

Equivalent Algebraic Expressions: math lesson, Grade 7 – download the PDF

Algebra lets you describe a pattern once and use it for every number. In this chapter you will learn to write expressions in several equivalent forms, to simplify them, and to read what they mean in a real situation.

1. The parts of an expression

An **algebraic expression** combines numbers, variables, and operations, for example $4x + 7$ or $5a - 2b + 9$. A **variable** is a letter that stands for a number that can change.

D Vocabulary

- A **term** is a part of the expression separated by $+$ or $-$. In $5a - 2b + 9$ the terms are $5a$, $-2b$, and 9 .
- The **coefficient** is the number multiplied by the variable: it is 5 in $5a$ and -2 in $-2b$.
- A **constant term** has no variable, like 9 .

Two expressions are **equivalent** if they have the same value for every possible value of the variable. For example, $2x + 2x$ and $4x$ are equivalent.

2. Like terms

D Like terms

Like terms have exactly the same variable part. $7a$ and $-2a$ are like terms. $7a$ and $7b$ are not, and neither are $3x$ and $3x^2$. All constants are like terms with each other.

Think of a variable as an object. Seven apples and two apples make nine apples, but seven apples and two bananas stay as they are.

3. Combining like terms

M Method: combine like terms

1. Circle or underline the terms that match, keeping the sign in front of each one.
2. Add or subtract the coefficients of matching terms.
3. Keep the variable part unchanged and write the result.

$2x + 3 + x + 2$

$3x + 5$

E Example 1

Simplify $6x - 4 + 3x + 9 - 8x$.

The x -terms: $6x + 3x - 8x = 1x = x$. The constants: $-4 + 9 = 5$. So the expression equals $x + 5$.

⚠ Careful

Only the coefficient changes. $5x + 3x = 8x$, not $8x^2$. And $4x + 3$ cannot be written as $7x$, because $4x$ and 3 are not like terms.

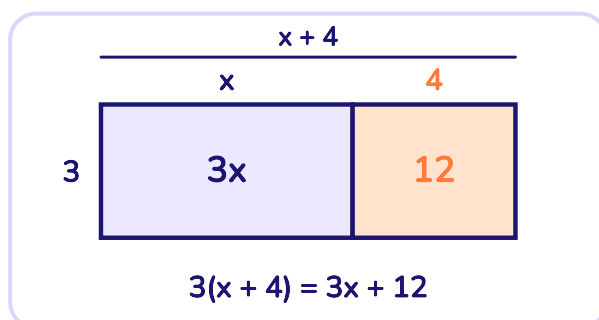
4. The distributive property

P Distributive property

For any numbers a , b , and c :

$$a(b + c) = ab + ac \quad \text{and} \quad a(b - c) = ab - ac.$$

The picture below shows why. A rectangle of height 3 is cut into two parts, one of width x and one of width 4. The whole area is $3(x + 4)$, and the two pieces have areas $3x$ and 12 .



E**Example 2**

Expand $-2(5y - 3)$.

Multiply every term inside by -2 : $-2 \cdot 5y = -10y$ and $-2 \cdot (-3) = +6$. So $-2(5y - 3) = -10y + 6$.

**Careful**

The factor outside multiplies *every* term. $4(x + 3)$ is $4x + 12$, not $4x + 3$. A minus sign in front of a parenthesis changes every sign inside: $-(m - 8) = -m + 8$.

5. Factoring out a common factor

Factoring is the distributive property read backward: you turn a sum into a product. To factor, find the greatest common factor (GCF) of all the terms, write it outside, and keep what is left inside.

M**Method: factor out the GCF**

1. Find the GCF of the coefficients (and any variable they all share).
2. Divide each term by the GCF.
3. Write $\text{GCF} \times (\text{the quotients})$. Check by expanding.

E**Example 3**

Factor $12x + 18$.

The GCF of 12 and 18 is 6. Divide: $12x \div 6 = 2x$ and $18 \div 6 = 3$. So $12x + 18 = 6(2x + 3)$. Check: $6 \cdot 2x + 6 \cdot 3 = 12x + 18$.

6. Adding and subtracting linear expressions

A **linear expression** has a variable only to the first power, like $3x + 5$. To add two of them, remove the parentheses and combine like terms. To subtract, first distribute the minus sign.

E**Example 4**

Compute $(7x + 2) - (3x - 6)$.

$(7x + 2) - (3x - 6) = 7x + 2 - 3x + 6 = 4x + 8$. Notice that subtracting -6 became $+6$.

7. Rewriting an expression in different forms

One expression can have many equivalent forms. For example, $3(x + 2) + x$, $3x + 6 + x$, $4x + 6$, and $2(2x + 3)$ are all equivalent. The best form depends on your goal: the expanded form is easy to add, and the factored form shows a common factor.

To test an equivalence quickly, substitute a value. If two expressions give different results for the same number, they are not equivalent. A match for one value is not a proof, so simplify to be sure.

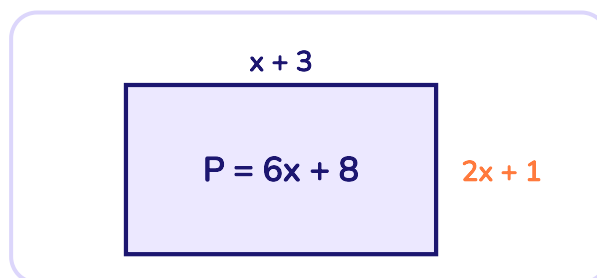
x	$3(x + 2) + x$	$4x + 6$	$5x + 2$
1	10	10	7
4	22	22	22
6	30	30	32

! Zyro's tip

On my planet we always test with a second number. At $x = 4$ the expression $5x + 2$ matched the others, but at $x = 1$ it did not, so it is not equivalent!

8. Interpreting expressions in context

An expression tells a story. The rectangle below has sides $x + 3$ and $2x + 1$. Its perimeter is $2(x + 3) + 2(2x + 1) = 2x + 6 + 4x + 2 = 6x + 8$.



E Example 5

A tutoring center charges 5 dollars to register and 12 dollars per hour. The cost of h hours is $12h + 5$ dollars. Here **12** is the price of one hour and **5** is the fixed fee. For $h = 3$, the cost is $12 \cdot 3 + 5 = 41$, so you pay 41 dollars.

When you read $6(t + 4)$ with tickets at t dollars and a snack at 4 dollars, it means six people each buy one ticket and one snack. Expanding gives $6t + 24$: the cost of 6 tickets plus the cost of 6 snacks.

Key takeaways

- Like terms have the same variable part, and you combine them by adding or subtracting coefficients.
- $a(b + c) = ab + ac$: the outside factor multiplies every term, and a minus sign changes every sign.
- Factoring out the GCF rewrites a sum as a product, and you can check it by expanding.
- To subtract an expression, distribute the minus sign first.
- Equivalent expressions have the same value for every number: test with several values, then simplify to prove it.
- In a word problem, the coefficient is a rate and the constant is a fixed amount.



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