

# For All Values Of $x$ $f(x) = (x + 2)^2$ And $G(x) = 3(x - 1)$ Find $Gf(x)$ , Giving Your Answer In The Form

For All Values Of  $x$   $f(x) = (x + 2)^2$  And  $G(x) = 3(x - 1)$  Find  $Gf(x)$ , Giving Your Answer In The Form

Understanding the composition of functions is a fundamental concept in algebra and calculus, especially when dealing with complex expressions and transformations. In this article, we will explore how to find the composite function  $Gf(x)$  given specific functions  $f(x)$  and  $G(x)$ . The problem states that for all values of  $x$ ,  $f(x) = (x + 2)^2$  and  $G(x) = 3(x - 1)$ . Our goal is to compute  $Gf(x)$ , which means applying  $G$  to the output of  $f(x)$ , and express the result in a simplified, standard form.

This process involves a step-by-step substitution and algebraic manipulation, which not only reinforces understanding of function composition but also enhances algebraic skills. Whether you are a student preparing for exams or someone interested in mathematical concepts, mastering this technique will deepen your comprehension of how functions interact.

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## Understanding Function Composition

Before diving into calculations, it is essential to understand what function composition entails.

## What Is Function Composition?

Function composition involves combining two functions such that the output of one function becomes the input of another. If  $f$  and  $G$  are functions, then:

- The composition of  $G$  after  $f$  is written as  $G \circ f$  or  $Gf(x)$ , which equals  $G(f(x))$
- Similarly, the composition of  $f$  after  $G$  is written as  $f \circ G$  or  $fG(x)$ , which equals  $f(G(x))$

In this context, since we are asked to find  $Gf(x)$ , it means:

$$Gf(x) = G(f(x))$$

## Why Is Function Composition Important?

Function composition is crucial in various fields such as calculus, computer science, physics, and engineering because it models layered processes or transformations. It helps analyze how a change in the input propagates through multiple functions, ultimately impacting the output.

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## Given Functions and What Is Being Asked

The problem provides two functions:

- $f(x) = (x + 2)^2$
- $G(x) = 3(x - 1)$

and asks to find  $Gf(x)$ , which is  $G$  applied to  $f(x)$ .

Objective:

Calculate  $G(f(x))$  and express the answer in a simplified algebraic form.

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## Step-by-Step Solution to Find $Gf(x)$

To find  $Gf(x)$ , follow these systematic steps:

### Step 1: Write Down the Composition

By definition:

$$Gf(x) = G(f(x))$$

which means replace every occurrence of  $x$  in  $G(x)$  with  $f(x)$ .

### Step 2: Substitute $f(x)$ into $G(x)$

Given  $G(x) = 3(x - 1)$ , replace  $x$  with  $f(x)$ :

$$Gf(x) = 3(f(x) - 1)$$

Since  $f(x) = (x + 2)^2$ , substitute:

$$Gf(x) = 3(((x + 2)^2) - 1)$$

### Step 3: Simplify the Expression Inside the Parentheses

Focus on simplifying:

$$((x + 2)^2) - 1$$

Recall that  $(x + 2)^2$  expands to:

$$x^2 + 4x + 4$$

Thus,

$$((x + 2)^2) - 1 = (x^2 + 4x + 4) - 1 = x^2 + 4x + 3$$

### Step 4: Multiply by 3

Now, multiply the entire expression by 3:

$$Gf(x) = 3(x^2 + 4x + 3)$$

Distribute the 3 across all terms:

$$Gf(x) = 3x^2 + 12x + 9$$

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## Final Expression and Its Significance

The simplified form of  $Gf(x)$  is:

$$Gf(x) = 3x^2 + 12x + 9$$

This quadratic expression clearly shows how the composition of the given functions results in a polynomial.

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## Expressing $Gf(x)$ in the Requested Form

The problem asks to give the answer in a specific form, which, although not explicitly provided in the excerpt, typically refers to standard polynomial form or factored form.

Standard Polynomial Form:

$$Gf(x) = 3x^2 + 12x + 9$$

Factored Form:

We can factor  $Gf(x)$  further:

First, factor out the common factor 3:

$$Gf(x) = 3(x^2 + 4x + 3)$$

Next, factor the quadratic inside the parentheses:

$$x^2 + 4x + 3 = (x + 1)(x + 3)$$

Therefore:

$$Gf(x) = 3(x + 1)(x + 3)$$

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## Conclusion and Applications

By carefully substituting and simplifying, we have determined that:

$$Gf(x) = 3(x + 1)(x + 3)$$

This process illustrates the importance of understanding function composition and algebraic manipulation. It also emphasizes the value of recognizing factorizable quadratics to express functions in their most simplified, factored form.

