WILL GIVE BRAINLIESTGiven The Parent Function G(x) = Log2 XWhat Is The Equation Of The Function Shownin

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Understanding logarithmic functions is fundamental in algebra and higher mathematics, as they provide essential tools for solving exponential equations, modeling real-world phenomena, and analyzing data patterns. When presented with a parent logarithmic function, such as $G(x) = \log_2 x$, mathematicians and students alike seek to comprehend how transformations influence its graph and equation. In this article, we will explore in detail the process of determining the equation of a logarithmic function given a graph, focusing specifically on the parent function $G(x) = \log_2 x$. We will cover the properties of logarithmic functions, how to interpret transformations from the graph, and how to derive the precise equation of the transformed function.

This comprehensive guide aims to equip you with the knowledge and skills necessary to analyze logarithmic functions thoroughly, making it an invaluable resource for students preparing for exams, educators teaching algebra, or anyone interested in understanding the behavior of logarithmic graphs.

Understanding the Parent Function $G(x) = \log_2 x$

What Is a Logarithmic Function?

A logarithmic function is the inverse of an exponential function. For the base b, where $b > 0$ and $b \neq 1$, the logarithmic function is defined as:

$$
y = \log_b x
$$

This equation states that y is the exponent to which the base b must be raised to produce x. Mathematically:

$$
b^y = x
$$

For example, if $b=2$:

$$
\log_2 x = y \quad \text{means} \quad 2^y = x
$$

The parent function $G(x) = \log_2 x$ is the simplest form of a logarithmic function with base 2, serving as the fundamental reference point for transformations.

Key Properties of $G(x) = \log_2 x$

Understanding the core properties of the parent logarithmic function helps interpret its graph and how transformations affect it:

- Domain: $x > 0$. The function is only defined for positive real numbers.
- Range: $-\infty < y < \infty$. The output can be any real number.
- Vertical Asymptote: The y-axis ($x=0$) is a vertical asymptote; the graph approaches but never touches this line.
- Intercept: The graph passes through $(1, 0)$ because $\log_2 1 = 0$.
- Growth Pattern: The function increases slowly for larger x, reflecting the logarithmic growth.

Recognizing Transformations in Logarithmic Graphs

When analyzing a transformed logarithmic function, it’s essential to identify the transformations applied to the parent function $G(x) = \log_2 x$. These transformations can include shifts, stretches, compressions, and reflections.

Types of Transformations

Transformations are generally described by modifying the equation with parameters that affect the graph's shape and position:

1. Vertical Shifts: $f(x) = \log_2 x + k$

- Shifts the graph up by k units if $k > 0$.
- Shifts down by k units if $k < 0$.

2. Horizontal Shifts: $f(x) = \log_2 (x - h)$

- Moves the graph to the right by h units if $h > 0$.
- Moves to the left if $h < 0$.

3. Vertical Stretch/Compression and Reflection: $f(x) = a \cdot \log_2 x$

- $a > 1$: vertical stretch (graph becomes steeper).

- $0 < a < 1$: vertical compression.
- Negative a: reflects the graph across the x-axis.

4. Horizontal Stretch/Compression and Reflection: $f(x) = \log_2 (b x)$

- $b > 1$: compresses the graph horizontally.
- $0 < b < 1$: stretches the graph horizontally.
- Negative b: reflection across the y-axis (not typical in logarithmic functions because the domain must remain positive).

How to Find the Equation of a Logarithmic Function from Its Graph

Given a graph of a logarithmic function, the goal is to determine its equation, which involves identifying transformations applied to the parent function. The process involves several steps:

Step 1: Identify Key Points

Find points on the graph, especially those that are easy to read, such as $(1, 0)$, and other points that appear to be visible. These points help establish the equation parameters.

Step 2: Determine Horizontal and Vertical Shifts

- Look for the point where the graph crosses the x-axis (usually at $x=1$ for the parent function). If this point shifts, note its new position.
- Find the y-intercept if possible, or other points that provide insight into vertical shifts.

