Chapter 5 Exponential and Logarithmic Functions

1. Use a calculator to evaluate the expression.

   $11^{0.5}$
   A) 0.0005
   B) 3.3166
   C) 0.3015
   D) 4096
   E) 6
   Ans: B

2. Use a calculator to evaluate the expression.

   $6^{-2.3}$
   A) 0.006755
   B) –0.016228
   C) 61.623715
   D) 148.035889
   E) 0.016228
   Ans: E

3. Use a calculator to evaluate the expression.

   $7^{\frac{1}{7}}$
   A) 823543
   B) 1
   C) 1.32047
   D) 0.00000
   E) 49
   Ans: C

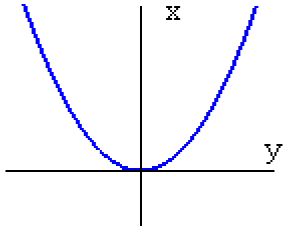
4. Use a calculator to evaluate the expression. Round your answer to two decimal places.

   e^{7}
   A) 1096.63
   B) 198.25
   C) 19.03
   D) 128.00
   E) 49.00
   Ans: A

5. Graph the function.

$y = 2^x$

A)



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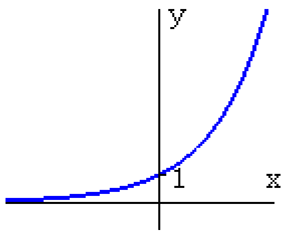

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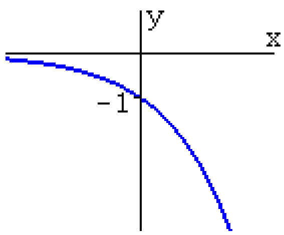
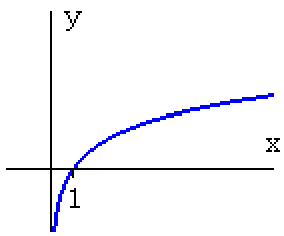
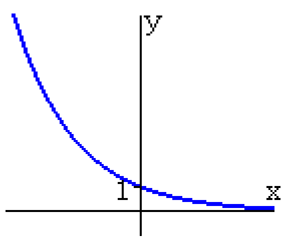


D)



E)

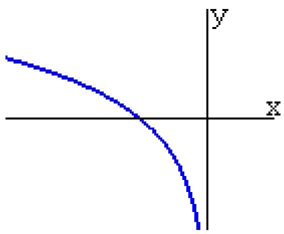


Ans: B

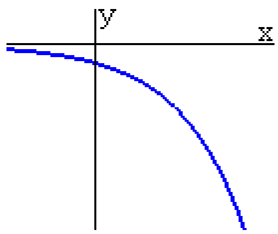
6. Graph the function.

$y = 3(2^x)$

A)



B)



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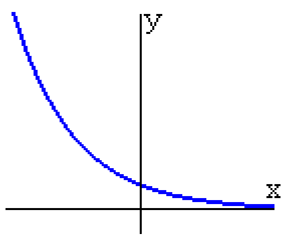
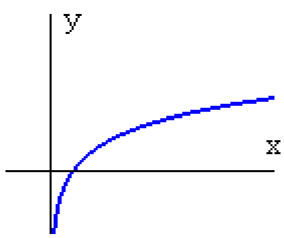
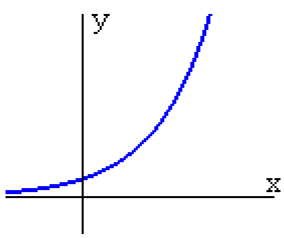


D)



E)

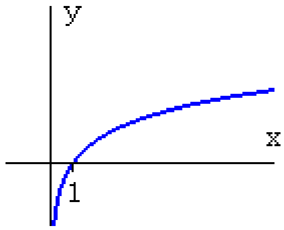


Ans: E

7. Graph the function.

$y = 2^{-x}$

A)



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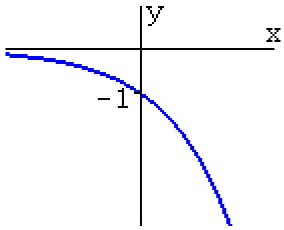

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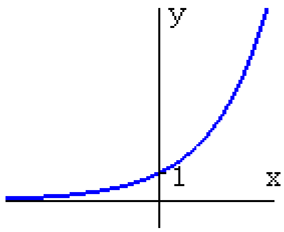
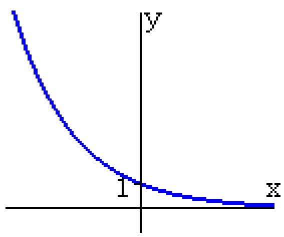
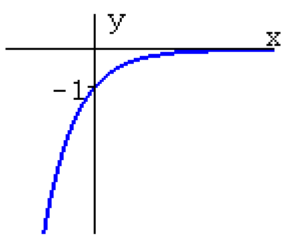


D)



E)

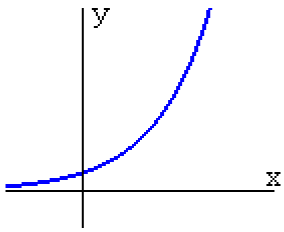


Ans: D

8. Graph the function.

$y = 2e^x$

A)



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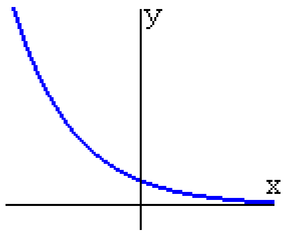
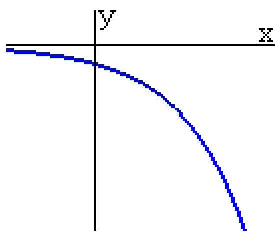
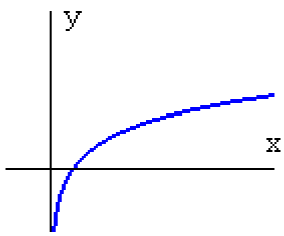