Applications of this concept include:

- Solving complex algebraic problems
- Analyzing transformations in coordinate geometry
- Understanding layered functions in calculus
- Modeling real-world situations involving multiple variables

Mastering these techniques enhances mathematical fluency and prepares learners for more advanced topics such as derivatives, integrals, and functional analysis.

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## Additional Tips for Mastering Function Composition

- Always clearly write down the functions involved before starting calculations.
- Substitute step-by-step, avoiding shortcuts that could lead to mistakes.
- Simplify expressions systematically, using algebraic identities where applicable.
- Practice with different types of functions (linear, quadratic, polynomial, exponential) to build confidence.

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In summary, combining functions like  $f(x) = (x + 2)^2$  and  $G(x) = 3(x - 1)$  involves substitution and algebraic simplification. The resulting composite function  $Gf(x) = 3(x + 1)(x + 3)$  demonstrates the layered nature of functions and the importance of careful algebraic manipulation. This fundamental skill is essential for tackling more complex problems across mathematics and related disciplines.

## Frequently Asked Questions

**What is the composition  $G(f(x))$  for the functions  $f(x) = (x + 2)^2$  and  $G(x) = 3(x - 1)$ ?**

$$G(f(x)) = 3[(f(x)) - 1] = 3[(x + 2)^2 - 1] = 3[(x + 2)^2 - 1].$$

**How do you find the composite function  $G(f(x))$  given  $f(x) = (x + 2)^2$  and  $G(x) = 3(x - 1)$ ?**

To find  $G(f(x))$ , substitute  $f(x)$  into  $G(x)$ :  $G(f(x)) = 3(f(x) - 1)$ . Since  $f(x) = (x + 2)^2$ , it becomes  $G(f(x)) = 3[(x + 2)^2 - 1]$ .

**What is the simplified form of  $G(f(x))$  for the given functions?**

$$G(f(x)) = 3[(x + 2)^2 - 1] = 3(x + 2)^2 - 3.$$

**Can you express  $G(f(x))$  in the form  $a(x + b)^2 + c$ ?**

Yes.  $G(f(x)) = 3(x + 2)^2 - 3$ , which is in the form  $a(x + b)^2 + c$  with  $a=3$ ,  $b=2$ , and  $c=-3$ .

**What is the step-by-step process to compute  $G(f(x))$  for the functions provided?**

First, identify  $f(x) = (x + 2)^2$ . Next, substitute  $f(x)$  into  $G(x)$ :  $G(f(x)) = 3(f(x) - 1)$ . Then, replace  $f(x)$  with  $(x + 2)^2$ :  $G(f(x)) = 3[(x + 2)^2 - 1]$ . Finally, simplify the expression to get  $G(f(x)) = 3(x + 2)^2 - 3$ .

**Is the composition  $G(f(x))$  a quadratic function, and why?**

Yes, because  $f(x)$  is quadratic, and  $G(x)$  is linear. When composed,  $G(f(x))$  results in a quadratic function since it involves  $(x + 2)^2$  multiplied by 3.

## Additional Resources

For All Values Of  $X$   $f(x) = (x + 2)^2$  And  $G(x) = 3(x - 1)$  Find  $Gf(x)$ , Giving Your Answer In The Form

In the realm of algebra and function composition, understanding how to combine functions is a fundamental skill that unlocks complex problem-solving. When given two functions, the task often involves finding their composite, denoted as  $(G(f(x)))$ , which represents applying one function to the output of another. This process not only deepens comprehension of functional relationships but also enhances problem-solving versatility across mathematics and its applications. In this article, we delve into the specific problem of finding  $(G(f(x)))$  given the functions  $(f(x) = (x + 2)^2)$  and  $(G(x) = 3(x - 1))$ , and express the solution in a clear, structured form suitable for learners and practitioners alike.

## Understanding the Functions Involved

Before embarking on the composition process, it is essential to dissect the individual functions to grasp their structure and behavior.

The Function  $f(x) = (x + 2)^2$

This is a quadratic function, characterized by its parabola shape opening upwards. Its key features include:

- Vertex: Located at  $(x = -2)$ , where  $f(-2) = 0$ .
- Domain: All real numbers, since squaring is defined everywhere.
- Range:  $y \geq 0$ , as squares are non-negative.

The function essentially shifts the basic quadratic  $x^2$  two units to the left and then squares the result, affecting the shape and position of the parabola.

The Function  $G(x) = 3(x - 1)a$

At first glance, this appears to be a linear function, scaled by a factor of 3, and shifted horizontally by 1. However, the presence of the variable  $(a)$  introduces an additional parameter or constant, which could be:

- A constant coefficient, representing a fixed scalar.
- A typo or notation that might require clarification.

For the purpose of this article, we will interpret  $(a)$  as a constant parameter, meaning  $G(x)$  is linear with respect to  $(x)$ , scaled by  $(3a)$ , and shifted to the right by 1.

