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Definition of Logarithms

take note

Key Concept Logarithm

A **logarithm** base b of a positive number x satisfies the following definition.

For $b > 0$, $b \neq 1$, $\log_b x = y$ if and only if $b^y = x$.

You can read $\log_b x$ as "log base b of x." In other words, the logarithm y is the exponent to which b must be raised to get x.

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Problem 1 Writing Exponential Equations in Logarithmic Form

Got It? What is the logarithmic form of each equation?

a. $36 = 6^2$ **b.** $\frac{8}{27} = \left(\frac{2}{3}\right)^3$ **c.** $1 = 3^0$

A Practice Write each equation in logarithmic form.

1. $\left(\frac{1}{3}\right)^3 = \frac{1}{27}$ **2.** $10^{-2} = 0.01$

Problem 2 **Evaluating a Logarithm**

Got It? What is the value of each logarithm?

a. $\log_5 125$

c. $\log_{64} \frac{1}{32}$

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A Practice Evaluate each logarithm.

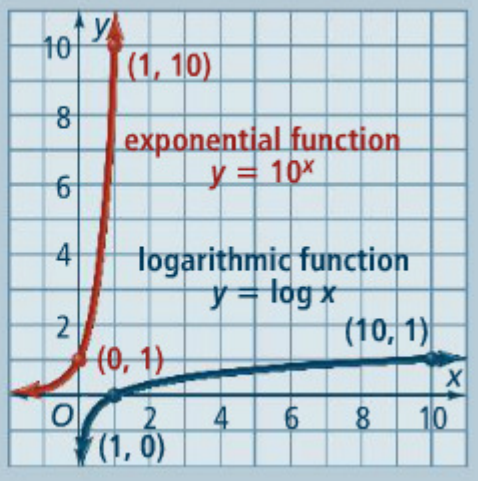
3. $\log_{49} 7$

4. $\log_2 16$

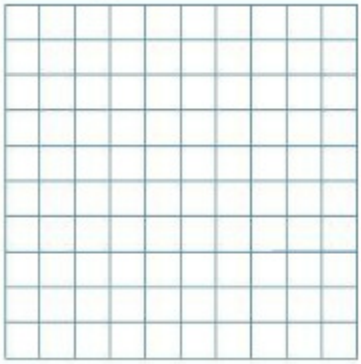
A **common logarithm** is a logarithm with base 10. You can write a common logarithm $\log_{10} x$ simply as $\log x$, without showing the 10.

A **logarithmic function** is the inverse of an exponential function. The graph shows $y = 10^x$ and its inverse $y = \log x$. Note that $(0, 1)$ and $(1, 10)$ are on the graph of $y = 10^x$, and that $(1, 0)$ and $(10, 1)$ are on the graph of $y = \log x$.

Recall that the graphs of inverse functions are reflections of each other across the line $y = x$. You can graph $y = \log_b x$ as the inverse of $y = b^x$.



Graph $y = 2^x$

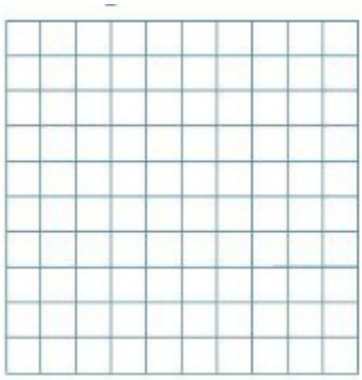


Problem 4 Graphing a Logarithmic Function

A Practice Graph each function on the same set of axes.

7. $y = \log_2 x$

8. $y = \left(\frac{1}{2}\right)^x$



take note

Concept Summary Families of Logarithmic Functions

Parent function:	$y = \log_b x,\ b > 0,\ b \neq 1$
Stretch ($\lvert a\rvert > 1$) Compression (Shrink) ($0 < \lvert a\rvert < 1$) Reflection ($a < 0$) in x-axis	$y = a \log_b x$
Translation (horizontal by h; vertical by k)	$y = \log_b(x - h) + k$
All transformations together	$y = a \log_b(x - h) + k$

Problem 5 Translating $y = \log_b x$

Got It? How does the graph of each function compare to the graph of the parent function?

a. $y = \log_2(x - 3) + 4$

b. $y = 5 \log_2 x$

Practice Describe how the graph of each function compares with the graph of the parent function, $y = \log_b x$.

9. $y = \log_3(x - 5) + 3$

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10. $y = \log_4(x + 2) - 1$