Welcome Back!

1. Staple rubric on top of project.

2. Turn into basket

	Assignment Effort Grade (Circle One)	Comments (What was interesting or challenging?)
Monday Date: 2/26 Topic: Exponential Project Due!	0 1 2	
Tuesday Date: _____ Topic: _____	0 1 2	
Wednesday Date: _____ Topic: _____	0 1 2	
Thursday Date: _____ Topic: _____	0 1 2	
Friday		

Plan for Tuesday 2-27

Knox: (Room **N135**) Last names: materials
A - ELLIS

Paulson: (Room **E122**) Last names:
ERDRICH -KYLLONEN Video

Mohamud: (Room **207**) Last names:
LACOURSIERE - ROMERO-R materials

Kohnert: (Room **E102**) Last names:
RUSSELL - ZWACK-LAFAURIE Video

Warm-up:

$x = \log_3(3^2)$

$x = \log_3(9)$

$3^x = 9$

$x = 2$

$x = 2\log_3(3)$

$x = 2(\log_3(3))$

$3^a = 3^1$

$x = 2(1) = 2$

Warm-up:

$x = \log_5(5^3)$

$x = 3 \log_5(5)$

Class Plan:

1. Warm-up
2. Properties of Logarithms Part 2
3. Practice & Finish Project

Introduction to Investigation:

Find the value of ***x***.

$x = \log_4(8^2)$

Power Property Investigation of Logs

1) Fill in the blanks to discover the property.

a)

$4^{\frac{3}{2}} = \sqrt[2]{4^{3}} = 8$

b)

$\log_4(8) = 1.5, \log_4(2^3) = \frac{3}{2}$

$3\log_4(2) = 3(.5) = 1.5$

Try conclude

What can we conclude?

iii. $\log_4(2^3) = 3\log_4(2)$

"How many factors of 4 produce 8?"

$4^1 \cdot 4^{\frac{1}{2}} = 4 \cdot 2 = 8$

"How many factors of 4 produce 2?"

$4^{\frac{1}{2}} = 2 = \sqrt[2]{4}$

Investigation: Properties of Logarithms

5) "Power property of exponents"

a)

$4^{\frac{3}{2}} = \sqrt[2]{4^{3}} = 8$

b)

i. $\log_4(8) = \frac{3}{2}$, $\log_4(2^3) = \frac{3}{2}$

ii. $3\log_4(2) = 3(\frac{1}{2}) = \frac{3}{2}$

Question: What can we conclude?

iii. $\log_4(2^3) = 3\log_4(2)$

[Solutions]

Power Property Investigation of Logs

c)

$2^{\frac{10}{2}} = \sqrt{2^{\square}} = \_\_\_\_$

d)

$\log_2(32) = \_\_\_, \log_2(2^5) = \_\_\_\_$

$5\log_2(2) = 5(\_\_\_\_) = \_\_\_\_$

What can we conclude?

iii. $\log_2(2^5) = \_\_\_\_\log_2(\_\_\_\_)$

Examine parts **a), b), c) and d)** when finding the log of a value that is raised by an exponent.

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

Investigation: Properties of Logarithms

c)

$2^{\frac{10}{2}} = \sqrt[2]{2^{10}} = 32$

d)

i. $\log_2(32) = 5$, $\log_2(2^5) = 5$

ii. $5\log_2(2) = 5(1) = 5$

Question: What can we conclude?

iii. $\log_2(2^5) = 5\log_2(2)$

6) Examine parts **a), b), c) and d)** when finding the log of a value that is raised by an exponent.

$\log_a(x^y) = y\log_a(x)$

$(x^m)^n$

Solutions

Change of Base Property

$$\log_3(70) = n$$

$$3^n = 70$$

$\log_x(\quad)$

$\log_x(3^n) = \log_x(70)$

$$\frac{n\log_x(3)}{\log_x(3)} = \frac{\log_x(70)}{\log_x(3)}$$

$$\log_b(a) = \frac{\log_x(a)}{\log_x(b)}$$

a) Why does this work?

1. Rewrite as an exponential expression
2. Take the log base x of both sides
3. Apply the Power Property
4. Rearrange your equation.

$$\log_3(70) = n$$

$$3^n = 70$$

$\log_x(3^n) = \log_x(70)$

$n \cdot \log_x(3) = \log_x(70)$

Division, isolate *n*

$$n = \frac{\log_x(3)}{\log_x(70)} \text{ hence,}$$

$$\log_3(70) = \frac{\log_x(3)}{\log_x(70)}$$

Change of Base Property

a) Why does this work?

1. Rewrite as an exponential expression
2. Take the log base x of both sides
3. Apply the Power Property
4. Rearrange your equation.

$$\log_b(a) = \frac{\log_x(a)}{\log_x(b)}$$

Properties of Exponents and Logarithms

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

$\log_a x^n = n \log_a x$ (Today's property!)

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

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

Definition of Rational Exponents

$a^{m/n} = \left(\sqrt[n]{a}\right)^m$ or $\sqrt[n]{a^m}$

Definition of Negative Exponents

$a^{-n} = \frac{1}{a^n}$ or $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$

Notes

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

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

Power of a Power Property

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

Power of a Product Property

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

Change-of-Base Property

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

Power of a Quotient Propert

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

Exercises:

REVIEW: Evaluate each expression. (Show conversion to an exponential expression)

1) $\log_3 81$

2) $\log_6 36$

3) $\log_5 125$

4) $\log_2 32$

$2^x = 32$

$x = 5$

5) $\log_4 \frac{1}{16}$

6) $\log_2 \frac{1}{4}$

7) $\log_6 216$

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

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

$x = -3$

Exercises:

Expand each logarithm.

