Name:_____________________ Date:__________

Notes: Common Logs and Natural Logs

Do Now: Evaluate each logarithm without a calculator.

1) $\log_2 8$

2) $\log_8 2$

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

Think for a minute, describe when you have used each of the mathematical operations below

4) 2.4×10^9

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5) $A = Pe^{rt}$

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What Should I Be Able to Do?

- I can explain what a common logarithm is and why we use shorthand to write a common logarithm.

- I can explain what a natural logarithm is and why we use shorthand to write a natural logarithm.

- I can generalize a rule to simplify $\log_a 1$ and explain/justify why $\log_a 1$ simplifies to that given value.

- I can generalize a rule to simplify $\log_a a$ and explain/justify why $\log_a a$ simplifies to that given value.

- I can generalize a rule to simplify $\log_a a^x$ and explain/justify why $\log_a a^x$ simplifies to that given value.

- I can generalize a rule to simplify $a^{\log_a x}$ and explain/justify why $a^{\log_a x}$ simplifies to that given value.

Since we frequently use 10 or e as a base for exponential expressions and equations, we give the logarithms with a base of 10 or e a special name.

Common Logarithm:

The logarithm with base 10 is called the **common logarithm** and is written by excluding the base:

$$\log_{10} x = \log x$$

Evaluate or estimate the following logarithms:

1) $\log 100$

2) $\log 350$

Scientific calculators of a __LOG__ button you can press to evaluate any common log. Check each of you answers using the calculator.

Natural Logarithm:

The logarithm with base e is called the **natural logarithm** and is written by **ln**:

$$\log_e x = \ln x$$

Scientific calculators of a __LN__ button you can press to evaluate any natural log. Use your calculator to evaluate the following:

1) $\ln 9$

2) $\ln 64$

Simplify the following logarithmic expressions:

1) $\log_8 1$ 2) $\log_{36} 1$ 3) $\log_x 1$

Generalize your findings:

$$\boldsymbol{\log_a 1 =}$$

Explain why this is true, using correct and effective mathematical vocabulary.

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Simplify the following logarithmic expressions:

1) $\log_2 2$ 2) $\log_{12} 12$ 3) $\log_x x$

Generalize your findings:

$$\boldsymbol{\log_a a =}$$

Explain why this is true, using correct and effective mathematical vocabulary.

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Simplify the following logarithmic expressions:

1) $\log_4 4^5$ 2) $\log_9 9^3$ 3) $\log_c c^d$

Generalize your findings:

$$\boldsymbol{\log_a a^x =}$$

Explain why this is true, using correct and effective mathematical vocabulary.

Simplify the following logarithmic expressions:

1) $3^{\log_3 7}$ 2) $9^{\log_9 20}$ 3) $c^{\log_c d}$

Generalize your findings:

$$\boldsymbol{a^{\log_a x} =}$$

Explain why this is true, using correct and effective mathematical vocabulary.

Putting Everything Together

Simplify the following logarithmic expressions:

1) $\log 1$

2) $\ln 1$

3) $\log 10$

4) $\ln e$

5) $\log 10^x$

6) $\ln e^x$

7) $\log 10^4$

8) $10^{\log x}$

9) $e^{\ln x}$

10) $e^{\ln 5}$

Success Criteria

- I can explain what a common logarithm is and why we use shorthand to write a common logarithm.

- I can explain what a natural logarithm is and why we use shorthand to write a natural logarithm.

- I can generalize a rule to simplify $\log_a 1$ and explain/justify why $\log_a 1$ simplifies to that given value.

- I can generalize a rule to simplify $\log_a a$ and explain/justify why $\log_a a$ simplifies to that given value.

- I can generalize a rule to simplify $\log_a a^x$ and explain/justify why $\log_a a^x$ simplifies to that given value.

- I can generalize a rule to simplify $a^{\log_a x}$ and explain/justify why $a^{\log_a x}$ simplifies to that given value.

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Logarithm Practice

Convert each exponential equation into its equivalent logarithmic equation.

1) $e^4 = x$

2) $10^3 = 1000$

3) $2^y = 14$

4) $a^{10} = 76$

5) $10^4 = x$

6) $\frac{1}{6}^3 = b$

7) $e^x = 9$

8) $10^y = 76$

Convert each logarithmic equation into its equivalent exponential equation.

9) $\log 9 = x$

10) $\ln x = 14.5$

11) $\log_{2.5} x = 7$

12) $\ln \frac{1}{2} = y$

Evaluate each logarithm without a calculator.

13) $\log 10$

14) $\ln e^9$

15) $\ln e$

16) $10^{\log 30}$

17) $e^{\ln x^2}$

18) $\log 1$

19) $\log \frac{1}{100}$

20) $\ln \frac{1}{e^8}$

21) $3(\log 100)$

22) $10^{\log \sqrt{x}}$

23) $\ln e^{x-7}$

24) $e^{\ln 8x}$

25) Is the following equation true or false? Justify your answer.

$$\frac{\log_2 16}{\log_2 4} = 4$$

26) Is the following equation true or false? Justify your answer.

$$\log(-100) = -2$$

27) Is the following equation true or false? Justify your answer.

$$2(\ln e^3) = 6$$

Evaluate each of the following expressions without a calculator.

28) $\log 1000 + \ln e$

29) $e^{\ln 11} + \ln e^8$

30) $\log_4(\log_5 5)$

31) $10^{\log x^2} - \ln e^x$

32) $\log_2(\log 10000)$

33) $\ln(\log 10)$

Using you calculator, round each expression to the nearest thousandth.

34) $\log 341$

35) $\ln 4.5$

36) $\log 87 + \ln 87$

37) A group of scientists are studying the division of amebas to better understand how to better treat patients. The ameba the scientists are studying divides itself into two amebas every hour. The scientists use the equation $t = \log_2 A$ where t, is the number of hours it takes to produce A number of amebas. Find, to the nearest hundredth of an hour, how long it takes to produce 25,000 amebas if the scientists start with one ameba.

Evaluate the following expression without a calculator.

38) $\frac{\log_{\sqrt{2}} 1 - \log 0.1}{\ln e^4 - \log_3 27}$

Looking Ahead...

Describe the transformation being done from the graph of $f(x)$ to obtain the graph of $g(x)$.

39) $f(x) = \ln x$

$g(x) = \ln(x - 4)$

40) $f(x) = \log x$

$g(x) = \log x + 9$