Step 3: Examine the Shape and Asymptote

- Check the vertical asymptote: the line $x=0$ for the parent function. Is it shifted?
- Observe the steepness of the graph to infer stretching or compression.

Step 4: Write the General Equation

Express the function as:

$$
f(x) = a \cdot \log_b (x - h) + k
$$

where:

- a affects the steepness.
- b is the base (commonly 2, but could be different).
- h and k are the horizontal and vertical shifts, respectively.

Step 5: Use Known Points to Solve for Parameters

Plug in the known points to create equations. For example, if (x_1, y_1) is a point on the graph:

$$
y_1 = a \cdot \log_b (x_1 - h) + k
$$

Solve for the unknown parameters.

Example: Deriving the Equation from the Graph

Suppose you have a graph similar to the parent function $G(x) = \log_2 x$, but shifted and stretched. The key points identified are:

- The graph passes through $(2, 1)$
- The vertical asymptote is at $x=1$
- The graph crosses the y-axis at $y=-2$

Step 1: Recognize the asymptote at $x=1$, suggesting a horizontal shift $h = 1$.

Step 2: Use the point $(2,1)$:

$$
1 = a \cdot \log_b (2 - 1) + k
$$

Since the parent function has base $b=2$:

$$
1 = a \cdot \log_2 (1) + k
$$

But $\log_2 1 = 0$, so:

$$
1 = a \cdot 0 + k \Rightarrow k = 1
$$

\]

Step 3: Use the point where the graph crosses the y-axis at $(x, y) = (x, -2)$. Notice that the graph does not necessarily cross the y-axis at $x=0$, but we can find the corresponding x value by considering the shifts. Alternatively, if the point $(x, y) = (1, -2)$ is on the graph:

$$
-2 = a \cdot \log_2 (1 - h) + k
$$

But since the asymptote is at $x=1$, the logarithm argument becomes zero, which is undefined, so this point is likely not on the graph. Instead, suppose at $x=3$, the graph passes through $y = 2$:

$$
2 = a \cdot \log_2 (3 - 1) + 1
$$

$$
2 = a \cdot \log_2 2 + 1
$$

$$
2 = a \cdot 1 + 1
$$

$$
a = 1
$$

Step 4: Final Equation:

$$
f(x) = \log_2 (x - 1) + 1
$$

This matches the observed transformations: a shift to the right by 1 unit and an upward shift by 1 unit.

Common Mistakes to Avoid When Determining Logarithmic Equations

- Ignoring the domain restrictions: Remember that the argument of the logarithm must be positive; the domain is constrained accordingly.
- Misidentifying the asymptote: The vertical asymptote is always at $x=h$ in the transformed function $f(x) = a \cdot \log_b (x - h) + k$.
- Incorrectly calculating parameters: Use multiple points to verify the parameters, rather than

relying on a single

Frequently Asked Questions

What is the parent function G(x) in the given problem?

The parent function G(x) is the logarithmic function $G(x) = \log_2 x$.

How do you find the equation of a transformed logarithmic function given its graph?

You identify the transformations (shifts, stretches, reflections) from the graph and apply them to the parent function $G(x) = \log_2 x$ to determine the specific equation.

What does a shift to the right or left look like in the logarithmic function's equation?

A shift to the right by h units results in the equation $\log_2(x - h)$, while a shift to the left by h units results in $\log_2(x + h)$.

How can vertical shifts be represented in the logarithmic function?

Vertical shifts are represented by adding or subtracting a constant: $\log_2 x + k$ shifts the graph vertically by k units.

What is the significance of the asymptote in the graph of a logarithmic function?

The vertical asymptote of a logarithmic function is the line $x = 0$, which is where the function is undefined and the graph approaches but never touches.

How do you determine the base of the logarithm from the graph?

