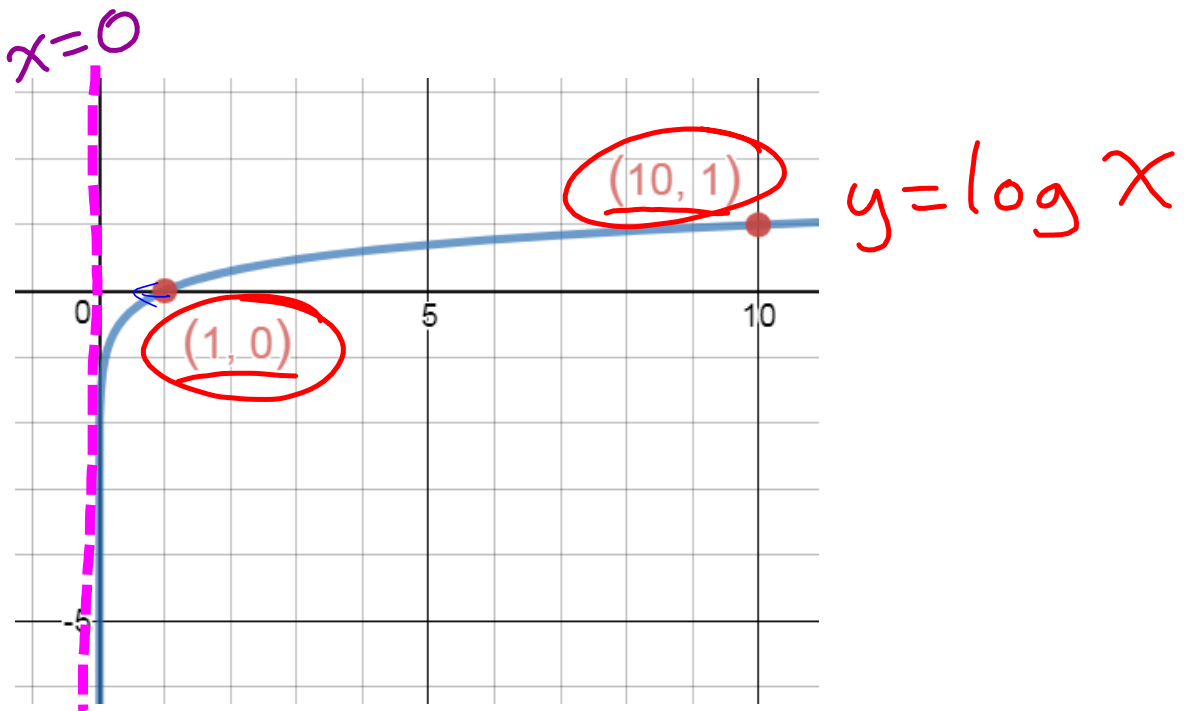


Transformations of Logarithms

$$y = a \log (k (x - d)) + c$$

- | | | | |
|---|--|--|---|
| <p>↑
- V. Stretch
$a > 1$</p> <p>- V. Compression
$a < 1$</p> <p>- reflection
in x-axis</p> | <p>↑
- H. Stretch
$k < 1$</p> <p>- H. Compression
$k > 1$</p> <p>- reflection in
y-axis.</p> | <p>↑
left
(x+d)</p> <p>right
(x-d)</p> | <p>↑
up
+ c</p> <p>down
- c</p> |
|---|--|--|---|



Logarithm Laws

Power Law of Logarithms

$$\log_b a^x = x \log_b a$$

Evaluate

$$\begin{aligned} & \log_3 9^4 \quad 3^x = 9 \\ & = 4 \log_3 9 \\ & = 4(2) \\ & = 8 \end{aligned}$$

$$\begin{aligned} & \log_2 8^5 \\ & = 5 \log_2 8 = 3 \quad 2^x = 8 \\ & = 5 \times 3 \\ & = 15 \end{aligned}$$

$$\begin{aligned} & \log_3 (3^2)^4 \\ & \log_3 9^4 \\ & = 4 \log_3 3^2 \\ & = 8 \log_3 3 \\ & = 8 \end{aligned}$$

$$\begin{aligned} & \log_5 \sqrt[2]{125} \\ & = \log_5 (125)^{1/2} \\ & = \frac{1}{2} \log_5 125 \\ & \quad 5^x = 125 \\ & = \frac{1}{2} \log_5 5^3 \\ & = \frac{3}{2} \log_5 5 = 1 \\ & = \frac{3}{2} \end{aligned}$$

A handwritten diagram illustrating the relationship between powers of x. On the left, a blue 'x' is shown. To its right is an equals sign. To the right of the equals sign is a blue square root symbol. Inside the square root symbol is a red 'b'. To the right of the square root symbol is another blue 'x'. To the right of this 'x' is a red 'a'. Above the 'x' on the left, there are two red circles. The top circle contains a red 'a', and the bottom circle contains a red 'b'. A red arrow points from the 'a' in the top circle to the 'a' on the right. Another red arrow points from the 'b' in the bottom circle to the 'b' inside the square root symbol. A blue arrow points from the 'x' on the left to the 'x' inside the square root symbol.

