Welcome Back to MYP Math 9!

	Assignment Effort Grade (Circle One)	Comments (What was interesting or challenging?)
Monday Date: 2/19 Topic:_____	0 1 2	No School
Tuesday Date: 2/20 Topic: Logarithms	0 1 2	
Wednesday Date: _____ Topic:_____	0 1 2	
Thursday Date: _____ Topic:_____	0 1 2	
Friday Date: _____ Topic:_____	0 1 2	

Warm-up:

$b^x = y \quad x = \log_b(y)$

Solve for y. (Try without a calculator!)

$y = \log_2(128)$

$2^y = 128$

$y = 7$

$y = \log_3(81)$

$3^y = 81$

$y = 4$

Class Plan:

1. Warm-up
2. Investigation:
   Properties of Logarithms
3. Practice

Investigation:
Properties of Logarithms

Product Property

$$\log_a(x) + \log_a(y) = \log_a(\_\_\_\_)$$

Quotient Property

$$\log_a(x) - \log_a(y) = \log_a(\_\_\_\_)$$

Done? Write Properties in your notebook & raise your hand

1. Product/Multiplication Property

$2^3 \cdot 2^4 = 2^{\boxed{7}}$, $2^3 = 8$, $2^4 = 16$, $2^7 = 128$

$8 \cdot 16 = 128$

i. $\log_2(8) = 3$, $\log_2(16) = 4$,

ii. $\log_2(8) + \log_2(16) = 7$

iii. $\log_2(8) + \log_2(16) = \log_2(128)$

Question: How are parts **i, ii, iii** related?

$\log_2(\quad)$

1. Product/Multiplication Property

$4^2 \cdot 4^3 = 4^{\square}, 4^2 = \_\_, 4^3 = \_\_, 4^5 = \_\_\_\_$

$\_\_ \cdot \_\_\_\_ = \_\_\_\_ .$

i. $\log_4(16) = \_\_\_, \log_4(64) = \_\_\_,$

ii. $\log_4(16) + \log_4(64) = \_\_\_$

iii. $\log_4(16) + \log_4(64) = \log_4(\_\_\_\_\_)$

Question: How are parts **i, ii, iii** related?

2) Examine parts **a), b), and c).** Complete the rule when adding logarithms with a common ***base.***

$$\log_a(x) + \log_a(y) = \log_a(\_\_\_\_)$$

Investigation: Properties of Logarithms

1) "Product property of exponents"

a)

$2^3 \cdot 2^4 = 2^{\boxed{7}}$, $2^3 = 8$, $2^4 = 16$, $2^7 = 128$

$8 \cdot 16 = 128$.

b)

i. $\log_2(8) = 3$, $\log_2(16) = 4$,

ii. $\log_2(8) + \log_2(16) = 7$

iii. $\log_2(8) + \log_2(16) = \log_2(128)$

Question: How are parts **i, ii, iii** related?

The sum of the logs is equal to the log of (8·16)

[Solutions]

Investigation: Properties of Logarithms

c) $4^2 \cdot 4^3 = 4^{\boxed{5}}$, $4^2 = 16$, $4^3 = 64$, $4^5 = 1024$

i. $\log_4(16) = 2$, $\log_4(64) = 3$,

ii. $\log_4(16) + \log_4(64) = 5$

iii. $\log_4(16) + \log_4(64) = \log_4(16 \cdot 64)$

Question: How are parts **i, ii, iii** related?
The sum of the logs is equal to the log of $(16 \cdot 24)$

2) Examine parts **a), b), and c).** Complete the rule when adding logarithms with a common ***base***.

$$\log_a(x) + \log_a(y) = \log_a(xy)$$

[Solutions]

2. Quotient/Division Property

$\frac{4^5}{4^3} = 4^{\square}, 4^5 = \_\_\_\_\_, 4^3 = \_\_\_\_\_, 4^2 = \_\_\_\_$

i. $\log_4(1024) = \_\_\_, \log_4(64) = \_\_\_,$

ii. $\log_4(1024) - \log_4(64) = \_\_\_$

iii. $\log_4(1024) - \log_4(64) = \log_4(\_\_\_\_\_)$

Question: How are parts **i, ii, iii** related?

2. Quotient/Division Property

$\frac{3^6}{3^2} = 3^{\boxed{4}}, 3^6 = \underline{729}, 3^2 = \underline{9}, 3^4 = \underline{81}$

i. $\log_3(729) = \underline{6}, \log_3(9) = \underline{2}$

ii. $\log_3(729) - \log_3(9) = \underline{4}$

iii. $\log_3(729) - \log_3(9) = \log_4(\underline{81})$

Question: How are parts **i, ii, iii** related?

Division of values = difference of logs

4) Examine parts **a), b), c) and d).** Complete the rule when subtracting logs with a common ***base***.

$$\log_a(x) - \log_a(y) = \log_a(\underline{\frac{x}{y}})$$

Investigation: Properties of Logarithms

3) "Division property of exponents"

a)

$\frac{4^5}{4^3} = 4^{\boxed{2}}$, $4^5 = 1024$, $4^3 = 64$, $4^2 = 16$

b)

i. $\log_4(1024) = 5$, $\log_4(64) = 3$,

ii. $\log_4(1024) - \log_4(64) = 2$

iii. $\log_4(1024) - \log_4(64) = \log_4\left(\frac{1024}{64}\right)$

Question: How are parts **i, ii, iii** related?
The difference of the logs is equal to the log of $\left(\frac{1024}{64}\right)$

[Solutions]