The base of the logarithm (here, base 2) determines the shape of the graph; knowing the parent function $G(x) = \log_2 x$ helps identify the base directly.

What transformations would turn $G(x) = \log_2 x$ into its shifted or scaled version?

Transformations such as horizontal shifts, vertical shifts, reflections, and stretches/compressions are applied to the parent function to match the graph shown.

If a logarithmic graph passes through the point (4,1), what can you say about its equation?

Since $\log_2 4 = 2$, if the point (4,1) lies on the graph, the equation likely includes a vertical shift, for example, $\log_2 x - 1$, or involves other transformations.

What is the general form of the equation of a logarithmic function after transformations?

The general form is $y = a \cdot \log_b (x - h) + k$, where a is a vertical stretch/compression and reflection, b is the base, h is the horizontal shift, and k is the vertical shift.

How does understanding the parent function help in graphing logarithmic functions?

Knowing the parent function $G(x) = \log_2 x$ provides a baseline shape and asymptote, making it easier to identify how transformations affect the graph and to write the equation accordingly.

Additional Resources

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Understanding the transformation of functions is a fundamental part of mastering algebra and precalculus. When presented with a parent function such as $G(x) = \text{Log}_2\, x$, students and educators alike often seek to determine the specific equation of a transformed or shifted version of this function. The question "Given the parent function $G(x) = \text{Log}_2\, x$, what is the equation of the function shown in?" invites a detailed exploration of how transformations influence the characteristics and equations of logarithmic functions. This article provides a comprehensive guide to analyzing such transformations, including shifts, stretches, compressions, and reflections, enabling you to accurately identify the equation of the transformed logarithmic function.

Understanding the Parent Function: $G(x) = \text{Log}_2\, x$

Before diving into transformations, it’s essential to understand the foundational parent function:

- $G(x) = \text{Log}_2\, x$ is a logarithmic function with base 2.
- Its domain is all positive real numbers: $(0, \infty)$.
- Its range is all real numbers: $(-\infty, \infty)$.
- The vertical asymptote is at $x = 0$, meaning the graph approaches but never touches the y-axis.
- The key point on the graph is (1, 0), because $\log_2 1 = 0$.
- The graph is increasing, passing through (1, 0), and slowly rising to infinity as x increases, approaching the asymptote as x approaches 0 from the right.

Visualizing this parent function is crucial. It resembles a curve that rises gradually from negative infinity near x=0 and continues upward as x increases.

The Nature of Logarithmic Transformations

Transformations of logarithmic functions follow specific rules, similar to those for linear and exponential functions. They often involve:

- Horizontal shifts (left or right)
- Vertical shifts (up or down)
- Vertical stretches or compressions
- Reflections across axes

Understanding how each transformation modifies the parent function allows you to reconstruct the equation of the altered graph.

General Form of Transformed Logarithmic Functions

The most common form of a transformed logarithmic function is:

$f(x) = a \log_b (k(x - h)) + d$

Where:

- a: vertical stretch or compression (and reflection if negative)
- b: base of the logarithm (commonly 2, e, 10, etc.)
- k: affects the horizontal stretch/compression
- h: horizontal shift ($h > 0$ shifts right; $h < 0$ shifts left)
- d: vertical shift ($d > 0$ shifts up; $d < 0$ shifts down)

In many problems, the base is specified or given as 2, which is the case here with $G(x) = \text{Log}_2\, x$.

Step-by-Step Approach To Find The Equation of the Transformed Function

1. Identify the parent function.
For this problem, it's $G(x) = \text{Log}_2\, x$.

2. Analyze the graph (or description) of the transformed function.
Notice key features like shifts, stretches, or reflections.

3. Determine the transformations applied.
Look for:
- Horizontal shifts (e.g., the graph moved right or left)
- Vertical shifts (up or down)
- Stretches/compressions
- Reflections

4. Use key points and asymptotes.
Find points that are easy to read off the graph (such as where the graph crosses specific x-values or y-values). Use these points to set up equations.

