Name:____ Period: ___________

Accel. Pre-Calculus

Unit 10 Packet

Logarithms Unit

10.01 Exponentials Review Date: ____________________

Properties of Exponents:

Product of Powers	
Quotient of Powers	
Power of a Product	
Power of a Quotient	
Power of a Power	
Negative Exponent	
Zero Exponent	
Rational Exponent	

Simplify. Your answers should only contain positive exponents.

1. $(4a^3b^{-2})^3$

2. $(x^3)^3 2x^{-1}$

3. $\left(\frac{x^{-2}}{y^4}\right)^3$

4. $\frac{a^4b^2}{ab^5}$

5. $\frac{z}{(2z^0)^2}$

6. $\left(\frac{3^{4x}}{3^{2x}}\right)^3$

Evaluate.

7. 2^{-5}

8. $36^{1/2}$

9. $27^{4/3}$

10. $8^{-2/3}$

Solve.

11. $10^{4x+3} = 10^{2x+23}$

12. $3^x = 9^{x-2}$

13. $25^{2x-4} = 125^{x+4}$

10.01 Practice:

Simplify. Your answers should only contain positive exponents.

1. $(x^{-2}x^{-3})^4$

2. $\frac{3xy^3 2y^3}{3x^2y^{-4}}$

3. $\frac{2a^{-4}}{(2a^{-4})^3}$

Solve.

4. $27^x = 3^{2x+3}$

5. $8^{2x+2} = 4^{x+15}$

6. $3^{x^2} + 5 = 6$

7. $16^a \cdot 64^{3-3a} = 64$

8. $243^{x+2} \cdot 9^{2x-1} = 9$

9. $\frac{125^{-3a}}{25^{3a}} = 125$

10. $2^x \cdot \frac{1}{32} = 32$

11. $\frac{4^{3x-1}}{64} = 4^x$

12. $\frac{343^{-2x}}{49^{x-3}} = 5^0$

10.02 Intro to Log Function **Date: ______________________**

A logarithmic function is the *inverse* of an exponential function.

Definition: Let *b* and *y* be positive numbers with *b ≠ 1*. Then, the ***logarithm of y with base b*** is denoted by $\log_b y$ and is defined as follows:

$$\log_b y = x \text{ if and only if } b^x = y$$

Examples: Convert from exponential form into logarithmic form.

1. $2^3 = 8$
2. $5^{-3} = \frac{1}{125}$
3. $81^{1/4} = 3$

Examples: Convert from logarithmic form into exponential form.

4. $\log_5 25 = 2$
5. $\log_7 \frac{1}{343} = -3$
6. $\log_{32} 2 = \frac{1}{5}$

- ***Common log*** is log base 10
- Denoted as $\log N$, it is understood to mean $\log_{10} N$
- The LOG button on the calculator evaluates $\log_{10} N$

- ***Natural log*** is log base e
- Denoted as $\ln N$, it is understood to mean $\log_e N$
- The LN button on the calculator evaluates $\log_e N$

Examples: Rewrite in exponential form.

7. $\log 100 = 2$
8. $\ln 7 = x$

Examples: Rewrite in logarithmic form.

9. $10^{-2} = \frac{1}{100}$
10. $e^2 = 7.389$

Examples: Evaluate the following logarithms.

11. $\log 1$
12. $\log_{64} 8$
13. $\log_5 \frac{1}{625}$

10.02 Homework: Evaluate each logarithmic expression.

1. $\log_5 125$

2. $\log_8 1$

3. $\log_6 \frac{1}{36}$

4. $\log_4 2$

5. $\log_7 -49$

6. $\log 10{,}000$

7. $\ln e^2$

8. $\log_{256} 4$

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

10. $\log \sqrt{10}$

11. $\log_{1/32} 2$

12. $\log_{\sqrt{3}} 27$

13. $\log_2 2^9$

14. $3 \cdot \ln e^4$

15. $\ln -5$

10.03 Properties of Logarithms **Date:** ____________________

Opener: Simplify the exponential expression.

1. $x^3 * x^7 * x$

2. $\frac{m^5n^2}{m^2n^9}$

3. $(g^4)^{11}$

Special properties of exponents and logarithms, where *b* is positive and not 1:

$\log_b 1 =$	Why?
$\log_b b =$	Why?
$\log_b b^x =$	Why?
$b^{\log_b x} =$	Why?

Properties of Logarithms:

Argument is a Product			
$\log_b u$	$\log_b v$	$\log_b uv$	General Rule:
$\log_2 4 =$	$\log_2 8 =$	$\log_2 32 =$	

Argument is a Quotient			
$\log_b u$	$\log_b v$	$\log_b \frac{u}{v}$	General Rule:
$\log_5 3125 =$	$\log_5 25 =$	$\log_5 125 =$	

Argument is a Power		
$\log_b u^n$	$n \log_b u$	General Rule:
$\log_2 4^5 =$	$5 \log_2 4 =$	

Examples: Use properties of logarithms to expand each expression. The expanded logarithm expressions should have arguments with no exponent, product, or quotient.

1. $\log_5 2x$ =

2. $\log_2 8a^2b^5$ =

3. $\log_7 \frac{g}{h}$

4. $\log_4 \frac{16w^3}{x^6}$

5. $\log \sqrt{r}$

6. $\ln \frac{a+1}{\sqrt[3]{b-2c}}$

Examples: Use properties of logarithms to condense each expression. The condensed logarithm expression should be written as a single logarithm with no coefficient.