Investigation: Properties of Logarithms

c)

$\frac{3^6}{3^2} = 3^{\boxed{4}}$, $3^6 = 729$, $3^2 = 9$, $3^4 = 81$

d)

i. $\log_3(729) = 6$, $\log_3(9) = 2$,

ii. $\log_3(729) - \log_3(9) = 4$

iii. $\log_3(729) - \log_3(9) = \log_3\left(\frac{729}{9}\right)$

Question: How are parts **i, ii, iii** related?
The difference of logs is equal to the log of $\left(\frac{729}{9}\right)$

4) Examine parts **a), b), c) and d).** Complete the rule when subtracting logs with a common ***base***.

$$\log_a(x) - \log_a(y) = \log_a\left(\frac{x}{y}\right)$$

[Solutions]

NOTES:
Properties of Logarithms

Product Property

$$\log_a(x) + \log_a(y) = \log_a(\_\_\_\_)$$

Quotient Property

$$\log_a(x) - \log_a(y) = \log_a(\_\_\_\_)$$

Properties of Exponents and Logarithms

Notes

Definition of Logarithm

If $x = a^m$, then $\log_a x = m$.

Product Property

$a^m \cdot a^n = a^{m+n}$ or $\log_a xy = \log_a x + \log_a y$

Quotient Property

$\frac{a^m}{a^n} = a^{m-n}$ or $\log_a \frac{x}{y} = \log_a x - \log_a y$

Power Property

$\log_a x^n = n \log_a x$

Power of a Power Property

$(a^m)^n = a^{mn}$

Power of a Product Property

$(ab)^m = a^m b^m$

Power of a Quotient Property

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Change-of-Base Property

$\log_a x = \frac{\log_b x}{\log_b a}$

log □ (□)

LOG

$\log_{(12)}(47) = \frac{\log 47}{\log 12}$

Example: Evaluate

Evaluate each expression.

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

10) $\log_4 \frac{1}{64} = \log_4(1) - \log_4(64)$

$= 0 - 3$

$= -3$

Example: Expand using properties

Expand each logarithm.

17) $\log_6(2 \cdot 5) = \log_6(2) + \log_6(5)$

Example: Expand using properties

Expand each logarithm.

19) $\log_6 \frac{7}{3} = \log_6(7) - \log_6(3)$

Solve each equation.

Example: Expand using properties

23) $\log_5(8) + \log_5(x-4) = 2$ Exponent

$\log_5(8x-32) = 5^2$

$8x - 32 = 25$

$\frac{8x}{8} = \frac{57}{8}$

$x = \frac{57}{8}$

Solve each equation.

Example: Expand using properties

23) $\log_5 8 + \log_5 (x-4) = 2$

$\log_5(8(x-4)) = 2$

$\log_5(8x-32) = 2$

$8x-32 = 5^2$

$8x-32 = 25$

$8x = 57$

$x = \frac{57}{8}$

Exercises

1) Practice applying log properties
2) Examine your quiz with EXEMPLARS (posted 3pm.)

Simplify.

1) $2^2 \cdot 2^2$

2) $(2^3)^3 \cdot 2^2$

3) $(2 \cdot 2^{-2})^3$

4) $2^{-2} \cdot (2^4)^{-2}$

5) $\frac{3^3 \cdot 3^2}{3^4}$

6) $\frac{4^{-1} \cdot 4^{-2}}{4}$

Exercises...

Evaluate each expression.

7) $\log_4 16$

8) $\log_3 \frac{1}{81}$

9) $\log_6 216$

10) $\log_4 \frac{1}{64}$

11) $\log_4 64$

12) $\log_7 343$

Exercises...

11) $\log_4 64$

12) $\log_7 343$

13) $\log_5 \frac{1}{125}$

14) $\log_2 \frac{1}{16}$

15) $\log_5 \frac{1}{25}$

16) $\log_3 \frac{1}{243}$

Exercises...

Expand each logarithm.

17) $\log_6 (2 \cdot 5)$

18) $\log_5 (3 \cdot 10)$

19) $\log_6 \frac{7}{3}$

20) $\log_2 \frac{12}{11}$

21) $\log_5 6^5$

22) $\log_4 (8 \cdot 3)$

Exercises...

Solve each equation.

23) $\log_5 8 + \log_5 (x-4) = 2$

24) $\log_2 3 + \log_2 (x-5) = \log_2 27$

25) $\log_3 6 - \log_3 -2x = 2$

26) $\log_5 2 + \log_5 -5x = 1$

27) $\log_2 10 - \log_2 5x = \log_2 69$

28) $\log_6 -x + \log_6 9 = 4$

Solutions

Answers to Exponent & Logarithm Properties (ID: 1)

1) 2^4	2) 2^{11}	3) $\frac{1}{2^3}$	4) $\frac{1}{2^{10}}$
5) 3	6) $\frac{1}{4^4}$	7) 2	8) -4
9) 3	10) -3	11) 3	12) 3
13) -3	14) -4	15) -2	16) -5
17) $\log_6 2 + \log_6 5$	18) $\log_5 3 + \log_5 10$	19) $\log_6 7 - \log_6 3$	20) $\log_2 12 - \log_2 11$
21) $5\log_5 6$	22) $\log_4 8 + \log_4 3$	23) $\left\{\frac{57}{8}\right\}$	24) $\{14\}$
25) $\left\{-\frac{1}{3}\right\}$	26) $\left\{-\frac{1}{2}\right\}$	27) $\left\{\frac{2}{69}\right\}$	28) $\{-144\}$