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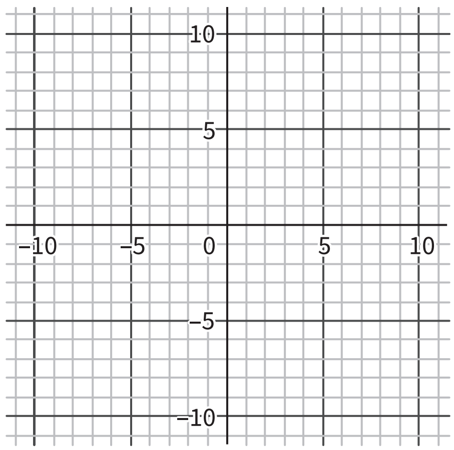
Lesson 2: Falling Off a Log

Solidify Understanding

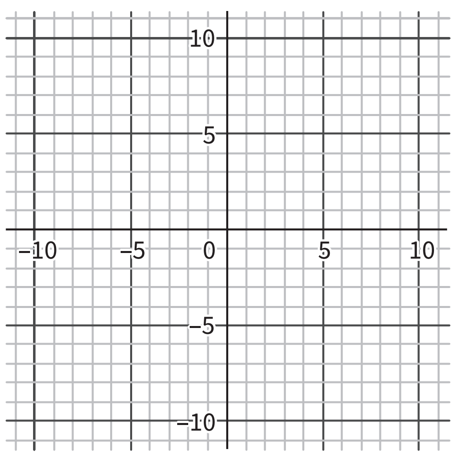
Jump Start

Graph each pair of functions on the same graph.

1. $y = x^2$ and $y = -(x+1)^2 + 3$



2. $y = 2^x$ and $y = 2^x - 3$



Learning Focus

Identify common features of the graphs of logarithmic functions.

Transform the graph of a logarithmic function.

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What are the features of the graphs of logarithmic functions?

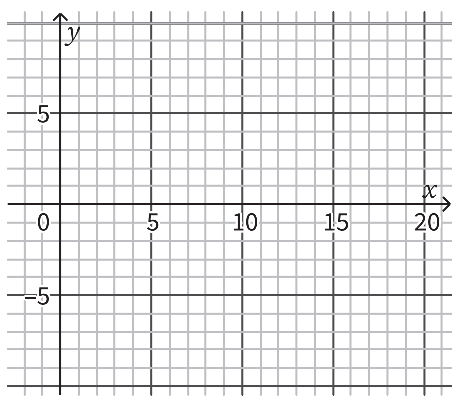
How can we use the features of the parent function to transform logarithmic functions?

How does transforming the graphs of logarithimic functions compare to transforming quadratic functions?

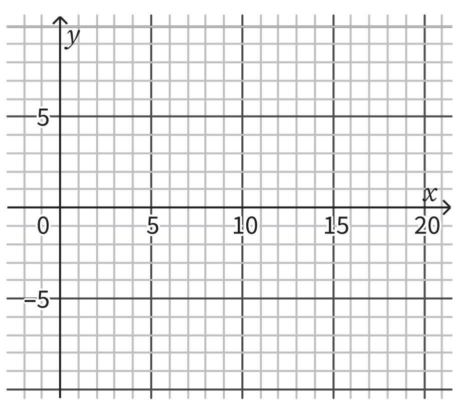
Open Up the Math
Launch, Explore, Discuss

1. Construct a table of values and a graph for each of the following functions. Be sure to select at least two values in the interval $0 < x < 1$.

   a. $f(x) = \log_2 x$

   b. $g(x) = \log_3 x$

   c. $k(x) = \log_{10} x$

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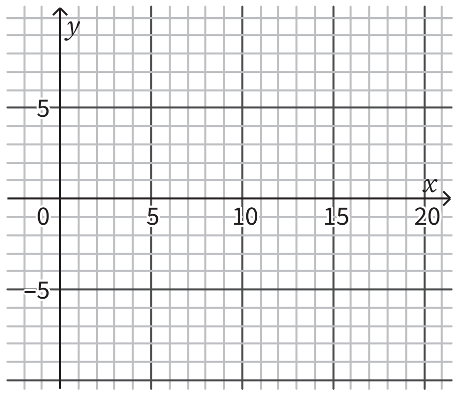

2. How did you decide what values to use for x in the table?

3. How did you use the x-values to find the y-values in the table?

4. What similarities do you see in the graphs?

5. What differences do you observe in the graphs?

6. What is the effect on the graph of changing the base on the graph of a logarithmic function?

Let's focus now on $k(x) = \log_{10} x$ so that we can use technology to observe the effects of changing parameters on the function. Because base 10 is a commonly used base for exponential and logarithmic functions, it is often abbreviated and written without the base, like this: $k(x) = \log x$.

7. Use technology to graph $y = \log x$. How does the graph compare to the graph that you constructed?

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8. How do you predict that the graph of $y = a + \log x$ will be different from the graph of $y = \log x$?

9. Test your prediction by graphing $y = a + \log x$ for various values of a. What is the effect of a on the graph? Make a general argument for why this would be true for all logarithmic functions.