7. $3\log 4 - 2\log k$

8. $-5\ \log_2(x+1) + 3\log_2(6x)$

9. $\frac{1}{3}\log_4 10 + \frac{1}{3}\log_4 h - 6\log_4 g$

10. $\ln(3m+5) - 4\ln m - \ln(m-1)$

11. $\log 20 + 2\log\frac{1}{2} - \log x + 3\log y$

10.03 Practice

Use properties of logarithms to expand each expression. The expanded logarithm expressions should have arguments with no exponent, product, or quotient.

1. $\ln\frac{4}{5}$

2. $\log_6 3x$

3. $\log\frac{7b}{\sqrt{c}}$

4. $\log_2\frac{m^4}{8n}$

5. $\ln\sqrt[3]{10g^2}$

6. $\log_3\frac{u-1}{v^5w^3}$

7. $\log\frac{a^2b}{\sqrt[5]{3a-1}}$

Use properties of logarithms to condense each expression. The condensed logarithm expression should be written as a single logarithm with no coefficient.

8. $\log_5 8 - \log_5 12$

9. $3 \ln x + 5 \ln y$

10. $10 \log k - 2 \log 3$

11. $\frac{1}{2} \log_5 36 + \log_5 r - 3 \log_5 p$

12. $2 \log_8 9 - 3 \log_8 c - 4 \log_8 d$

13. $3 \log n - \frac{1}{2} \log(6 - n) + \log 7$

14. $\frac{2}{5} \ln 32 - \left(3 \ln j - \frac{1}{2} \ln 9\right)$

10.03 More Practice with Log Properties Date: _______________

Choose "A" or "B" as the correct answer. Then, explain the mistake in the wrong answer.

		Answer A	**Answer B**
1.	Expand: $\log\left(\frac{j}{kp}\right)$	$\log j - \log k + \log p$	$\log j - \log k - \log p$
2.	Condense: $\frac{\log a}{4}$	$\log\left(\frac{a}{4}\right)$	$\log a^{1/4}$
3.	Expand: $\log cd^3$	$\log c + 3\log d$	$3\log c + 3\log d$
4.	Condense: $\frac{1}{2}\log m - 4\log r + \log u$	$\log\frac{\sqrt{m}}{r^4 u}$	$\log\frac{u\sqrt{m}}{r^4}$
5.	Expand: $\ln\sqrt[5]{z^2}$	$\frac{2\ln z}{5}$	$\frac{5\ln z}{2}$
6.	Condense: $\log_2(x+3) + \log_2(x-2)$	$\log_2(x+1)$	$\log_2(x^2+x-6)$
7.	Which is equivalent to: $5^x = 100$	$x = \log_5 100$	$x = \frac{100}{5}$
8.	Which is equivalent to: $e^2 = x$	$\log x = 2$	$\ln x = 2$
9.	Which is equivalent to: $\log_3 3^{2x}$	9^x	$2x$

Use the properties of logarithms to expand each expression to match with an equivalent one below. Then decode the answer to: **Why does a moon rock taste better than an Earth rock?**

1. $\log_4(xyz)$

2. $\log_4\left(\frac{x}{yz}\right)$

3. $\log_4 3x^4$

4. $\log_4\left(\frac{x^2y}{z}\right)$

5. $\log_4\left(\frac{3x^5}{y^2z}\right)$

6. $\log_4\left(\frac{6x^2y^8}{z^3}\right)$

7. $\log_4\left(\frac{6y^2z^5}{x^4}\right)$

8. $\log_4\left(\frac{3y^2z}{x^7}\right)$

9. $\log_4\left(\frac{xz^6}{\sqrt{y}}\right)$

$\log_4 3 + 5\log_4 x - 2\log_4 y + \log_4 z$ P	$4\log_4 3 + 4\log_4 x$ H
$\log_4 3 - 7\log_4 x + 2\log_4 y + \log_4 z$ E	$2\log_4 x + \log_4 y - \log_4 z$ M
$\log_4 3 + 5\log_4 x - 2\log_4 y - \log_4 z$ O	$\log_4 x + \log_4 y + \log_4 z$ A
$\log_4 6 - 4\log_4 x + 2\log_4 y + 5\log_4 z$ T	$\log_4 x - \log_4 y - \log_4 z$ S
$5\log_4 3 + 5\log_4 x - 2\log_4 y - \log_4 z$ H	$\log_4 x - \log_4 y + \log_4 z$ N
$\log_4 6 + 2\log_4 x + 8\log_4 y - 3\log_4 z$ I	$\log_4 3 + 4\log_4 x$ R
$6\log_4 x - \frac{1}{2}\log_4 y + 6\log_4 z$ C	$\log_4 x - \frac{1}{2}\log_4 y + 6\log_4 z$ L

___ ___   ___ ___   ___   ___ ___ ___ ___ ___ ___   ___ ___ ___ ___ ___ ___

6 7   6 2   1   9 6 7 7 9 8   4 8 7 8 5 3

10.04 Solving Exponential Equations Date: _______________

Recall the **One-to-One Property of Exponential Functions:**
$\boldsymbol{b^x = b^y}$ **if and only if** $\boldsymbol{x = y}$**.**

For this property to work, notice that the *bases must be the same*.
Examples: Solve each equation.

