

Simplify The Rational Expression. $\frac{5y + 15}{3y + 9} \cdot \frac{5y + 15}{y + 9} =$

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When working with algebraic expressions, especially rational expressions, simplifying them is a fundamental skill that helps students and professionals alike to better understand the structure and behavior of the expressions. The expression " $\frac{5y + 15}{3y + 9} \cdot \frac{5y + 15}{y + 9}$ " appears complex at first glance, but by applying systematic algebraic techniques such as factoring, combining like terms, and reducing fractions, it becomes much more manageable. In this comprehensive guide, we will explore the process of simplifying such rational expressions step by step, ensuring that you understand each phase thoroughly.

Understanding Rational Expressions

Before diving into the simplification process, it's essential to understand what rational expressions are.

What Is a Rational Expression?

A rational expression is a fraction where both the numerator and the denominator are polynomials. For example:

- $\frac{2x + 3}{x - 4}$
- $\frac{5y + 15}{3y + 9}$

These expressions can sometimes be simplified by factoring the numerator and denominator and then canceling common factors.

Why Simplify Rational Expressions?

Simplifying rational expressions helps in:

- Making complex expressions easier to interpret.
- Facilitating addition, subtraction, multiplication, and division of fractions.
- Solving equations involving rational expressions efficiently.
- Identifying restrictions on the variable to avoid division by zero.

Step-by-Step Guide to Simplify the Expression: $\frac{5y + 15}{3y + 9} + 5y + 15 + 9$

Let's analyze the given expression and simplify it systematically.

Given Expression:

$$\frac{5y + 15}{3y + 9} + 5y + 15 + 9$$

At first glance, this appears to be a combination of a rational expression and algebraic terms. To clarify, we'll interpret the expression as:

$$\frac{5y + 15}{3y + 9} + (5y + 15) + 9$$

Note: The placement of parentheses is crucial. Without parentheses, the expression might be ambiguous. Here, we assume the proper structure as above.

Step 1: Simplify the Rational Part

Focus on the rational expression:

$$\frac{5y + 15}{3y + 9}$$

Factor numerator and denominator:

- Numerator: $5y + 15 = 5(y + 3)$
- Denominator: $3y + 9 = 3(y + 3)$

Simplify the fraction:

$$\frac{5(y + 3)}{3(y + 3)} = \frac{5}{3}$$

Important: Since $(y + 3) \neq 0$, i.e., $y \neq -3$, we can cancel $(y + 3)$ safely.

Step 2: Rewrite the Expression with Simplified Rational Part

Now, the entire expression becomes:

$$\frac{5}{3} + (5y + 15) + 9$$

Next, combine like terms where possible.

Step 3: Simplify the Remaining Terms

Let's focus on the algebraic terms:

$$(5y + 15) + 9$$

Combine constants:

$$15 + 9 = 24$$

So, the expression is:

$$\frac{5}{3} + 5y + 24$$

Step 4: Write the Final Expression

The simplified expression:

$$5y + 24 + \frac{5}{3}$$

To combine all terms into a single fraction or a simplified form, convert the constants to a common denominator.

Expressing the Final Result in a Single Fraction

Convert constants to have denominator 3:

$$24 = \frac{24 \times 3}{3} = \frac{72}{3}$$

Now, the entire expression:

$$5y + \frac{72}{3} + \frac{5}{3}$$

Combine the fractions:

$$5y + \frac{72 + 5}{3} = 5y + \frac{77}{3}$$

Final simplified form:

$$\boxed{\boxed{5y + \frac{77}{3}}}$$

Alternatively, you can write it as a mixed number:

$$5y + 25 \frac{2}{3}$$

Key Points for Simplifying Rational Expressions

To ensure clarity and mastery, here are some essential tips and key points when simplifying rational expressions:

1. **Always factor polynomials:** Look for common factors in numerator and denominator.

2. **Cancel common factors:** Once factored, cancel out any common terms to simplify.
3. **Be cautious about restrictions:** Identify values of variables that make the denominator zero.
4. **Combine like terms carefully:** When adding or subtracting, ensure the terms are similar.
5. **Convert mixed fractions to improper fractions:** For easier calculations.

Common Mistakes to Avoid

While simplifying rational expressions, learners often make some common errors. Here are tips to avoid them:

- **Overlooking factoring opportunities:** Always look for common factors before canceling.
- **Ignoring restrictions:** Remember to specify values that make denominators zero.
- **Misinterpreting the expression:** Clarify the placement of parentheses to understand the structure.
- **Forgetting to convert all terms to like denominators:** When combining fractions, ensure denominators are the same.