Thus, the function explicitly reads:

$$\begin{aligned} & \backslash[ \\ G(x) &= 3a(x - 1) \\ & \backslash] \end{aligned}$$

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## The Process of Function Composition

Function composition involves creating a new function by applying one function to the result of another. The notation:

$$\begin{aligned} & \backslash[ \\ G(f(x)) & \\ & \backslash] \end{aligned}$$

means we substitute the entire expression for  $\backslash( f(x) \backslash$  into  $\backslash( G \backslash$ :

$$\begin{aligned} & \backslash[ \\ G(f(x)) &= G \backslashleft( (x + 2)^2 \backslashright) \\ & \backslash] \end{aligned}$$

This process requires:

1. Replacing the input variable  $\backslash( x \backslash$  in  $\backslash( G(x) \backslash$  with  $\backslash( f(x) \backslash$ .
2. Simplifying the resulting expression to its most reduced form.

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## Step-by-Step Calculation of $\backslash( G(f(x)) \backslash$

Let's proceed systematically:

Step 1: Write Down the Composition

Given:

$$\begin{aligned} & \backslash \\ G(x) &= 3a(x - 1) \\ & \backslash \end{aligned}$$

We substitute  $\backslash f(x) = (x + 2)^2 \backslash$ :

$$\begin{aligned} & \backslash \\ G(f(x)) &= 3a \backslash \text{left}( f(x) - 1 \backslash \text{right} ) = 3a \backslash \text{left}( (x + 2)^2 - 1 \backslash \text{right} ) \\ & \backslash \end{aligned}$$

Step 2: Simplify Inside the Parentheses

Focus on simplifying the expression:

$$\begin{aligned} & \backslash \\ (x + 2)^2 &- 1 \\ & \backslash \end{aligned}$$

Recall the expansion:

$$\begin{aligned} & \backslash \\ (x + 2)^2 &= x^2 + 4x + 4 \\ & \backslash \end{aligned}$$

Substituting back:

$$\begin{aligned} & \left[ \right. \\ & x^2 + 4x + 4 - 1 = x^2 + 4x + 3 \\ & \left. \right] \end{aligned}$$

Step 3: Final Expression for  $G(f(x))$

Multiply by  $(3a)$ :

$$\begin{aligned} & \left[ \right. \\ & Gf(x) = 3a \times (x^2 + 4x + 3) = 3a x^2 + 12a x + 9a \\ & \left. \right] \end{aligned}$$

Answer in the form:

$$\begin{aligned} & \left[ \right. \\ & \boxed{ \\ & Gf(x) = 3a x^2 + 12a x + 9a \\ & } \\ & \left. \right] \end{aligned}$$

which is a quadratic function scaled by  $(3a)$ , with coefficients reflecting the composition.

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Interpreting the Result

The composite function  $G(f(x))$  is a quadratic function with three terms:

- The quadratic term  $(3a x^2)$ , indicating the degree of curvature is scaled by  $(3a)$ .
- The linear term  $(12a x)$ , representing the slope contribution.
- The constant term  $(9a)$ , shifting the entire parabola vertically depending on the value of  $(a)$ .

This result illustrates how composition can elevate the degree of a function (from quadratic in  $f(x)$  to quadratic in the composite), and how parameters like  $a$  influence the overall shape and position.

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## Significance in Mathematics and Applications

Understanding function composition is vital in various fields, including calculus, physics, engineering, and computer science. For example:

- In calculus, it forms the foundation of the chain rule, which is used to differentiate composite functions.
- In physics, it models systems where one quantity depends on another, which in turn depends on a third.
- In computer science, function composition underpins functional programming paradigms.

The ability to manipulate and simplify composite functions is crucial for solving complex equations, modeling real-world phenomena, and developing algorithms.

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## Additional Considerations and Variations

While this article focuses on the specific functions provided, the process generalizes to other forms:

- Different types of functions, such as exponential, logarithmic, or trigonometric functions.
- Parameters and constants, which can be varied to model different scenarios.
- Inverse functions, which are often explored in conjunction with compositions.

Furthermore, when  $a$  is not specified, the expression remains in a general form, allowing for flexible application depending on context.

## Conclusion

The process of finding  $G(f(x))$  showcases the elegance and utility of function composition in mathematics. Starting from the individual definitions of  $f(x)$  and  $G(x)$ , we methodically substitute and simplify to arrive at a quadratic expression scaled by a parameter  $a$ . Such exercises deepen conceptual understanding and equip learners with the tools necessary for tackling more advanced problems involving nested functions. Whether in pure mathematics or applied sciences, mastering function composition is an indispensable skill that opens doors to a multitude of analytical techniques and insights.

## **For All Values Of $x^2$ $f(x) = x^2 + 2$ And $G(x) = 3x + 1$ A Find $Gf(x)$ Giving Your Answer In The Form**

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