GENERAL

simplify algebraic expressions by combining like terms

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Introduction

Algebra is the language of mathematics, and at its core lies the art of simplifying expressions. Whether you're a high school student tackling homework, a college freshman learning calculus, or an adult refreshing your math skills, mastering the technique of combining like terms is essential. Simplifying algebraic expressions not only makes calculations easier but also reveals patterns that help solve equations, graph functions, and model real world situations. In this guide, we'll walk through the fundamentals of like terms, show you how to combine them, and give you plenty of practice to build confidence. By the end, you'll be able to turn a cluttered algebraic expression into a clean, streamlined form that's ready for the next step in your problem solving journey.

What Are Like Terms?

Before you can combine terms, you need to know what makes terms "like." Two terms are **like terms** if they contain exactly the same variable factors raised to the same powers, regardless of their coefficients. The coefficients can be any real number (including fractions, decimals, or negatives). For example:

- 3x and –5x are like terms because both contain the variable x to the first power.
- 4xy² and –2xy² are like terms because they share the same variables x and y, both raised to the same exponents (1 and 2).
- 7a²b and 7a²b are identical like terms.

Contrast these with non like terms such as **3x** and **5y** (different variables), or **4xy** and **4x²y** (different exponents). Only like terms can be combined by adding or subtracting their coefficients.

The Rule for Combining Like Terms

The process is simple: **add or subtract the coefficients of like terms while leaving the variable part unchanged**. The general formula looks like this:

$c_1 v + c_2 v = (c_1 + c_2)v$

where c_1 and c_2 are coefficients and v represents the shared variable factor. If you're subtracting, treat it as adding a negative:

$c_1 v - c_2 v = (c_1 - c_2)v = (c_1 + (-c_2))v$

Let's see how this works in practice with a series of examples.

Step by Step Examples

Example 1: A Simple Linear Expression

Combine the terms in the expression **5x – 3x + 2x – 7x**.

1. Identify like terms: all terms contain x to the first power.
2. Add the coefficients: 5 + (–3) + 2 + (–7) = –3.
3. Rewrite the expression: –3x.

Result: **–3x**.

Example 2: Variables and Constants

Simplify **$4y^2 + 3 – 2y^2 + 7$**.

1. Group like terms: $4y^2 – 2y^2$ and constants 3 + 7.
2. Combine the y^2 terms: 4 – 2 = 2, so $2y^2$.
3. Combine the constants: 3 + 7 = 10.
4. Final expression: $2y^2 + 10$.

Example 3: Multiple Variables and Exponents

Simplify **$6ab^2 – 3a^2b + 4ab^2 + 5a^2b – 2ab^2$**.

1. Identify distinct groups of like terms:

   ab^2 terms: $6ab^2 + 4ab^2 + (–2ab^2)$
2. a^2b terms: $(–3a^2b) + 5a^2b$

Example 4: Including Rational Coefficients

Simplify **$\frac{1}{2}x + 3x – \frac{1}{4}x + 1$**.

1. Combine the x terms: $\frac{1}{2} + 3 – \frac{1}{4} = (\frac{1}{2} – \frac{1}{4}) + 3 = \frac{1}{4} + 3 = 3\frac{1}{4}$.
2. Result: $3\frac{1}{4}x + 1$ (or as a mixed number, 3.25x + 1).

Common Mistakes to Avoid

- Mixing different variables: Do not add 5x to 3y; they are not like terms.
- Ignoring exponents: $4x^2$ and 4x are not like terms because the powers differ.
- Overlooking negative signs: Treat subtraction as addition of a negative number.
- Forgetting constants: Constants (numbers without variables) can only combine with other constants.

Tips for Mastering Like Term Combination

1. Organize your expression: Write each term in a separate line or use a table to keep track.
2. Use color coding: Assign a color to each distinct variable combination to spot like terms quickly.
3. Practice with real world data: Convert word problems into algebraic expressions and simplify.
4. Check your work: After simplifying, expand the result to verify it matches the original expression.
5. Leverage technology: Online calculators or algebra software can double check your simplifications.

Practical Applications of Simplification

Combining like terms is more than a classroom exercise; it’s a foundational skill in many areas:

- Solving Equations: Simplified expressions make isolating variables straightforward.
- Graphing Functions: A clean polynomial is easier to plot and analyze.
- Calculus: Differentiating or integrating a simplified expression reduces complexity.
- Engineering: Models often involve polynomial approximations; simplifying them speeds up calculations.
- Data Analysis: Algebraic simplification aids in deriving formulas for statistical measures.

Practice Problems

Test your skills with these exercises. Try to simplify each expression on your own before checking the answer.

Problem Set 1

1. $2a + 4b – 3a + 5b – 7$
2. $10x^2y – 4x^2y + 3xy^2 – xy^2 + 8$
3. $½m^2n + ¾m^2n – 2mn + 3mn – 1$
4. $9p – 4p + 7q – 2q + 6p – 3q$
5. $12x^3y^2 – 5x^3y^2 + 7x^2y^3 – 2x^2y^3 + 4$

Answers

1. $–a + 9b – 7$
2. $6x^2y + 2xy^2 + 8$
3. $1.25m^2n + mn – 1$ (or $5/4\ m^2n + mn – 1$)
4. $11p + 3q$
5. $7x^3y^2 + 5x^2y^3 + 4$

Advanced Topics: Combining Like Terms in Rational Expressions

When fractions are involved, the process remains the same, but you must handle the denominators carefully. Here's a quick refresher:

1. Find a common denominator if terms have different denominators.
2. Rewrite each term with the common denominator.
3. Combine the numerators as usual.
4. Simplify the resulting fraction.

Example:

Combine **!Sx + ½x –. !Yx**

1. Common denominator is 6.
2. Rewrite: (2/6)x + (3/6)x – (1/6)x.
3. Combine numerators: 2 + 3 – 1 = 4.
4. Result: 4/6x = 2/3x.

Why Simplification Matters for Algebraic Manipulation

When you simplify expressions, you're essentially reducing the problem's complexity. This has several benefits:

- Clarity: A neat expression is easier to read and interpret.
- Efficiency: Fewer terms mean quicker calculations.
- Accuracy: Simplified forms reduce the chance of arithmetic errors.
- Preparation: Many algebraic techniques—factoring, completing the square, or applying the quadratic formula—require a simplified starting point.

Common Extensions: Factoring After Simplification

Once you've combined like terms, you often move on to factoring. For instance, after simplifying **$4x^2 – 12x + 9$** to **$4x^2 – 12x + 9$** (already simplified), you can factor it as **$(2x – 3)^2$**. Knowing how to simplify first ensures you're working with the simplest possible polynomial before attempting factorization.

Frequently Asked Questions (FAQ)

What if I have terms with different variables but the same exponents?

Even if exponents match, different variables mean the terms are not like. For example, *3xy* and *4xz*cannot be combined because they involve different variable factors.

Can I combine constants with variable terms?

No. Constants are like

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