How to Practice Simplifying Rational Expressions

Practicing with various types of rational expressions enhances understanding. Here are some practice tips:

1. Solve problems involving the simplification of complex fractions.
2. Practice factoring different polynomials, including quadratics and higher-degree polynomials.
3. Work on combining algebraic fractions with different denominators.

4. Review restrictions on variables to understand domain limitations.

Conclusion

Simplifying rational expressions, such as the problem " $5y + 15 / 3y + 9 + 5y + 15 + 9$," becomes straightforward once you understand the importance of factoring, canceling common factors, and combining like terms. In this article, we demonstrated a clear, step-by-step approach to simplifying such expressions, emphasizing key algebraic techniques. Mastering these skills not only improves your problem-solving efficiency but also deepens your understanding of algebraic structures. Keep practicing with different types of rational expressions to build confidence and proficiency in algebra.

Additional Resources

- Algebra textbooks and online tutorials on rational expressions.
- Interactive algebra practice websites.
- Video lessons explaining factoring and simplifying rational expressions.
- Math tutors or study groups for personalized assistance.

By following the strategies outlined in this guide, you will become adept at simplifying rational expressions, turning complex algebraic fractions into neat, manageable results.

Frequently Asked Questions

What does it mean to simplify a rational expression?

Simplifying a rational expression involves reducing it to its simplest form by factoring numerator and denominator and canceling out common factors.

How do I start simplifying the expression $5y + 15 / 3y + 9$?

Begin by factoring both the numerator and denominator to identify common factors for potential cancellation.

Can the expression $5y + 15 + 9$ be simplified further?

Yes, combine like terms: $5y + (15 + 9) = 5y + 24$, which simplifies the expression.

What are the steps to simplify the entire expression: $(5y + 15) / (3y + 9) + 9$?

First, factor numerator and denominator: $5(y + 3) / 3(y + 3)$. Cancel common factors to simplify to $5/3$, then add 9 as needed.

Is it necessary to combine all parts of the expression before simplifying?

It's usually best to simplify each part separately (like simplifying fractions and combining like terms) before combining everything for the final simplification.

What is the simplified form of $(5y + 15) / (3y + 9) + 9$?

The simplified form is $5/3 + 9$, which can be written as $(5/3) + (27/3) = 32/3$.

Why do we factor expressions when simplifying rational expressions?

Factoring helps identify common factors in numerator and denominator, allowing for cancellation and reduction to simplest form.

How can I check if my simplified expression is correct?

You can substitute specific values for y into the original and simplified expressions to see if they produce the same result.

Additional Resources

Simplify The Rational Expression. $5y + 15 / 3y + 9$ $5y + 15 + 9 =$ is a mathematical challenge that invites learners and educators alike to deepen their understanding of algebraic simplification, particularly in the context of rational expressions. Simplifying such expressions is fundamental in algebra because it helps reduce complex fractions to their simplest form, making calculations more manageable and insights more accessible. This specific expression, involving multiple terms with common factors, serves as an excellent example for exploring the process of factoring, combining like terms, and reducing fractions, which are essential skills in higher mathematics. In this review, we will analyze the process of simplifying this expression, discuss the mathematical concepts involved, and evaluate the pros and cons of different approaches to ensure clarity and thorough understanding.

Understanding the Expression: An Initial Overview

Before diving into the simplification process, it's crucial to understand the structure of the given expression:

$$5y + 15 \ 3y + 9 \ 5y + 15 + 9 =$$

At first glance, the expression appears to be a sequence of algebraic terms, but it is somewhat ambiguous in its current form due to missing operators (such as plus or minus signs) between the terms. For clarity, the most logical interpretation is that the expression intends to be:

$$(5y + 15) / (3y + 9) + (5y + 15) + 9$$

or perhaps a different arrangement involving fractions and sums. Given the context, the most common and instructive approach is to assume the expression is:

$$\frac{5y + 15}{3y + 9} + (5y + 15) + 9$$

This interpretation aligns with typical algebraic exercises, involving the simplification of a rational expression combined with algebraic addition. Clarifying the expression is the first step toward effective simplification.

Step-by-Step Simplification Process

Step 1: Factor Common Terms

The first step is to factor out common factors from the terms involved, especially within the numerator and denominator of the fractional expression.