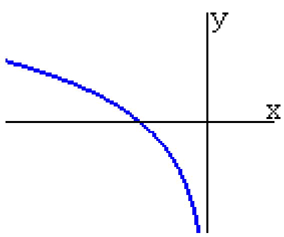
C)



D)



E)



Ans: A

9. Express $y = 3(\frac{2}{5})^x$ in the form $y = 3(b^{-x})$ with an appropriate value of $b > 1$.

A) $\frac{6}{5}$

B) $\frac{5}{2}$

C) $\frac{5}{6}$

D) $-\frac{6}{5}$

E) $-\frac{2}{5}$

Ans: B

10. Is the function $y = 7(\frac{4}{5})^x$ a growth exponential or decay exponential?

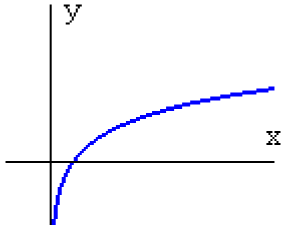
A) growth exponential

B) decay exponential

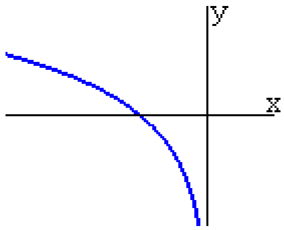
Ans: B

11. Graph the function $y = 4(3.5)^{-x}$.

A)



B)



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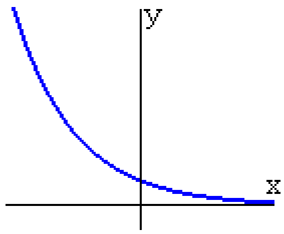
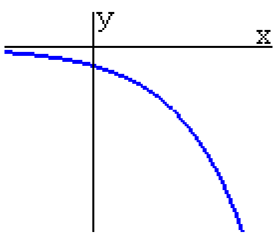


D)



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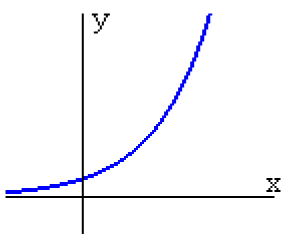
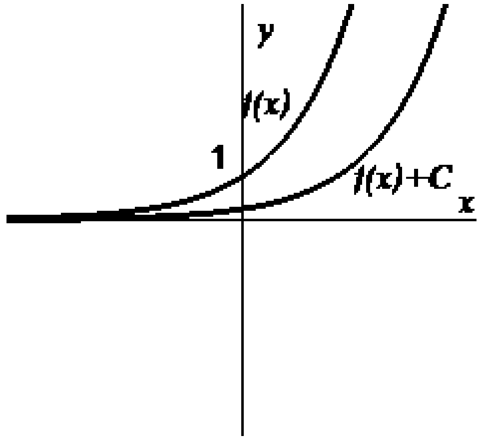


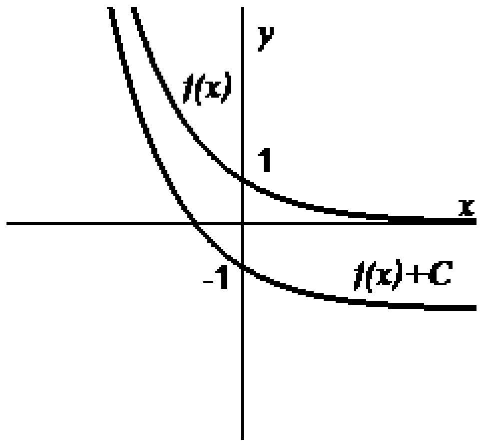
Ans: C

12. Given $f(x) = 3^x$. Graph $y = f(x)$ and $y = f(x) + C = 3^x + C$ for $C = -2$.

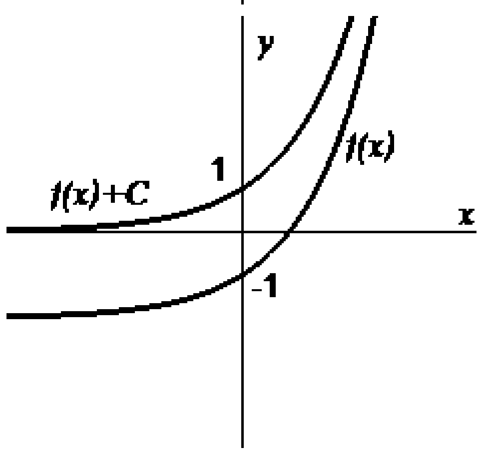
A)



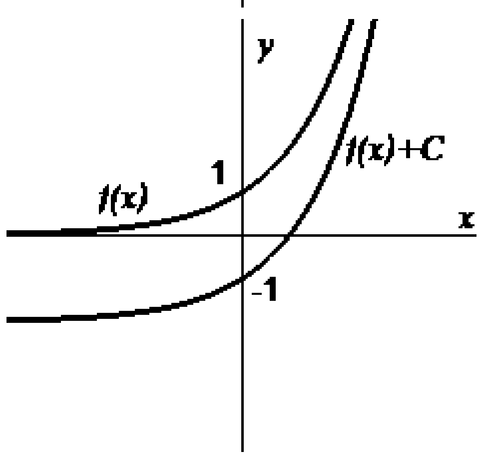
B)

