-6(0) $  
e. $-\frac{2}{3}\left(-\frac{3}{4}\right) $  
f. $-2(1)$

Which of the problems above shows the identity property of multiplication? _______
And which shows the multiplication property of zero? _______

Example 2: Evaluating Expressions with Multiplication

Evaluate $-2(xy)$ for $x = -20$ and $y = -3$

________ step 1 ____________________________

________ step 2 ____________________________

________ step 3 ____________________________

√ Understanding Check

Evaluate each expression for $c = -8$ and $d = -7$.

a. $(-2)(-3)(cd) $  
b. $-(cd) $  
c. $c(-d) $  
d. $-4c + 2d - c $
Example 3: Simplifying Exponential Expressions with and without parenthesis
Use order of operations (PEMDAS) to simplify each expression

a. \((-3)^4\)  
   b. \(-3^4\)

\[ \text{___________} \]  \[ \text{___________} \]

\[ \sqrt{} \] Understanding Check
Simplify each expression.

a. \(-4^3\)  
   b. \((-2)^4\)  
   c. \(-3^2\)  
   d. \((-5)^3\)

Example 3: Dividing Real Numbers

\[ \text{Rule:} \] The rules for dividing real numbers are the _____________ as those for multiplying real numbers. 
Basically, same signs make a ________________ answer, 
and different signs make a ________________ answer.

Examples: \[ 6 \div 3 = \] \[ -6 \div (-3) = \] 
\[ -6 \div 3 = \] \[ 6 \div (-3) = \]

\[ \sqrt{} \] Understanding Check

a. \(-42 \div 7\)  
   b. \(-8 \div (-2)\)  
   c. \(8 \div (-8)\)  
   d. \(-39 \div (-3)\)

\[ \text{e.} \] \[ \frac{-40}{5} \]  
\[ \text{f.} \] \[ \frac{-22}{-11} \]  
\[ \text{g.} \] \[ \frac{36}{-9} \]  
\[ \text{h.} \] \[ \frac{-12}{-4} \]
“Diamond” or “Magic x” Problems

“Magic x” problems are simply tools to help you find the __________ and __________ of two numbers. They can also be helpful with thinking ______________ when you learn to factor later this year.

Example 1:

Multiply ↓ Multiply ↓

\[ -3 \times -4 \quad 6 \times -2 \]

\[ \uparrow \quad \uparrow \]

Add Add

√ Understanding Check

\[ -10 \times 3 \quad -2 \times -8 \quad 5 \times -3 \quad 7 \times -11 \]

\[ -5 \times -8 \quad 1 \times -7 \quad -4 \times 9 \quad -6 \times -4 \]

\[ -10 \times 7 \quad 5 \times -2 \quad -3 \times -6 \quad 2 \times -7 \]
Combining Like Terms and The Distributive Property

**Vocabulary**

**Term**—A term is a ________________, ________________, or ______________ of a number and one or more variables.

**Coefficient**—A coefficient is the ________________ ______________ of a term.

**Constant**—A constant is a term that has _____ ________________.

Example:  
\[ 6a^2 - 5ab + 3b - 12 \]

**Like Terms**—Like terms have exactly the ________________ ________________ and ________________.

Examples:  
Like terms ____________ and ____________  
Not like terms ____________ and ____________

**Example 1: Combining Like Terms**

Simplify each expression.

a. \[ 3x + 5x \]
   step 1 ____________________________  
   __________________  step 2 ____________________________

b. \[ -5c^2 + 7c + 6 + c^2 - 2 - 3c \]
   step 1 ____________________________  
   __________________  step 2 ____________________________

√ **Understanding Check**

Simplify each expression:

a. \[ 7y + 6y \]  
b. \[ 3t - t \]  
c. \[ -9w^3 - 3w^3 \]  
d. \[ 8d + d \]

e. \[ 3m + 2 + 6m + 3 \]  
f. \[ 8x + 4 - 2x + 1 \]  
g. \[ 3p + p^2 - 5 - 6p + 3 + 8p^2 \]
**Rule:** Distributive Property: For every real number a, b, and c

\[
\begin{align*}
 a(b + c) &= \underline{\quad} & (b + c)a &= \underline{\quad} \\
 a(b - c) &= \underline{\quad} & (b - c)a &= \underline{\quad}
\end{align*}
\]

You have used distributive property before when doing “mental math”:

(*Think of 104 as _____ + ____ ) to simplify: 3(104)

\[
\begin{align*}
 &\text{step 1 } \underline{\quad} \\
 &\text{step 2 } \underline{\quad} \\
 &\text{step 3 } \underline{\quad} \\
 &\text{step 4 } \underline{\quad}
\end{align*}
\]

**Example 2: Simplifying an Expression using Distributive Property**

Simplify each expression.