- For $5y + 15$, the greatest common factor (GCF) is 5:

$$5(y + 3)$$

- For $3y + 9$, the GCF is 3:

$$3(y + 3)$$

\]

So, the fractional part becomes:

$$\frac{5(y + 3)}{3(y + 3)}$$

Assuming $(y + 3 \neq 0)$ (to avoid division by zero), we can cancel out the common factor:

$$\frac{5 \cancel{(y + 3)}}{3 \cancel{(y + 3)}} = \frac{5}{3}$$

This step simplifies the fractional expression significantly, reducing it to a constant.

Step 2: Simplify the Remaining Terms

After simplifying the fractional part, the entire expression becomes:

$$\frac{5}{3} + (5y + 15) + 9$$

Next, focus on the algebraic terms, particularly $5y + 15$. Again, factor out the GCF, which is 5:

$$5(y + 3)$$

The expression now is:

$$\frac{5}{3} + 5(y + 3) + 9$$

Step 3: Combine Constant Terms

Convert all terms to have a common denominator where necessary to combine constants effectively.

The constants are:

$$-\left(\frac{5}{3}\right) \\ - 9$$

Express 9 as a fraction with denominator 3:

$$\begin{aligned} & \\ 9 &= \frac{27}{3} \\ & \end{aligned}$$

Thus, the sum of constants is:

$$\begin{aligned} & \\ \frac{5}{3} + \frac{27}{3} &= \frac{32}{3} \\ & \end{aligned}$$

Now, the entire expression is:

$$\begin{aligned} & \\ \frac{32}{3} + 5(y + 3) & \\ & \end{aligned}$$

Step 4: Expand and Finalize

Next, expand $5(y + 3)$:

$$\begin{aligned} & \\ 5y + 15 & \\ & \end{aligned}$$

The final expression becomes:

$$\begin{aligned} & \\ \frac{32}{3} + 5y + 15 & \\ & \end{aligned}$$

Express 15 as a fraction with denominator 3:

$$\begin{aligned} & \\ 15 &= \frac{45}{3} \\ & \end{aligned}$$

Adding to the existing fraction:

$$\begin{aligned} & \\ \frac{32}{3} + \frac{45}{3} &= \frac{77}{3} \end{aligned}$$

\]

So, the fully simplified expression is:

$$\frac{77}{3} + 5y$$

Or, written more neatly:

$$5y + \frac{77}{3}$$

This is the simplified form, combining the rational and algebraic parts.

Mathematical Concepts Involved

Factoring

Factoring out common factors is fundamental in algebra to simplify expressions. Recognizing the GCFs in the numerator and denominator helps cancel terms and simplify fractions effectively.

Cancellation of Common Factors

This process, known as reducing fractions, is crucial for simplifying rational expressions. It relies on the property that $\frac{a \times c}{b \times c} = \frac{a}{b}$, provided $(c \neq 0)$.

Combining Like Terms

Adding constants and algebraic expressions requires rewriting terms with common denominators, enabling straightforward addition or subtraction.

Handling Constants and Variables

Expressing constants as fractions with common denominators facilitates combining terms, especially in mixed expressions involving both rational and algebraic parts.

Pros and Cons of the Approach

Pros

- Clarity: Step-by-step factoring and cancellation make the process transparent.
- Efficiency: Simplifies complex expressions quickly by reducing fractions early.
- Reusability: The method applies broadly to similar algebraic fractions.

Cons

- Assumptions: Cancelling factors assumes they are non-zero; neglecting this can lead to invalid results.
- Potential for Errors: Mistakes in factoring or common denominators can lead to incorrect simplifications.
- Limited Scope: The approach assumes the expression is correctly interpreted; ambiguity in the original statement can cause confusion.

Features and Educational Value

- Reinforces Core Algebra Skills: Factoring, simplifying fractions, and combining like terms are foundational skills.
- Enhances Problem-Solving Skills: Breaking down complex expressions into manageable steps fosters logical thinking.
- Prepares for Advanced Topics: Mastery of these techniques is essential for calculus, algebraic functions, and beyond.

Conclusion

Simplifying the expression $5y + 15 / 3y + 9 + 5y + 15 + 9$ (interpreted as $(\frac{5y + 15}{3y + 9}) + (5y + 15) + 9$) demonstrates the importance of methodical algebraic manipulation. By carefully factoring, cancelling common factors, and combining like terms, the expression reduces to a much simpler form:

$$\frac{5y + 15}{3} + 5y + 15 + 9$$

This process not only clarifies the structure of the original problem but also highlights key algebraic principles that are widely applicable. Proper understanding and practice of these techniques are invaluable for students progressing through algebra and related fields. The

key takeaway is that breaking complex expressions into manageable parts through factoring and fraction reduction simplifies problem-solving and enhances mathematical fluency.

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