

Sec. 3.2 Logarithmic Functions and Their Graphs

- Objectives**
- How to recognize and evaluate logarithmic functions with base a
 - How to graph logarithmic functions
 - How to recognize, evaluate and graph natural logarithmic functions
 - How to use logarithmic functions to model and solve real-life problems

Logarithms \rightarrow (log) Means the exponent in a problem

2 ways to express numbers with logs(exponents)

Log Form

$$\log_a y = x$$

$$\log_2 8 = 3$$

Common log

Natural log

Exponent Form

$$a^x = y$$

\rightarrow

\rightarrow

\rightarrow

\rightarrow

\rightarrow

$$3^2 = 9$$

$$10^2 = 100$$

base 10

base e

$e \approx 2.71828$ symbol \rightarrow ln

Properties of log and ln

$$\log_a 1 = 0$$

$$\log_a a = 1$$

$$\log_a a^x = x$$

$$\ln 1 = 0$$

$$\ln e = 1$$

$$\ln e^x = x$$

Ex.1 Solve without a calculator

$$\log_2 \frac{1}{8}$$

$$\log 1000$$

$$\log_{27} 9$$

$$\log_7 x = \log_7 9 \quad \ln e^x$$

$$\ln 4 = \ln x$$

Ex. 2 Solve with a calculator

$$\log_{10} \frac{4}{5}$$

$$\log 12.5$$

$$\ln 2$$

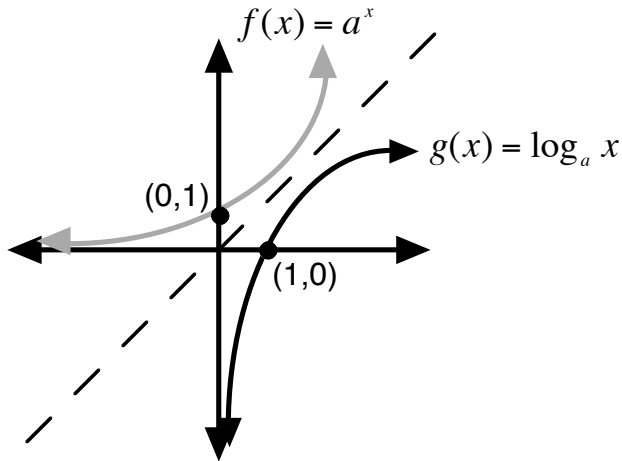
$$\ln e^2$$

$$\log_5 12$$

$$\ln(-1)$$

Ex. 3 Graph of log and In

Inverse of exponential function from Sec. 3.1
 The graph is the reflection over the line $y=x$.



Always looks like this

Domain $(0, \infty)$

Range $(-\infty, \infty)$

Vertical Asymptote $x = 0$

Continuous

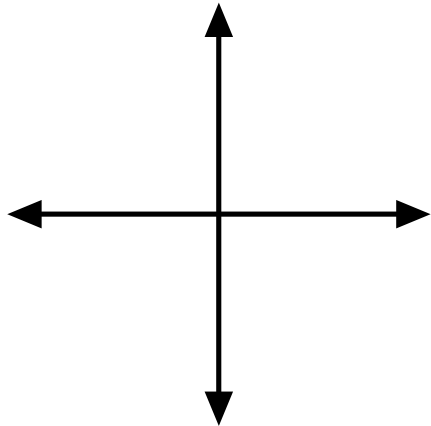
Increases

x-int $(1, 0)$

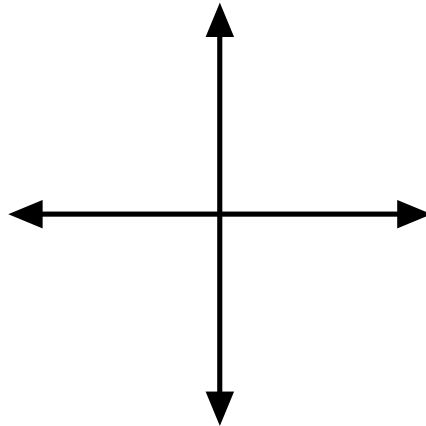
Ex. 4 Transformations (Same as in Sec 3.1)

Graph the following and find x intercept.

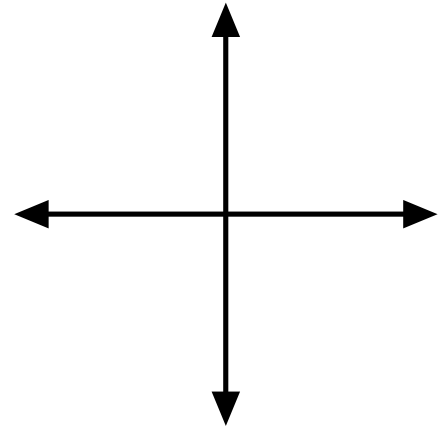
$$f(x) = \log(x - 1)$$



$$f(x) = \ln x + 2$$



$$f(x) = \ln(x - 2) + 1$$

**Ex. 5 Finding the Domain of Logarithmic Functions**

$$f(x) = \ln(x - 2)$$

$$f(x) = \ln(2 - x)$$

$$f(x) = \ln x^2$$

Ex. 6 Human Memory Model

Students participating in a psychological experiment attended several lectures on a subject. At the end of the last lecture, and every month for the next year, the students were tested to see how much of the material they remembered. The average scores for the group were given by *human memory model*

$$f(t) = 75 - 6\ln(t + 1), \quad 0 \leq t \leq 12, \text{ where } t \text{ is the time in months.}$$

- What was the average score on the original ($t = 0$) exam?
- What was the average score at the end of $t = 2$ months?
- What was the average score at the end of $t = 6$ months?