5. Construct the equation.
Apply the transformations to the parent function equation.

Common Transformations and How They Affect the Equation

Transformation	Effect on Equation	Example
Horizontal shift right by h	Replace x with (x - h) in the argument	$G(x) = Log_2(x - h)$
Horizontal shift left by h	Replace x with (x + h)	$G(x) = Log_2(x + h)$
Vertical stretch by factor a	Multiply the entire function by a	$G(x) = a\ Log_2\ x$
Vertical compression by factor a	Multiply by 1/a	$G(x) = (1/a)\ Log_2\ x$
Reflection across x-axis	Multiply by -1	$G(x) = -Log_2\ x$
Vertical shift up by d	Add d to the function	$G(x) = Log_2\ x + d$
Vertical shift down by d	Subtract d from the function	$G(x) = Log_2\ x - d$

Practical Example: Decoding the Graph

Suppose the graph shown has the following features:

- The vertical asymptote appears at x = 3.
- The graph passes through the point (4, 1).
- The graph is increasing, passing through (4, 1).

Step 1: Determine the horizontal shift

- The parent function $G(x) = Log_2\ x$ has an asymptote at x=0.
- The transformed graph's asymptote is at x=3, indicating a horizontal shift to the right by 3.

Thus, the argument of the logarithm is shifted:

`x` becomes `(x - 3)`.

Step 2: Use a known point to find the vertical stretch and vertical shift

- The point (4, 1) lies on the transformed graph.
- Substitute into the general form:

`$f(x) = a\ Log_2\ (x - 3) + d$`

Plug in x=4, y=1:

`$1 = a\ Log_2\ (4 - 3) + d$`

Simplify:

`$1 = a\ Log_2\ 1 + d$`

Recall that Log$_2$ 1 = 0:

`1 = a 0 + d`

Therefore:

`d = 1`

This indicates the graph has been shifted up by 1.

Step 3: Determine the vertical stretch/compression

- Since Log$_2$ 1 = 0, the point (4, 1) is consistent with the equation, but to find a, look for another point or consider the behavior at another x-value.

Suppose at x=5, the y-value is 2. (This is hypothetical for illustration.)

Plug in x=5:

`2 = a Log$_2$ (5 - 3) + 1`

Simplify:

`2 = a Log$_2$ 2 + 1`

Recall Log$_2$ 2 = 1:

`2 = a 1 + 1`

Solve for a:

`a = 1`

Thus, the vertical stretch factor is 1, meaning no stretch or compression; the graph is just shifted.

Final Equation:

`f(x) = Log$_2$(x - 3) + 1`

Summary: Constructing the Equation

Based on the features,

- The horizontal shift is right by 3 units: `(x - 3)`
- The vertical shift is up by 1: `+ 1`
- The base remains 2, as the parent function is Log$_2$.

Resulting equation:

$f(x) = \text{Log}_2(x - 3) + 1$

Additional Considerations

- Reflections: If the graph is reflected across the x-axis, multiply the entire function by -1.
- Scaling: Adjust the coefficient a to stretch or compress vertically.
- Multiple transformations: Apply each transformation step-by-step, following the order of operations (horizontal shifts inside the log, then stretches/compressions, then shifts).

Conclusion

Determining the equation of a logarithmic function when given its parent function $G(x) = \text{Log}_2 x$ involves understanding how various transformations modify the basic graph. By analyzing key points, asymptotes, and the shape of the graph, you can identify shifts, stretches, reflections, and shifts to reconstruct the exact equation.

Mastering these steps not only helps in solving specific problems but also deepens your understanding of how logarithmic functions behave under transformations. Remember, practice with different graphs and transformations will strengthen your ability to quickly and accurately identify the equations of transformed logarithmic functions.

Final Note

Always verify your derived equation by plotting the key points and ensuring they match the given graph. This process confirms the accuracy of your transformations and your understanding of the parent function's modifications.

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