1. $32^{x+3} = 4^{2x+10}$

2. $\left(\frac{1}{3}\right)^{2x} = 81^{x-3}$

There is a similar property of logarithms:
One-to-One Property of Logarithmic Functions:
$\boldsymbol{log_b\, x = log_b\, y}$ **if and only if** $\boldsymbol{x = y}$.

Examples: Solve each equation.
3. $\log_4 x = \log_4 3 + \log_4 (x - 2)$

This property also works backwards: if x = y, then $\log_b x = \log_b y$.
This method is often called "*taking the log of both sides*" and is helpful to solve exponential equations.
Examples: Solve each equation.

4. $4^x = 1.5$

5. $3.2e^{2x} + 2.5 = 16.9$

6. $6^{2x+4} = 5^{-x+1}$

7. $2^{3x+11} = 9^{2x+1}$

8. $e^{2x} + 2e^{x} - 8 = 0$

9. $4e^{2x} + 8e^{x} = 5$

Practice:
Solve.

1. $4^{x+7} = 8^{x+3}$

2. $\left(\frac{9}{16}\right)^{3x-2} = \left(\frac{3}{4}\right)^{5x+4}$

3. $1.8^{x} = 9.6$

4. $8^{x} - 1 = 3.4$

5. $e^{2x} + 5 = 16$

6. $2.5e^{x+4} = 14$

7. $0.75e^{3.4x} - 0.3 = 80.1$

8. $7^{2x+1} = 3^{x+3}$

9. $9^{x+2} = 2^{5x-4}$

10. $e^{2x} - 15e^{x} + 56 = 0$

11. $6e^{2x} - 5e^{x} = 6$

12. $300 = \frac{400}{1+3e^{-2x}}$

10.05 Solving Logarithmic Equations Date: _______________

The opposite of taking the *log of both sides* is to take *exponentiate both sides*. This can be used to cancel a logarithm from one or more sides of an equation. To do this, make each side of the equation the exponent of the value of the base of the logarithm(s):
If $\log_b x = y$, then $b^{\log_b x} = b^y$.

This may have the effect of converting the logarithm into its exponential form.

Also, the argument of a logarithm ***must be positive***. **Check for extraneous solutions before moving on from each problem. Meaning if the value you get for *x* makes the argument either 0 or a negative, you must exclude that value from the solution set.

Examples: Solve each equation.

1. $-3 \ln x = -24$
2. $4 - 3 \log(5x) = 16$
3. $\log_3(x - 1) = -2$
4. $\log_2(x^2 - 4) = \log_2 21$

You may have to use properties to change the equation to have <u>*at most*</u> one logarithm on each side of the equation.

5. $3 \log_7 x = \log_7 64$
6. $\log_2 5 = \log_2 10 - \log_2(x - 4)$
7. $\log_4(x - 3) + \log_4(x + 1) = \log_4(6x - 18)$
8. $\ln(3x - 4) = 1 + \ln(2x + 3)$

Practice:

Solve. Don't forget to check for extraneous solutions!

1. $-8\log x = -64$

2. $2 + 3\log 3d = 5$

3. $14 + 20\ln 7x = 54$

4. $7{,}000\ln x = -21{,}000$

5. $log_8(x^2 + 11) = log_8 92$

6. $log_{11} 3x = log_{11}(x + 5) - log_{11} 2$

7. $\ln x + \ln(x + 7) = \ln 18$

8. $\ln(3x + 1) + \ln(2x - 3) = ln10$

9. $\ln(x - 3) + \ln(2x + 3) = \ln(-4x^2)$

10. $log(5x^2 + 4) = 2log3x^2 - log(2x^2 - 1)$

11. $\log(3x + 2) = 1 + log2x$

12. $log_9 9x - 2 = -log_9 x$

10.06 Solving Exponential and Log Equations - Lumberjack Activity

Name: ______________________________ Date: __________________ Period: _______

DOODLE-ING MATH

Why do Lumberjacks Make Good Music?

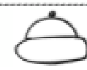
Directions: For each problem, solve the exponential or logarithmic function. Doodle or color on the lumberjack below according to your answer choice.

1. $2^{3x-19}=4$

If your answer is 7 color his pants grey.
If your answer is -7 color his pants blue.

2. $\log_2 x+\log_2(x+7)=3$

If your answer is 1 and -8 draw the following hat:



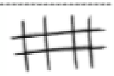
If your answer is 1 draw the following hat:

3. $2e^{2x}-7e^{x}+6=0$

If your answer is .69 and .41 color his hat red.
If your answer is 4.48 and 7.39 color his hat blue.

4. $\log(x+1)-\log(3x-2)=\log\left(\frac{2}{x}\right)$

If your answer is 1 draw the following pattern on his hat:



If your answer is 1 and 4 draw the following pattern on his hat:

5. $7^{x}=156$

If your answer is 22.3 draw a sledge hammer in his hands.

If your answer is 2.595 draw a guitar in his hands.

6. $3^{x^2-7}=27^{2x}$

If your answer is 7 and -1, draw the following shoes on the lumberjack:

If your answer is -7 and 1 draw the following shoes on the lumberjack:

7. $6\ln(2x)=12$

If your answer is 3.69 color his shoes yellow.
If your answer is 0 color his shoes brown.

8. $\log(x-3)=\log(7x-23)-\log(x+1)$

If your answer is -10 and 2 color his jacket red.
If your answer is 4 and 5 color his jacket blue.

9. $2\log_4 x-\log_4(x-1)=1$

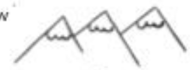
If your answer is 1 draw 3 chest hairs on the lumberjack.
If your answer is 2 draw 5 chest hairs on the lumberjack.

