Name_____ Date _____

6.4 Transformations of Exponential and Logarithmic Functions

For use with Exploration 6.4

Essential Question How can you transform the graphs of exponential and logarithmic functions?

1 EXPLORATION: Identifying Transformations

Work with a partner. Each graph shown is a transformation of the parent function

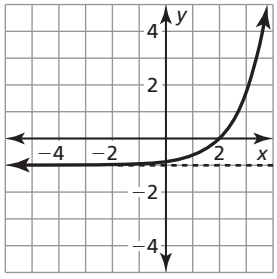
$$f(x) = e^x \quad \text{or} \quad f(x) = \ln x.$$

Match each function with its graph. Explain your reasoning. Then describe the transformation of f represented by g.

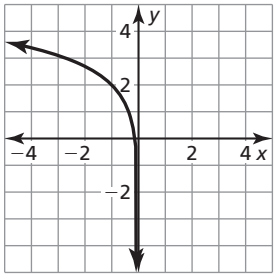
a. $g(x) = e^{x+2} - 3$ **b.** $g(x) = -e^{x+2} + 1$ **c.** $g(x) = e^{x-2} - 1$

d. $g(x) = \ln(x + 2)$ **e.** $g(x) = 2 + \ln x$ **f.** $g(x) = 2 + \ln(-x)$

A.



B.



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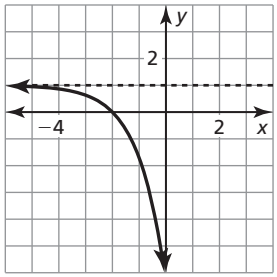
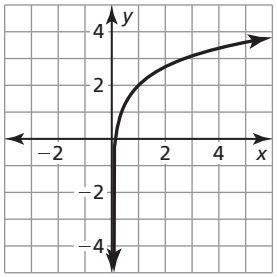
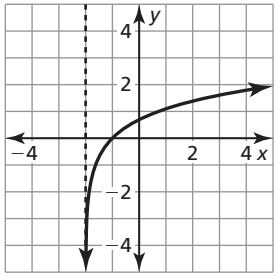


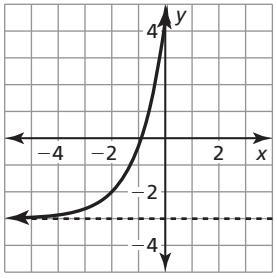
D.



E.



F.



2 EXPLORATION: Characteristics of Graphs

Work with a partner. Determine the domain, range, and asymptote of each function in Exploration 1. Justify your answers.

Communicate Your Answer

3. How can you transform the graphs of exponential and logarithmic functions?

4. Find the inverse of each function in Exploration 1. Then check your answer by using a graphing calculator to graph each function and its inverse in the same viewing window.

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6.4 Notetaking with Vocabulary

For use after Lesson 6.4

In your own words, write the meaning of each vocabulary term.

exponential function

logarithmic function

transformations

Core Concepts

Transformation	$f(x)$ Notation	Examples	
Horizontal Translation Graph shifts left or right.	$f(x - h)$	$g(x) = 4^{x-3}$ $g(x) = 4^{x+2}$	3 units right 2 units left
Vertical Translation Graph shifts up or down.	$f(x) + k$	$g(x) = 4^{x} + 5$ $g(x) = 4^{x} - 1$	5 units up 1 unit down
Reflection Graph flips over x- or y-axis.	$f(-x)$ $-f(x)$	$g(x) = 4^{-x}$ $g(x) = -4^{x}$	over y-axis over x-axis
Horizontal Stretch or Shrink Graph stretches away from or shrinks toward y-axis	$f(ax)$	$g(x) = 4^{2x}$ $g(x) = 4^{x/2}$	shrink by $\frac{1}{2}$ stretch by 2
Vertical Stretch or Shrink Graph stretches away from or shrinks toward x-axis	$a \bullet f(x)$	$g(x) = 3(4^{x})$ $g(x) = \frac{1}{4}(4^{x})$	stretch by 3 shrink by $\frac{1}{4}$