a. 2(5x + 3)

\[
\begin{align*}
 &\underline{\quad} \quad \text{step 1 } \underline{\quad} \\
 &\underline{\quad} \quad \text{step 2 } \underline{\quad}
\end{align*}
\]

b. \(\frac{1}{2}(2b - 4)\)

\[
\begin{align*}
 &\underline{\quad} \quad \text{step 1 } \underline{\quad} \\
 &\underline{\quad} \quad \text{step 2 } \underline{\quad}
\end{align*}
\]

**\(\sqrt{\text{Understanding Check}}\)**

Simplify: a. 2(7t – 3) \hspace{1cm} b. 3(4c + 1) \hspace{1cm} c. \(\frac{1}{5}(10x – 35)\)

**Example 3: Using the Multiplication Property of \(-1\)**

Simplify \(- (6x + 4)\)

\[
\begin{align*}
 &\underline{\quad} \quad \text{step 1 } \underline{\quad} \\
 &\underline{\quad} \quad \text{step 2 } \underline{\quad} \\
 &\underline{\quad} \quad \text{step 3 } \underline{\quad}
\end{align*}
\]
\[\sqrt{\text{Understanding Check}}\]
Simplify: \( a. \ - (2x + 6) \quad b. \ - (8a + 3) \)

\[\text{Example 4: Writing an Expression}\]
Write an expression for
a. 3 times \( \text{the quantity} \ x \) minus 5 \quad b. 5 times \( \text{the sum of} \ x \) and 6

\[\sqrt{\text{Understanding Check}}\]
Write an expression for each phrase:

a. \(-2 \times \text{the quantity} \ t \) plus 7 \quad b. 14 times \( \text{the difference of} \ w \) and 8

\[\text{Example 5: Distributing and Combining Like Terms}\]
Simplify.

a. \( 5(-4x + 2) + 3(5x - 2) \)
   \[\text{Step 1: } \quad \text{Step 2: } \]

b. \(-4(2x - 7) - (6x + 3) \)
   \[\text{Step 1: } \quad \text{Step 2: } \]

c. \( 5 - 2(3x + 4) + 8x \)
   \[\text{Step 1: } \quad \text{Step 2: } \]

\[\sqrt{\text{Understanding Check}}\]
Simplify.

a. \(-2(3x - 4) + 3(5x - 1) \quad b. \ 7x - (9x - 2) + 5 \quad c. \ 20 - 4(5x + 6) + 2x \)
Tools of Algebra
(Review of Pre-Algebra)

What you will learn:

- CA Algebra Standard 1.0: Identify and use the arithmetic properties of integers and rational, irrational, and real numbers, including closure properties for the four basic arithmetic operations where applicable.

- CA Algebra Standard 2.0: Understand and use such operations as taking the opposite and finding the reciprocal.

- CA Algebra Standard 25.0: Use properties of the number system to judge the validity of results, to justify each step of a procedure, and to prove or disprove statements.
Vocabulary

**Variable**- A variable is a **symbol**, usually a **letter**, that represents one or more numbers.

**Algebraic Expressions**- An algebraic expression is a **mathematical phrase** that can include **numbers**, **variables**, and **operation symbols**.

Examples: 0 x 2 3 x 3 - 6 x y z + 2

**Showing Multiplication in Algebra** – Multiplication in algebra is shown by **parentheses** or by **a dot** or by making numbers and variables **touch**.

Example: Show “5 times a number, n” three different ways.

\[ 5(n) \quad 5 \cdot n \quad 5n \]

**Example 1: Writing an Algebraic Expression**

We usually use \( n \) or \( x \).

Write an algebraic expression for each phrase.

1. four **more than** a number \( n + 4 \)
2. two **less than** a number \( n - 2 \)
3. the **sum** of a number and 2 \( n + 2 \)
4. the **difference** of a number and 4 \( n - 4 \)
5. the **product** of seven and \( n \) \( 7n \)
6. the **quotient** of \( n \) and 6 \( \frac{n}{6} \) or \( \frac{n}{6} \)
7. a number **increased by four** \( n + 4 \)
8. a number **decreased by eight** \( n - 8 \)

√**Understanding Check**

a. the sum of 3 and a number \( n + 3 \text{ or } 3 + n \)
b. the product of seven and a number \( 7n \)
c. the quotient of \( p \) and 2 \( \frac{p}{2} \text{ or } \frac{p}{2} \)
d. a number increased by 3 \( n + 3 \)
e. the difference of a number and 8 \( n - 8 \)
f. six less than a number \( n - 6 \)
g. 9 more than a number \( n + 9 \)
h. a number decreased by 10 \( n - 10 \)
Example 2: Writing an Algebraic Expression with two operations

Define a variable and write an algebraic expression for each phrase.

\[ a. \ 5 \text{ more than eight times a number } = 8n + 5 \]
\[ b. \ 7 \text{ less than three times a number } = 3n - 7 \]
\[ c. \ 9 \text{ more than twice a number } = 2n + 9 \]

\[ \sqrt{\text{Understanding Check}} \]
\[ a. \ 9 \text{ less than six times a number } = 6n - 9 \]
\[ b. \ 3 \text{ more than ten times a number } = 10n + 3 \]
\[ c. \ 2 \text{ less than half a number } = \frac{n}{2} - 2 \]

