Logarithmic Properties
3.31.16
Section 11.4
Warm-up

1) Solve and rewrite as a logarithmic statement.

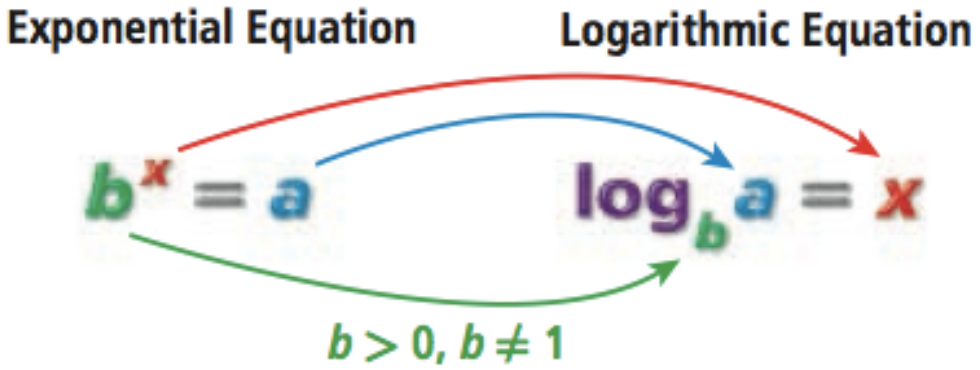
$$1{,}000{,}000 = 10^6$$

2) Solve and rewrite as an exponential statement.

$$\log 10{,}000 = 4$$

3) $3^{-\frac{1}{2}} =$

A ***Logarithm*** is the exponent to which a specified base is raised to obtain a given value.



Examples

$2^3 = 8$	$\log_2 8 = 3$
$5^4 = 625$	$\log_5 625 = 4$
Exponential	Logarithmic

We Try:
Write each exponential equation in logarithmic form.

1) $4^3 = 64$

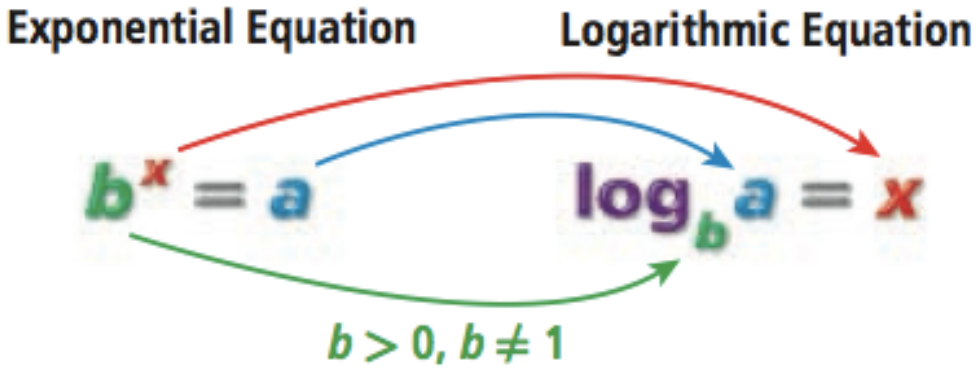
2) $3^4 = 81$

3) $2^5 = 32$

You Try with your partner on the whiteboards:

1) $5^2 = 25$

2) $3^3 = 27$



Write each logarithmic equation in exponential form

We Try:

1) $\log_7 343 = 3$

2) $\log_4 64 = 3$

$\log_4 4^3 = 3$

You Try with your partners on whiteboards:

1) $\log_4 16 = 2$
2) $log_2 1 = 0$

$Product\ Property$: $logm + logn = logmn$

Example:
Rewrite $log30$ $in\ two\ different\ ways$

$$log30 = \log(6 \cdot 5) = log6 + log5$$

$$log30 =$$

I do:
Simplify the expression:
$log100 = \log \quad + \log \quad + \log$

$$log5 + log3 + log2 =$$

We do:

Simplify the expression:
$log200 = \log \quad + \log \quad + \log$

$$log3 + log2 + log4 + log5 =$$

You do with your partner:
Simplify the expression:
$log18 = \log \quad + \log \quad + \log$

$$log3 + log3 + log2 + log2 =$$

Quotient Property: $\log\left(\frac{m}{n}\right) = logm - logn$

I do:
Rewrite in 2 ways.
$$log100 = \log\left(\frac{200}{2}\right) = log200 - log2$$

