Advanced Algebra – Unit 4A

Logarithms

Monday, February 2nd
Graphing Exponential Functions
Outline w/PowerPoint (Day 1):
Graphing an Exponential Parent
CW/HW: Graphing Exp & Logs WS 1
(exponentials ONLY)

Tuesday, February 3rd
Graphing Exponential Functions
Outline w/PowerPoint (Day 2):
Transformations of Exponentials
CW/HW: Graphing Exp & Logs WS 2
(exponentials ONLY)

Wednesday, February 4th
Inverse Functions
Inverses Notes Outline w/SMART
CW/HW: Inverses WS 1

Thursday, February 5th
Inverse Functions 2
Go over Inverses WS 1
CW/HW: Inverses WS 2

Friday, February 6th
Composition of Functions
Notes & Examples PowerPoint
CW/HW: Composition WS

Monday, February 9th
Verifying Inverses
Verifying Inverses Notes &
Examples PowerPoint
CW/HW: Inverses WS 3

Tuesday, February 10th
Quiz: Graphing, Inverses and
Composition

Wednesday, February 11th
Solving Exponential Equations Notes
(with like bases)
CW/HW: Solving Exponential
Equations WS (with like bases)

Thursday, February 12th
Applications with exponentials
Walk-Through Problems
CW/HW: More Exponential
Applications WS

Friday, February 13th
Graphing Inverses of Exponential
Equations Notes [Smart]
CW/HW: Graphing Exponential
Functions & Their Inverse WS

Monday, February 16th
Intro to logs Notes [Smart]
CW/HW: Converting Forms WS &
Logs WS1

Tuesday, February 17th
Inverses of exponential functions
notes [Smart]
CW/HW:Finding Inverses of
Exponential Functions WS

Wednedaay, February 18th
CFA

Thursday, February 19th
Review

Friday, February 20th
Test

Graphing Exponential and Logarithmic Functions

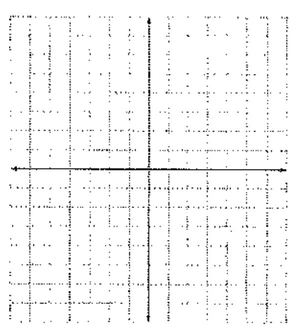
Day 1 – Exponential Functions ONLY – slides 1 and 2

Day 2 – Exponential Functions ONLY – slides 3 and 4

Day 3 – Logarithmic Functions – slides 1, 2, 3, 4

Slide 1

$f(x) = 5^x$



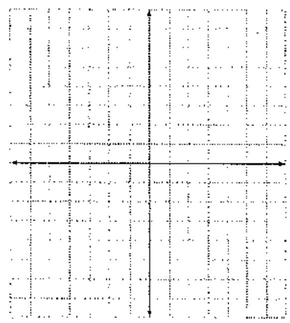
	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

Slide 2

$f(x) = 5^{-x}$



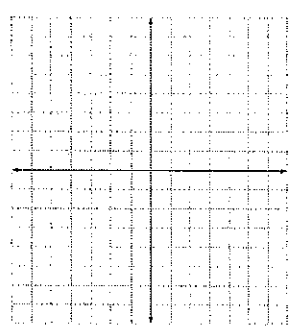
	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain		
Range		
Intercept		
Asymptote		
Growth/Decay?		N/A

**Equation of the inverse of the exponential function

____

Slide 3

$f(x) = 5^{(x-2)} - 3$



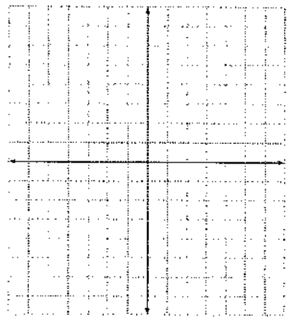
	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain		
Range		
Intercept		
Asymptote		
Growth/Decay?		N/A

**Equation of the inverse of the exponential function

____

Slide 4

$f(x) = -(1/5)^x + 2$



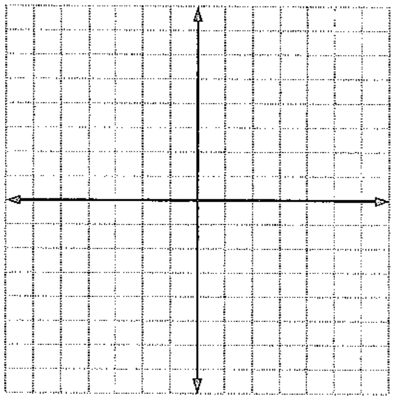
	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

