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GPS # 27 **3.2** **LOGARITHMIC FUNCTIONS I** Class Time: 11:30 Date: 3/6/07

20/20 Gave no hlp.

Useful Guidelines:

* The logarithmic function to the base a, where $a > 0$ and $a \neq 1$: $y = \log_a x$ <u>if and only if</u> $x = a^y$;
* Properties of the logarithmic Function $y = \log_a x$ (where $a > 0$ and $a \neq 1$):
  (1) Domain: the interval $(0, \infty)$; Range: the interval $(-\infty, \infty)$;
  (2) x-intercepts: 1; y-intercept: none;
  (3) Vertical asymptote: $x = 0$;
  (4) $f(x) = \log_a x, a > 1$, is an increasing, one-to-one, smooth and continuous function;
  $f(x) = \log_a x, 0 < a < 1$, is a decreasing, one-to-one, smooth and continuous function;
  (5) The points $(1,0), (a,1)$, and $(\frac{1}{a}, -1)$ are always on the graph of f.
* Natural logarithm function: $y = \log_e x = \ln x$ <u>if and only if</u> $x = e^y$.
* Common logarithm function: $y = \log x$ <u>if and only if</u> $x = 10^y$.

1. Change each logarithmic expression to an equivalent expression involving an exponent.

a) $\log_{10} m = 5$

$m = 10^5$

b) $\log_e b = 4$

$b = e^4$

c) $\log_p 3 = x$

p p

$3 = p^x$

d) $\log_2 M = c$

2 2

$M = 2^c$

e) $\ln 5 = x$

$\ln(x) = \log_e(x)$

$5 = e^x$

f) $\ln x = 3$

$\log_e(x) = 3$

e e

$x = e^3$

2. Find the exact value of the following:

a) $y = \log_3 27$

$y = \log_3(3^3)$

$= 3 \cancel{\log_3(3)} = 3 \cdot 1 = 3$

b) $y = \log_{10} 100$

$y = \log_{10}(10^2)$

$= 2 \cancel{\log_{10}(10)} = 2 \cdot 1 = 2$

c) $y = \log_3 \frac{1}{9}$

$y = \log_3(3^{-2})$

$y = -2 \cancel{\log_3(3)} = -2 \cdot 1 = -2$

d) $y = \log_{10} \frac{1}{1000}$

$y = \log_{10}\left(\frac{1}{10^3}\right) = \log_{10}(10^{-3})$

$= -3 \cancel{\log_{10}(10)} = -3$

e) $y = \ln e^4$

$y = \log_e(e^4)$

$= 4 \cancel{\log_e(e)} = 4 \cdot 1 = 4$

f) $y = \ln \sqrt{e}$

$= \log_e(e^{\frac{1}{2}})$

$= \frac{1}{2}$

3. Find the domain of each function.

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

$x + 1 > 0$

$x > -1$

D: $\{x \mid x > -1\}$

b) $g(x) = 4 + 2\ln(5x)$

$5x > 0$

$x > 0$

D: $\{x \mid x > 0\}$

c) $f(x) = \sqrt{\ln x}$

$\ln(x) \geq 0 \} e^{\ln(x)} \geq e^0$

$x \geq 1$

D: $\{x \mid x \geq 1\}$

d) $g(x) = \frac{1}{\ln x}$

$x > 0$

$e^{\ln(x)} \neq 0$

e

$x \neq 1$

D: $\{x \mid x > 0, x \neq 1\}$