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NOTES: Section 7.4 – Evaluate Logarithms and Graph Logarithmic Functions

Goals: #1 - I can interchange between exponential and logarithmic form.

#2 - I can evaluate a logarithm without using a calculator.

#3 - I can evaluate common and natural logarithms with a calculator.

#4 - I can simplify a logarithm.

#5 - I can find the inverse of an exponential function or logarithm.

#6 - I can graph a logarithm.

Homework: Lesson 7.4 Worksheet

Exploration #1: Work with a partner and answer the following questions.

1. Find the value of x in each exponential equation.

a. $2^x = 8$ $x = 3$

b. $3^x = 9$ $x = 2$

c. $4^x = 2$ $x = 1/2$

d. $5^x = 1$ $x = 0$

e. $5^x = \frac{1}{5}$ $x = -1$

f. $8^x = 2$ $x = 1/3$

Notes:

We know that $2^2 = 4$ and $2^3 = 8$. However, for what value of x does $2^x = 6$?

Mathematicians define this x-value using a logarithm and write $x = \log_2 6$.

The logarithm of y with base b is defined as:

$\log_b y = x$ if and only if $b^x = y$

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Example #1: Rewrite the equations.

Logarithmic Form	Exponential Form
1. $\log_2 32 = 5$	$2^5 = 32$
2. $\log_7 1 = 0$	$7^0 = 1$
3. $\log_{13} 13 = 1$	$13^1 = 13$
4. $\log_{1/2} 2 = -1$	$\frac{1}{2}^{-1} = 2$
5. $\log_3 x = 5$	$3^5 = x$
6. $y = \log_6 x$	$6^y = x$
7. $\log_8 y = x$	$8^x = y$
8. $\log_4 64 = 3$	$4^3 = 64$
9. $\log_5 25 = 4x$	$25 = 5^{4x}$

Notes:

Logarithms evaluate powers. To help you find the value of a $\log_b y$ ask yourself "what power of "b" gives you "y"?"

Example #2: Evaluate the logarithm.

1. $\log_3 81$

$3^? = 81$

4

2. $\log_4 0.25$

$4^? = \frac{1}{4}$

-1

3. $\log_{1/4} 256$

$\frac{1}{4}^? = 256$

-4

4. $\log_{49} 7$

$49^? = 7$

$\frac{1}{2}$

You practice: Evaluate the logarithm.

1. $\log_{1/5} 25$

$\frac{1}{5}^? = 25$

-2

2. $\log_{10} 0.001$

$10^? = \frac{1}{1000}$

-3

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Notes:

A Common logarithm is a logarithm with base 10.

Common Logarithm: $\log_{10} x = \log x$

A Natural logarithm is a logarithm with base e.

Natural Logarithm: $\log_e x = \ln x$

Most calculators have keys for evaluate common and natural logarithms.

Practice: Evaluate the common and natural logarithms using your calculator.

1. $\log 8 =$ 0.9031
2. $\ln 0.3 =$ −1.204

Notes:

By the definition of a logarithm, it follows that the logarithmic function $g(x) = \log_b x$ is the inverse of the exponential function $f(x) = b^x$.

This means that: $\log_b b^x = x$ $\quad b^{\log_b x} = x$

$b^? = b^x$

$\boxed{x}$

Example #3: Simplify the expression.

1. $e^{\ln 9}$ $\boxed{9}$
2. $\log_3(3^4)$ $\boxed{4}$
3. $\log_2 64^x$ $\log_2(2^{6x})$ $\boxed{6x}$

You practice: Simplify the expression.

1. $8^{\log_8 x}$ $\boxed{x}$
2. $\log_5 25^x$ $\log_5 5^{2x}$ $\boxed{2x}$
3. $10^{\log 4}$ $\boxed{4}$

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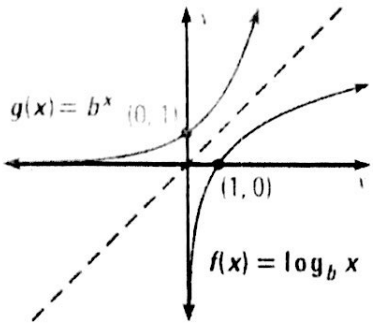
Notes:

Logarithmic and exponential functions are inverses of each other.

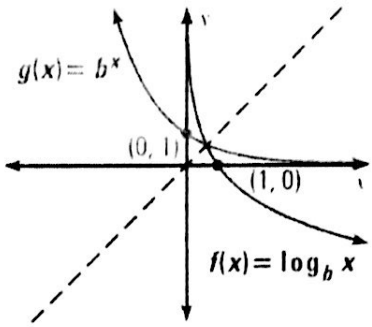
Graph of $f(x) = \log_b x$ for $b > 1$



D: $(0, \infty)$

R: $(-\infty, \infty)$

Graph of $f(x) = \log_b x$ for $0 < b < 1$



D: $(0, \infty)$

R: $(-\infty, \infty)$

To find the inverse of these functions, we will rewrite the equation and switch the x and y.

To graph logarithmic functions, we will rewrite the equation.

Example #4: Find the inverse of the function.

1. $y = \log_{3/2} x$

① Rewrite

$(3/2)^y = x$

② Switch

$\boxed{(3/2)^x = y}$

2. $y = e^x$

① Rewrite

$\ln y = x$

② Switch

$\boxed{\ln x = y}$

You practice: Find the inverse of the function.

1. $y = \ln(x - 4)$

$e^y = x - 4$

$e^x = y - 4$

$+4 \quad +4$

$\boxed{y = e^x + 4}$

2. $y = 6^x$

$\log_6 y = x$

$\boxed{\log_6 x = y}$

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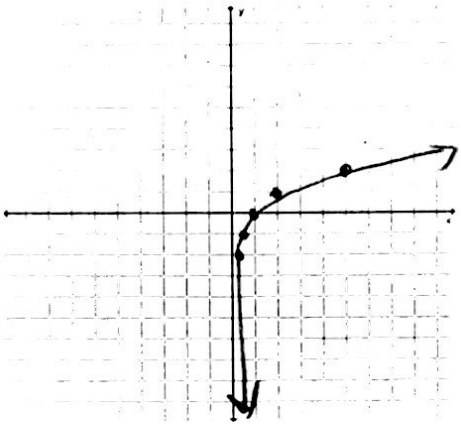
Example #4: Graph the following logarithmic functions. State the domain and range.

1. $y = \log_2 x$ → $2^y = x$



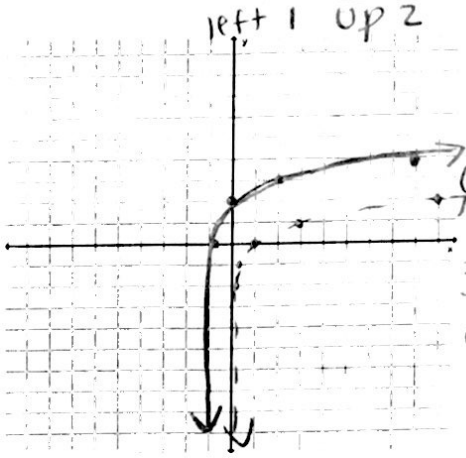
X	y
0.25	-2
0.5	-1
1	0
2	1
4	2

Domain: $(0, \infty)$

Range: $(-\infty, \infty)$

2. $y = \log_3(x-1)+2$ $3^y = x$

left 1 up 2



X	y
0.1	-2
0.3	-1
1	0
3	1
9	2

Domain: $(-1, \infty)$

Range: $(-\infty, \infty)$