Worksheet—Graphing Exponential Functions I Name ____________________

1. $f(x) = 2^x$

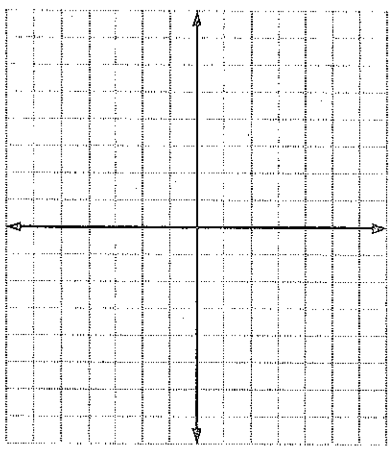


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

2. $f(x) = \frac{1}{3}^x$

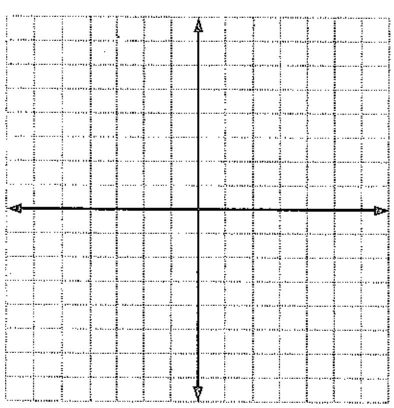


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

3. $f(x) = 10^x$

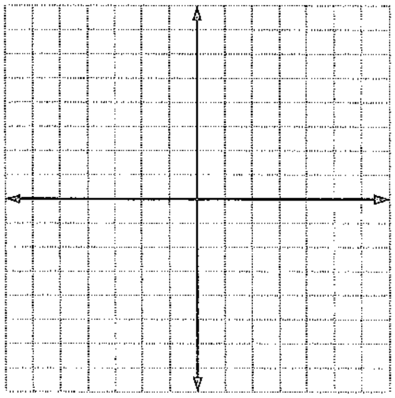


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

4. $f(x) = 3^x$

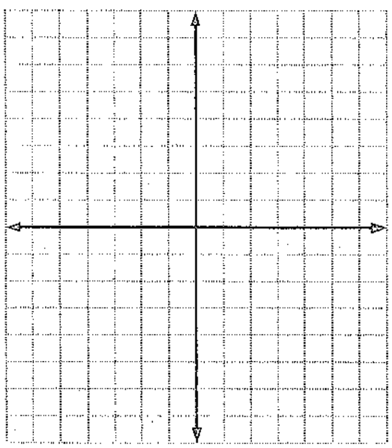


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	______	______
Range	______	______
intercept	______	______
Asymptote	______	______
Growth/Decay?	______	N/A

**Equation of the inverse of the exponential function

____

5. $f(x) = 2^{-x}$

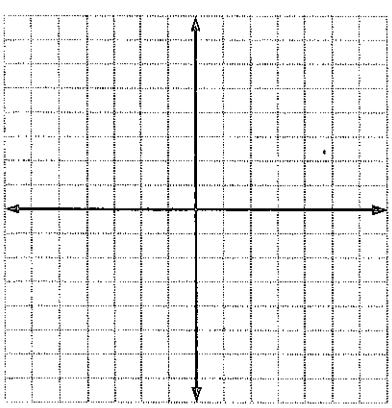


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	______	______
Range	______	______
intercept	______	______
Asymptote	______	______
Growth/Decay?	______	N/A

**Equation of the inverse of the exponential function

____

6. $f(x) = e^x$



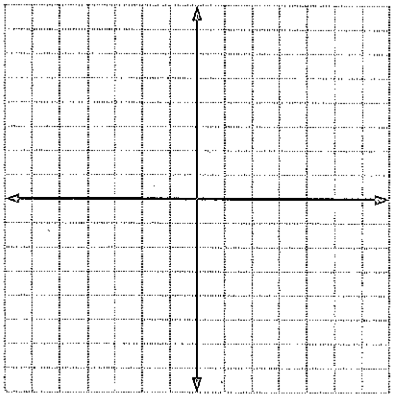
	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	______	______
Range	______	______
intercept	______	______
Asymptote	______	______
Growth/Decay?	______	N/A

