Chapter 3

(46) $\log_6 b = a$

(47) $\log_2 32 = 5$

(48) $7^b = a$

(49) $e^3 = x$

(50) $\log_2 4 = x$

$2^x = 4$

$\boxed{x=2}$ since $2^2 = 4 \Rightarrow \boxed{(a)}$

(51) $\log_6 \left(\frac{1}{6}\right) = x$

$6^x = \frac{1}{6}$

$\boxed{x=-1}$ since $6^{-1} = \frac{1}{6} \Rightarrow \boxed{(c)}$

(52) $\log_{10} 100 = x$

$10^x = 100$

$\boxed{x=2}$ since $10^2 = 100 \Rightarrow \boxed{(b)}$

(53) $\ln_e 1 = x$

$e^x = 1$

$\boxed{x=0}$ since $e^0 = 1 \Rightarrow \boxed{(b)}$

(54) $\ln(x) = -7 \Rightarrow e^{-7} = x \Rightarrow \boxed{(c)}$

(55) $6^2 = 36 \Rightarrow \log_6 36 = 2 \Rightarrow \boxed{(c)}$

(56) $\frac{\log 4}{\log 9} \approx \boxed{0.6309}$

(57) $\frac{\log 3}{\log 0.28} \approx \boxed{-0.8630}$

(58) $\log_2 9x = \boxed{\log_2 9 + \log_2 x}$

(59) $\log_6 x^6 = \boxed{6\log_6 x}$

(60) $\ln\left(\frac{xy^3}{3e^x}\right) = \ln xy^3 - (\ln 3e^x)$

$= \ln x + \ln y^3 - (\ln 3 + \ln e^x)$

$= \ln x + 3\ln y - (\ln 3 + x\ln e)$ ($\ln(e) = 1$)

$= \ln x + 3\ln y - (\ln 3 + x)$

$= \boxed{\ln x + 3\ln y - \ln 3 - x}$

(61) $\log_7 5x^3y\sqrt{z} = \log_7 5 + \log_7 x^3 + \log_7 y + \log_7 \sqrt{z}$

$= \log_7 5 + 3\log_7 x + \log_7 y + \log_7 z^{1/2}$

$= \boxed{\log_7 5 + 3\log_7 x + \log_7 y + \frac{1}{2}\log_7 z}$

(62) $2\ln x + \ln 5 = \ln x^2 + \ln 5$

$= \boxed{\ln 5x^2}$

(63) $4\ln(x-4) - 2\ln x = \ln(x-4)^4 - \ln x^2$

$= \boxed{\ln \frac{(x-4)^4}{x^2}}$

(64) $5\log_4 2 + 7\log_4 x + 4\log_4 y = \log_4 2^5 + \log_4 x^7 + \log_4 y^4$

$= \log_4 32 + \log_4 x^7 + \log_4 y^4$

$= \boxed{\log_4 32x^7y^4}$

(65) $7\ln x - (3\ln y + 8\ln z) = \ln x^7 - (\ln y^3 + \ln z^8)$

$= \ln x^7 - (\ln y^3 z^8)$

$= \boxed{\ln \frac{x^7}{y^3 z^8}}$

(66) $\log_2 10 - \log_2 9 = \boxed{\log_2 \frac{10}{9}}$

(67) $\log_6 15 - \log_6 24 = \log_6\left(\frac{15}{24}\right) = \boxed{\log_6\left(\frac{5}{8}\right)}$