Exponents and Order of Operations

Vocabulary

\[ \text{Exponent} - \text{An exponent tells how many times a number, the } \text{base}, \text{ is used as a factor.} \]
\[ 2^4 = \frac{2 \cdot 2 \cdot 2 \cdot 2}{\text{Base}} = 16 \]

\[ \sqrt{\text{Understanding Check}} \]
\[ \text{Simplify:} \]
\[ a. \ 5^3 \quad b. \ 2^3 \quad c. \ 3^4 \quad d. \ 10^5 \]
\[ 5 \cdot 5 \cdot 5 = 125 \quad 2 \cdot 2 \cdot 2 = 8 \quad 3 \cdot 3 \cdot 3 \cdot 3 = 81 \quad 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 = 100,000 \]

Vocabulary

Order of Operations (PEMDAS) - Mathematicians have agreed on the following order for simplifying mathematical expressions:

1. Parentheses (P)
2. Exponents (E)
3. Multiply or divide (MD)
4. Add or subtract (AS)

From left to right!!!

An easy way to remember the order of operations is to remember the saying: “Please Excuse My Dear Aunt Sally”
Example 1: Simplifying a Numerical Expression

Simplify \(25 - 8 \cdot 2 + 3^2 + (5 - 2)\)

\[
\begin{align*}
25 - 8 \cdot 2 + 3^2 + 3 & \quad \text{step 1: Parenthesis (5 - 2)} \\
25 - 8 \cdot 2 + 9 + 3 & \quad \text{step 2: Exponents 3^2} \\
25 - 16 + 9 + 3 & \quad \text{step 3: Multiply 8 \cdot 2} \\
9 + 9 + 3 & \quad \text{step 4: Subtract 25 - 16} \\
= 21 & \quad \text{step 5: Add 9 + 9 + 3}
\end{align*}
\]

√ Understanding Check

a. \(6 - 10 + 5\) \hspace{1cm} b. \(3 \cdot 6 - 4^2 + 2\) \hspace{1cm} c. \(4 + 2^2 + 4 \cdot 7\)

\[
\begin{align*}
6 - 2 & \quad \text{= 4} \\
6 - 2 & \quad \text{= 4} \\
18 - 8 & \quad \text{= 28}
\end{align*}
\]

\[
\begin{align*}
3 \cdot 6 - 16 \div 2 & \quad \text{= 10} \\
3 \cdot 6 - 16 \div 2 & \quad \text{= 10} \\
18 - 8 & \quad \text{= 10}
\end{align*}
\]

d. \((5 + 3) + 2 + (5^2 - 3)\) \hspace{1cm} e. \(8 - 3(2) + 6^2\)

\[
\begin{align*}
8 \div 2 + 2(25 - 3) & \quad \text{= 26} \\
8 \div 2 + 22 & \quad \text{= 26} \\
4 + 22 & \quad \text{= 26}
\end{align*}
\]

d. \(8 \div 2 + 2(25 - 3) = 26\) \hspace{1cm} e. \(8 - 3(2) + 6^2 = 38\)

Example 2: Simplifying an Expression with brackets

Simplify \(2[(13 - 7)^2 + 3]\)

\[
\begin{align*}
2[(13 - 7)^2 + 3] & \quad \text{step 1: Inside parenthesis (13 - 7)} \\
2[(13 - 7)^2 + 3] & \quad \text{step 2: Exponent [6]^2} \\
72 \div 3 & \quad \text{step 3: Multiply 2[36]} \\
24 & \quad \text{step 4: Divide 72 \div 3}
\end{align*}
\]

√ Understanding Check

Simplify each expression.

a. \(5[4 + 3(2^2 + 1)]\) \hspace{1cm} b. \(12 + 3[18 - 5(16 - 13)]\) \hspace{1cm} c. \(5 + [(2 + 1)^3 - 3]\)

\[
\begin{align*}
5[4 + 3(2^2 + 1)] & \quad \text{= 95} \\
5[4 + 3(2^2 + 1)] & \quad \text{= 21} \\
12 + 3[18 - 5(16 - 13)] & \quad \text{= 21}
\end{align*}
\]

c. \(5 + [(2 + 1)^3 - 3]\) \hspace{1cm} d. \(5 + [(2 + 1)^3 - 3]\) \hspace{1cm} e. \(5 + [(2 + 1)^3 - 3]\)

\[
\begin{align*}
5 + [27 - 3] & \quad \text{= 29} \\
5 + [27 - 3] & \quad \text{= 29} \\
5 + [27 - 3] & \quad \text{= 29}
\end{align*}
\]
Example 3: Evaluating an Algebraic Expression