**Equation of the inverse of the exponential function

____

Worksheet—Graphing Exponential Functions II Name ________________

1. $f(x) = 2^x - 3$

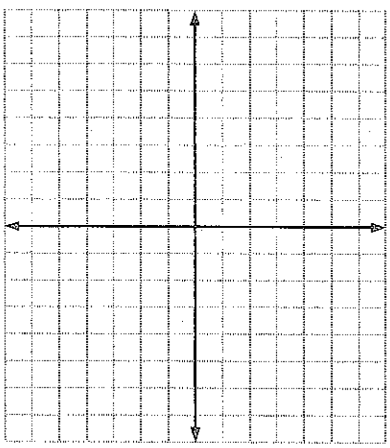


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

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

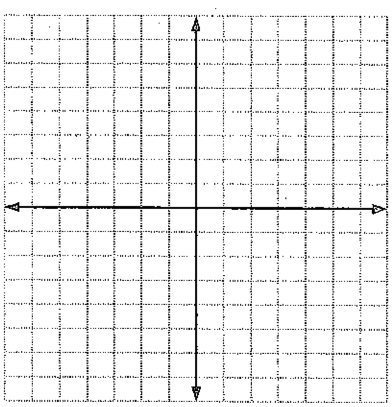


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

3. $f(x) = -10^x + 4$

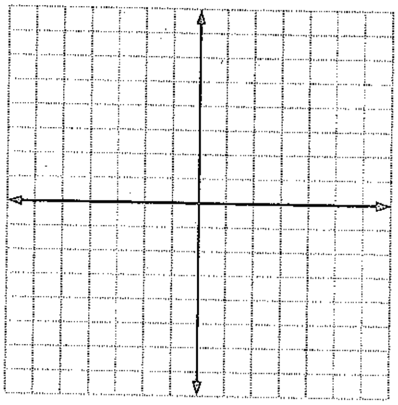


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

4. $f(x) = 3^{x+4} - 5$

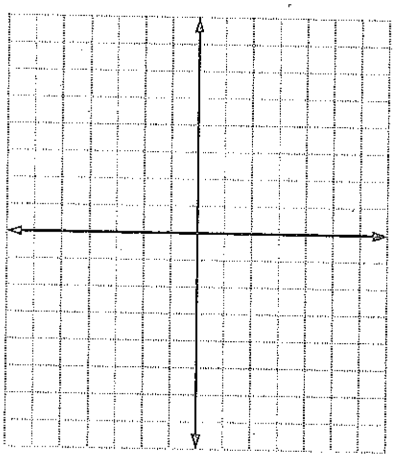


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

5. $f(x) = -2^{-x} - 3$

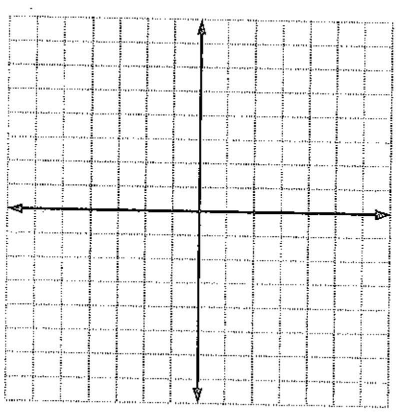


	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

6. $f(x) = e^{x-1} + 3$



	EXPONENTIAL FUNCTION	**LOGARITHMIC FUNCTION
Domain	________	________
Range	________	________
Intercept	________	________
Asymptote	________	________
Growth/Decay?	________	N/A

**Equation of the inverse of the exponential function

____

NOTES ON INVERSES

INVERSES – Two functions are inverses, if and only if, when one function contains a point (a, b), the other function contains the point ___________ .

Example: f(x): { (3, 1) , (–2, 4) , (5, –1) } Domain of f(x) ______________ Range of f(x) __________

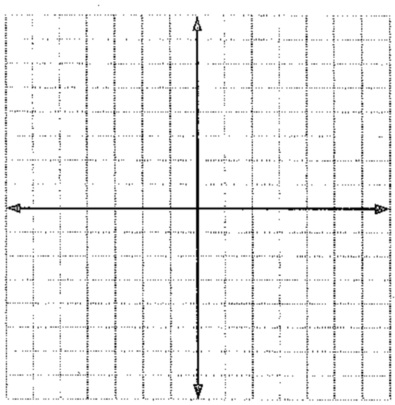
The inverse of f(x) will be { ________________________ } Domain of inverse ______________

Range of inverse ___________________

****The **domain** of function f(x) has become the _________________ of the inverse;

The **range** of function f(x) has become the _________________ of the inverse.

Graphing Inverse Functions



1. Graph $y = 3x - 6$ and list four points that appear on your graph.

2. Now graph $y = \frac{1}{3}x + 2$ on the same axes.

3. Switch the x and y coordinates in your original ordered pairs and list the new ordered pairs below. Are your new points on the graph of the second equation?

These two equations are **inverses** of each other. We can call one of them ________ and the other ________.

Look again at the graphs you drew. Now sketch in the graph of the line y = x on the same graph grid.

What do you notice?

Finding Inverse Functions Algebraically

To find the equation of the inverse of a function algebraically, follow these steps:

1.

2.

Examples: Find the equation of the inverse of each of the following functions.

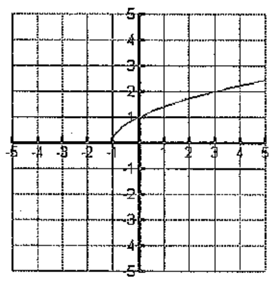
a. $f(x)=\frac{2}{3}x-1$

b. $g(x)=2x^3+1$

Inverses WS 1 Name ___________________________

Graph the inverse of the following functions on the same set of axes. And identify the domain and range of the function and of its inverse.