10. $\log_2(x+2)-\log_2(x-5)=3$

If your answer is 6, draw a pile of 6 logs next to the lumberjack.
If your answer is -4, draw a pile of 4 logs next to the lumberjack.

11. $27^{2x+4}=9^{x-2}$

If your answer is -6, draw 3 snowcapped mountains:



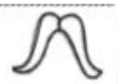
If your answer is -4, draw 3 mountains:

12. $\log_4(x-6)=-2$

If your answer is $\frac{291}{48}$ draw 2 trees near your log pile.
If your answer is $\frac{97}{16}$ draw 1 tree near your log pile.

13. $\ln\sqrt{2x-4}=0$

If your answer is 2, draw the following mustache on the lumberjack:



If your answer is 2.5 draw the following mustache on the lumberjack:

14. $e^{2x}-5e^{x}+6=0$

If your answer is .69 and 1.099 color his beard brown and his mustache grey.
If your answer is 1.792 color his beard grey and his mustache brown.

15. $\log_2(3x-1)=3$

If your answer is 3, the answer to the puzzle is: "because they've got natural logarithm."
If your answer is $\frac{10}{3}$ the answer to the puzzle is: "because they've got great logarithm."

Why do Lumberjacks Make Good Music?

15. ______________________________

10.07 Solving Exponential and Log Equations Solve the exponential/log equations

1. $5^{2x-1} = 5^4$

2. $3\log_2(x+2) = 6$

3. $\ln x + \ln 4 = 2$

4. $2\log x - \log 4 = 2$

5. $e^{2x} = 25$

6. $\log(3x-5) = \log(2x-1)$

7. $\frac{1}{25} = 5^{3x+2}$

8. $3^{2x-7} = 27^x$

9.

$$4^{x-1} = 4^3$$

10.

$$5^{2x+3} = 125^x$$

11.

$$\log(6x) = \log(4x + 5)$$

12.

$$2 \ln e^x = 9$$

13.

$$2 \log 3x - \log 9 = 1$$

14.

$$2 \ln x + \ln x^2 = 4$$

15.

$$\frac{1}{16} = 4^{3x-1}$$

16.

$$3 \ln e^{2x} = 30$$

17.

$$\ln e^{x+5} = 17$$

18.

$$\log x - \log 4 = 3$$

19.

$$\log(8 - 3x) = \log(7 - 5x)$$

20.

$$5\ln(3x - 2) = 15$$

21.

$$\log(3x - 2) = 3$$

22.

$$4^{x-1} = 64^{x}$$

23.

$$4\ln x = -2$$

24.

$$e^{x-4} = 2$$

25.
$$\ln x + \ln 4x = 16$$

26.
$$4 \log x = -4$$

27.
$$\frac{1}{4} = 2^{2x-3}$$

28.
$$\log 5x = \log(9 + 8x)$$

29.
$$\ln(x - 1) - \ln 2 = 3$$

30.
$$\ln x = -1$$

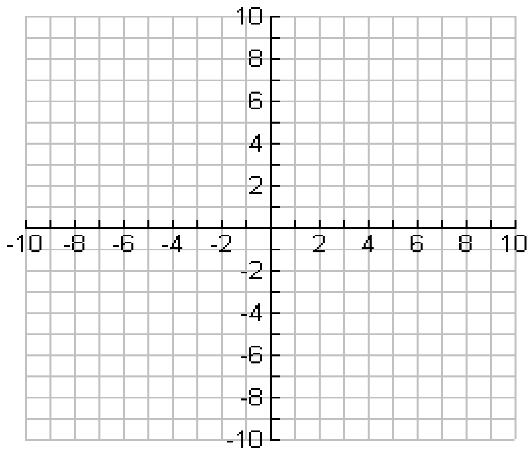
31.
$$e^{\frac{x}{5}} = 32$$

32.
$$-2 \log_3 6x = 2$$

10.08 Intro to Graphing Logarithmic Functions **Date:** ______________

Graph $f(x) = 2^x$

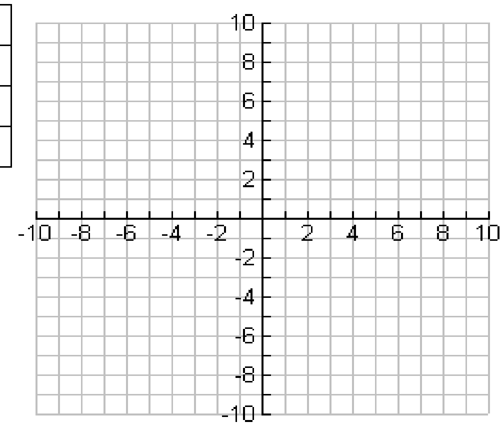
x	y



Find the inverse of $f(x) = 2^x$ then graph it

$f(x) =$

x	y



Domain: ______________ Range: _____________

Asymptote: _____________ x-intercept: ________

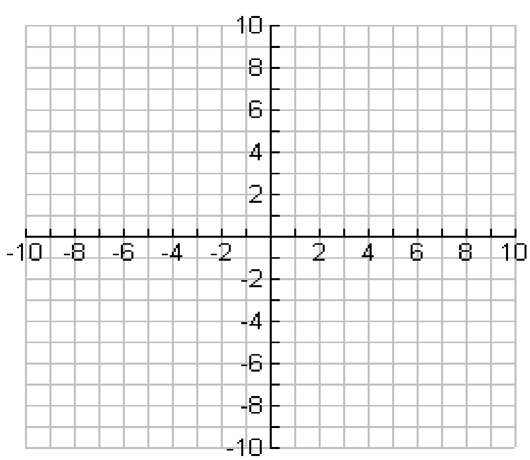
Domain: ______________ Range: _____________

Asymptote: _____________ x-intercept: ________

What do you notice about the two graphs?