Evaluate \(3a - 2^3 + b\) for \(a = 7\) and \(b = 4\)

\[
\begin{align*}
3(7) - 2^3 & \div 4 \\
21 - 8 & \div 4 \\
13 & \div 4 \\
= 19 & \\
\end{align*}
\]

step 1: **Substitute in** for \(a\) and \(b\)

step 2: **Exponent**

step 3: **Multiply and Divide**

step 4: **Subtract**

\[\sqrt{\textbf{Understanding Check}}\]

Evaluate each expression for \(c = 2\) and \(d = 5\)

a. \(4c - 2d + c\)  b. \(d + 6c + 4\)  c. \(11c - d \cdot 2\)

\[
\begin{align*}
4(2) - 2(5) & \div 2 \\
8 - 10 & \div 2 \\
8 & - 5 \\
3 & = \\
5 & + 3 \\
8 & =
\end{align*}
\]

\[
\begin{align*}
5 + 6(2) & \div 4 \\
5 + 12 & \div 4 \\
x & - 10 \\
22 & = 12
\end{align*}
\]

\[\sqrt{\textbf{Example 4: Evaluating Expressions with Exponents}}\]

Evaluate each expression for \(c = 5\) and \(d = 4\)

a. \((cd)^2\)  b. \(cd^2\)

\[
\begin{align*}
(5 \cdot 4)^2 & \leftarrow \text{Substitute} \rightarrow (5)(4)^2 \\
(20)^2 & \leftarrow \text{mult. / Exp.} \rightarrow (5)(16) \\
= 400 & \leftarrow \text{simplify} \rightarrow 80
\end{align*}
\]

\[
\begin{align*}
6 \cdot 3^2 & \leftarrow 6^2 \cdot 3 \\
6 \cdot 9 & \leftarrow 36 \cdot 3 \\
= 54 & \leftarrow 108 \\
\end{align*}
\]

\[
\begin{align*}
(r^2 t) & \leftarrow \text{substitute} \\
(18)^2 & \leftarrow \text{exp.} \\
= 324 & \leftarrow \text{simplify}
\end{align*}
\]

\[\sqrt{\textbf{Understanding Check}}\]

Evaluate each expression for \(r = 6\) and \(t = 3\)

a. \(rt^2\)  b. \(r^2 t\)  c. \((rt)^2\)

\[
\begin{align*}
6 \cdot 3^2 & \leftarrow 6^2 \cdot 3 \\
6 \cdot 9 & \leftarrow 36 \cdot 3 \\
= 54 & \leftarrow 108 \\
\end{align*}
\]

\[
\begin{align*}
(6 \cdot 3)^2 & \leftarrow (18)^2 \\
= 324 & \leftarrow \frac{18 \times 18}{194} = \frac{180}{324}
\end{align*}
\]
Example 5: Application

A neighborhood association turned a vacant lot into a park. The park is shaped like the trapezoid below. Use the formula \( A = h \left( \frac{b_1 + b_2}{2} \right) \) to find the area of the lot for:

\[
h = 12 \text{ ft and bases } b_1 = 100 \text{ ft and } b_2 = 40 \text{ ft.}
\]

**Step 1:** Substitute in for \( b_1, b_2, h \)

**Step 2:** Simplify the numerator

**Step 3:** Divide inside parenthesis

**Step 4:** Multiply

√ Understanding Check

1. Find the area of a trapezoid with height \( h = 4 \text{ ft} \) and bases \( b_1 = 20 \text{ ft} \) and \( b_2 = 10 \text{ ft} \), using the formula.

\[
A = h \left( \frac{b_1 + b_2}{2} \right)
\]

\[
A = 4 \left( \frac{20 + 10}{2} \right)
A = 4 \left( \frac{30}{2} \right)
A = 4 \left( 15 \right)
A = 60 \text{ ft}^2
\]

2. Find the area of a triangle with height \( h = 8 \text{ ft} \) and a base \( b_1 = 6 \text{ ft} \), using the formula.

\[
A = \frac{1}{2} (bh)
\]

\[
A = \frac{1}{2} (6 \cdot 8)
A = \frac{1}{2} (48)
A = 24 \text{ ft}^2
\]
**Vocabulary**

**Natural Numbers** – Natural numbers are the **positive** counting numbers you learned when you were three years old.

1, 2, 3, 4, 5, ...

**Whole Numbers** – Whole numbers are the natural numbers and **zero**.

**Integers** – Integers are the whole numbers and the **negative** numbers.

**Rational Numbers** – A rational number is any number that you can write in the form \( \frac{a}{b} \), where \( a \) and \( b \) are **integers** and \( b \neq 0 \). A rational number in decimal form is either **terminating**, such as 6.27, or **non-terminating** such as 8.2222... which you can write as \( 8.\bar{2} \) (repeating).