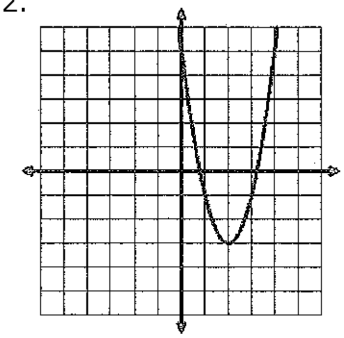
1.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

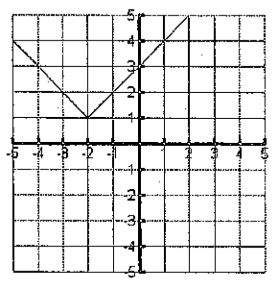
2.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

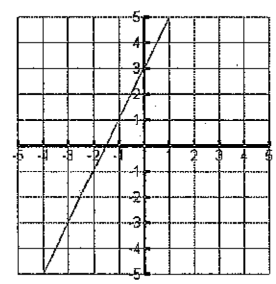
3.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

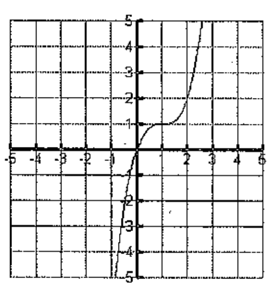
4.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

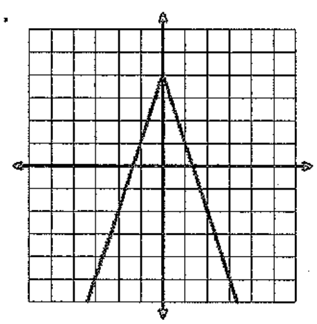
5.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

6.



Function
D:_______________
R:_______________

Inverse
D:_____________
R:_____________

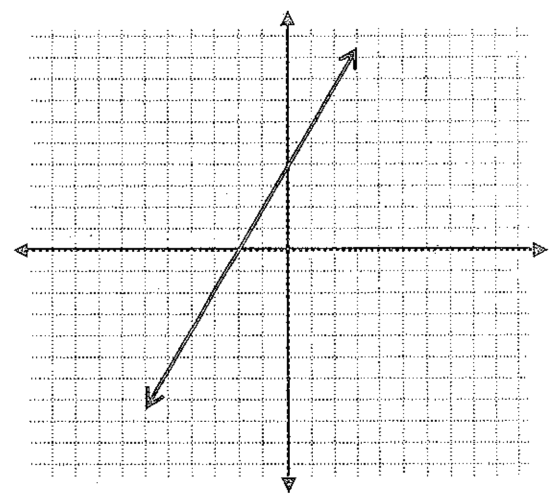
Inverses WS 2 Name ____________________

The given coordinates are on $f(x)$, find the coordinates for $f^{-1}(x)$

1. $(-2, 4)$
2. $(4, 7)$
3. $(0, 11)$
4. $(-3, -8)$
5. $(10, 10)$

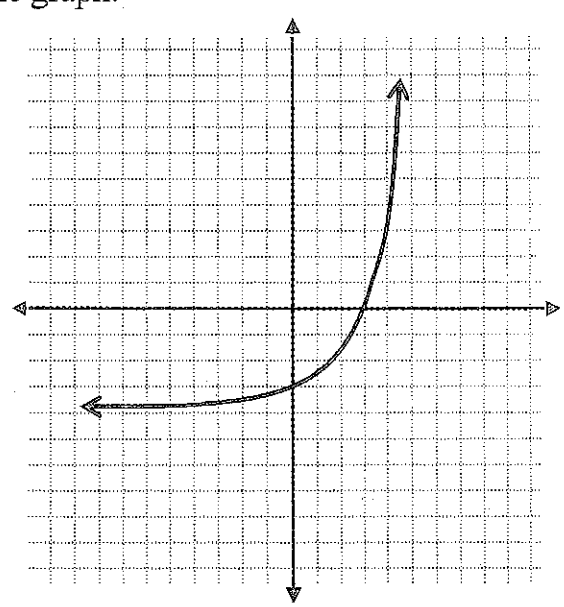
Answer each question regarding the function shown in the graph.

6. What is the x-intercept of the function?
7. What is the y-intercept of the function?
8. What is the x-intercept of the inverse?
9. What is the y-intercept of the inverse?
10. Name one other point on the function.
11. Name one other point on the inverse.
12. Graph the y = x line with a dotted line.
13. Graph the inverse.



