121 §4.3 #s 5, 9, 13, 17, 21, 25, 29, 31, 33, 35, 39-63 odds, 67, 71, 75, 77, 81, 85, 96

#s 5-10 Simplify each expression

5. $e^{\ln(\sqrt{y})} = \sqrt{y}$     9. $7^{\log_7(999)} = 999$

#s 11-18 Rewrite as a single logarithm.

13. $\log_2(x-1) + \log_2(x) = \log_2((x-1)x) = \log_2(x^2-x)$

17. $\ln(x^8) - \ln(x^3) = \ln\left(\frac{x^8}{x^3}\right) = \ln(x^5)$

#s 19-26 Rewrite as a sum / difference of logarithms

21. $\log\left(\frac{x}{2}\right) = \log(x) - \log(2)$

25. $\ln\left(\frac{x-1}{x}\right) = \ln(x-1) - \ln(x)$

#s 27-32 Rewrite in terms of $\log_a(5)$

29. $\log_a(\sqrt{5}) = \log_a(5^{\frac{1}{2}}) = \frac{1}{2}\log_a(5)$

31. $\log_a\left(\frac{1}{5}\right) = \log_a(5^{-1}) = -1\log_a(5)$

or $\log_a(1) - \log_a(5) = 0 - \log_a(5) =$

#s 33-40 Rewrite each expression in terms of $\log_a(2)$ & $\log_a(5)$.

121 §4.3 #s 33, 35, 39-63 odds, 67, 71, 75, 77, 81, 85, 96

33 $\log_a(10) = \log_a(2\cdot 5) = \log_a(2) + \log_a(5)$

35 $\log_a(2.5) = \log_a\left(\frac{5}{2}\right) = \log_a(5) - \log_a(2)$

39 $\log_a\left(\frac{4}{25}\right) = \log_a\left(\left(\frac{2}{5}\right)^2\right) = 2\log_a(2) - 2\log_a(5)$

#s 41-52 Rewrite each logarithm as a sum or difference of multiples of logarithms

41 $\log_3(5x)$

$= \log_3(5) + \log_3(x)$

43 $\log_2\left(\frac{5}{2y}\right)$

$= \log_2(5) - \log_2(2) - \log_2(y)$

$= \log_2(5) - \log_2(y) - 1$

45 $\log(3\sqrt{x})$

$= \log(3) + \log(x^{\frac{1}{2}})$

$= \log(3) + \frac{1}{2}\log(x)$

47 $\log(3\cdot 2^{x-1})$

$= \log(3) + (x-1)\log(2)$

49 $\ln\left(\frac{\sqrt[3]{xy}}{t^{4/3}}\right) =$

$= \ln\left((xy)^{\frac{1}{3}}\right) - \ln(t^{4/3})$

$= \frac{1}{3}\ln(x) + \frac{1}{3}\ln(y) - \frac{4}{3}\ln(t)$

51 $\ln\left(\frac{6\sqrt{x-1}}{5x^3}\right)$

$= \ln(6) + \frac{1}{2}\ln(x-1)$

$- \ln(5) - 3\ln(x)$

#s 53-62 Rewrite each expression as a single logarithm.

53 $\log_2(5) + 3\log_2(x) = \log_2(5x^3)$

55 $\log_7(x^5) - 4\log_7(x^2) = \log_7\left(\frac{x^5}{x^8}\right) = \log_7(x^{-3})$

$=$

121 §4.3 #s 57-63 odds, 67, 71, 75, 77, 81, 85, 96

57 $\log(2) + \log(x) + \log(y) - \log(z)$

$= \log\left(\frac{2xy}{z}\right)$

59 $\frac{1}{2}\log(x) - \log(y) + \log(z) - \frac{1}{3}\log(w)$

$= \log\left(\frac{x^{\frac{1}{2}}z}{y\,w^{1/3}}\right) = \log\left(\frac{z\sqrt{x}}{y\sqrt[3]{w}}\right)$

61 $3\log_4(x^2) - 4\log_4(x^{-3}) + 2\log_4(x)$

$= \log_4(x^6) - \log_4(x^{-12}) + \log_4(x^2) =$

$= \log_4\left(\frac{x^6x^2}{x^{-12}}\right) = \log_4(x^{20})$

#s 63-70 Find an approximate rational solution. Round FINAL answers to 4 places.

63 $2^x = 9$

METHOD 1

$\log_2(2^x) = \log_2(9)$

$x = \log_2(9) = \frac{\ln(9)}{\ln(2)}$

$\approx \boxed{3.1699}$

METHOD 2

$\ln(2^x) = \ln(9)$

$x \cdot \ln(2) = \ln(9)$

$x = \frac{\ln(9)}{\ln(2)}$, etc

121 §4.3 #s 67, 71, 75, 77, 81, 85, 96

67 $(1.06)^x = 2$

METHOD 1

$$\log_{1.06}(1.06)^x = \log_{1.06}(2)$$

$$x = \log_{1.06}(2)$$

$$= \frac{\ln(2)}{\ln(1.06)} \approx \boxed{11.8957}$$

METHOD 2

$$\ln(1.06^x) = \ln(2)$$

$$x \cdot \ln(1.06) = \ln(2)$$

$$x = \frac{\ln(2)}{\ln(1.06)}, \text{etc.}$$

#s 71-76 Use change-of-base formula to find each logarithm to 4 places.

71 $\log_4(9) = \frac{\ln(9)}{\ln(4)} \approx \boxed{1.5850}$

75 $\log_{\frac{1}{2}}(12) = \frac{\ln(12)}{\ln(\frac{1}{2})} \approx \boxed{-3.5850}$

#s 77-88 Solve. Round FINAL answer to 4 decimal places.

77 $(1.02)^{4t} = 3$

$$\ln\left((1.02)^{4t}\right) = \ln(3)$$

$$4t \ln(1.02) = \ln(3)$$

$$t = \frac{\ln(3)}{4\ln(1.02)} \approx \boxed{13.8695}$$

121 §4.3 #s 81, 85, 96

81 $(1+r)^3 = 2.3$

$\left((1+r)^3\right)^{\frac{1}{3}} = 2.3^{\frac{1}{3}}$

$1+r = 2.3^{\frac{1}{3}}$

$r = 2.3^{\frac{1}{3}} - 1 \approx \boxed{1.3200}$

85 $\log_x(33.4) = 5$

$x^{\log_x(33.4)} = x^5$

$33.4 = x^5$

$(33.4)^{\frac{1}{5}} = x \approx \boxed{2.0172}$

96 Ben's gift grew from \$4,000 to \$2,000,000 in 200 years. At what interest rate, compounded monthly, would this growth occur.

$A = 2 \times 10^6$

$P = 4 \times 10^3$

$r = ?$

$m = 12$

$t = 200$

$A = P\left(1 + \frac{r}{m}\right)^{mt}$

$2 \times 10^6 = 4 \times 10^3 \left(1 + \frac{r}{12}\right)^{(12)(200)}$

$.5 \times 10^3 = \left(1 + \frac{r}{12}\right)^{2400}$

$\left(5 \times 10^2\right)^{\frac{1}{2400}} = 1 + \frac{r}{12}$

$500^{\frac{1}{2400}} - 1 = \frac{r}{12}$

$12\left(500^{\frac{1}{2400}} - 1\right) = r$

$\approx .0311133058$

$\approx \boxed{3.11\%}$