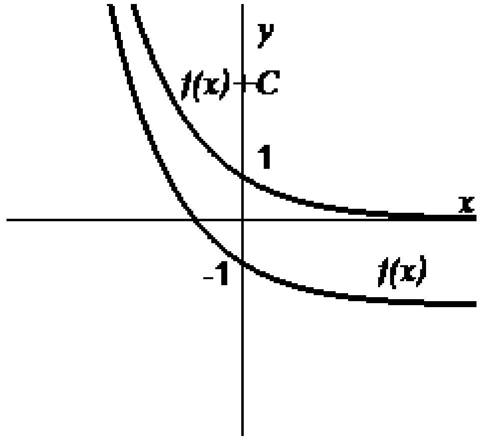


C)



D)

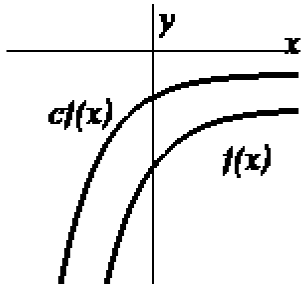


E) 

Ans: D

13. Let $f(x) = (2 + e^{-4x})$. Use a graphing utility to graph the functions $f(x)$ and $cf(x)$ where $c = 50$. Identify the graphs of *f*(*x*) and *cf*(*x*) below.

A)



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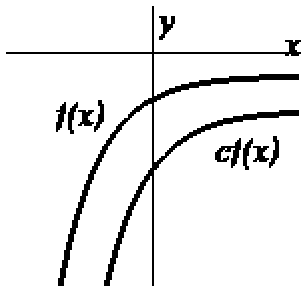
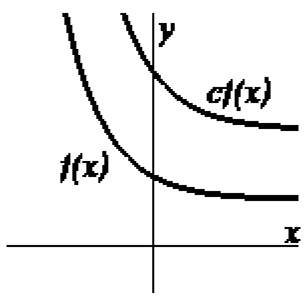
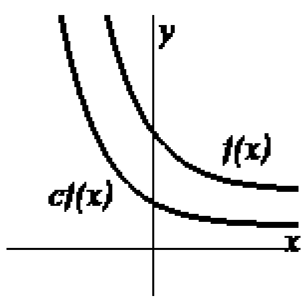


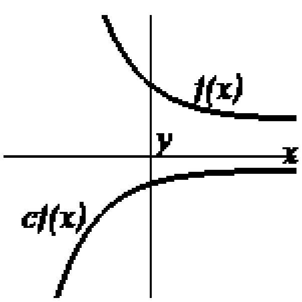
C)



D)



E)



Ans: C

14. Let $f(x) = (4 + e^{-3x})$. Using a graphing utility, graph $y = g(x) = cf(x) = c(4 + e^{-3x})$ for $c = 10, 50,$ and 100.

What effect does *c* have on the graphs?

A) As *c* changes, the graph is shifted horizontally by *c* units.
B) As *c* changes, the graph is shifted vertically by *c* units.
C) As *c* changes, the *y*-intercept and the horizontal asymptote change.
D) As *c* changes, the graph is rotated c degrees.
E) As *c* changes, the graph is reflected over the line $y = c$.

Ans: C

15. If $800 is invested for *x* years at an annual rate of 6%, compounded quarterly, the future value that will result is

$$S = 800(1.06)^{4x}$$

Determine the value of the investment after 7 years.

A) $2044.67
B) $4089.35
C) $1202.90
D) $3289.35
E) $336.00

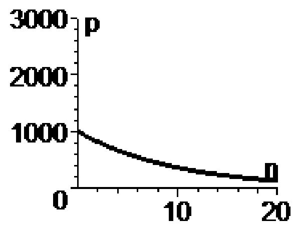
Ans: B

16. We will show in the next chapter that if $$P$ is invested for n years at an annual rate of 11% compounded continuously, the future value of the investment is given by

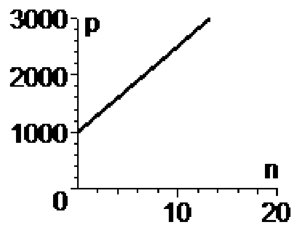
$$S = Pe^{0.11n}$$

Use $P = 1000$ and graph this function for $0 \le n \le 20$.

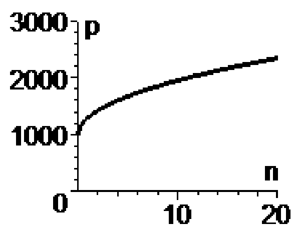
A)



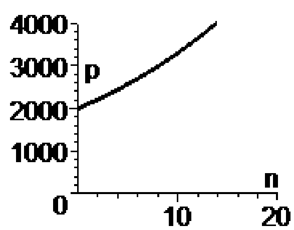
B)



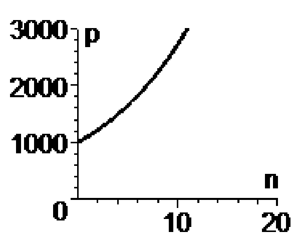
C)



D)



E)



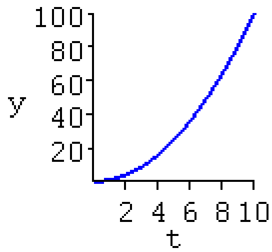
Ans: E

17. The percent concentration y of a certain drug in the bloodstream at any time t in minutes is given by the equation

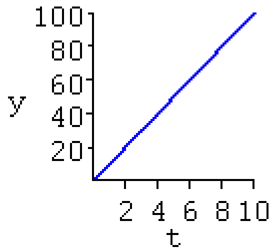
$$y = 100(1 - e^{-0.438t})$$

Graph this equation for $0 \le t \le 10$.