---

**Real Numbers**

---

\[ \frac{3}{8} \]

---

\[ \frac{7}{8} \]

---

\[ \frac{5}{8} \]

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Adding Real Numbers

Vocabulary

Identity Property of Addition – For every real number n,

\[ n + 0 = n \quad \text{and} \quad 0 + n = n \]

Example:

\[ 5 + 0 = 5 \quad 0 + 5 = 5 \]

Inverse Property of Addition – For every real number n, there is an additive inverse \((-n)\) such that \(n + (-n) = 0\)

Example:

\[ 5 + (-5) = 0 \quad (-5) + 5 = 0 \]

Example 1: Using a Number Line Model

Simplify each expression:

a. \(2 + 6\)

b. \(2 + (-6)\)

c. \(-2 + 6\)

d. \(-2 + (-6)\)

Example 2: Adding Integers with Symbols

a. \(5 + 2\)

b. \(-5 + (-2)\)

c. \(7 + (-3)\)

d. \(-8 + 6\)

\[ \sqrt{\text{Understanding Check}} \]

1. \(3 + (-6) = -3\)

2. \(-7 + (-11) = -18\)

3. \(-8 + 10 = 2\)

4. \(-2 + (-6) = -8\)

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

6. \(-3 + 3 = 0\)

7. \(-1 + 5 = 4\)

8. \(-4 + 0 = -4\)

Which problem above is an example of identity property of addition? \(\#8\)

And which is an example of inverse property? \(\#6\)
Example 3: Application
A football team gains 2 yd and then loses 7 yd in two plays. You express a loss of 7 yd as −7. Use addition to find the result of the two plays.

\[ 2 + (-7) = -5 \]

The team lost 5 yards.

√ Understanding Check
The temperature falls 15 degrees and then rises 18 degrees. Use addition to find the change in temperature. (Show your work.)

\[ -15 + 18 = 3 \]

The temperature rose 3 degrees.

Subtracting Real Numbers

Example 1: Using a Number Line Model

a. \[ 7 - 2 = 5 \]

b. \[ 1 - 4 = -3 \]

c. \[ -2 - 5 = -7 \]

Example 2: Subtracting Real Numbers

Both \[ 2 + (-6) \] and \[ 2 - 6 \] have the \underline{same} \underline{answer}, −4. This illustrates the following rule for subtracting real numbers:

**Rule:** To subtract a number, \underline{add the opposite}.

Examples:

\[ 3 - 5 = 3 + (-5) \quad 4 - (-9) = 4 + 9 \]

\[ = -2 \quad = 13 \]

Simplify each expression by adding the opposite. (Show your changes!)

a. \[ 5 - 11 \]

\[ 5 + (-11) = -6 \]

b. \[ -3 - 7 \]

\[ -3 + (-7) = -10 \]

c. \[ -8 - 5 \]

\[ -8 + (-5) = -13 \]

d. \[ -4 - (-9) \]

\[ -4 + 9 = 5 \]
\( \sqrt{\text{Understanding Check}} \)

a. \(-6 - 2\)  
b. \(8 - (-4)\)  
c. \(3 - (4)\)  
d. \(-5 - (-7)\)

\[
\begin{align*}
-6 &+ (-2) \\
8 &+ 4 \\
3 &+ (-4) \\
-5 &+ 7 \\
&= -8 \\
&= 12 \\
&= -1 \\
&= 2
\end{align*}
\]

\( \sqrt{\text{Example 3: Applying Subtraction – Evaluating Expressions}} \)

Evaluate \(-a - b\) for \(a = -3\) and \(b = -5\)

\[
\begin{align*}
-(-3) - (-5) \\
3 + 5 \\
&= 8
\end{align*}
\]

\( \sqrt{\text{Understanding Check}} \)

Evaluate each expression for \(r = 7\) and \(t = -2\)

\[
\begin{align*}
a. r - t &
\quad b. t - r \\
7 &- (-2) \\
7 + 2 \\
&= 9 \\
\quad c. -t - r \\
-2 - 7 \\
-2 + 7 \\
&= -9 \\
\quad d. -r - (-t) \\
-(2) - 7 \\
2 - 7 \\
2 + (-7) \\
&= -5 \\
&= -9
\end{align*}
\]

\( \boxed{\text{Multiplying and Dividing Real Numbers}} \)

\( \sqrt{\text{Vocabulary}} \)

\( \text{Identity Property of Multiplication} \) – For every real number \(n\), \(n \cdot 1 = n\).

Examples:
\[
\begin{align*}
5 \cdot 1 &= 5 \\
-3 \cdot 1 &= -3
\end{align*}
\]

\( \text{Multiplication Property of Zero} \) – For every real number \(n\), \(n \cdot 0 = 0\).

Examples:
\[
\begin{align*}
5 \cdot 0 &= 0 \\
-3 \cdot 0 &= 0
\end{align*}
\]

\( \text{Multiplication Property of} \ -1 \) – For every real number \(n\), \(n \cdot -1 = -n\).

