MAT 012 **Lecture Notes, Ch 12.5 & 12.7: Logarithms**

Since the exponential function is one-to-one (it passes the horizontal line test), it has an inverse function. This inverse is the logarithmic function.

Solving an exponential function for the exponent produces the logarithm.

$\log_b c = x$ is equivalent to $b^x = c$
When working with logarithms, rewrite them in exponential form, then evaluate.

Examples:

1) Evaluate: $\log_2 16$

2) Evaluate: $\log_2 \frac{1}{4}$

3) Evaluate: $\log_{10} 10{,}000$

4) Evaluate: $\log_2(-4)$

5) Find x: $\log_2 x = -3$

6) Find x: $\log_x 125 = 3$

7) Find x: $\log_{10} x = 5$

8) Find *x*: $\log_7 x = 0$

9) Evaluate: $\log_{10} 0.001$

10) Evaluate: $\log_5 5$

11) Find *x*: $\log_4 x = 1$

12) Find *x*: $\log_x 32 = 5$

13) Evaluate $\log_{10} \frac{1}{1000}$

14) Find *x*: $\log_9 x = \frac{1}{2}$

15) Find *x*: $\log_{10} x = -2$

16) Evaluate: $\log_6 1$

17) Find x: $\log_x \frac{1}{49} = -2$

18) Evaluate: $\log_{\frac{1}{4}} 64$

19) Find x: $\log_{\frac{1}{3}} x = -4$

20) Evaluate: $\log_8 \sqrt{8}$

21) Find x: $\log_x \frac{81}{16} = -4$

Often base 10 is implied. By convention: $\log_{10} x$ is written as $\log x$.

If the so called Euler number ***e* = 2.7182818284…** (pronounce "Oiler number") is used as a base in a logarithm, then we call this logarithm base e the ***natural logarithm***. The convention for this logarithm is that $\log_e x$ is written as $\ln x$.

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Logarithms on the calculator

Base **10** $\boxed{\text{LOG}}$ key: to evaluate $\log_{10} 10{,}000$, type log(10,000) =

to evaluate $\log_{10} 0.00001$, type log(0.00001) =

Base ***e*** $\boxed{\text{LN}}$ key to evaluate $\ln 7$ type ln(7) for a decimal approximation.

If you need it exact, leave ln 7

Evaluating logarithms other than base 10 or base *e*

A useful relationship called the base change formula: $\boxed{\log_b c = \dfrac{\log_{10} c}{\log_{10} b} \text{ or alternatively } \dfrac{\ln c}{\ln b}}$

Example:

22) Evaluate: $\log_2 128$

23) Evaluate: $\log_2(-2)$

24) Evaluate: *Give an exact answer*: $\log_{\frac{1}{2}} \sqrt[3]{2}$

Graphing logarithms other than base 10 or base *e* with the graphing calculator

To graph logarithms that are not base 10 or base *e*, use the same base change formula as above:

25) Graph on a graphing calculator: $f(x) = -\log_3 x$

26) Graph on a graphing calculator: $g(x) = \log_{\frac{1}{2}}(x+4)$