

Use a calculator to evaluate each expression to the nearest ten-thousandth.

1.  $\log 101$  *2.0043*      2.  $\log 2.2$  *0.3424*      3.  $\log 0.05$  *-1.3010*

Use the formula  $\text{pH} = -\log[H^+]$  to find the pH of each substance given its concentration of hydrogen ions.

4. milk:  $[H^+] = 2.51 \times 10^{-7}$  mole per liter *6.6*  
 5. acid rain:  $[H^+] = 2.51 \times 10^{-6}$  mole per liter *5.6*  
 6. black coffee:  $[H^+] = 1.0 \times 10^{-5}$  mole per liter *5.0*  
 7. milk of magnesia:  $[H^+] = 3.16 \times 10^{-11}$  mole per liter *10.5*

Solve each equation or inequality. Round to the nearest ten-thousandth.

8.  $2^x < 25$  *{x | x < 4.6439}*      9.  $5^a = 120$  *2.9746*      10.  $6^z = 45.6$  *2.1319*  
 11.  $9^m \geq 100$  *{m | m \geq 2.0959}*      12.  $3.5^x = 47.9$  *3.0885*      13.  $8.2^y = 64.5$  *1.9802*  
 14.  $2^{b+1} \leq 7.31$  *{b | b \leq 1.8699}*      15.  $4^{2x} = 27$  *1.1887*      16.  $2^{a-4} = 82.1$  *10.3593*  
 17.  $9^{z-2} > 38$  *{z | z > 3.6555}*      18.  $5^{w+8} = 17$  *-1.2396*      19.  $30^{x^2} = 50$  *\pm 1.0725*  
 20.  $5^{x^2-3} = 72$  *\pm 2.3785*      21.  $4^{2x} = 9^{x+1}$  *2.8188*      22.  $2^{n+1} = 5^{2n-1}$  *0.9117*

Express each logarithm in terms of common logarithms. Then approximate its value to the nearest ten-thousandth.

23.  $\log_5 12$   $\frac{\log 12}{\log 5} \approx 1.5440$       24.  $\log_8 32$   $\frac{\log 32}{\log 8} = 1.6667$       25.  $\log_{11} 9$   $\frac{\log 9}{\log 11} = 0.9163$   
 26.  $\log_2 18$   $\frac{\log 18}{\log 2} \approx 4.1699$       27.  $\log_9 6$   $\frac{\log 6}{\log 9} \approx 0.8155$       28.  $\log_7 \sqrt{8}$   $\frac{\log 8}{2 \log 7} \approx 0.5343$

29. **HORTICULTURE** Siberian irises flourish when the concentration of hydrogen ions  $[H^+]$  in the soil is not less than  $1.58 \times 10^{-8}$  mole per liter. What is the pH of the soil in which these irises will flourish? *7.8 or less*

$\text{pH} = \log_{10} \frac{1}{[H^+]}$   
 $\text{pH} = \log_{10} \frac{1}{1.58 \times 10^{-8}}$   
 CALC

30. **ACIDITY** The pH of vinegar is 2.9 and the pH of milk is 6.6. Approximately how many times greater is the hydrogen ion concentration of vinegar than of milk? *about 5,000*

31. **BIOLOGY** There are initially 1000 bacteria in a culture. The number of bacteria doubles each hour. The number of bacteria  $N$  present after  $t$  hours is  $N = 1000(2)^t$ . How long will it take the culture to increase to 50,000 bacteria? *about 5.6 h*

32. **SOUND** An equation for loudness  $L$  in decibels is given by  $L = 10 \log R$ , where  $R$  is the sound's relative intensity. An air-raid siren can reach 150 decibels and jet engine noise can reach 120 decibels. How many times greater is the relative intensity of the air-raid siren than of the jet engine noise? *1000*

Write an equivalent exponential or logarithmic equation.

1.  $\ln 50 = x$   
 $e^x = 50$

2.  $\ln 36 = 2x$   
 $e^{2x} = 36$

3.  $\ln 6 \approx 1.7918$   
 $e^{1.7918} \approx 6$

4.  $\ln 9.3 \approx 2.2300$   
 $e^{2.2300} \approx 9.3$

5.  $e^x = 8$   
 $x = \ln 8$

6.  $e^5 = 10x$   
 $\ln 10x = 5$

7.  $e^{-x} = 4$   
 $x = -\ln 4$

8.  $e^2 = x + 1$   
 $2 = \ln(x + 1)$

Solve each equation or inequality. Round to four decimal places.

9.  $e^x < 9$   
 $\{x | x < 2.1972\}$

10.  $e^{-x} = 31$   
 $-3.4340$

11.  $e^x = 1.1$   
 $0.0953$

12.  $e^x = 5.8$   
 $1.7579$

13.  $2e^x - 3 = 1$   
 $0.6931$

14.  $5e^x + 1 \geq 7$   
 $\{x | x \geq 0.1823\}$

15.  $4 + e^x = 19$   
 $2.7081$

16.  $-3e^x + 10 < 8$   
 $\{x | x > -0.4055\}$

17.  $e^{8x} = 8$   
 $0.6931$

18.  $e^{-4x} = 5$   
 $-0.4024$

19.  $e^{0.5x} = 6$   
 $3.5835$

20.  $2e^{5x} = 24$   
 $0.4970$

21.  $e^{2x} + 1 = 55$   
 $1.9945$

22.  $e^{3x} - 5 = 32$   
 $1.2036$

23.  $9 + e^{2x} = 10$   
 $0$

24.  $e^{-3x} + 7 \geq 15$   
 $\{x | x \leq -0.6931\}$

25.  $\ln 4x = 3$   
 $5.0214$

26.  $\ln(-2x) = 7$   
 $-548.3166$

27.  $\ln 2.5x = 10$   
 $8810.5863$

28.  $\ln(x - 6) = 1$   
 $8.7183$

29.  $\ln(x + 2) = 3$   
 $18.0855$

30.  $\ln(x + 3) = 5$   
 $145.4132$

31.  $\ln 3x + \ln 2x = 9$   
 $36.7493$

32.  $\ln 5x + \ln x = 7$   
 $14.8097$

33. **INVESTING** Sarita deposits \$1000 in an account paying 3.4% annual interest compounded continuously. Use the formula for continuously compounded interest,  $A = Pe^{rt}$ , where  $P$  is the principal,  $r$  is the annual interest rate, and  $t$  is the time in years.

a. What is the balance in Sarita's account after 5 years?  $\$1,185.30$

b. How long will it take the balance in Sarita's account to reach \$2000? *abt 20.4 yr*

34. **RADIOACTIVE DECAY** The amount of a radioactive substance  $y$  that remains after  $t$  years is given by the equation  $y = ae^{kt}$ , where  $a$  is the initial amount present and  $k$  is the decay constant for the radioactive substance. If  $a = 100$ ,  $y = 50$ , and  $k = -0.035$ , find  $t$ . *about 19.8 yr.*

*37.2  
2.3 each  
12 paws*