(68) $\frac{50}{34.706} = \frac{34.706e^{0.0097t}}{34.706}$

$1.4407 = e^{0.0097t}$

$\ln 1.4407 = \ln e^{0.0097t}$

$\frac{\ln 1.4407}{0.0097} = \frac{0.0097t}{0.0097}$

$t = 37.6$

$t = 0$: 2000

$\Rightarrow$ $t = 15$: 2015

$t = 37.6$: 2037

In the year 2037, the population will exceed 50 million

(69) $x = 2013 - 2008$

$x = 5$ years

$\Rightarrow R(5) = 97(3)^5$

$= 23571$

The population in 2013 will be 23,571 rodents

(70) $A = Pe^{rt}$

$A = 500 \times 2 = 1000$

$P = 500$

$r = .0675$

$\Rightarrow \frac{1000}{500} = \frac{500e^{.0675t}}{500}$

$2 = e^{.0675t}$

$\ln 2 = \ln e^{.0675t}$

$\frac{\ln 2}{.0675} = \frac{.0675t}{.0675}$

$t = 10.3$

It will take about 10 years for the money to double

(71) $2^{2x+1} = 4$

$2^{2x+1} = 2^2$

$2x + 1 = 2$

$2x = 1$

$\boxed{x = 1/2}$

(72) $(3^2)^{-x} = 3^{-1}$

$3^{-2x} = 3^{-1} \Rightarrow -2x = -1 \Rightarrow \boxed{x = 1/2}$

(13) $4^x = 8$

$(2^2)^x = 2^3$

$2^{2x} = 2^3$

$2x = 3$

$\boxed{x = 1.5}$

(14) $\ln_e(3x+1) = 3$

$e^3 = 3x+1$

$e^3 - 1 = 3x$

$x = \frac{e^3-1}{3}$

$\boxed{x \approx 6.3618}$

(15) $e^x = 13$

$\ln e^x = \ln 13$

$x = \ln 13$

$\boxed{x \approx 2.5649}$

(16) $8^x - 4 = 3$

$8^x = 7$

$\log_8 8^x = \log_8 7$

$x = \log_8 7$

$x = \frac{\log 8}{\log 7} \approx \boxed{1.0686}$

(17) $e^{2x} - 6 = 23$

$e^{2x} = 29$

$\ln e^{2x} = \ln 29$

$2x = \ln 29$

$x = \frac{\ln 29}{2} \approx \boxed{1.6836}$

(78) $\frac{10\ln(x+2)}{10} = \frac{50}{10}$

$\ln_e(x+2) = 5$

$e^5 = x+2$

$x = e^5 - 2$

$\boxed{x \approx 146.4132}$

(79) $5 + 3\log_5 x = 8$
$-5 \qquad\quad -5$

$\frac{3\log_5 x}{3} = \frac{3}{3}$

$\log_5 x = 1$

$5^1 = x$

$\boxed{x = 5}$

(80) $10 + \log(x+14) = 13$
$-10 \qquad\quad -10$

$\log_{10}(x+14) = 3$

$10^3 = x+14$

$1000 = x+14$

$\boxed{x = 986}$

(81) $\log_{20}(x^2-x) = 1$

$20^1 = x^2 - x$

$0 = x^2 - x - 20$

$0 = (x-5)(x+4)$

$x = 5, \; x = -4$

check: $\log_{20}((5)^2-(5)) = 1$

$\log_{20}(25-5) = 1$

$\log_{20}(20) = 1$ ✓

$\log_{20}((-4)^2-(-4)) = 1$

$\log_{20}(16+4) = 1$

$\log_{20}(20) = 1$ ✓

(82) $\log_6(x) = 2 - \log_6(x+5)$

$\log_6(x) + \log_6(x+5) = 2$

$\log_6(x(x+5)) = 2$

$\log_6(x^2+5x) = 2$

$6^2 = x^2+5x$

$36 = x^2+5x$

$0 = x^2+5x-36$

$0 = (x+9)(x-4)$

$x = \cancel{-9}, \boxed{x=4}$

check: $\log_6(-9) = 2 - \log_6(-9+5)$

$\log_6(-9) = 2 - \log_6(-4)$ (x)

↑ can't be negatives in original equation

$\log_6(4) = 2 - \log_6(4+5)$

$\log_6(4) = 2 - \log_6(9)$ (✓)