Answer each question regarding the function shown in the graph.

14. What is the x-intercept of the function?
15. What is the y-intercept of the function?
16. What is the x-intercept of the inverse?
17. What is the y-intercept of the inverse?
18. Name one other point on the function.
19. Name one other point on the inverse.
20. Graph the y = x line with a dotted line.
21. Graph the inverse.



Composition of Functions

The COMPOSITION of f with g is

$$(f \circ g)(x) = f(g(x))$$

Ex. Given: $f(x) = 2x$, $g(x) = 8x - 6$

$f(g(x))=$

Now, evaluate $f(g(5))$ two ways ...

Ex. Given: $f(x) = 2x$, $g(x) = 8x - 6$

$g(f(x))=$

$f(f(x))=$

Ex. Given: $f(x) = x^2 - 2x - 15$, $g(x) = x+3$

$f(g(x))$

$g(f(x))$

$g(g(x))$

Composition of Functions WS Name ________________________

Use the following functions:

$f(x) = 3x + 5$ $g(x) = x^2 - 1$ $h(x) = -\frac{1}{2}x - 2$ $k(x) = 3x$

Find the following:

1. $f\left(h(2)\right)$

2. $f\left(k\left(\frac{1}{2}\right)\right)$

3. $g\left(f(4)\right)$

4. $h\left(f(1)\right)$

5. $(h \circ g)(-4)$

6. $(k \circ f)(-5)$

7. $(f \circ f)(3)$

8. $(g \circ g)(-2)$

9. $f\left(h\left(k(2)\right)\right)$

10. $h\left(f\left(g(-5)\right)\right)$

11. $f\left(g(x)\right)$

12. $f\left(f(x)\right)$

13. $f\left(h(x)\right)$

14. $g\left(k(x)\right)$

15. $(h \circ k)(x)$

16. $(k \circ g)(x)$

17. $(g \circ f)(x)$

18. $(h \circ g)(x)$

*Verifying Inverses

Proofs

*Verifying Inverses

*f and g are inverses iff ...

*$f(g(x)) = x$ AND $g(f(x)) = x$

*Example 1

*Verify that f and g are inverses.

$$f(x)=\frac{5}{x-2} \qquad g(x)=\frac{5}{x}+2$$

*Example 2

*Verify that f and g are inverses.

$$f(x)=2x^3-1 \qquad g(x)=\sqrt[3]{\frac{x+1}{2}}$$

Inverses WS 3 Name________________________

Fill in the blank.

1. If (−3, 1) is on f, then ______________ is on f^{-1}.

2. If (−3, 0) is the x-intercept of f, then __________ is the y-intercept of f^{-1}.

3. If $[-2,\infty)$ is the range of f, then ___________ is the domain of f^{-1}.

4. If $[3,\infty)$ is the domain of f^{-1}, then ___________ is the range of f.

Verify that *f* and *g* are inverse functions (or not).
In order to do this you must prove that $f(g(x))=x$ and $g(f(x))=x$.

5. $f(x)=x+4;\ \ g(x)=x-4$

6. $f(x)=2x-4;\ \ g(x)=\frac{1}{2}x+2$

7. $f(x)=x^2+2, x\geq 0;\ \ g(x)=\sqrt{x-2}$

8. $f(x)=\frac{1}{3}x^3-2;\ \ g(x)=\sqrt[3]{3x+6}$

9. $f(x)=3-x;\ \ g(x)=3-x$

Solving Exponential Equations

(with like bases)

Ex 1:

$$7^{2x} = 7^{3x-5}$$

Ex 2:

- $5^{4m} = 125^{m+2}$

Ex 3:

- $9^{x} = 27$

Ex 4:

$$\left(\tfrac{1}{2}\right)^{x} = 16^{3x-1}$$

Exponential Equations (Like Bases) WS 1 Name ________________________________

Solve each equation.

1. $5^x = 5^{-3}$	2. $6^x = 216$
3. $7^y = \frac{1}{49}$	4. $10^x = .001$
5. $2^{2x} = \frac{1}{8}$	6. $\left(\frac{1}{5}\right)^{x-3} = 125$
7. $3^y = 3^{3y+1}$	8. $5^{3y+4} = 5^y$
9. $3^x = 9^{x+1}$	10. $2^5 = 2^{2x-1}$
11. $8^{x-1} = 16^{3x}$	12. $2^{x+3} = \frac{1}{16}$

Answers: 1) –3 2) 3 3) –2 4) –3 5) –3/2 6) 0 7) –1/2 8) –2 9) –2 10) 3 11) –1/3 12) –7

WORKSHEET—EXPONENTIAL APPLICATIONS NAME __________

Interest compounded continuously $A = Pe^{rt}$ Growth/Decay $y = ae^{kt}$

Interest compounded frequently but not continuously $A = P\left(1+\frac{r}{n}\right)^{nt}$

Write an equation for each of the following. Then use your calculator to find the answer.

