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Study Guide

Common Logarithms

Logarithms with base 10 are called **common logarithms.** The change of base formula, $\log_a n = \frac{\log_b n}{\log_b a}$, where *a, b,* and *n* are positive numbers and neither *a* nor *b* is 1, allows you to evaluate logarithms in other bases with a calculator. Logarithms can be used to solve **exponential equations.**

Example 1 **Evaluate each expression.**

a. log $8(3)^2$

$$\begin{aligned} \log 8(3)^2 &= \log 8 + 2 \log 3 && \textit{log } ab = \textit{log } a + \textit{log } b, \textit{ log } b^n = n \textit{ log } b \\ &\approx 0.9031 + 2(0.4771) && \textit{Use a calculator.} \\ &\approx 0.9031 + 0.9542 \\ &\approx 1.8573 \end{aligned}$$

b. log $\frac{15^3}{7}$

$$\begin{aligned} \log \frac{15^3}{7} &= 3 \log 15 - \log 7 && \textit{log } \frac{a}{b} = \textit{log } a - \textit{log } b, \textit{ log } a^m = m \textit{ log } a \\ &\approx 3(1.1761) - 0.8451 && \textit{Use a calculator.} \\ &\approx 3.5283 - 0.8451 \\ &\approx 2.6832 \end{aligned}$$

Example 2 **Find the value of $\log_8 2037$ using the change of base formula.**

$$\begin{aligned} \log_8 2037 &= \frac{\log_{10} 2037}{\log_{10} 8} && \textit{log}_a\, n = \frac{\textit{log}_b\, n}{\textit{log}_b\, a} \\ &\approx \frac{3.3090}{0.9031} && \textit{Use a calculator.} \\ &\approx 3.6641 \end{aligned}$$

Example 3 **Solve $7^{2x} = 93$.**

$$\begin{aligned} 7^{2x} &= 93 \\ \log 7^{2x} &= \log 93 && \textit{Take the logarithm of each side.} \\ 2x \log 7 &= \log 93 && \textit{log}_b\, m^p = p \cdot \textit{log}_b\, m \\ 2x &= \frac{\log 93}{\log 7} && \textit{Divide each side by log 7.} \\ 2x &\approx 2.3293 && \textit{Use a calculator.} \\ x &\approx 1.1646 \end{aligned}$$

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Practice

Common Logarithms

Given that log 3 = 0.4771, log 5 = 0.6990, and log 9 = 0.9542, evaluate each logarithm.

1. log 300,000

2. log 0.0005

3. log 9000

4. log 27

5. log 75

6. log 81

Evaluate each expression.

7. log 66.3

8. $\log \frac{17^4}{5}$

9. $\log 7(4^3)$

Find the value of each logarithm using the change of base formula.

10. $\log_6 832$

11. $\log_{11} 47$

12. $\log_3 9$

Solve each equation or inequality.

13. $8^x = 10$

14. $2.4^x \leq 20$

15. $1.8^{x-5} = 19.8$

16. $3^{5x} = 85$

17. $4^{2x} > 25$

18. $3^{2x-2} = 2^x$

19. ***Seismology*** The intensity of a shock wave from an earthquake is given by the formula $R = \log_{10} \frac{I}{I_0}$, where R is the magnitude, I is a measure of wave energy, and $I_0 = 1$. Find the intensity per unit of area for the following earthquakes.

a. Northridge, California, in 1994, $R = 6.7$

b. Hector Mine, California, in 1999, $R = 7.1$