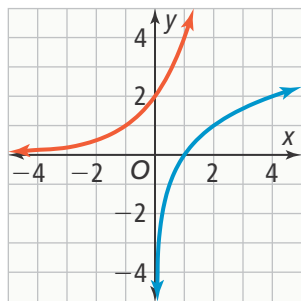




UNDERSTAND

7. **Look for Relationships** Are the logarithmic and exponential functions shown inverses of each other? Explain.



8. **Communicate Precisely** How is the graph of the logarithmic function $g(x) = \log_2(x - 7)$ related to the graph of the function $f(x) = \log_2 x$? Explain your reasoning.
9. **Error Analysis** Describe and correct the error a student made in finding the inverse of the exponential function $f(x) = 5^{x-6} + 2$.

$$y = 5^{x-6} + 2$$

$$x = 5^{y-6} + 2$$

$$x - 2 = 5^{y-6}$$

$$y - 6 = \log_5 x - 2$$

$$y = \log_5 x - 2 + 6$$

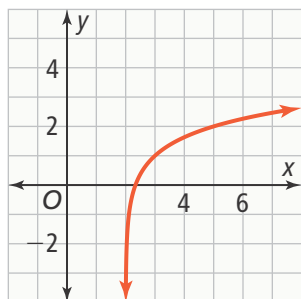
$$y = \log_5 x + 4$$

$$f^{-1}(x) = \log_5 x + 4$$

Write in $y = f(x)$ form.
Interchange x and y .
Subtract 2 from each side.
Rewrite in logarithmic form.
Add 6 to each side.
Simplify.



10. **Make Sense and Persevere** The number of members m who joined a new workout center w weeks after opening is modeled by the equation $m = 1.6^{w+2}$, where $0 \leq w \leq 10$. Find the inverse of the function and explain what the inverse tells you.
11. **Use Structure** The graph shows a transformation of the parent graph $f(x) = \log_3 x$. Write an equation for the graph.



PRACTICE

Graph each function and identify the domain and range. List any intercepts or asymptotes. Describe the end behavior. SEE EXAMPLE 1

12. $y = \log_5 x$ 13. $y = \log_8 x$
14. $y = \log_{\frac{3}{10}} x$ 15. $y = \log_{0.1} x$

Describe the graph in terms of transformations of the parent function $f(x) = \log_6 x$. Compare the asymptote and x -intercept of the given function to the parent function. SEE EXAMPLE 2

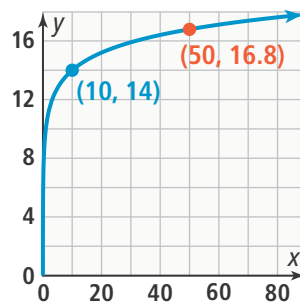
16. $g(x) = \frac{1}{2} \log_6 x$ 17. $g(x) = \log_6(-x)$
18. Describe how the graph of $g(x) = -\ln(x + 0.5)$ is related to the graph of $f(x) = \ln x$. SEE EXAMPLE 2

Find the equation of the inverse of each function.

SEE EXAMPLE 3

19. $f(x) = 5^{x-3}$ 20. $f(x) = \left(\frac{1}{2}\right)^{x-1}$
21. $f(x) = 6^{x+7}$ 22. $f(x) = \log_2(8x)$
23. $f(x) = \ln(x + 3) - 1$ 24. $f(x) = 4 \log_2(x - 3) + 2$
25. The altitude y , in feet, of a plane t minutes after takeoff is approximated by the function $y = 5,000 \ln(.05t) + 8,000$. Solve for t in terms of y . What is a situation in which it would be easier to use your new equation rather than the original? SEE EXAMPLE 4
26. Find the average rate of change of the function graphed below over the interval $10 \leq x \leq 50$. Compare it to the average rate of change of $y = 3 \log x + 12$ over the same interval.