Examples:
\[
\begin{align*}
5 \cdot -1 &= -5 \\
-3 \cdot -1 &= -(3) \\
&= 3
\end{align*}
\]
Example 1: Multiplying Real Numbers

**Rule:** The product of two positive numbers or two negative numbers is **positive**. (In other words, same signs make a positive.)

Examples: \(5 \cdot 2 = 10\) \(-5(-2) = 10\)

**Rule:** The product of a positive number and a negative number, or a negative number and a positive number, is **negative**. (In other words, different signs make a negative.)

Examples: \(3(-6) = -18\) \(-3 \cdot 8 = -24\)

---

Example 1: Simplify

\[\frac{\mathbf{4.2}}{\mathbf{37.8}} \times \frac{\mathbf{9}}{\mathbf{9}} = \frac{-37.8}{\mathbf{37.8}} \text{ or } 3 \frac{1}{3}\]

\[\begin{align*}
\text{a. } 9(-4.2) & \quad \text{b. } -5\left(-\frac{2}{3}\right) = \frac{10}{3} \quad \text{c. } -4(-8.1) = 32.4 \\
-24 & \quad \text{d. } -6(0) = 0 & \quad \text{e. } -2\left(-\frac{3}{4}\right) = -\frac{6}{12} = -\frac{1}{2} \\
-2 & \quad \text{f. } -2(1) \quad \text{No such thing as neg. zero!}
\end{align*}\]

Which of the problems above shows the **identity property of multiplication**? \(\square\)
And which shows the **multiplication property of zero**? \(\square\)

---

Example 2: Evaluating Expressions with Multiplication

Evaluate \(-2(xy)\) for \(x = -20\) and \(y = -3\)

\[\begin{align*}
\text{step 1} & \quad \text{substitute} & \quad \text{step 2} & \quad \text{multiply} \\
\text{step 3} & \quad \text{multiply}
\end{align*}\]

\[\begin{align*}
\text{Evaluate each expression for } c = -8 \text{ and } d = -7. \\
a. \ (-2)(-3)(cd) & \quad b. \ -(cd) & \quad c. \ c(-d) & \quad d. \ -4c + 2d - c \\
(-2)(-3)(8 \cdot -7) & \quad -(-8 \cdot -7) & \quad -8[(-7)] & \quad -4(-8) + 2(-7) - (-8) \\
(6)(56) & \quad -(56) & \quad -8[7] & \quad 32 + (-14) + 8 \\
= 336 & \quad = -56 & \quad = -56 & \quad 18 + 8 \quad 11
\end{align*}\]
Example 3: Dividing Real Numbers

**Rule:** The rules for dividing real numbers are the **same** as those for multiplying real numbers. Basically, same signs make a **positive** answer, and different signs make a **negative** answer.

Examples:

\[
6 \div 3 = 2 \quad -6 \div (-3) = 2 \\
-6 \div 3 = -2 \quad 6 \div (-3) = -2
\]

√ Understanding Check

a. \(-42 \div 7\)  
   \[-6\]

b. \(-8 \div (-2)\)  
   \[4\]

c. \(8 \div (-8)\)  
   \[-1\]

d. \(-39 \div (-3)\)  
   \[13\]

Example 4: Simplifying Exponential Expressions with and without parenthesis

Use order of operations (PEMDAS) to simplify each expression

a. \(-3^4\)  
   \[-1 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = -81\]

b. \((-3)^4\)  
   \[-3 \cdot -3 \cdot -3 \cdot -3 = 81\]

※ The negative waits until the end unless its inside the parenthesis

√ Understanding Check

Simplify each expression.

a. \(-4^3\)  
   \[-1 \cdot 4 \cdot 4 \cdot 4 = -64\]

b. \((-2)^4\)  
   \[4 \cdot 4 \cdot 4 = 16\]

c. \(-3^2\)  
   \[-1 \cdot 3 \cdot 3 = -9\]

d. \((-5)^3\)  
   \[25 \cdot -5 \cdot -5 = -125\]
“Diamond” or “Magic x” Problems

“Magic x” problems are simply tools to help you find the \underline{product} and \underline{sum} of two numbers. They can also be helpful with thinking \underline{backwards} when you learn to factor later this year.

\textbf{Example 1:}

\begin{align*}
\text{Multiply} & \quad \downarrow \\
12 & \quad -12 \\
-3 & \quad 6 \\
-7 & \quad 4 \\
\text{Add} & \\
\end{align*}

\textbf{Understanding Check}

\begin{align*}
\begin{array}{cccc}
-30 & 16 & -15 & -77 \\
-10 & -2 & 5 & 7 \\
-7 & -8 & -3 & -11 \\
\end{array}
\end{align*}

\begin{align*}
\begin{array}{cccc}
-40 & -7 & -36 & 24 \\
-5 & 1 & -4 & 6 \\
-8 & -7 & 9 & -4 \\
\end{array}
\end{align*}

\begin{align*}
\begin{array}{cccc}
-70 & -10 & 18 & -14 \\
-10 & 5 & -3 & 2 \\
7 & -2 & -6 & -7 \\
\end{array}
\end{align*}

\begin{align*}
\begin{array}{cccc}
-3 & 3 & -9 & -5 \\
\end{array}
\end{align*}
Combining Like Terms and The Distributive Property

Vocabulary

Term—A term is a number, variable, or product of a number and one or more variables.