10. How do you predict that the graph of $y = \log(x + b)$ will be different from the graph of $y = \log x$?

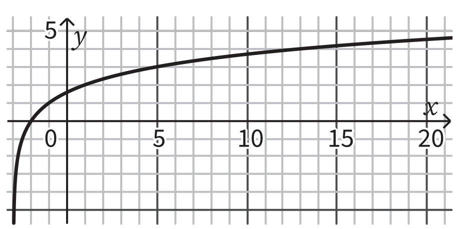
11. Test your prediction by graphing $y = \log(x + b)$ for various values of b.

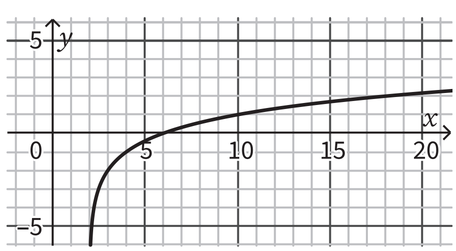
    a. What is the effect of adding b?

    b. What will be the effect of subtracting b (or adding a negative number)?

    c. Make a general argument for why this is true for all logarithmic functions.

12. Write an equation for each of the following functions that are transformations of $f(x) = \log_2 x$.

    a. 

    b. 

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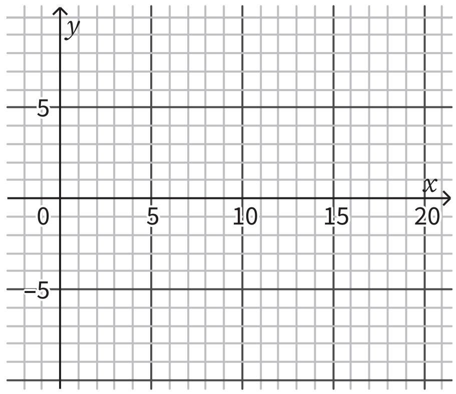
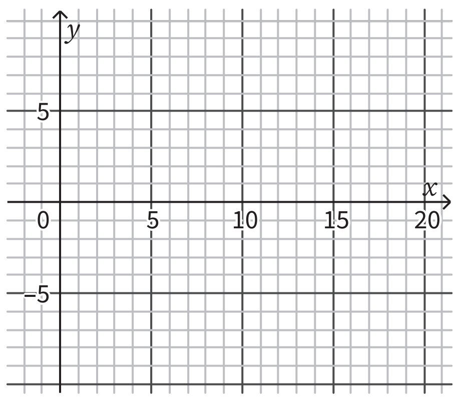
13. Graph each of the following functions:

a. $f(x) = 2 + \log_2(x - 1)$



b. $g(x) = -1 + \log_2(x + 2)$



14. Compare the transformation of the graphs of logarithmic functions with the transformation of the graphs of quadratic functions. What similarities and differences do you observe?

Ready for More?

Graph: $y = 3\log_2 x$.

What is the effect on the graph of the 3 in the equation?

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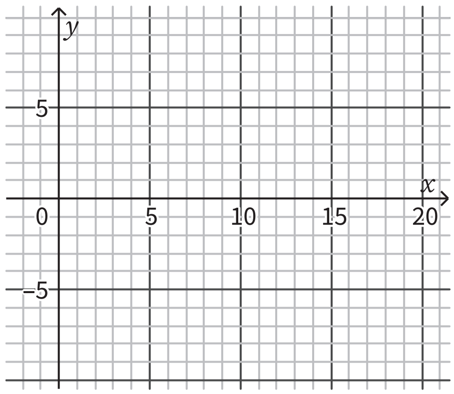
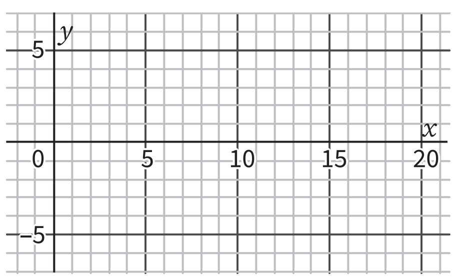


Takeaways

Features of logarithmic functions, $b > 1$:



Quick Graphs for Logarithmic Functions:

1.

2.

3.

Demonstrating with the function:
$y = -2 + \log_2(x - 1)$.

1.

2.

3.

Adding Notation, Vocabulary, and Conventions

Vertical asymptote:

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Vocabulary

- **asymptote**
- horizontal shift
- parent function
- reflection
- transformations on a function (rigid)
- **vertical asymptote**
- vertical shift
- vertical stretch

Bold terms are new in this lesson.

Lesson Summary

In this lesson, we graphed logarithmic functions by hand and used technology to determine common features in the graphs. We used technology to identify how the transformations appear in the equations of logarithmic functions. We examined graphs and wrote equations for the transformed functions, and we graphed transformed functions given the equations.

Retrieval

1. **a.** Evaluate: $\log_2 128$

   b. Evaluate: $\log_5 125$

2. Rewrite $\left(5x^{-3}\right)^{-2} \cdot 5x^{-4}$. Your answer should have only positive exponents.