I do:

Simplify the expression:

$log30 = \log \quad - \log$

$log5 - log2 =$

We do:

Simplify the expression:

$log25 = \log \quad - \log$

$log10 - log5 =$

You do with your partner:
Simplify the expression:
$log15 = \log \quad - \log$

$log25 - log5 =$

Power Property
$mlogn = logn^m$

I do:
Rewrite $log25$ *using power property*

$log25 = \log 5^2 = 2log5$

$log8 = log2^3 = 3log2$

We do:
Simplify the expression:
$log100 =$

$log27 =$

You do with your partner on whiteboards:
Simplify the expression:
$log32 =$

$$4log2 =$$

Combined properties

$$I\ do:$$
$$\log\frac{x^4y}{3z}$$

Expand by quotient.	$(logx^4y) - log3z$
Expand by product	$(logx^4 + logy) - (log3 + logz)$
Expand by power	$(4logx + logy) - (log3 + logz)$

We do:

$$\log\frac{2x^3}{3y^4}$$

Expand by quotient.	
Expand by product	
Expand by power	

You do with your partner:

$$\log\frac{15xy^4}{2a^3z}$$

Expand by quotient.	
Expand by product	
Expand by power	

Condense log expressions:

$I\ do$:

$(2loga + logy + logd) - (2logf + logz)$

Condense by power	$(loga^2 + logy + logd) - (logf^2 + logz)$
Condense by product	$(loga^2yd) - (logf^2z)$
Condense by quotient	$\log\frac{a^2yd}{f^2z}$

We do:

$(2logx + 3logy + logd + log9) - (log3 + logy)$

Condense by power	
Condense by product	
Condense by quotient	

You do with your partner:

$(logx + logy + log3) - (logx + 2logy + logz)$

Condense by power	
Condense by product	
Condense by quotient	

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		
$\log_b b = 1$	$b^1 = b$	$\log_{10} 10 = 1$ $10^1 = 10$
Logarithm of 1		
$\log_b 1 = 0$	$b^0 = 1$	$\log_{10} 1 = 0$ $10^0 = 1$

A logarithm with base 10 is called a ***Common Logarithm.*** If there is no base, you can assume it to be 10.

EXAMPLE: $log 5 = \log_{10} 5$

I Try:
Evaluate by using mental math.
$\log_2 1$

Setup by solving for x	$\log_2 1 = x$
Write in exponential form	$2^x = 1$
Solve for x	$2^0 = 1, x = 0$

We Try:
Evaluate by using mental math.
1) $\log_6 36$

Setup by solving for x	
Write in exponential form	
Solve for x	

You Try with your partner on a whiteboard.
Odd Talk, Even Write
Evaluate by using mental math.
1) $\log_3 81$

2) $\log_4 4$

I Try:
$\log_4(2x - 6) = 3$
How can we get rid of the log_4?

Isolate the log	

Raise both sides by the base	
Simplify and solve for x	
Check for extraneous answers	

We Try:

$\log_3(x + 10) = 2$

Isolate the log	
Raise both sides by the base	
Simplify and solve for x	

Check for extraneous answers	

We Try:

$$log_3(x-2)=4$$

You Try with your partners on whiteboards:

1) $\log_2(2x+4)=3$

2) $log(x-3)=4$

I do:

Multistep log equations

$\log_3 x + \log_3(x) = 1$

Combine logs	
Raise both sides by the base	
Simplify and solve for x	
Check for extraneous solutions	

We do:

$\log_4 5x - \log_4(15) = 2$

Combine logs	
Raise both sides by the base	
Simplify and solve for x	
Check for extraneous	

solutions	

We do:

$$\log(x+2) + log5 = 3$$

Combine logs	
Raise both sides by the base	
Simplify and solve for x	
Check for extraneous solutions	

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You do:

$$\log(x-2) + log3 = 5$$

Exit Slip
Solve for

1) $\log_3 x + \log_3 x = 3$

2) Condense

$$(logz + 2logy + log3) - (log9 + 2logy + logz)$$

3) Expand:

$$\log \frac{14ay^4z}{2a^2z^2}$$