Level 1 Evaluate Logarithmic Functions Name:

Use the Definition of Log to Evaluate and solve these log equations

Level 1 Logs are exponents, so when you see the expression $log_5(125)$ use the **definition of log** and ask yourself… **what does the base** 5 **need as an exponent, to become** 125? The answer is 3 because $5^3 = 125$	$log_4(16)$ 2	$log_4(64)$
$log_5(0)$ not possible $5^? = 0$	$log_5(1)$	$log_2(32)$

Solve these Equations using the Definition of Log.

Level 1 Remember, **logs are exponents**, so the thing on the other side of the equal sign is the exponent for the base from the log. $log_x(49) = 2$ Base is x and 2 is exponent. $x^2 = 49$ Square root both sides. x = 7 and -7, but log bases can't be negative. So, x = 7 only	$log_4(1) = x$ answer is exponent base $4^x = 1$ $x = 0$	$log_x(36) = 2$	$log_x(81) = 4$
	$log_3(x) = 3$	$log_5(x) = 0$	$log_8\left(\frac{1}{64}\right) = x$ $8^x = \frac{1}{64}$ $8^x = 8^{-2}$ $x = -2$

$\frac{2}{1} \cdot \frac{1}{2} = 1$

$\frac{2}{2} = 1$

$(x^2)^{\frac{1}{2}} = (49)^{\frac{1}{2}}$

$x = 49^{(1/2)}$

negative exponents make fractions

Use Change of Base Formula to Evaluate these logs.

Level 1 If there is not an exact whole number answer that can be the exponent, then we use the **change of base formula**. But first make an estimate. $log_{12}(110)$ should be just under 2 because $12^2 = 144$ $\frac{\log(\textit{of what you want})}{\log(\textit{of the base you need})} = \frac{log(110)}{\log(12)}$ 1.89	$log_4(15)$ $\frac{\log(15)}{\log(4)} = 1.95$ Note $4^2 = 16$ should be less than 2	$log_{2.4}(64)$
	$log_5(2)$	$log_2(60)$

Base like basement

Level 2 Apply Properties of Logarithmic Functions

Name:

Condense these log expressions into one single logarithm.

Turn Fractions into coefficients

Power Rule: coefficients move to exponent

Product Rule: anything added or positive is multiplied on top

Quotient Rule: anything subtracted or negative is divided on bottom

Simplify like terms, exponents

Fraction exponents become radicals

Level 2 $7\log_5(m) - \frac{1\cdot\log_5(2)}{6} + 2\log_5(m)$ $7\log_5(m) - \frac{1}{6}\log_5(2) + 2\log_5(m)$ $\log_5(m^7) - \log_5(2^{\frac{1}{6}}) + \log_5(m^2)$ $\log_5\left(\frac{m^7 \cdot m^2}{2^{\frac{1}{6}}}\right)$ $\log_5\left(\frac{m^9}{\sqrt[6]{2}}\right)$	$6\log_7(x) + 24\log_7(y)$ $\log_7(x^6) + \log_7(y^{24})$ $\log_7(x^6 \cdot y^{24})$	$2\log_8(x) - 6\log_8(x)$ $\log_8(x^2) - \log_8(x^6)$ $\log_8\left(\frac{x^2}{x^6}\right)$ $\log_8\left(\frac{1}{x^4}\right)$ $\frac{x^2}{x^6} = x^{2-6} = x^{-4}$ $\frac{x \cdot x \cdot 1}{x \cdot x \cdot x \cdot x \cdot x \cdot x}$
	$\frac{\log_9 a}{3} + \frac{\log_9 b}{3} + \frac{\log_9 c}{3}$ $\log_9 a^{1/3} + \log_9 b^{1/3} + \log_9 c^{1/3}$ $\log_9(a^{1/3} b^{1/3} c^{1/3})$ $\log_9(\sqrt[3]{abc})$	$18\ln u + 3\ln u$ $\ln u^{18} + \ln u^3$ $\ln(u^{18} \cdot u^3)$ $\ln(u^{21})$

Expand these log expressions into multiple logarithms.

Level 2 This is the above in the reverse order. Remember: • things that are multiplied are added • things that are divided are subtracted • exponents become coefficients	$\log\frac{x}{y}$ ~~$\log x - y$~~ $\log(x) - \log(y)$	$\log(u \cdot v)$
	$\log_2\frac{x^2y^4}{w}$	$\log_3(\sqrt{(a\cdot b)} \div c$ $\log_3(a \cdot b \div c)^{1/2}$ $\log_3(a^{1/2} b^{1/2} \div c^{1/2})$ $\log_3 a^{1/2} + \log_3 b^{1/2} - \log_3 c^{1/2}$ $\frac{1}{2}\log_3 a + \frac{1}{2}\log_3 b - \frac{1}{2}\log_3 c$

Logarithms and bases with exponents are Inverses.