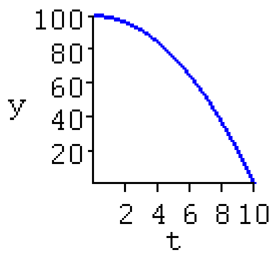
A)



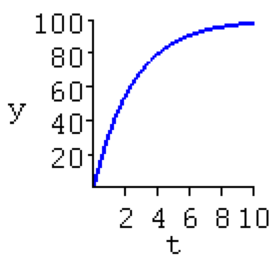
B)



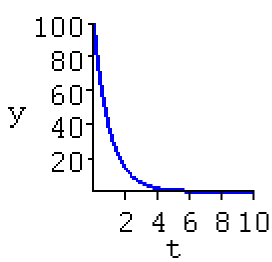
C)



D)



E)

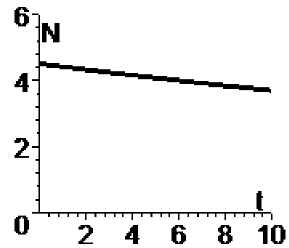


Ans: D

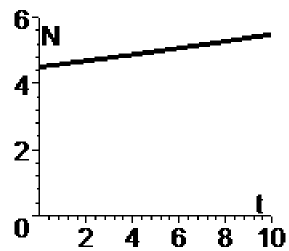
18. The percent concentration *y* of a certain drug in the bloodstream at any time *t* in minutes is given by the equation
$y = 100(1 - e^{-0.485t})$. Graph this function with a graphing utility. Which of the following statements best describes the situation after 10 hours?
A) After 10 hours, 50% of the drug is in the blood stream.
B) After 10 hours, 10% of the drug is in the blood stream.
C) After 10 hours, there are almost 100 units of the drug in the blood stream.
D) After 10 hours, the drug has almost completely dissipated.
E) After 10 hours, the drug is almost completely in the blood stream.
Ans: E

19. A starfish population can be modeled by $N = N_0(1+r)^t$, where N_0 is the number of individuals at time $t = 0$, *r* is the yearly rate of growth, and *t* is the number of years. Sketch the graph for $t = 0$ to $t = 10$ when the growth rate is 2.1% and N_0 is 4.5 billion. All numbers on the vertical axis are in billions.

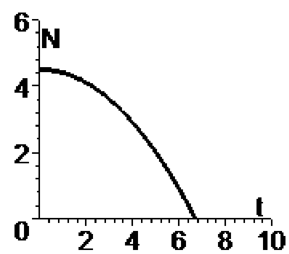
A)



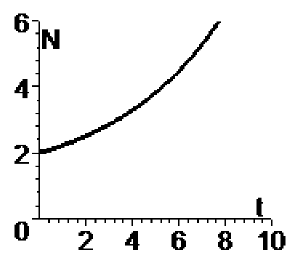
B)



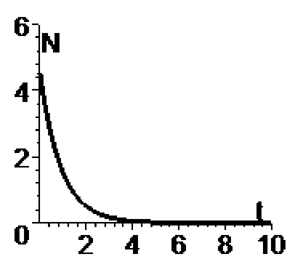
C)



D)

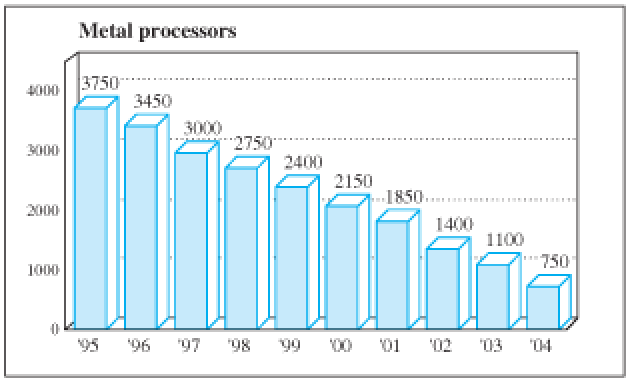


E)



Ans: B

20. The following figure, from *Investor's Business Daily* (March 5, 1998), shows how quickly the U.S. metal processing industry is consolidating. The linear equation that is the best fit for the number of metal processors as a function of years after 1990 is $y_1 = -329.6970x + 5392.1212$, and the best exponential fit is $y_2 = 9933.7353e^{-0.1672x}$.
The linear equation seems to give a much better fit for the data points than the exponential equation. Why then is the exponential equation a more useful model to predict the number of metal processors in 2016?



A) The quantity of metal processing units as a function of time is exponential for the first five years, and linear for the next five years.
B) As the quantity of metal processors decreases, they decrease at an increasingly quadratic rate as a function of time.
C) The number of metal processing units will probably start to increase in 2007.
D) The linear model gives a negative number of processors in 2010. The exponential model is always non-negative.
E) The number of metal processing units follows a parabolic model.
Ans: D

21. Total personal income in the United States (in billions of dollars) for selected years from 1960 to 2002 is given in the following table.

Year	1960	1970	1980	1990	2000	2002
Personal Income	411.7	836.1	2285.7	4791.6	8406.6	8929.1

Source: Bureau of Economic Analysis, U.S. Department of Commerce

These data can be modeled by an exponential function. Write the equation of this function, with *x* as the number of years past 1960.
A) $y = 1.0695x^2 + 8929.1$
B) $y = 434.2404(1.0779)^x$
C) $y - 20 = 1.0695(x - 836.1)$
D) $y = 1.077x + 434.2403$
E) $y = 8929.1(1.0695)^x$
Ans: B

22. Total personal income in the United States (in billions of dollars) for selected years from 1960 to 2002 is given in the following table.

Year	1960	1970	1980	1990	2000	2002
Personal Income	411.7	836.1	2285.7	4791.6	8406.6	8929.1

Source: Bureau of Economic Analysis, U.S. Department of Commerce

These data can be modeled by an exponential function. Write the equation of this function, with x as the number of years past 1960. If this model is accurate, what will be the total U.S. personal income in 2010?