Graph $f(x) = \log_3 x$

x	y

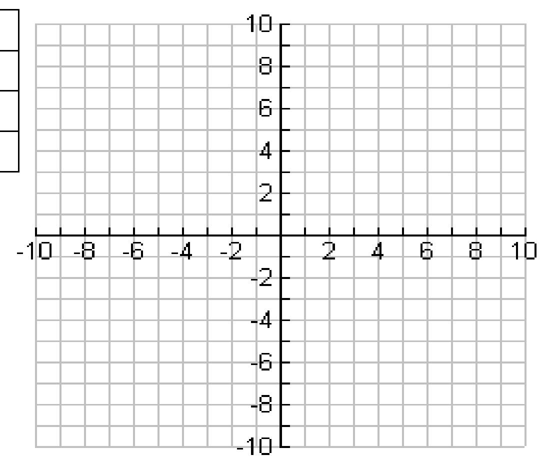


Domain: ______________ Range: _____________

Asymptote: _____________ x-intercept: ________

$f(x) = ln\, x$

x	y



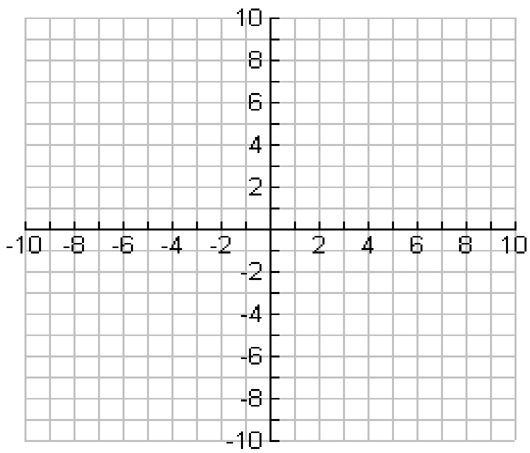
Domain: ______________ Range: _____________

Asymptote: _____________ x-intercept: ________

10.09 Graphing Logarithmic Functions

Graph the following functions.

