

Algebraic Expressions and Properties of Real Numbers: math lesson, Grade 9 – download the PDF

Algebra is the language that lets you describe a pattern once and use it again and again. In this chapter you will learn to read and write algebraic expressions, to compute with them in the right order, and to rewrite them in simpler forms using the properties of real numbers. These tools are the foundation of everything else in Algebra 1.

1. Variables and algebraic expressions

A **variable** is a letter that stands for a number that can change or that you do not know yet. A **constant** is a number that never changes. An **algebraic expression** combines numbers, variables, and operation symbols, such as $5n + 12$ or $3x^2 - 7x + 4$. An expression has no equal sign: it is a phrase, not a complete sentence.

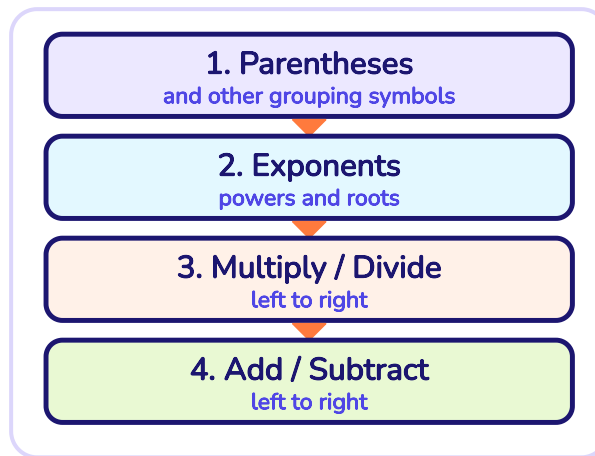
D Vocabulary of an expression

The parts separated by plus or minus signs are called **terms**. In $3x^2 - 7x + 4$ the terms are $3x^2$, $-7x$, and 4 . The number multiplying a variable is its **coefficient**: here 3 and -7 . The term with no variable, 4 , is the **constant term**.

Remember that a sign in front of a term belongs to that term. Also, $5n$ means $5 \cdot n$, and n alone has the coefficient 1 , because $n = 1 \cdot n$.

2. Order of operations

When an expression has several operations, everyone must compute in the same order, or the same expression would have different values. The agreed order is often remembered as PEMDAS.



M

Method: computing with PEMDAS

1. Work inside parentheses and brackets first, starting with the innermost pair.
2. Compute exponents (powers) next.
3. Do multiplications and divisions from left to right, as they appear.
4. Do additions and subtractions from left to right.

E

Example 1: a multi-step calculation

Compute $18 - 4 \cdot (2 + 1)^2 \div 6$.

Parentheses: $2 + 1 = 3$. Exponent: $3^2 = 9$. Multiplication and division from left to right: $4 \cdot 9 = 36$, then $36 \div 6 = 6$. Subtraction: $18 - 6 = 12$.

So $18 - 4 \cdot (2 + 1)^2 \div 6 = 12$.



Common mistake

Multiplication does not always come before division, and addition does not always come before subtraction. They share the same rank, so you go left to right:

$24 \div 4 \cdot 3 = 6 \cdot 3 = 18$, not $24 \div 12 = 2$. Also, $-3^2 = -9$, but $(-3)^2 = 9$: the exponent only applies to what is right next to it.

3. Evaluating expressions

To **evaluate** an expression means to replace each variable by a given number and then compute. Always put the replacement number in parentheses, especially when it is negative, so that signs and exponents are handled correctly.



Example 2: two variables

Evaluate $3x^2 - 2xy + y$ for $x = -2$ and $y = 5$.

Substitute: $3(-2)^2 - 2(-2)(5) + 5$. Exponent first: $3 \cdot 4 - 2(-2)(5) + 5$. Multiply: $12 + 20 + 5$. Add: **37**.

The value is **37**.



Example 3: a real formula

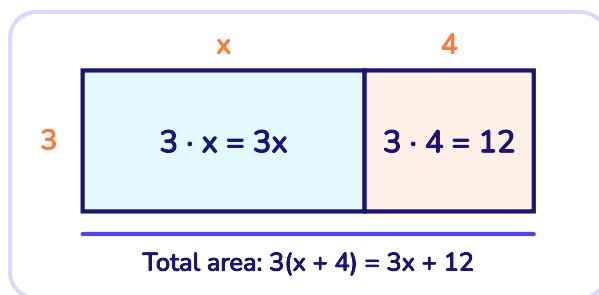
A weather app converts Celsius to Fahrenheit with the expression $1.8C + 32$. When it is 25°C outside, we get $1.8(25) + 32 = 45 + 32 = 77$. So it is 77°F .