A) $12873.9 billion
B) $15927.68 billion
C) $17018.55 billion
D) $18,477.95 billion
E) $19789.31 billion
Ans: D

23. The consumer price index (CPI) is calculated by averaging the prices of various items after assigning a weight to each item. The following table gives the consumer price indexes for selected years from 1940 through 2002, reflecting buying patterns of all urban consumers, with x representing years past 1900. Find an equation that models these data.

Year	Consumer Price Index	Year	Consumer Price Index
1940	14	1980	82.4
1950	24.1	1990	130.7
1960	29.6	2000	172.2
1970	38.8	2002	179.9

Source: U.S. Bureau of the Census

A) $y = 2.58(1.043)^x$
B) $y = 1.06(2.58)^{-x}$
C) $y = 1.043(2.58)^{-x}$
D) $y = 1.087x + 2.36$
E) $y = 1.06(2.36)^{-x}$
Ans: A

24. The consumer price index (CPI) is calculated by averaging the prices of various items after assigning a weight to each item. The following table gives the consumer price indexes for selected years from 1940 through 2002, reflecting buying patterns of all urban consumers. Find an equation that models these data and use it to predict the consumer price index in 2011. Use the model to predict the consumer price index in 2011.

Year	Consumer Price Index	Year	Consumer Price Index
1940	14	1980	82.4
1950	24.1	1990	130.7
1960	29.6	2000	172.2
1970	38.8	2002	179.9

Source: U.S. Bureau of the Census

A) 60.92
B) 134.98
C) 181.7
D) 214.09
E) 276.17
Ans: E

25. The consumer price index (CPI) is calculated by averaging the prices of various items after assigning a weight to each item. The following table gives the consumer price indexes for selected years from 1940 through 2002, reflecting buying patterns of all urban consumers. Find an equation that models these data and use it to determine when the consumer price index will pass 286.

Year	Consumer Price Index	Year	Consumer Price Index
1940	14	1980	82.4
1950	24.1	1990	130.7
1960	29.6	2000	172.2
1970	38.8	2002	179.9

Source: U.S. Bureau of the Census

A) The 2006-2007 year
B) The 2007-2008 year
C) The 2009-2010 year
D) The 2011-2012 year
E) The 2014-2015 year
Ans: D

26. The following table gives the average number of students per computer in public schools for the school years that ended in 1985 through 2002. Let *x* be the number of years past 1980. Find an exponential model for these data.

Year	Students per Computer	Year	Students per Computer
1985	75	1994	14
1986	50	1995	10.5
1987	37	1996	10
1988	32	1997	7.8
1989	25	1998	6.1
1990	22	1999	5.7
1991	20	2000	5.4
1992	18	2001	5.0
1993	16	2002	4.9

Source: Quality Education Data, Inc., Denver, Colorado

A) $y = 71.75(0.68894)^{-x}$

B) $y = 71.75(0.84826)^{x}$

C) $y = 116.83\left(0.8564152\right)^{x}$

D) $y = 71.75(0.68894)^{x}$

E) $y = 118.18e^{x}$

Ans: C

27. The following table gives the average number of students per computer in public schools for the school years that ended in 1985 through 2002. Find an exponential model for these data. How many students per computer in public schools does this model predict for 2008?

Year	Students per Computer	Year	Students per Computer
1985	75	1994	14
1986	50	1995	10.5
1987	37	1996	10
1988	32	1997	7.8
1989	25	1998	6.1
1990	22	1999	5.7
1991	20	2000	5.4
1992	18	2001	5.0
1993	16	2002	4.9

Source: Quality Education Data, Inc., Denver, Colorado

A) 0.70
B) 1.18
C) 2.18
D) 2.88
E) 4.18
Ans: B

28. Write the equation in exponential form.

$3 = \log_4 64$

A) $64^3 = 4$
B) $4^{64} = 3$
C) $64^3 = 4$
D) $4^3 = 64$
E) $3^4 = 64$
Ans: D

29. Write the equation in exponential form.

$\frac{1}{2} = \log_{81} 9$

A) $81^{1/2} = 81$
B) $9^{1/2} = 81$
C) $\frac{1}{2}^{81} = 9$
D) $\frac{1}{2}^{9} = 81$
E) $81^{1/2} = 9$
Ans: E

30. Solve for *x* by writing the equation in exponential form.

$\log_4 x = 3$

A) 20.09
B) 256
C) 64
D) 81
E) 12
Ans: C

31. Solve for *x* by writing the equation in exponential form.

$\log_8 x = -\frac{1}{3}$

A) 2
B) $\frac{1}{512}$
C) 512
D) $\frac{1}{2}$
E) –2.67
Ans: D

32. Solve for *x* by writing the equation in exponential form.

$\log_6 (4x+1) = 2$

A) 16.75
B) 8.75
C) 31.50
D) 0.25
E) 35
Ans: B

33. Write the equation in logarithmic form.

$4^2 = 16$

A) $\log_4 16 = 2$
B) $\log_{16} 4 = 2$
C) $\log 16 = 2$
D) $\ln 16 = 2$
E) $\log_2 16 = 4$

Ans: A

34. Write the equation in logarithmic form.

$9^{-1} = \frac{1}{9}$

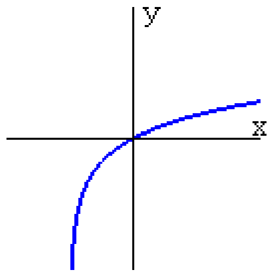
A) $1 = \log_9\left(\frac{1}{9}\right)$
B) $-9 = \log_9(-1)$
C) $-1 = \log_9\left(\frac{1}{9}\right)$
D) $-1 = \log_{\frac{1}{9}} 9$
E) $-1 = \log\left(\frac{1}{9}\right)$

Ans: C

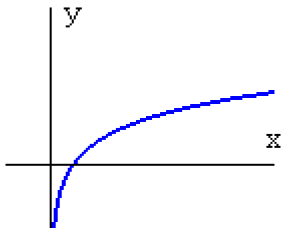
35. Graph the function.