1. Thrifty Thelma invests $7500 in an account paying 4% interest compounded quarterly. How much will be in Thelma's account at the end of 6 years?

2. Sam the Saver invests $500 in an account that pays 3.5% interest compounded continuously. How much money will Sam have after 3 years?

3. If you invest $2100 in a savings account that pays 2.25% interest compounded monthly, how much money will you have at the end of one year?

4. Ted invested $675 in an account that pays 3.4% interest compounded continuously. How much will be in his account after 6 months?

5. Your parents just won the Mega Millions Lottery. Because they love you so much, they decide to give you some of their winnings; however, they don't want you to have the money until your 22nd birthday. So they invest $15,000 in a trust fund that pays $3\frac{5}{8}\%$ interest compounded continuously.

Assuming that you are 17 years old right now, how much money will you get when you are 22?

Adv Alg – Exponential Functions
More application problems

Name ___________________________

1. The amount in trillions of cubic feet of natural gas consumed in the United States from 1940 to 1970 can be modeled by the function $y = a(1.07)^t$, where t is the number of years since 1940.

   (a) Assuming 2.91 trillion cubic feet of natural gas was consumed in the US in 1940, estimate how many cubic feet were consumed in 1937.

   (b) Predict the natural gas usage for 2012.

2. From 1971 to 1995, the average number of transistors on a computer chip can be modeled by the function $y = a(1.59)^t$, where t represents the number of years since 1971.

   (a) Assuming there was an average of 2300 transistors per chip in 1971, estimate the number of transistors on each chip in 1998.

   (b) How many transistors were used on each chip in 2011?

3. Connor the contractor likes to buy houses, remodel them, live in them for a while and then sell the house and buy another one. Seven and a half years ago, he paid $137,000 for the house he now lives in. During that time, house values have appreciated according to the model $y = a(1.024)^t$ where a is the initial value and t is time in years.

   (a) How much is his house worth now?

   (b) Connor decides to use a real estate agent to sell the house. He must pay the agent a commission of 3.5% of the selling price of the house. Connor has found a buyer willing to pay $173,900 for the house. After the real estate agent is paid, how much profit will Connor make on the sale of the house?

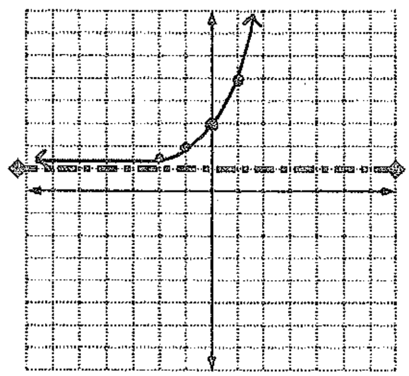
4. Since 1972 the US Fish and Wildlife Service has kept a list of endangered species in the United States. In 1972 there were 119 species on the endangered list. For the years from 1972 to 1998, the number of species on the list can be modeled by the equation $y = ae^{0.0917t}$ where t is the number of years since 1972. Estimate the number of species on the endangered list at the present time.

Graphing Exponential Equations and Their Inverse Functions - NOTES

- What do we need to find to graph an exponential function?

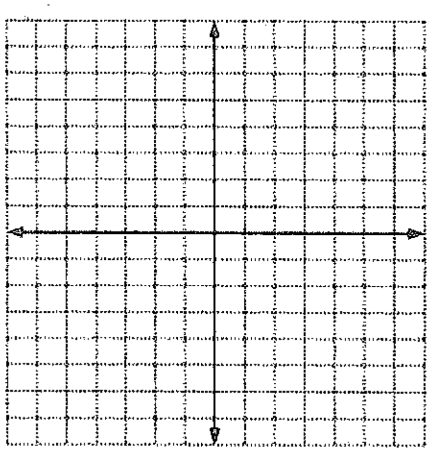
- To graph:
  1) Make a T-Chart centered where the exponent will = 0.
  2) Find the y-intercept (will always have one)
  3) Sketch the asymptote
  4) Sketch the graph
  5) Determine the domain, range and equation of the asymptote

ALL EXPONENTIAL FUNCTIONS WILL HAVE AN ASYMPTOTE!



Example 1: Graph the following function and its inverse.