Level 2 Logarithm functions were created to undo exponential functions. So if you have 5^3, to cancel the base 5, you take $\log_5$ of it, and the exponent is all that is left. $\cancel{\log_5}(5^3)$ Log with same base cancels that base holding the exponent Leaving just: 3 Things to know: Log is $\log_{10}$ and ln is $\log_e$ we call it the "Natural Log" $e = 2.718....$	$\cancel{\log_2}(2^4)$ 4 Side Note $2^? = 2^4$	$3^{\log_3(5)}$	$\log_e(e^{41})$
	$\cancel{e}^{\ln(1.25)}$ $\cancel{e}^{\log_e(1.25)}$ 1.25	$\log(10^{90})$	$10^{\log x}$

Level 3 Graphing Log Functions

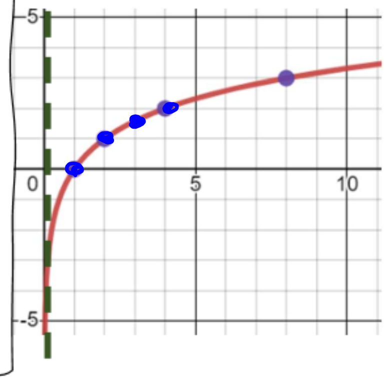
Graph the functions and identify the key features.

x	$y = log_2(\ )$ → $2^? = (\ )$	(x, y)
0	$y = log_2(0)$ → $2^? = (0)$ → Nothing	Asymptote X = 0
1	$y = log_2(1)$ → $2^? = (1)$ → 0	(1,0)
2	$y = log_2(2)$ → $2^? = (2)$ → 1	(2,1)
3	$y = log_2(3)$ → $2^? = (3)$ → some decimal, so skip	(3, ?)
4	$y = log_2(4)$ → $2^? = (4)$ → 2	(4,2)

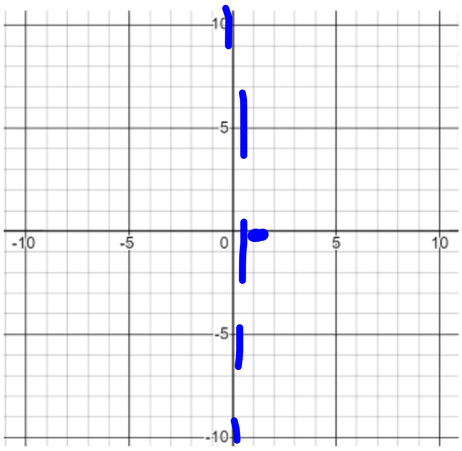
$\frac{\log(3)}{\log(2)}$

Notice that the **asymptote here is a vertical line** instead of a horizontal line, so it is "x=" not "y=". Logs cannot be taken of negative numbers or 0.

$y = log_2(x)$



1. $y = log_3(x)$



x	$y = log_3(\ )$ → $3^? = (\ )$	(x, y)
0	$y = log_3(0)$ → $3^? = (0)$ → Nothing	Asymptote X = 0
1	$y = log_3(1) \to 3^? = 1 \to 0$	(1, 0)
3		(3,)
9		

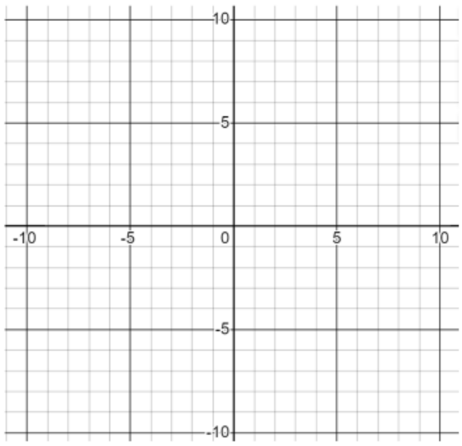
What is the Vertical Asymptote? X = 0

What is the Domain? L to R $< x <$

What is the Range? low to high $< y <$

What is the x-intercept? when y=0 (1,0)

2. $y = log_{10}(x)$



x	$y = log_{10}(\ )$ → $10^? = (\ )$	(x, y)
0		
1		
10		

What is the Vertical Asymptote?

What is the Domain?

What is the Range?

What is the x-intercept?