$y = \ln 5x$

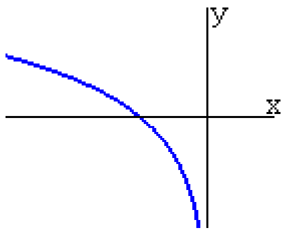
A)



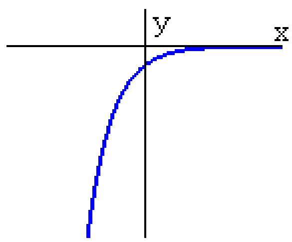
B)



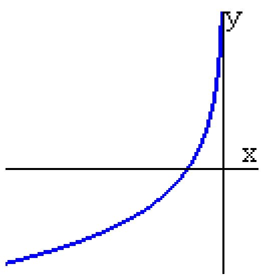
C)



D)



E)

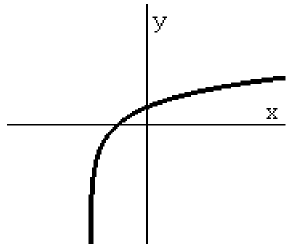


Ans: B

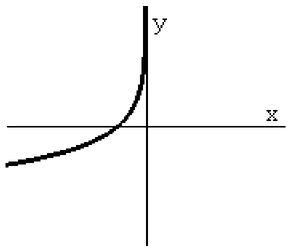
36. Graph the function.

$y = \log_2(-x)$

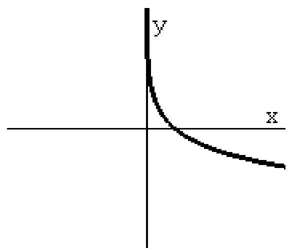
A)



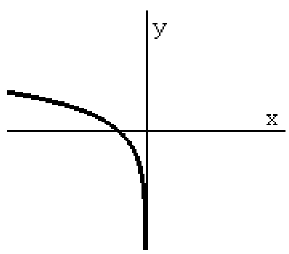
B)



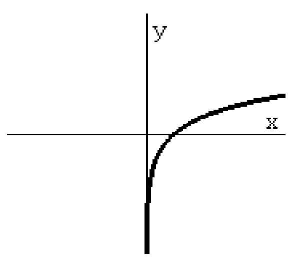
C)



D)



E)



Ans: D

37. Use properties of logarithms or a definition to simplify the expression. Check the result with a change-of-base formula and a calculator.

$\log_4 16$

A) 64.00
B) 2.00
C) 2.77
D) 1.20
E) no solution
Ans: B

38. Use properties of logarithms or a definition to simplify the expression. Check the result with a change-of-base formula and a calculator.

$\log_3\left(\frac{1}{3}\right)$

A) 9
B) 1
C) 6
D) –1
E) no solution
Ans: D

39. Use properties of logarithms or a definition to simplify the expression.

If $f(x) = \ln(x)$, find $f(e^{4x})$.

A) 4^x
B) $4e^{4x}$
C) $\ln(4x)$
D) e^{4x}
E) $4x$
Ans: E

40. Use properties of logarithms or a definition to simplify the expression.

If $f(x) = e^x$, find $f(\ln 8)$.

A) $8x$
B) $e^{\ln(8x)}$
C) e^8
D) 8
E) $\ln 8$
Ans: D

41. Use properties of logarithms or a definition to simplify the expression.

If $f(x) = 10^x$, find $f(\log 3)$.

A) 3
B) 10
C) $\log(3x)$
D) 1000
E) 30
Ans: A

42. Evaluate the logarithm by using properties of logarithms and the following facts.
$\log_a x = 2.5 \quad \log_a y = 2.9$

$\log_a(xy)$

A) 5.40
B) 7.25
C) –0.40
D) 0.98
E) 0.86
Ans: A

43. Evaluate the logarithm by using properties of logarithms and the following facts.
$\log_a x = 2.9 \quad \log_a z = 3.2$

$\log_a\left(\frac{x}{z}\right)$

A) 0.91
B) 9.28
C) 0.92
D) –0.30
E) 6.10
Ans: D

44. Evaluate the logarithm by using properties of logarithms and the following fact.
$\log_a x = 2.1$

$\log_a(x^4)$

A) 33.60
B) 2.97
C) 6.10
D) 19.45
E) 8.40
Ans: E

45. Evaluate the logarithm by using properties of logarithms and the following facts.
$\log_a y = 2.7$

$\log_a \sqrt{y}$

A) 1.64
B) 1.35
C) 1.2
D) 5.4
E) 0.61
Ans: B

46. Write the expression as the sum or difference of two logarithmic functions containing no exponents.

$\log\left(\frac{5x}{x+2}\right)$

A) $\log(x+2)+\log(5x)$
B) $\frac{\log(5x)}{\log(x+2)}$
C) $\log(x+2)-\log(5x)$
D) $\log(5x)-\log(x+2)$
E) $\frac{\log(x+2)}{\log(5x)}$
Ans: D

47. Write the expression as the sum or difference of two logarithmic functions containing no exponents.

$\log_4(x\sqrt{x+1})$

A) $2\log_4 x(x+1)$
B) $\frac{1}{2}\log_4 x(x+1)$
C) $\log_4 x + 2\log_4(x+1)$
D) $\log_4 x + \frac{1}{2}\log_4 x + \frac{1}{2}\log_4 1$
E) $\log_4 x + \frac{1}{2}\log_4(x+1)$
Ans: E