4. Properties of real numbers

Properties are rules that are always true for any real numbers. They explain why certain rewritings are allowed, and they make mental math and algebra much faster.

Property	In symbols	Example
Commutative (addition)	$a + b = b + a$	$7 + x = x + 7$
Commutative (multiplication)	$a \cdot b = b \cdot a$	$6 \cdot 9 = 9 \cdot 6$
Associative (addition)	$(a + b) + c = a + (b + c)$	$(4 + 5) + 1 = 4 + (5 + 1)$
Associative (multiplication)	$(ab)c = a(bc)$	$(2 \cdot 7) \cdot 5 = 2 \cdot (7 \cdot 5)$
Distributive	$a(b + c) = ab + ac$	$3(x + 4) = 3x + 12$
Identities	$a + 0 = a, a \cdot 1 = a$	$8 + 0 = 8, 1 \cdot y = y$
Inverses	$a + (-a) = 0,$ $a \cdot \frac{1}{a} = 1 \ (a \neq 0)$	$5 + (-5) = 0, 5 \cdot \frac{1}{5} = 1$

The **commutative** properties say that order does not matter for adding or multiplying. The **associative** properties say that grouping does not matter. The **distributive property** connects multiplication and addition, and it is the most used property in algebra. An area picture shows why it works.



Subtraction and division are not commutative or associative

$5 - 2 \neq 2 - 5$ and $12 \div (3 \cdot 2) \neq (12 \div 3) \cdot 2$ because $12 \div 6 = 2$ but $4 \cdot 2 = 8$. To get around this, rewrite subtraction as adding the opposite, $a - b = a + (-b)$, and division as multiplying by the reciprocal.



Example 4: mental math with properties

Compute $25 \cdot 17 \cdot 4$ quickly. By the commutative and associative properties,
 $25 \cdot 17 \cdot 4 = (25 \cdot 4) \cdot 17 = 100 \cdot 17 = 1,700$. Similarly,
 $8 \cdot 53 = 8(50 + 3) = 400 + 24 = 424$.

5. Combining like terms

Like terms have exactly the same variable part, with the same exponents. Only the coefficients can differ. So $4x$ and $-9x$ are like terms, and $6xy^2$ and xy^2 are like terms, but $3x$ and $3x^2$ are not, and neither are $2a$ and $2b$. Constants are like terms with each other.

The distributive property lets you add the coefficients: $4x + 9x = (4 + 9)x = 13x$. The variable part does not change.

E**Example 5: combining like terms**

Simplify $5x^2 + 3x - 2x^2 + 7 - x + 4$.

Group by type: $(5x^2 - 2x^2) + (3x - x) + (7 + 4)$. Add the coefficients:
 $3x^2 + 2x + 11$.

6. Simplifying expressions

An expression is **simplified** when it has no parentheses and no like terms left to combine. To get there, distribute first, then combine like terms.

M**Method: simplifying an expression**

1. Distribute every factor or negative sign that sits in front of parentheses, multiplying it by every term inside.
2. Underline or circle terms of the same type, keeping their signs.
3. Add the coefficients of the like terms.
4. Write the result, usually with the highest power first.

E Example 6: distribute, then combine

Simplify $4(2x - 3) - 3(x - 5)$.

Distribute: $8x - 12 - 3x + 15$. Notice that $-3 \cdot (-5) = +15$. Combine:
 $(8x - 3x) + (-12 + 15) = 5x + 3$.

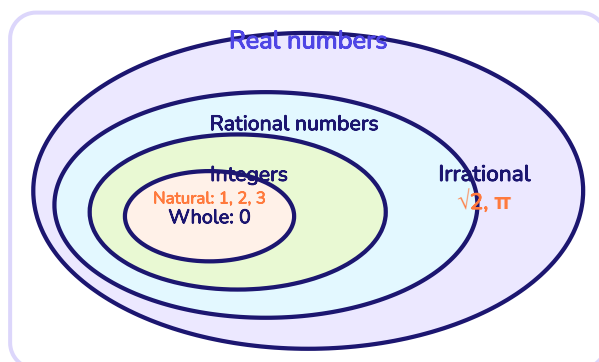
Check with $x = 2$: the original gives $4(1) - 3(-3) = 4 + 9 = 13$, and
 $5(2) + 3 = 13$. It matches.