We can use the power law to solve for an unknown exponent, by taking the log of both sides.

Ex. Solve for x

$$1.04^x = 3$$

$$\log 1.04^x = \log 3$$

$$\frac{x \log 1.04}{\log 1.04} = \frac{\log 3}{\log 1.04}$$

$$x = 28.01$$

Jake puts \$1000 into a bank account that pays him 4% per year, compounded monthly. How long does Jake need to keep his money in the bank before it will double?

$$A = A_0 (1 + i)^t$$

$$A = 1000 (1 + 0.00333\dots)^t$$

$$\frac{2000}{1000} = \frac{1000 (1.00333)^t}{1000}$$

$$2 = (1.00333)^t$$

$$\log 2 = \log 1.00333^t$$

$$\log 2 = t \log 1.00333$$

$$\frac{\log 2}{\log 1.00333} = t$$

$$t = 208.3$$

Change of Base Formula

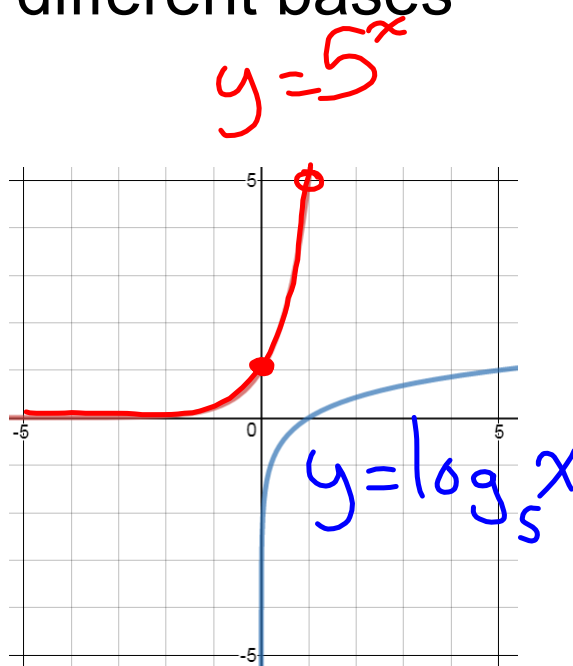
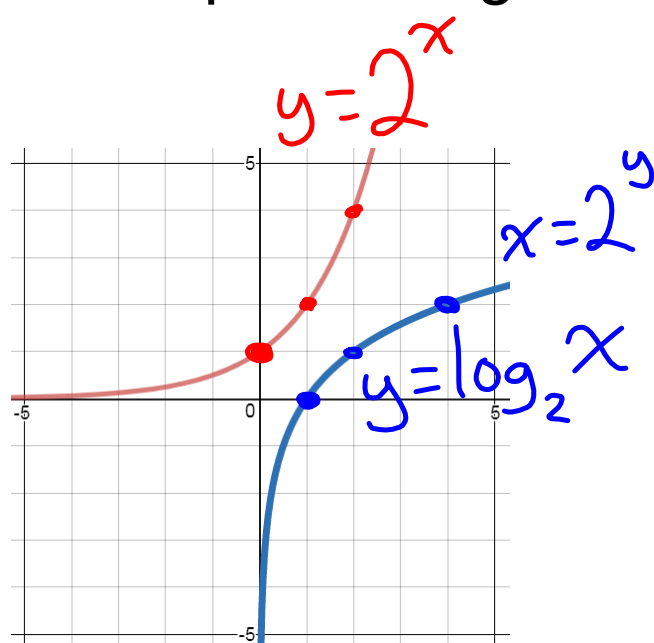
$$\log_b a = \frac{\log a}{\log b}$$

Evaluate

$$\log_3 21$$
$$= \frac{\log 21}{\log 3}$$
$$= 2.77$$

$$\log_{\frac{1}{2}} 20$$
$$= \frac{\log 20}{\log \frac{1}{2}}$$
$$= -4.32$$

Graphs of Logs with different bases



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1 - 6, 9, 10