48. Use the properties of logarithms to write the expression as a single logarithm.

$\ln(5x) - \ln(2y)$

A) $\ln\left(\dfrac{5x}{2y}\right)$

B) $\ln(2y - 5x)$

C) $\ln(5x - 2y)$

D) $\dfrac{\ln(5x)}{\ln(2y)}$

E) $\ln\left(\dfrac{5y}{2x}\right)$

Ans: A

49. Use the properties of logarithms to write the expression as a single logarithm.

$\log_7(x+4) + \dfrac{1}{3}\log_7 x$

A) $\dfrac{1}{3}\log_7\left[x^{1/3}(x+4)\right]$

B) $\log_7\left[x^{1/3}(x+4)\right]$

C) $\log_7\left[x^3(x+4)\right]$

D) $\log_3\left[x^{1/7}(x+4)\right]$

E) $\log_7\left[x(x+4)^{1/3}\right]$

Ans: B

50. Use a calculator to determine whether expression (a) is equivalent to expression (b).

(a) $\ln \sqrt{4*6}$ (b) $\dfrac{1}{2}(\ln 4 + \ln 6)$

A) equivalent
B) not equivalent
Ans: A

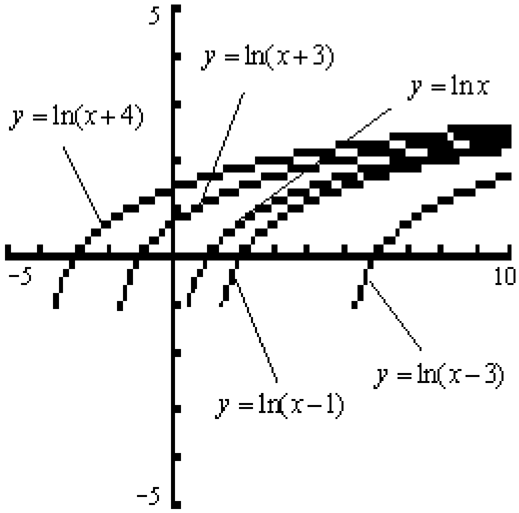
51. Use a calculator to determine whether expression (a) is equivalent to expression (b).

(a) $\log\sqrt[3]{\dfrac{8}{5}}$ (b) $\dfrac{1}{3}\log 8 - \log 5$

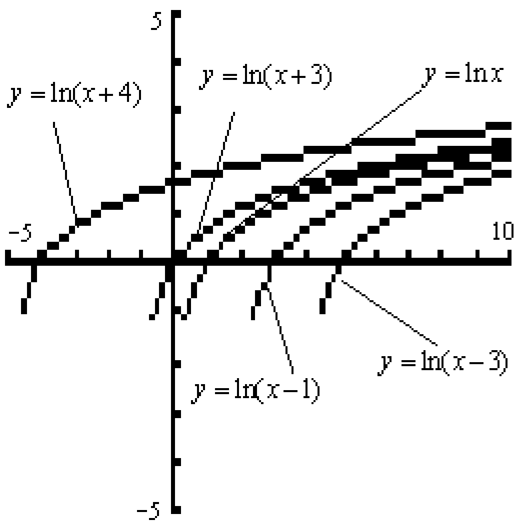
A) equivalent
B) not equivalent
Ans: B

52. Given $f(x) = \ln x$, use a graphing calculator to graph $f(x-c)$ for $c = -4, -3, 1,$ and 3.

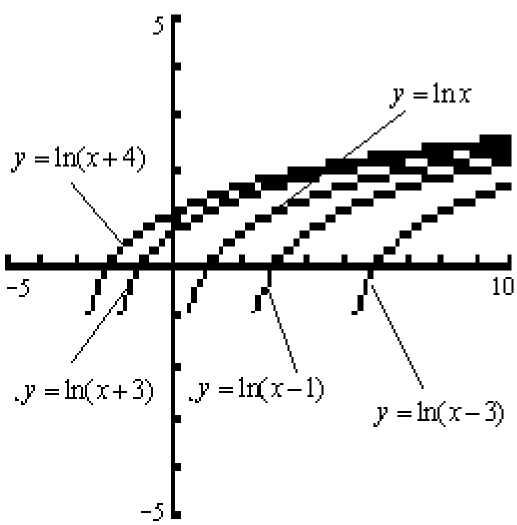
A)



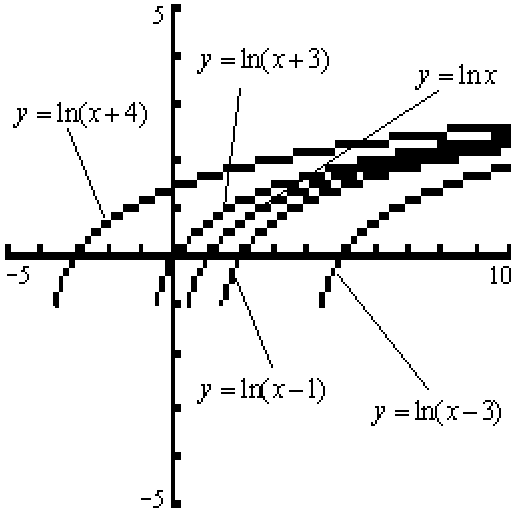
B)



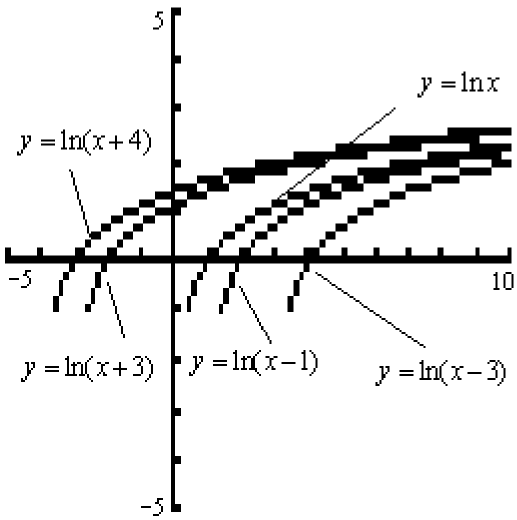
C)