9) $\log 5^2$

10) $\log (7 \cdot 3)$

11) $\log \sqrt{2} = \frac{1}{2}\log 2$

12) $\log 5^5$

13) $\log 8^4$

14) $\log \sqrt[3]{12}$

$$\frac{\log 12}{3} = \log 12^{\frac{1}{3}} = \boxed{\frac{1}{3}\log 12}$$

Exercises: Expand each logarithm

15) $\log \frac{3}{7}$ $= \log 3 - \log 7$

16) $\log (7 \cdot 8)$

17) $\log (7 \cdot 6 \cdot 11^6)$

18) $\log_2 \sqrt[3]{5 \cdot 3 \cdot 8}$

$\log 7 + \log 6 + \log 11^6$

$\log 7 + \log 6 + 6 \log 11$

Exercises: Expand each logarithm

15) $\log \frac{3}{7}$

16) $\log (7 \cdot 8)$

17) $\log (7 \cdot 6 \cdot 11^6)$

18) $\log_2 \sqrt[3]{5 \cdot 3 \cdot 8}$

$\frac{1}{3}\log_2 5 + \frac{1}{3}\log_2 3 + \frac{1}{3}\log_2 8$

$\frac{1}{3}\log_2 5 + \frac{1}{3}\log_2 3 + 1$

Exercises: Expand each logarithm

19) $\log_6\left(11\sqrt[3]{3\cdot 2}\right)$

20) $\log_2\left(6^2\cdot 5^4\right)$

21) $\log_5\left(\frac{11^4}{10}\right)^2$

22) $\log_3\sqrt[3]{12\cdot 7\cdot 5}$

Exercises: Expand each logarithm

21) $\log_5 \left(\frac{11^4}{10}\right)^2$

22) $\log_3 \sqrt[3]{12 \cdot 7 \cdot 5}$

$\log_3 (12 \cdot 7 \cdot 5)^{1/3}$

$\log_3 12^{1/3} + \log_3 7^{1/3} + \log_3 5^{1/3}$

$\frac{1}{3}(\log_3 12 + \log_3 7 + \log_3 5)$

Exercises: Expand each logarithm

21) $\log_5 \left(\frac{11^4}{10}\right)^2$

22) $\log_3 \sqrt[3]{12 \cdot 7 \cdot 5}$

$2\log_5 11^4 - 2\log_5 10$

$8\log_5 11 - 2\log_5 10$

$x^2 = \frac{x^5}{x^3}$

Exercises: Expand each logarithm

23) $\log_5\left(11\sqrt[3]{7\cdot 10}\right)$

$\log_9 3 = \frac{1}{2}$

$9^{1/2} = \sqrt{9} = 3$

24) $\log_9\left(3^6\cdot 10\right)^3$

$\log_9(3^6)^3 + \log_9 10^3$

$18\log_9 3 + 3\log_9 10$

$18\left(\frac{1}{2}\right) + 3\log_9 10$

$9 + 3\log_9 10$

Exercises: Expand each logarithm

25) $\log_2 \sqrt[3]{7 \cdot 5 \cdot 8}$

26) $\log_2 \left(8^3 \sqrt[3]{3}\right)$

$\log_2(8^3) + \log_2 3^{1/3}$

$3\log_2(8) + \frac{1}{3}\log_2(3)$

$3(3) + \frac{\log_2(3)}{3}$

$9 + \frac{\log_2(3)}{3}$

Exercises:

Use a calculator and the change of base formula to approximate each to the nearest thousandth.

27) $\log_3 4.7$

28) $\log_7 13$

29) $\log_6 6.9$

30) $\log_5 20$

Exercises:

Use a calculator and the change of base formula to approximate each to the nearest thousandth.

31) $\log_4 6$

32) $\log_2 1.2$

33) $\log_6 8$

34) $\log_2 2$

Exercises: Solutions!

1) 4
2) 2
3) 3
4) 5
5) −2
6) −2
7) 3
8) −3
9) $2\log 5$
10) $\log 7 + \log 3$
11) $\frac{\log 2}{2}$
12) $5\log 5$
13) $4\log 8$
14) $\frac{\log 12}{3}$
15) $\log 3 - \log 7$
16) $\log 7 + \log 8$
17) $\log 7 + \log 6 + 6\log 11$
18) $\frac{\log_2 5}{3} + \frac{\log_2 3}{3} + 1$
19) $\log_6 11 + \frac{\log_6 3}{3} + \frac{\log_6 2}{3}$
20) $2\log_2 6 + 4\log_2 5$
21) $8\log_5 11 - 2\log_5 10$
22) $\frac{\log_3 12}{3} + \frac{\log_3 7}{3} + \frac{\log_3 5}{3}$
23) $\log_5 11 + \frac{\log_5 7}{3} + \frac{\log_5 10}{3}$
24) $18\log_9 3 + 3\log_9 10$
25) $\frac{\log_2 7}{3} + \frac{\log_2 5}{3} + 1$
26) $9 + \frac{\log_2 3}{3}$
27) 1.409
28) 1.318
29) 1.078
30) 1.861
31) 1.292
32) 0.263
33) 1.161
34) 1