Coefficient—A coefficient is the numerical factor of a term.

Constant—A constant is a term that has no variables.

Example: \[ 6a^2 - 5ab + 3b - 12 \]

This expression has 4 terms.

Like Terms—Like terms have exactly the same variables and exponents.

Examples

Like terms \[ \frac{5x^2y}{4xmp^2} \] and \[ \frac{-3x^2y}{4xp} \]

Example 1: Combining Like Terms

Simplify each expression.

\[ \frac{3x + 5x}{8x} \] step 1 Find like terms step 2 Add the coefficients of like terms

\[ \frac{-5c^2 + 7c}{-4c^2 + 4c + 4} \] step 1 Find like terms step 2 Add the coefficients of like terms

√ Understanding Check

Simplify each expression:

a. \[ 7y + 6y \] b. \[ 3t - t \] c. \[ -9w^3 - 3w^3 \] d. \[ 8d + d \]

\[ = 13y \] \[ = 2t \] \[ = -12w^3 \] \[ = 9d \]

e. \[ \frac{3m + 2 + 6m + 3}{9m + 5} \] f. \[ \frac{8x + 4 - 2x + 1}{6x + 5} \] e. \[ \frac{3p^2 + 5 - 6p + 3 + 8p^2}{9p^2 - 3p - 2} \]

\[ = 9m + 5 \] \[ = 6x + 5 \]

\[ \text{Try not to use double signs.} \]
Rule: Distributive Property: For every real number a, b, and c
\[ a(b + c) = ab + ac \quad (b + c)a = ab + ac \]
\[ a(b - c) = ab - ac \quad (b - c)a = ab - ac \]

You have used distributive property before when doing “mental math”:
(*Think of 104 as \(100 + 4\) ) to simplify:
\[ \begin{array}{c}
\text{step 1} \quad \text{Rewrite} \\
\text{step 2} \quad \text{Distribute} \\
\text{step 3} \quad \text{Multiply} \\
\text{step 4} \quad \text{Add}
\end{array} \]
\[ 3(104) \]
\[ = 3(100 + 4) \]
\[ = 3(100) + 3(4) \]
\[ = 300 + 12 \]
\[ = 312 \]

Example 2: Simplifying an Expression using Distributive Property
Simplify each expression.

\[ \text{a. } 2(5x + 3) \]
\[ \frac{1}{2}(2b - 4) \]

\[ \underline{\text{step 1} \quad \text{Distribute}} \]
\[ 10x + 6 \quad b - 2 \]

\[ \underline{\text{step 2} \quad \text{Simplify}} \]

\[ \underline{\text{step 2} \quad \text{Simplify}} \]

\[ \sqrt{\text{Understanding Check}} \]
Simplify:
\[ \text{a. } 2(7t - 3) \]
\[ \text{b. } 3(4c + 1) \]
\[ \text{c. } \frac{1}{5}(10x - 35) \]
\[ = 14t - 6 \quad = 12c + 3 \quad = \frac{1}{5}(10x) - \frac{1}{5}(35) \]
\[ = 2x - 7 \]

Example 3: Using the Multiplication Property of -1
Simplify \(- (6x + 4)\)
\[ \underline{\text{step 1} \quad \text{Distribute the } - \text{ as } -1} \]
\[ -6x + (-4) \quad \underline{\text{step 2} \quad \text{Multiply}} \]
\[ -6x - 4 \quad \underline{\text{step 3} \quad \text{Eliminate double signs}} \]
\textbf{Understanding Check}
Simplify:
\begin{align*}
\text{a. } & -(2x + 6) = -2x - 6 \\
\text{b. } & -(8a + 3) = 8a - 3
\end{align*}

\textbf{Example 4: Writing an Expression}
Write an expression for
\begin{align*}
\text{a. } & 3 \text{ times the quantity } x \text{ minus 5} \\
& \quad \Rightarrow 3(x - 5) \\
\text{b. } & 5 \text{ times the sum of } x \text{ and 6} \\
& \quad \Rightarrow 5(x + 6)
\end{align*}

\textbf{Understanding Check}
Write an expression for each phrase:
\begin{align*}
\text{a. } & -2 \text{ times the quantity } t \text{ plus 7} \\
& \quad \Rightarrow -2(t + 7) \\
\text{b. } & 14 \text{ times the difference of } w \text{ and 8} \\
& \quad \Rightarrow 14(w - 8)
\end{align*}