SEE EXAMPLE 5



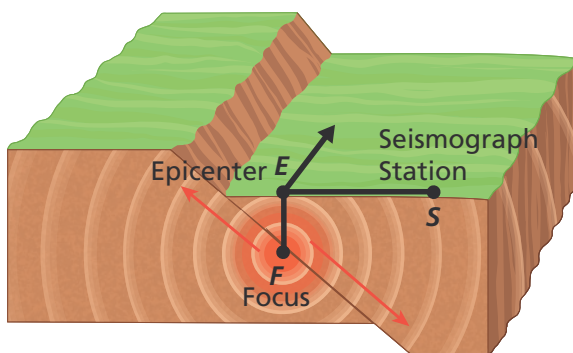
APPLY

- 27. Model with Mathematics** The equation $r = 90 - 25 \log(t + 1)$ is to model a student's retention r after taking a physics course where r represents a student's test score (as a percent), and t represents the number of months since taking the course.
- Make a table of values for ordered pairs that represent $r = 90 - 25 \log(t + 1)$, rounding to the nearest tenth. Then sketch the graph of the function on a coordinate plane through those ordered pairs. (You may use a graphing calculator to check.)
 - Find the equation of the inverse. Interpret the meaning of this function.

- 28. Higher Order Thinking** As shown by the diagram, an earthquake occurs below Earth's surface at point F (the focus). Point E , on the surface above the focus, is called the *epicenter*. A seismograph station at point S records the waves of energy generated by the earthquake. The surface wave magnitude M of the earthquake is given by this formula:

$$M = \log\left(\frac{A}{T}\right) + 1.66(\log D) + 3.3$$

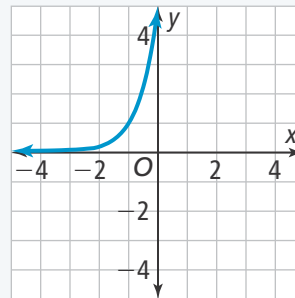
In the formula, A is the amplitude of the ground motion in micrometers, T is the period in seconds, and D is the measure of ES in degrees.



- Find surface wave magnitude of an earthquake with $A = 700$ micrometers, $T = 2$ and $D = 100^\circ$.
- In the formula, $20^\circ < D \leq 160^\circ$. By how much can the size of arc ES affect the surface wave magnitude? Explain.

ASSESSMENT PRACTICE

- 29.** The logarithmic function $g(x) = \ln x$ is transformed to $h(x) = \ln(x + 2) - 1$. Which of the following are true? Select **all** that apply.
- $g(x)$ is translated 2 units upward.
 - $g(x)$ is translated 2 units to the right.
 - $g(x)$ is translated 2 units to the left.
 - $g(x)$ is translated 1 unit downward.
 - $g(x)$ is translated 1 unit to the left.
 - The vertical asymptote shifts 2 units to the left.
 - The vertical asymptote shifts 2 units to the right.
- 30. SAT/ACT** The graph shows the exponential function $f(x) = 5^{x+1}$. Which of the following functions represents its inverse, $f^{-1}(x)$?



- $f^{-1}(x) = 1 + \log_5 x$
 - $f^{-1}(x) = \log_5 x - 1$
 - $f^{-1}(x) = \log_5(x - 1)$
 - $f^{-1}(x) = \log_5(x + 1)$
- 31. Performance Task** The logarithmic function $M(d) = 5 \log d + 2$ is used to find the limiting magnitude of a telescope, where d represents the diameter of the lens of the telescope (mm) that is being used for the observation.
- Part A** Find the limiting magnitude of a telescope having a lens diameter of 40 mm.
- Part B** Find the equation of the inverse of this function.
- Part C** Interpret why astronomers may wish to use the inverse of this function. Justify your reasoning.
- Part D** Using the inverse function, find the diameter of the lens that has a limiting magnitude of 13.5. Check your answer with the table function of your graphing calculator.