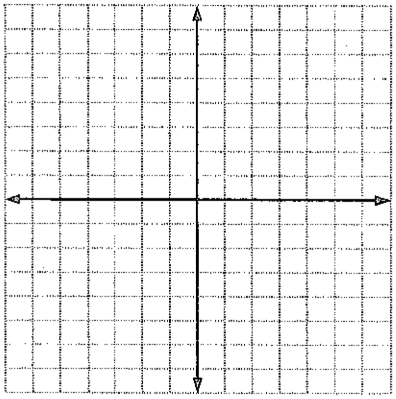
$$f(x) = 2^{x+1} - 3$$



	Function	**Inverse**
x-int:	______	______
y-int:	______	______
Dom:	______	______
Range:	______	______
Asymp:	______	______

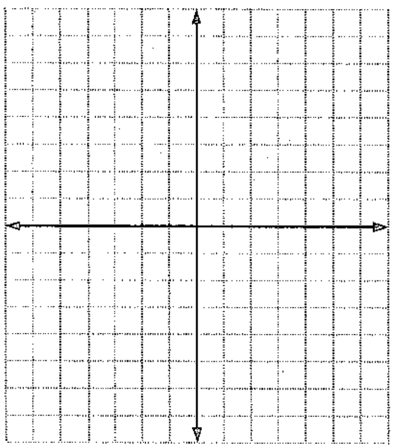
Worksheet—Graphing Exponential Functions and Their Inverses Name ____________________

1. $f(x) = 2^x$



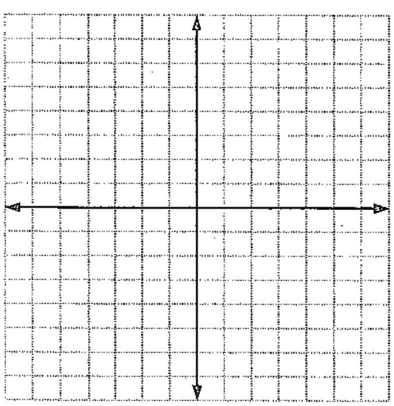
	EXPONENTIAL FUNCTION	INVERSE FUNCTION
Domain	________	________
Range	________	________
Y intercept	________	________
X intercept	________	________
Asymptote	________	________

2. $f(x) = 2^x - 3$



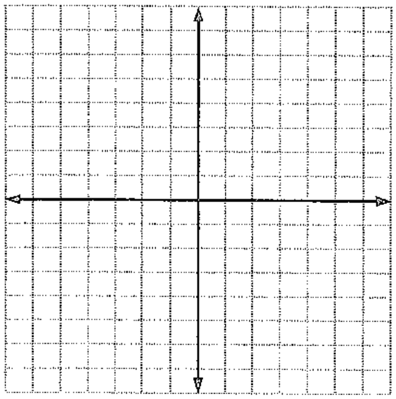
	EXPONENTIAL FUNCTION	INVERSE FUNCTION
Domain	________	________
Range	________	________
Y intercept	________	________
X intercept	________	________
Asymptote	________	________

3. $f(x) = \frac{1}{3}^x$



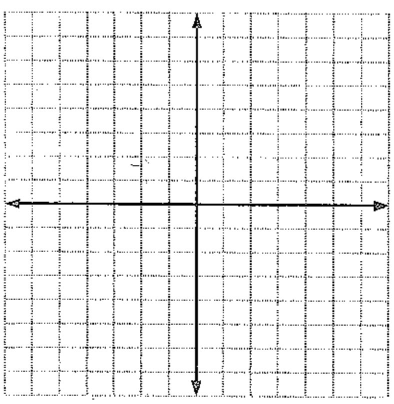
	EXPONENTIAL FUNCTION	INVERSE FUNCTION
Domain	________	________
Range	________	________
Y intercept	________	________
X intercept	________	________
Asymptote	________	________

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



	EXPONENTIAL FUNCTION	INVERSE FUNCTION
Domain	________	________
Range	________	________
Y intercept	________	________
X intercept	________	________
Asymptote	________	________

8. $f(x)=e^{x-1}+3$



	EXPONENTIAL FUNCTION	INVERSE FUNCTION
Domain	________	________
Range	________	________
Y intercept	________	________
X intercept	________	________
Asymptote	________	________

Intro to Logarithms

Definition of Logarithm with base *b*

The **logarithm of *y* with base *b***
is denoted by $\log_b y$ and is defined as follows:

$\log_b y = x$ iff $b^x = y$

$b > 0,\ y > 0,\ b \neq 1$

$\log_b y$ is read as " log base b of y"

Example 1: Write the logarithmic equation in exponential form.

a. $\log_3 9 = 2$ b. $\log_8 1 = 0$ c. $\log_5 \left(\frac{1}{25}\right) = -2$

Special Logarithmic Values

$\log_b 1 = 0$

$\log_b b = 1$

Example 2: Evaluate the expression.

a. $\log_4 64$

b. $\log_2 0.125$

c. $\log_{\frac{1}{4}} 256$

d. $\log_{32} 2$

Example 3: Solve for x.

