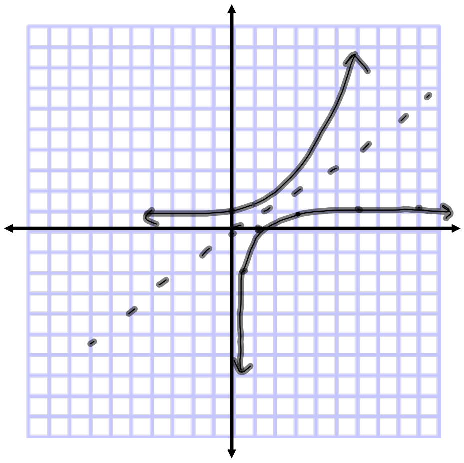
Warm up:
What is an inverse?

Find the inverse of:
$y=3x+2$ $y=x/2$

$x=3y+2$ $x=y/2$

We will start our exploration of logarithms by completing an activity in our groups...

Things to watch out for:
What are logarithms?
How do they relate to exponents?



# 7-3 Logarithmic Functions

## Objectives

Write equivalent forms for exponential and logarithmic functions.

Write, evaluate, and graph logarithmic functions.

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## 7-3 Logarithmic Functions

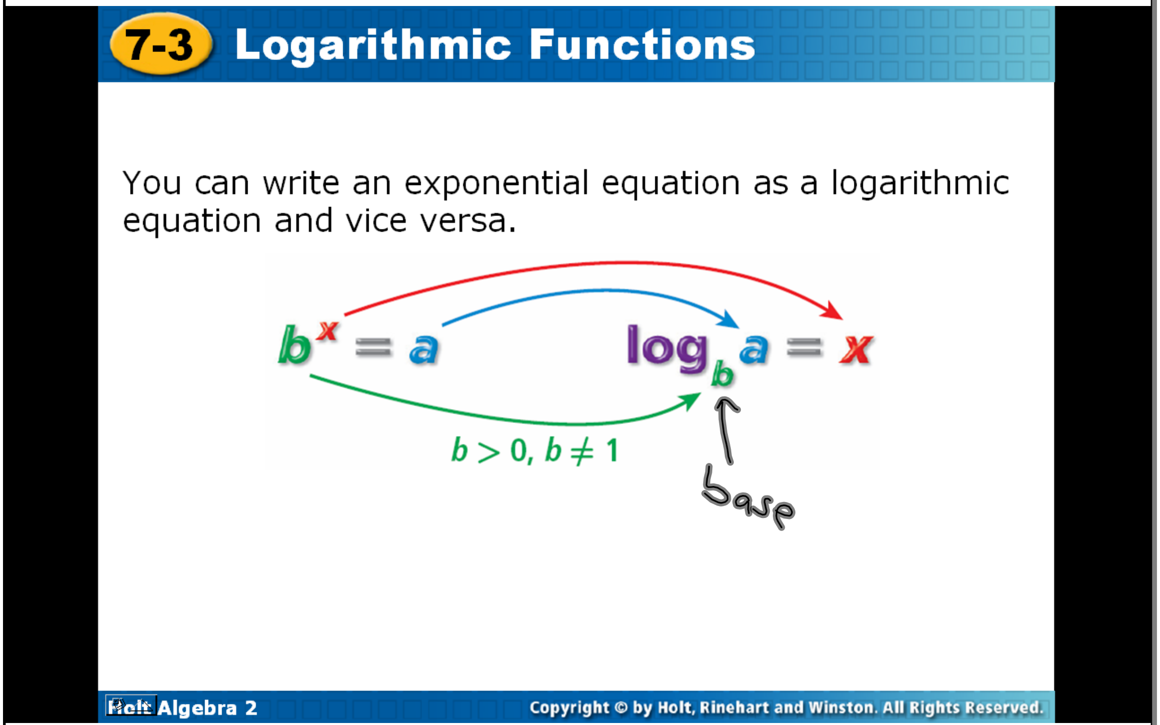
### *Vocabulary*

logarithm
common logarithm
logarithmic function




## 7-3 Logarithmic Functions

How many times would you have to double \$1 before you had \$512? You could solve this problem if you could solve $2^x = 8$ by using an inverse operation that undoes raising a base to an exponent equation to model this situation. This operation is called finding the logarithm. A **logarithm** is the exponent to which a specified base is raised to obtain a given value.




Now to find equivalent logs and exponents you can memorize the equation on the last page...or you can use what I call the wrap around way. Here is how it works:

Start at the base (the little number below log), and move your pencil towards the equal, then wrap it around the answer to the third number. The order you go is your base, then its power = third number...

Words are tricky, here is how it works...

