Logarithms

I. A **logarithm** is another way to write an **exponent.**

Logarithm Form	Exponent Form
$log_a x = y$	$a^y = x$
$ln_e x = y$	$e^y = x$
$log_{10} 1000 = 3$	$10^3 = 1000$
$log_2 16 = 4$	$2^4 = 16$
$log_3 3 = 1$	$3^1 = 3$
$log_5 1 = 0$	$5^0 = 1$

exponent

$\log_a x = y$ ***means*** $a^y = x$

base

II. **Note:** If the **base** for ***log*** is left out, it is **understood** to be **10**.
The **base** for ***ln*** is always ***e***.

Common Logarithm – *log*	**Natural Logarithm – *ln***
Note: $\log x = \log_{10} x$	*Note:* $\ln x = \log_e x$

III. **Properties of Logarithms:**

log		***ln***
$\log_b xy = \log_b x + \log_b y$	**Product Property**	$\ln xy = \ln x + \ln y$
$\log_b \frac{x}{y} = \log_b x - \log_b y$	**Quotient Property**	$\ln \frac{x}{y} = \ln x - \ln y$
$\log_b x^r = r \log_b x$	**Power Property**	$\ln x^r = r \ln x$
$\log_b b^x = x$ $b^{\log_b x} = x$	**Inverses**	$\ln e^x = x$ $e^{\ln x} = x$

IV. Change-of-Base Theorem:

	Formula	Example
log	$log_a\, x = \frac{log_b\, x}{a}\, log_b$	$log_\pi 9 = \frac{\log 9}{\log \pi} = 1.9194$
ln	$log_a x = \frac{\ln x}{\ln a}$	$log_{32} 5 = \frac{\ln 5}{\ln 32} = 0.4644$

V. Property of Logarithms

$\boldsymbol{x = y}$	*if and only if*	$\boldsymbol{log_a x = log_a y}$

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