A logarithm is just a special way to ask a specific question "log base b of a is x"

$\log_b a = x$

THE QUESTION: What exponent is required to go from a base of b to reach a value of a

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EXPONENTIAL FORM	LOGARITHMIC FORM
base exponent = answer	$\log_{\text{base}}$ answer = exponent

base goes to bottom

answer goes next to log

E's go next to each other

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CONVERT BETWEEN EXPONENTIAL AND LOGARITHMIC FORM

$\log_{\frac{1}{5}} y = x$ $\quad \left(\frac{1}{5}\right)^x = y$

$\log_9 x = y$ $\quad 9^y = x$

$\log_6 x = y$ $\quad 6^y = x$

$\log_u \frac{15}{16} = v$ $\quad u^v = \frac{15}{16}$

$\log_{\frac{7}{4}} x = y$ $\quad \frac{7}{4}^y = x$

$\log_u v = -16$ $\quad u^{-16} = v$

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The Logarithm Loop Trick

Always draw your loop counter-clockwise from the base!

$\log_b a = x$ $\quad b^x = a$

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CALCULATE THE FOLLOWING LOGARITHMS

$\log_4 64 = y$ $\quad 4^y = 64$ $\quad y = 3$

$\log_6 216 = y$ $\quad 6^y = 216$ $\quad y = 3$

$\log_4 16$ $\quad 4^y = 16$ $\quad y = 2$

$\log_3 \frac{1}{243}$ $\quad 3^y = 243$ $\quad y = 5$

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$\log_{343} 7$

$343^y = 7$

$y = \frac{1}{3}$

$\log_2 16$

$2^x = 16$

$x = 4$

$\log_{64} 4$

$64^y = 4$ $\frac{1}{3}$

$\log_6 \frac{1}{216}$

$6^y = 216$

$y = -3$

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COMMON LOG

OH NO!
MY LOGARITHM HAS NO BASE

ANYTIME THE BASE OF A LOGARITHM IS NOT WRITTEN, IT IS ASSUMED TO BE THE NUMBER 10

$\log 10 = \log_{10} 10 = 1$

$\log\left(\frac{1}{100}\right) = \log_{10}\left(\frac{1}{100}\right) = -2$

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NATURAL LOG

$\log_e x$ *write as* $\longrightarrow$ $\ln x$

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basic Logs

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Rewrite each equation in logarithmic form.

1) $5^2 = 25$

2) $9^2 = 81$

3) $5^{-2} = \frac{1}{25}$

4) $x^{11} = y$

5) $\left(\frac{1}{15}\right)^0 = 1$

6) $m^{-9} = n$

7) $16^0 = 1$

8) $12^2 = 144$

9) $18^2 = 324$

10) $y^x = z$

Evaluate each expression.

11) $\log_6 6$

12) $\log_3 -\frac{1}{27}$

13) $\log_2 16$

14) $\log_7 49$

15) $\log_5 125$

16) $\log_6 216$

17) $\log_7 -343$

18) $\log_2 8$

19) $\log_5 -25$

20) $\log_2 4$

PROPERTIES OF LOGARITHMS

PRODUCT PROPERTY

$\log_b xy =$ $\log_b x + \log_b y$

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QUOTIENT PROPERTY

$\log_b \frac{x}{y} =$ $\log_b x - \log_b y$

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POWER PROPERTY

$\log_b x^y =$ $y \log_b x$

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EXPANDING LOGARITHMS

$\log_2 3x^4y =$ $\log_2 3 + \log_2 x^4 + \log_2 y$

$\log_2 3 + 4\log_2 x + \log_2 y$

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EXPANDING CONTINUED

$\log \frac{a^2b}{c}$ $\log a^2b - \log c$

$\log a^2 + \log b - \log c$

$2\log a + \log b - \log c$

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EXPANDING CONTINUED

$\log_5 \frac{p}{q^2 r^3}$

$\log_5 p - \log q^2 r^3$

$\log_5 p - \log q^2 + \log r^3$

$\log_5 p - 2\log_5 q + 3\log r$

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EXPANDING CONTINUED

$\log_7 \left(c^2 \sqrt[3]{a}\right) = \log_7 c^2 a^{\frac{1}{3}}$

$\log_7 c^2 + \log_7 a^{\frac{1}{3}}$

$2\log_7 c + \frac{1}{3}\log_7 a)$

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EXPANDING CONTINUED

$\log_2 \sqrt{x \cdot y \cdot z}$

$\log_2 (xyz)^{\frac{1}{2}}$

$\frac{1}{2}\log_2 (xyz)$

$\frac{1}{2}(\log_2 x + \log_2 y + \log_2 z)$

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CONDENSING LOGARITHMS

$\log_3 5 + 2\log_3 x - 6\log_3 z$

$\log_3 5 + \log_3 x^2 - \log_3 z^6$

$\log_3 5x^2 - \log_3 z^6$

$\log_3 \left(\frac{5x^2}{z^6}\right)$

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CONDENSING CONTINUED

$2\ln a - \ln b - 3\ln c$

$\ln a^2 - \ln b - \ln c^3$

$\ln \frac{a^2}{b} - \ln c^3$ $\ln \frac{a^2}{bc^3}$

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CONDENSING CONTINUED

$2(\log_4 6 - \log_4 3) + 0.5\log_4 25$

$2(\log_4 \frac{6}{3}) + \log_4 25^{.5}$

$\log_4 (\frac{1}{3})^2 + \log_4 25^5$

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$\log_4 ((\frac{6}{3})^2 (25)^5)$

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Expand/Condense

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Expand each logarithm.

1) $\log_8 (a^2 \cdot b)^3$

2) $\log_7 \frac{a^6}{b^4}$

3) $\log_9 (a^5 b^3)$

4) $\log_8 \left(\frac{x}{y^4}\right)^2$

5) $\log_7 \left(z\sqrt[3]{x \cdot y}\right)$

Condense each expression to a single logarithm.

6) $4\log_3 u - 2\log_3 v$

7) $6\log_5 c + \frac{\log_5 a}{2}$

8) $5\log u - 6\log v$

9) $16\log_9 u + 4\log_9 v$

10) $\frac{\log_3 u}{3} + \frac{\log_3 v}{3} + \frac{\log_3 w}{3}$

CHANGE OF BASE

$\log_b b^x =$ X

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$b^{\log_b x} =$ X

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EXAMPLES

$10^{\log 6} = 6$

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. $\log_3 9^x = \log_3 3^{2x} = 2x$

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$e^{\ln 3x} = 3x$

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$\ln e^{\frac{x}{2}}$ $\frac{x}{2}$

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CHANGE OF BASE FORMULA

$$\log_c a = \frac{\log a}{\log c}$$

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EVALUATE USING CHANGE OF BASE

$\log_5 7 = \frac{\log 7}{\log 5}$

$= 1.21$

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$\log_2 5 \quad \frac{\log 5}{\log 2} =$

2.32

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Change of Base

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Use a calculator to approximate each to the nearest thousandth.

1) $\log_4 52$

2) $\log_4 23$

3) $\log_5 26$

4) $\log_6 6.16$

5) $\ln 8$

6) $\log_3 34$

7) $\log_2 5.5$

8) $\log_2 5.1$