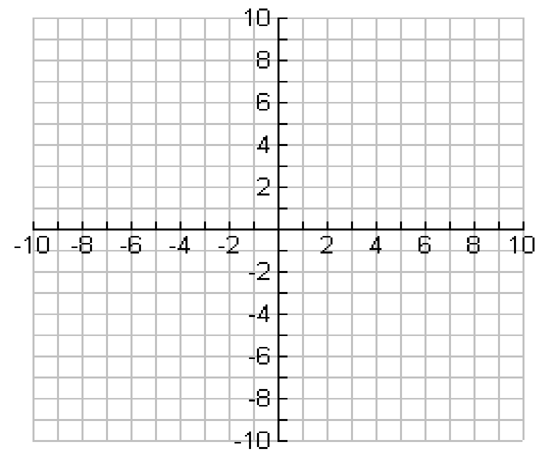
1. $f(x) = \log_2(x-1)$



Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

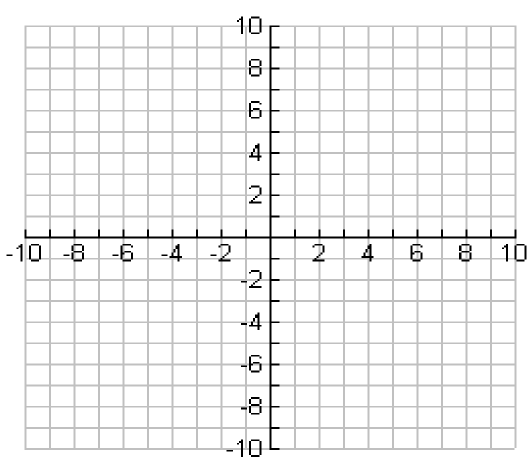
2. $f(x) = \log x + 1$



Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

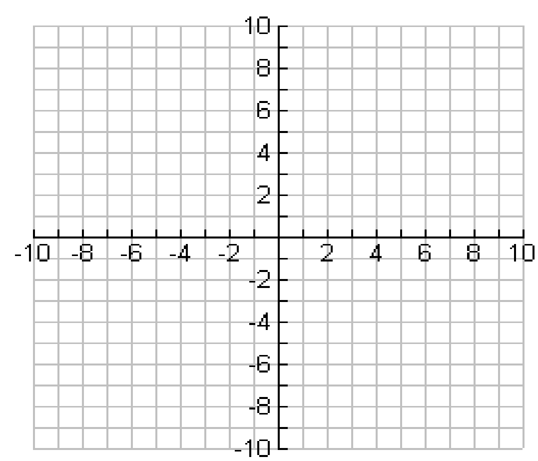
3. $f(x) = 3\ln x$



Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

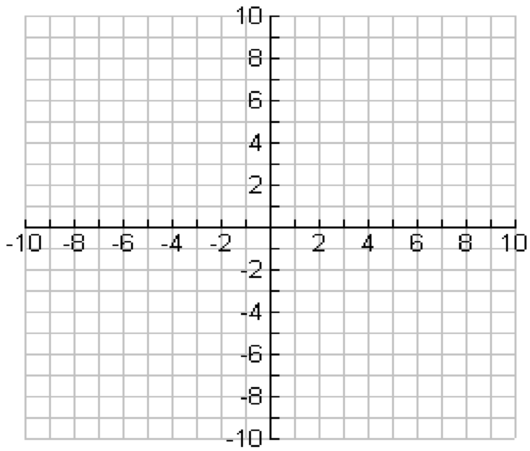
4. $f(x) = -\log_4(x+3)$



Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

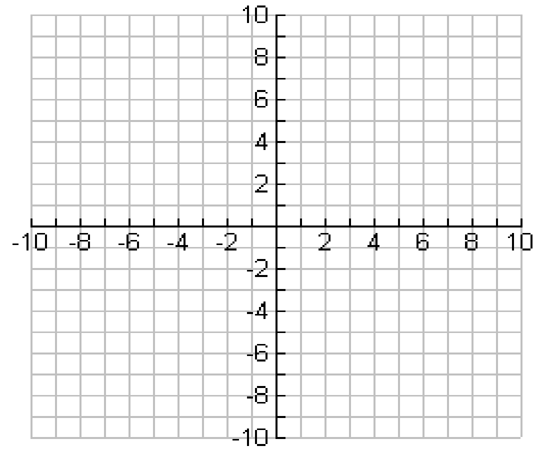
5. $f(x) = \ln(-x)$



Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

6. $f(x) = 4\log_5(x+2) + 3$



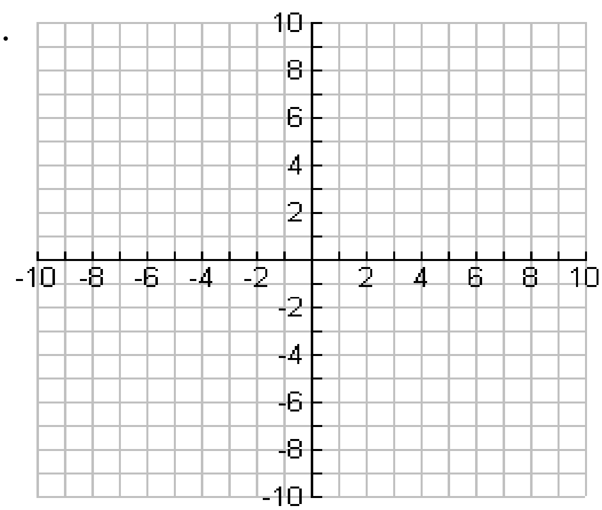
Domain: ____________ Range: ___________

Asymptote: ___________ x-intercept: _______

Practice:

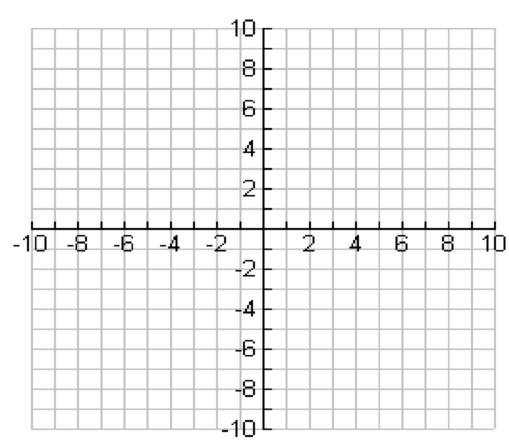
Sketch and analyze the graph of the function. Describe the domain, range, intercepts, asymptote, end behavior, and where the function is increasing or decreasing.

1. $f(x) = log_{\frac{1}{4}}x$

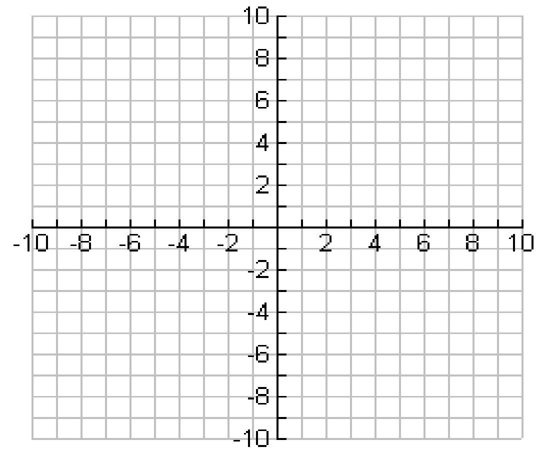


Use the graph of f(x) to describe the transformation that results in g(x) then sketch both graphs.