\textbf{Example 5: Distributing and Combining Like Terms}
Simplify.
\begin{align*}
\text{a. } & 5(-4x + 2) + 3(5x - 2) \\
& \quad \Rightarrow -20x + 10 + 15x - 6 \\
& \quad \Rightarrow -5x + 4 \\
& \text{Step 1: Distribute} \\
& \text{Step 2: Combine Like Terms} \\
\text{b. } & -4(2x - 7) - 1(6x + 3) \\
& \quad \Rightarrow -8x + 28 - 6x - 3 \\
& \quad \Rightarrow -14x + 25 \\
& \text{Step 1: Distribute} \\
& \text{Step 2: Combine Like Terms} \\
\text{c. } & 5 + 2(3x + 4) + 8x \\
& \quad \Rightarrow 5 - 6x + 8 + 8x \\
& \quad \Rightarrow 2x + 3 \\
& \text{Step 1: Distribute} \\
& \text{Step 2: Combine Like Terms}
\end{align*}

\textbf{Understanding Check}
Simplify.
\begin{align*}
\text{a. } & -2(3x - 4) + 3(5x - 1) \\
& \quad \Rightarrow -6x + 8 + 15x - 3 \\
& \quad \Rightarrow 9x + 5 \\
\text{b. } & 7x - (9x - 2) + 5 \\
& \quad \Rightarrow 7x - 9x + 2 + 5 \\
& \quad \Rightarrow -2x + 7 \\
\text{c. } & 20 + 4(5x + 6) + 2x \\
& \quad \Rightarrow 20 - 20x - 24 + 2x \\
& \quad \Rightarrow -18x - 4
\end{align*}
Tools of Algebra
(Review of Pre-Algebra)

QUICK VOCABULARY REVIEW
(One Page)
Unit 1
Vocabulary Review

Directions: Match each Unit 1 vocabulary word with it’s example from the box.

1. exponent ____
2. natural number ____
3. whole number ____
4. integer ____
5. rational number ____
6. identity property of addition ____
7. inverse property of addition ____
8. identity property of multiplication ____
9. multiplication property of zero ____
10. multiplication property of −1 ____
11. terms ____
12. coefficient ____
13. constant ____
14. distributive property ____

a. \( n + (−n) = 0 \)
b. \( \frac{6x^2 + 5x - 3}{\uparrow \downarrow} \)
c. \( a(b + c) \Rightarrow ab + ac \)
d. \( n \cdot (−1) = −n \)
e. \( 3x^2 - 4x + 2 \)
f. \( n \cdot 1 = n \)
g. \( \ldots−3, −2, −1, 0, 1, 2, 3, \ldots \)
h. \( n + 0 = n \)
i. \( m^3 \)
j. \( 1, 2, 3, 4, 5, 6, 7, \ldots \)
k. \( 7xy \)
l. \( n \cdot 0 = 0 \)
m. \( 0, 1, 2, 3, 4, 5, 6, 7, \ldots \)
n. \( 5\overline{23} \)
Answer Key:

1. i
2. j
3. m
4. g
5. n
6. h
7. a
8. f
9. l
10. d
11. b
12. k
13. e
14. c
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**Product List**
(November 7, 2012)

Algebra Notes, Homework, and Tests:

- **Unit 1**
  - Guided Notes
  - HW Bundle
  - Multiple Choice Test
  - Quick Vocabulary Review

- **Unit 2**
  - Guided Notes
  - HW Bundle
  - Multiple Choice Test

- **Unit 3**
  - Guided Notes
  - HW Bundle
  - Multiple Choice Test
Unit 4 Guided Notes

Unit 4 HW Bundle

Unit 4 Multiple Choice Test

Unit 5 Guided Notes
Warm-ups | Flashcards | Speed Drills | Partner Reviews
---|---|---|---
Unit 1 Warm-ups | Unit 1 Flashcards | Unit 1 Speed Drills | Partner Review
Raffle Tickets | Distributive Prop. | Operations with Integers

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Unit 2 Flashcards | Unit 2 Speed Drills | Solving Equations
Distributive Prop. | 1-step Equations | Partner Review

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Unit 3 Flashcards | Unit 3 Speed Drills | Solving Inequalities
1-step Inequalities | 1-step Inequalities | Partner Review

---
One-Step Inequalities Flashcards | Solving Inequalities | Partner Practice

---
Solving Equations Review | Partner Practice

---
Solving Inequalities Review | Partner Review
Learning Games, Songs, Labs, and Cooperative Learning:

Adding Integers Dot Game
Combining Like Terms Dot Game
Number Line Game
“Algetropolis” C.L.Terms Game
Adding Integers with M&M’s Activity
Slope Battleship Game
Treasure Run 1-step Inequalities Game
Exponent Song
Using Proportions Activity
Combining Like Terms Game
Inequality Number Line Warm-up PPT
Order of Operations Challenge
Algebra Lab 1 (Proportions)
Algebra Lab 2 (One step Equations)
Algebra Lab 3 Linear Equations
Plotting Points Thanksgiving Activity