a. $\log_{\frac{1}{2}} x = -3$

b. $\log_x \sqrt{8} = \frac{1}{2}$

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

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

Example 4: Evaluate using a calculator.

a. $\log 7$

b. $\ln 0.25$

Intro to Logarithms

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Example 4:
Evaluate using a calculator.

a. $\log 7$ b. $\ln 0.25$

Student Name: ______________________ **Score:**

Logarithmic Form

Write the following exponents in logarithmic form:

Exponent Form	Logarithmic Form
$2^5 = 32$	
$3^3 = 27$	
$5^3 = 125$	
$2^{-4} = \frac{1}{16}$	
$4^3 = 64$	
$3^2 = 9$	
$7^{-2} = \frac{1}{49}$	

Student Name: ____________________ Score:

Exponent Form

Write the following logarithmic form into exponent form:

Logarithmic Form	Exponent Form
$\log_3 9 = 2$	
$\log_4 64 = 3$	
$\log_5 25 = 2$	
$\log_2 128 = 7$	
$\log_3 \left(\frac{1}{27}\right) = -3$	
$\log_6 36 = 2$	
$\log_5 \left(\frac{1}{625}\right) = -4$	

Logarithms WS Name ______________________________

I. Change the expression to logarithmic form.

1. $3^4 = 81$	2. $10^3 = 1000$
3. $2^x = 32$	4. $2^3 = x$

II. Change the expression to exponential form.

5. $\log_4 16 = 2$	6. $\log_5 125 = 3$
7. $\log_3 9 = 2$	8. $\log_6 6 = 1$

III. Evaluate

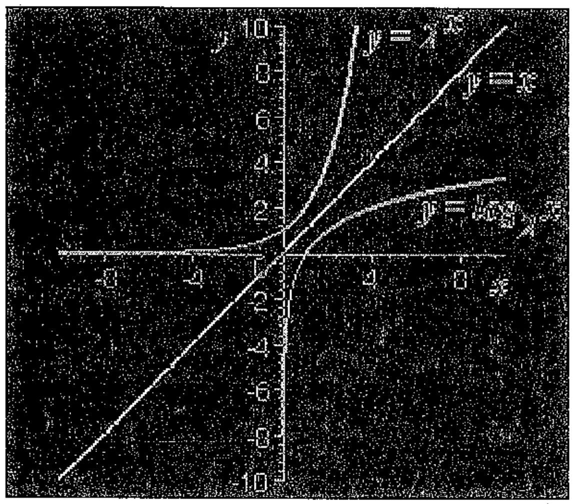
9. $\log_8 2$	10. $\log_7 1$	11. $\log 0.01$
12. $\log_3 \frac{1}{81}$	13. $\log_{\frac{1}{2}} 8$	14. $\log_4 2$
15. $\log_m m^3$	16. $\log_{27} 9$	17. $\log_3 243$
18. $\log_{\frac{1}{16}} \frac{1}{8}$	19. $\log \sqrt{1000}$	20. $5^{\log_5 14}$
21. $\log_3 3^4$	22. $\log_{15} 1$	23. $\log_2 \frac{1}{16}$
24. $\log_{\frac{1}{3}} 27$	25. $\log_9 9$	26. $\log_8 4$

IV. Solve

27. $\log_{\frac{1}{2}} 16 = x$	28. $\log_5 x = -2$
29. $\log_m \frac{1}{27} = -3$	30. $\log_x \sqrt[3]{7} = \frac{1}{3}$
31. $\log_{\frac{1}{2}} x = -6$	32. $\log_{64} 8 = x$

Odd Answers: 9) 1/3 11) −2 13) −3 15) 3 17) 5 19) 3/2 21) 4 23) −4 25) 1 27) −4 29) 3 31) 64

Finding Inverses of Exponential and Log Functions Notes



* The inverse of an exponential function is a log function.

* The inverse of a log function is an exponential function.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

We can convert forms following the rule:

$y=b^x$ ----------> $\log_b y=x$
&
$\log_b y=x$ ----------> $y=b^x$

To find the inverse of either of these functions, simply convert forms, then switch the 'x' and 'y'.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Example 1:

Find the inverse of the following.

$y=5^x$

Example 2:

Find the inverse of the following.

$y=5^{x-2}+1$

Example 3:

Find the inverse of the following.

$y = \log_5 x - 3$

Finding Inverses of Exponential Functions WS
GPS Advanced Algebra

Name____________________________

For each of the following, find the inverse.

1. $f(x) = 3^x$	2. $f(x) = 3^x + 4$
3. $f(x) = 3^{x-2}$	4. $f(x) = 3^{x+3} - 5$
5. $g(x) = \left(\frac{1}{2}\right)^x + 8$	6. $f(x) = e^{x+3}$
7. $f(x) = e^x - 4$	8. $h(x) = e^{x+2} - 3$