2. $f(x) = logx$; $g(x) = -\log(x-2)$



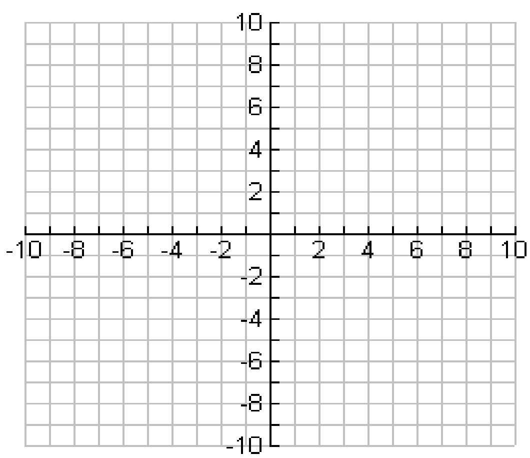
3. $f(x) = \ln x; g(x) = 3\ln(x) + 1$

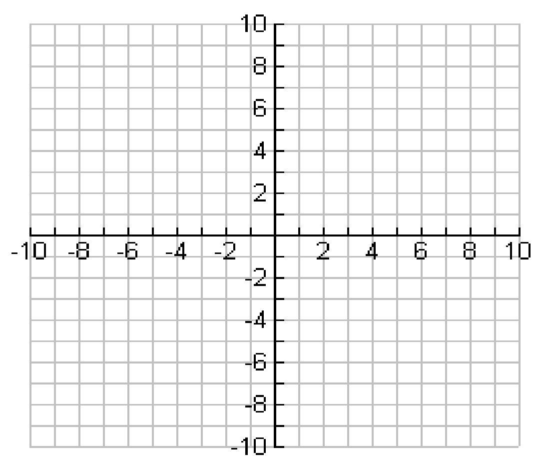


Determine the domain, range, x-intercept, and asymptote.

4. $y = \log(x + 7)$

5. $y = \ln(x - 3)$





8.10 Log Test Review Date: _______________

Complete each problem without using a calculator.

Write each logarithm in exponential form.

1. $log_{49} 7 = \frac{1}{2}$

2. $log\, x = 4.5$

Write each exponential in logarithmic form.

3. $3^{-4} = \frac{1}{81}$

4. $e^5 = 148.413$

Evaluate.

5. $log_5 \sqrt[3]{25}$

6. $log_2 \frac{1}{16}$

7. $log_6(-36)$

8. $log\ 0.01$

9. $ln\ e^4$

10. $log_9 \sqrt[4]{3}$

11. $log_3 27 + 2\ log_5 25$

12. $8\ log_2 \sqrt{32}$

Use properties of logs to expand. Simplify, if possible.

13. $log_9 \frac{3x^4}{y}$

14. $log_3 \sqrt[5]{x^2y^3z^4}$

15. $ln \sqrt[5]{x^3(x+1)}$

Use properties of logs to condense. Simplify, if possible.

16. $5log_4 a + 6log_4 b - \frac{1}{3}log_4 7c$

17. $2\log(x+1) - \log(x^2-1)$

18. $\frac{5}{2}lnx + \frac{1}{2}\ln(y+8) - 3lny - \ln(10-x)$

Solve. Write answers in simplest form.

13. $9^{3x+1} = 81$

14. $125^{x-2} = 25^{2x+1}$

15. $4e^{2x} - 13 = 5$

16. $4^{x-1} = 12$

17. $e^{2x} - 3e^{x} = 10$

18. $3e^{4x} - 5e^{2x} - 2 = 0$

19. $4^{2x+3} = 11^{2-x}$

Solve.

20. $log_8(3x + 1) = 2$

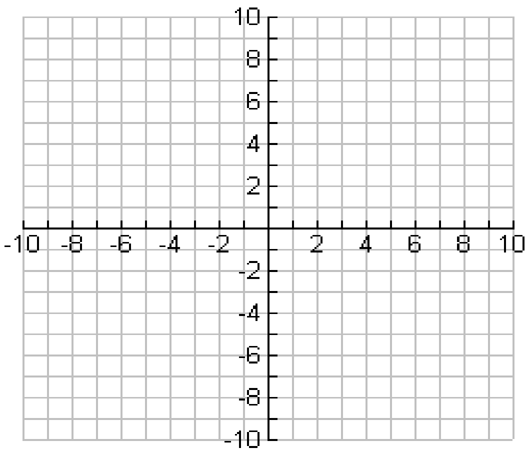
21. $ln(3x) + 5 = 5$

22. $log_4 x + log_4(x + 6) = 2$

23. $ln(4x^2) = 2\ ln\ (x + 4)$

24. $log_7(x + 6) - log_7(2x) = log_7(x + 1)$

25. $f(x) = log_4 x$ **Graph the parent function, *f(x)*. State its asymptote, domain, range, and x-intercept**



Asymptote: ________________

Domain: ____________________

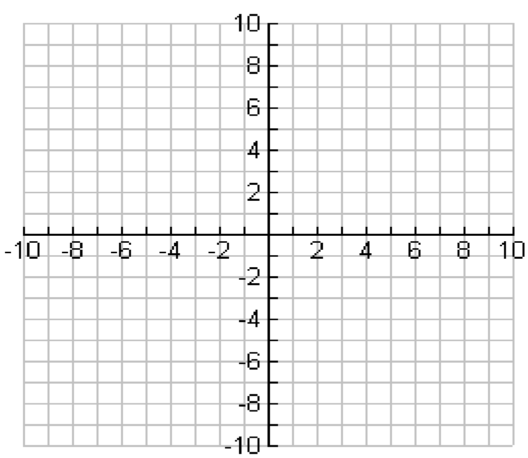
Range: _____________________

X-Intercept: ________________

Next, analyze the other functions as transformations of *f(x) from #25 above*. Graph each. Then state its asymptote, domain and range.