## 7-3 Logarithmic Functions

### Example 2: Converting from Logarithmic to Exponential Form

**Write each logarithmic form in exponential equation.**

| Logarithmic Form | Exponential Equation |
|---|---|
| $\log_9 9 = 1$ | $9^1 = 9$ |
| $\log_2 512 = 9$ | $2^9 = 512$ |
| $\log_8 2 = \frac{1}{3}$ | $8^{1/3} = 2$ |
| $\log_4 \frac{1}{16} = -2$ | |
| $\log_b 1 = 0$ | |

$\log_9 9 = 1$

$\log_2 512 = 9$




## 7-3 Logarithmic Functions

### Check It Out! Example 2

**Write each logarithmic form in exponential equation.**

$\log_{12} 144 = 2$

| Logarithmic Form | Exponential Equation |
|---|---|
| $\log_{10} 10 = 1$ | |
| $\log_{12} 144 = 2$ | $12^2 = 144$ |
| $\log_{\frac{1}{2}} 8 = -3$ | |

To go backwards, from exponent to log it is helpful to have the wrap around rule already written out and then just fill in the blank places...

log $\_\_$ = $\_\_$ $3^2 = 9$

## 7-3 Logarithmic Functions

### Example 1: Converting from Exponential to Logarithmic Form

**Write each exponential equation in logarithmic form.**

| Exponential Equation | Logarithmic Form |
|---|---|
| $3^5 = 243$ | $\log_3 243 = 5$ |
| $25^{\frac{1}{2}} = 5$ | |
| $10^4 = 10{,}000$ | $\log_{10} 10000 = 4$ |
| $6^{-1} = \frac{1}{6}$ | |
| $a^b = c$ | |

$\log_3 243 = 5$

$10^4 = 10000$

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## 7-3 Logarithmic Functions

A logarithm is an exponent, so the rules for exponents also apply to logarithms. You may have noticed the following properties in the last example.

**Special Properties of Logarithms**

For any base $b$ such that $b > 0$ and $b \neq 1$,

| LOGARITHMIC FORM | EXPONENTIAL FORM | EXAMPLE |
|---|---|---|
| **Logarithm of Base $b$** | | |
| $\log_b b = 1$ | $b^1 = b$ | $\log_{10} 10 = 1$<br>$10^1 = 10$ |
| **Logarithm of 1** | | |
| $\log_b 1 = 0$ | $b^0 = 1$ | $\log_{10} 1 = 0$<br>$10^0 = 1$ |

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## 7-3 Logarithmic Functions

A logarithm with base 10 is called a **common logarithm**. If no base is written for a logarithm, the base is assumed to be 10. For example, $\log 5 = \log_{10} 5$.

$\log_{10} 100$

No base = 10

$\log 100$

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## 7-3 Logarithmic Functions

### Example 3A: Evaluating Logarithms by Using Mental Math

Evaluate by using mental math.

$\log_{10} 0.01 = x$

$2^{-12} = x$

$10^x = .01$




## 7-3 Logarithmic Functions

### Example 3B: Evaluating Logarithms by Using Mental Math

Evaluate by using mental math.

$\log_5 125 = x$

$5^x = 125$

$x = 3$

## 7-3 Logarithmic Functions

### Example 3C: Evaluating Logarithms by Using Mental Math

**Evaluate by using mental math.**

$\log_5 \frac{1}{5}$

$\log_4 16 = x$

$4^x = 16$




## 7-3 Logarithmic Functions

### Check It Out! Example 3a

**Evaluate by using mental math.**

log 0.00001

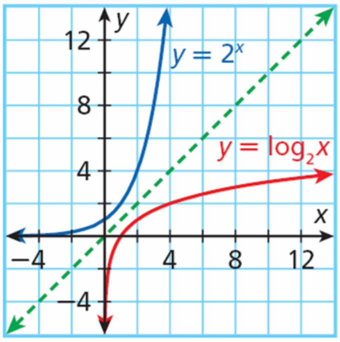
$\log_2 16$

## 7-3 Logarithmic Functions

Because logarithms are the inverses of exponents, the inverse of an exponential function, such as $y = 2^x$, is a **logarithmic function**, such as $y = \log_2 x$.

You may notice that the domain and range of each function are switched.

The domain of $y = 2^x$ is all real numbers (R), and the range is $\{y|y > 0\}$. The domain of $y = \log_2 x$ is $\{x|x > 0\}$, and the range is all real numbers (R).







## 7-3 Logarithmic Functions

### Example 4A: Graphing Logarithmic Functions

**Use the $x$-values {–2, –1, 0, 1, 2}. Graph the function and its inverse. Describe the domain and range of the inverse function.**

**$f(x) = 1.25^x$**

$y = 1.25^x$

$\log_{1.25} y = x$

## 7-3 Logarithmic Functions

**Helpful Hint**

The LOG key is used to evaluate logarithms in base 10. 2nd LOG ($10^x$) is used to find $10^x$, the inverse of log.



Homework:
p.509 #17-30, 33, 38

33 38

$2^{-2}$

$\frac{1}{2^2}$