! Zyro's tip

On my planet we always test our work: pick an easy number such as $x = 2$ and evaluate the expression before and after simplifying. If the two results differ, a mistake is hiding somewhere!

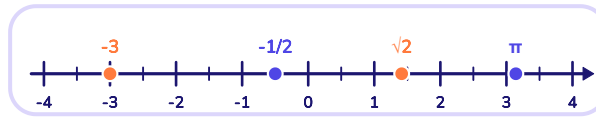
7. The real number system

Every number you meet in Algebra 1 is a **real number**, which means it has a place on the number line. Real numbers are organized into sets that sit inside each other.



- **Natural numbers** (counting numbers): $1, 2, 3, \dots$
- **Whole numbers**: $0, 1, 2, 3, \dots$

- **Integers:** $\dots, -2, -1, 0, 1, 2, \dots$
- **Rational numbers:** numbers that can be written as $\frac{a}{b}$ with integers a and $b \neq 0$. Their decimals stop or repeat, like **0.75** or **$0.\overline{3}$** .
- **Irrational numbers:** real numbers that are not rational. Their decimals never stop and never repeat, like **$\sqrt{2} \approx 1.414$** and **$\pi \approx 3.14159$** .



E Example 7: classifying numbers

Classify $\sqrt{49}$, $-\frac{3}{4}$, and $\sqrt{11}$.

$\sqrt{49} = 7$, which is a natural number, so it is also whole, an integer, rational, and real.

$-\frac{3}{4}$ is a fraction of integers, so it is rational and real but not an integer. $\sqrt{11}$ is not a perfect square root, so it is irrational and real.

P Closure facts

The sum or product of two rational numbers is rational. The product of a nonzero rational number and an irrational number is irrational. The sum of two irrational numbers can be rational (for example $\sqrt{2} + (3 - \sqrt{2}) = 3$).

8. Translating words into expressions

Many word problems start with turning a phrase into an expression. Look for key words and choose a variable for the unknown number.

Words	Expression
the sum of a number and 9; 9 more than a number	$n + 9$
a number decreased by 4; 4 less than a number	$n - 4$
4 subtracted from a number, but also “the difference of 4 and a number”	$n - 4$ and $4 - n$
7 times a number; the product of 7 and a number	$7n$
the quotient of a number and 6	$\frac{n}{6}$
twice a number, increased by 5	$2n + 5$

E Example 8: from a sentence to an expression

“Five less than twice a number” is written $2n - 5$, not $5 - 2n$: first “twice a number” gives $2n$, then we take away 5. A taxi that charges a \$3 base fee plus \$2 per mile costs $3 + 2m$ dollars for m miles; for a 7-mile ride that is $3 + 2(7) = 17$ dollars.

Key takeaways

- An expression is made of terms; coefficients multiply variables and the constant term has no variable.
- Follow PEMDAS: parentheses, exponents, multiplication and division left to right, addition and subtraction left to right.
- To evaluate, substitute the number in parentheses and compute in order.
- Addition and multiplication are commutative and associative; the distributive law is $a(b + c) = ab + ac$.
- Only like terms can be combined: add the coefficients and keep the variable part.
- Simplify by distributing first, then combining like terms; check with a test value.
- Real numbers include natural, whole, integer, rational, and irrational numbers.
- “Less than” and “subtracted from” reverse the order of the subtraction.



Test yourself: quick challenge for Grade 9

[Change level](#)

Level : **Grade 9**

6 random questions, instant feedback.



Start the challenge



 **Speed drill for Grade 9: how many in 60 seconds?**

 Keep exploring with Zyro

 Math practice

Algebraic Expressions and Properties of Real Numbers: math practice, Grade 9

 Math tests

Algebraic Expressions and Properties of Real Numbers: math test, Grade 9

 Math quizzes

Algebraic Expressions and Properties of Real Numbers: math quiz, Grade 9

 Math practice

Linear Inequalities: math practice, Grade 9

 Math practice

Relations and Functions: math practice,
Grade 9

 Math tests

Linear Inequalities: math test, Grade 9

Zyro vous emmène sur nos sites partenaires

Embarquez pour d'autres planètes du savoir et leurs applis.

Décollage