26. $g(x) = log_4(x + 6) - 2$

Transformations to map *f(x)* onto *g(x)*:



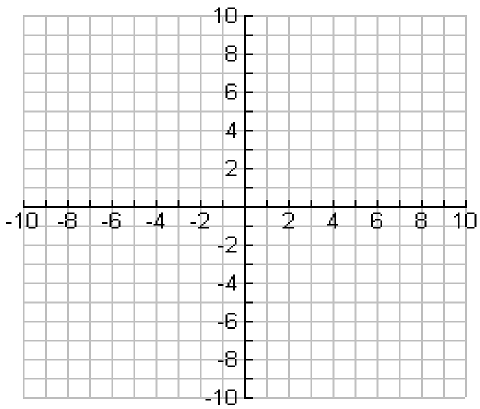
Asymptote: ________________

Domain: ____________________

Range: _____________________

27. $h(x) = -log_4(x) + 5$

Transformations to map *f(x)* onto *h(x)*:



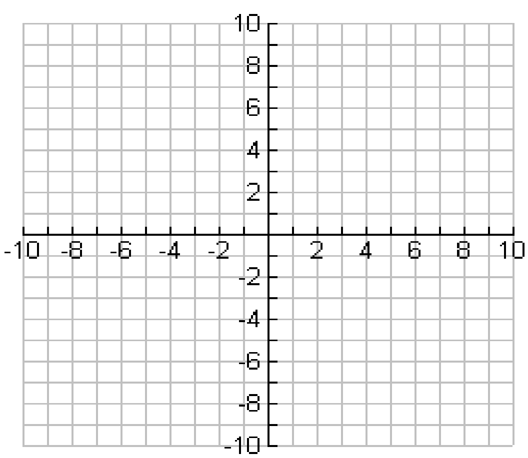
Asymptote: ________________

Domain: ____________________

Range: _____________________

28. $j(x) = 3log_4(-x)$

Transformations to map *f(x)* onto *j(x)*:



Asymptote: ________________

Domain: ____________________

Range: _____________________

Accelerated Pre-Calculus

May 2022 Calendar

Units 10 - Logarithms

Monday	Tuesday	Wednesday	Thursday	Friday
2 10.01 Exponential Function Review Solving Equations with like bases	3 10.02 Log Functions Converting between log form and exponential form • Special log bases • Evaluate logs	4 10.03 Properties of Logs • Expanding Logs • Condensing Logs	5 10.3 Properties of Logs Day 2	6 10.04 Solving Equations (Lesson 3-4) Exponential Equations
9 10.05 Solving Log Equations (Lesson 3-4) • Log Equations	10 10.06 Solving Log and exponential Equations- Lumberjack Logs Activity	11 10.07a Review Logs- Solving Equations and Properties	12 10.07b Review : Logs- Solving Equations and Properties	13 10.08 Graphing Log Functions
16 10.09 Graphing Log Functions (Day 2)	17 10.10 Log Test Review (Day 1)	18 10.10 Log Test Review (Day 2)	19 **10.11 Log Test**	20 Makeups and Recoveries
23 Makeups and Recoveries	24 Help Sessions (Virtual Day)	25 Makeups and Recoveries	26 **Last Day of School** Makeups and Recoveries	

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

The **logarithm** of a positive number is the **power** of the ***base*** that produces that number.

$\log N$: A logarithm whose ***base*** is 10 is called a ***common logarithm***.

$\ln N$: A logarithm whose ***base*** is *e* is called a ***natural logarithm***.

Properties of Logarithms:

(1) Argument = 1: $\log_b 1 = 0$ or $\log 1 = 0$ or $\ln 1 = 0$

(2) Argument = Base: $\log_b b = 1$ or $\log 10 = 1$ or $\ln e = 1$

(3) Argument = Power of Base: $\log_b b^x = x$ or $\log 10^x = x$ or $\ln e^x = x$

(4) Exponent = Logarithm: $b^{\log_b x} = x$ or $10^{\log x} = x$ or $e^{\ln x} = x$

(5) Product Property: $\log_b xy = \log_b x + \log_b y$

(6) Quotient Property: $\log_b \frac{x}{y} = \log_b x - \log_b y$

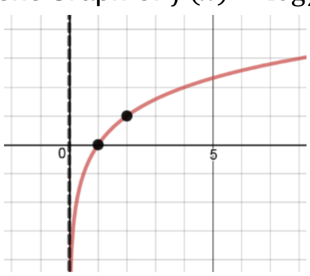
(7) Power Property: $\log_b x^m = m \log_b x$

(8) One-to-One Property: $\log_b x = \log_b y$ if and only if $x = y$

(9) Change of Base Property: $\log_b x = \frac{\log_a x}{\log_a b} = \frac{\log x}{\log b} = \frac{\ln x}{\ln b}$

Graph of Logarithmic Function:

Parent Graph of $f(x) = \log_2 x$



Function Transformation for $g(x) = a \log_n b(x - h) + k$

- a is the vertical stretch (if |a| > 1) or compression (if 0 < |a| < 1)
- a is the reflection over the x-axis (if a < 0)
- b is the reflection over the y-axis (if b < 0)
- h is the horizontal shift (left if h < 0 and right if h > 0)
- k is the vertical shift (up if k > 0 and down if k < 0)

(1) Graph the Asymptote: $x = h$, unless reflected over the y-axis then $x = -h$.

(2) Find where the parent's x-intercept moved to by following the transformations.

(3) Find where the additional point of $(base, 1)$ moved to by following the transformations.

(4) Draw a smooth curve approaching the asymptote.

Domain: (h, ∞), unless reflected over the y-axis then $(-\infty, -h)$

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

For the *new x-intercept*: set $g(x) = 0$ and solve for x.