Notes:

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6.4 Notetaking with Vocabulary (continued)

Transformation	$f(x)$ Notation	Examples	
Horizontal Translation Graph shifts left or right.	$f(x - h)$	$g(x) = \log(x - 4)$ $g(x) = \log(x + 7)$	4 units right 7 units left
Vertical Translation Graph shifts up or down.	$f(x) + k$	$g(x) = \log x + 3$ $g(x) = \log x - 1$	3 units up 1 unit down
Reflection Graph flips over x- or y-axis.	$f(-x)$ $-f(x)$	$g(x) = \log(-x)$ $g(x) = -\log x$	over y-axis over x-axis
Horizontal Stretch or Shrink Graph stretches away from or shrinks toward y-axis	$f(ax)$	$g(x) = \log(4x)$ $g(x) = \log\left(\frac{1}{3}x\right)$	shrink by $\frac{1}{4}$ stretch by 3
Vertical Stretch or Shrink Graph stretches away from or shrinks toward x-axis	$a \cdot f(x)$	$g(x) = 5 \log x$ $g(x) = \frac{2}{3} \log x$	stretch by 5 shrink by $\frac{2}{3}$

Notes:

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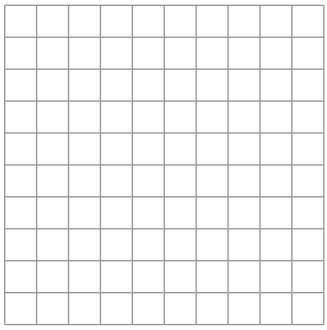
6.4 Notetaking with Vocabulary (continued)

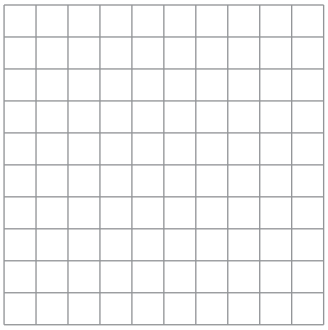
Extra Practice

In Exercises 1–6, describe the transformation of *f* represented by *g*. Then graph each function.

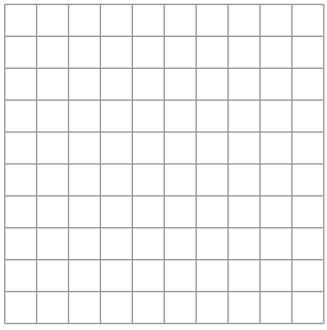
1. $f(x) = 6^x, g(x) = 6^x + 6$



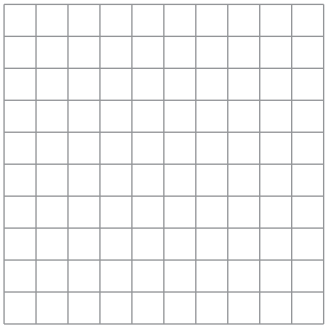
2. $f(x) = e^x, g(x) = e^{x-4}$



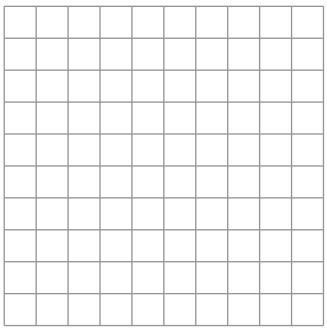
3. $f(x) = \log_5 x, g(x) = \frac{1}{2}\log_5(x + 7)$



4. $f(x) = \log_{1/3} x, g(x) = \log_{1/3} x - \frac{4}{3}$



5. $f(x) = \left(\frac{1}{5}\right)^x, g(x) = \left(\frac{1}{5}\right)^{-3x} + 4$



6. $f(x) = \log x, g(x) = -3\log(x - 2)$