D)



E)



Ans: E

53. Use a change-of-base formula to evaluate $\log_4 18$ with a calculator or other technology. Round your answer to four decimal places.
A) 0.4796
B) 4.0069
C) 2.0850
D) 4.2767
E) 3.0910
Ans: C

54. Find an equivalent expression for the given logarithm using the change-of-base formula.

$\log_5 8$

A) $\ln \frac{5}{8}$

B) $\ln \frac{8}{5}$

C) $\frac{\ln 8}{\ln 5}$

D) $\frac{\ln 5}{\ln 8}$

E) $5 \ln 8$

Ans: C

55. Use a change-of-base formula to rewrite the logarithm in terms of natural logarithms.

$y = \log_4 x$

A) $y = 4 \ln x$

B) $y = \ln (x - 4)$

C) $y = \ln x - \ln 4$

D) $y = 4^x$

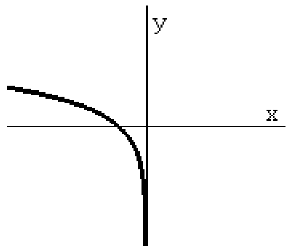
E) $y = \frac{\ln x}{\ln 4}$

Ans: E

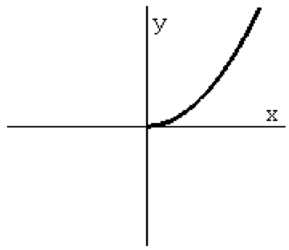
56. Which answer choice is a graph of the function?

$y = \log_2 x$

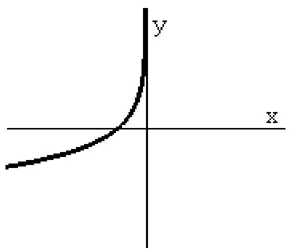
A)



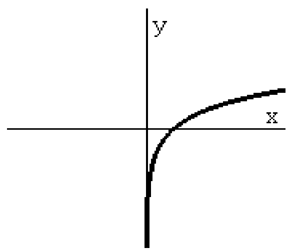
B)



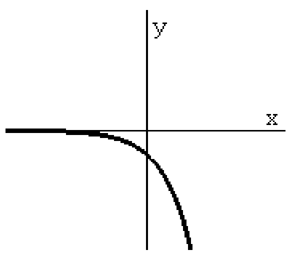
C)



D)



E)



Ans: D

57. Use the formula $R = \log (I / I_0)$.

In October 2004, an earthquake measuring 6.8 on the Richter scale occurred in Japan. The largest quake in Japan since 1990 was one in 1993 that registered 7.7. How many times more severe was the 1993 shock than the one in 2004 on the Richter scale?

A) 0.6 times as severe
B) 3 times as severe
C) 7.9 times as severe
D) 9.6 times as severe
E) 17.5 times as severe
Ans: C

58. Use the formula $R = \log (I / I_0)$.

The San Francisco earthquake of 1906 measured 8.25 on the Richter scale, and the San Francisco earthquake of 1989 measured 7.1. How much more intense was the 1906 quake?

A) 0.9 times as severe.
B) 2.3 times as severe
C) 5.3 times as severe
D) 10.7 times as severe
E) 14.1 times as severe
Ans: E

59. Use the fact that the loudness of sound (in decibels) perceived by the human ear depends on intensity levels according to $L = 10\ \log(I / I_0)$, where I_0 is the threshold of hearing for the average human ear. Find the loudness when *I* is 100,000 times I_0.

A) 5
B) 50
C) 6
D) 500
E) 10,000
Ans: B

60. Use the following information. Chemists use the pH (hydrogen potential) of a solution to measure its acidity or basicity. The pH is given by the formula $\text{pH} = -\log\,[\text{H}^+]$, where $[\text{H}^+]$ is the concentration of hydrogen ions in moles per liter. What value of $[\text{H}^+]$ is associated with pH level 7?

A) $-\log 7$
B) 10^7
C) -7
D) 10^{-7}
E) $-\frac{1}{7}$
Ans: D

61. Use the formula $2=\left(1+\frac{r}{100n}\right)^{nt}$ to find the doubling time *t*, in years, for an investment at *r*% compounded *n* times per year. Suppose you make an investment of $1400 at interest rate 11% compounded quarterly. How long will it take for your investment to double?
A) 3.32 years
B) 2.13 years
C) 12.78 years
D) 0.83 year
E) 6.39 years
Ans: E

62. Between the years 1960 and 2002, the percent of women in the work force is given by $w(x)=2.552+14.57\ \ln x$, where *x* is the number of years past 1950 (*Source:* U.S. Bureau of Labor Statistics). What does this model estimate to be the percent of women in the work force in 2013?
A) 62.92
B) 60.37
C) 65.29
D) 74.39
E) 50.36
Ans: A

63. Between the years 1960 and 2002, the percent of women in the work force is given by $w(x)=2.552+14.57\ \ln x$, where *x* is the number of years past 1950 (*Source:* U.S. Bureau of Labor Statistics). Graph this function with a graphing utility and use the graph drawn to estimate the year in which the percent reached 60.
A) 1990
B) 1992
C) 2002
D) 2012
E) 2007
Ans: C

64. Solve the exponential equation. Give answers correct to 3 decimal places.

$6^{7x}=7776$
A) 1296
B) 0.714
C) 0.898
D) 0.431
E) 648
Ans: B

65. Solve the exponential equation. Give answers correct to 3 decimal places.

$$0.14P = P(3^{-x})$$

A) 1.790
B) 0.047
C) 21.429
D) –0.046667
E) –0.655
Ans: A

66. Solve the exponential equation. Give the answer correct to 3 decimal places.

$$10,000 = 2000e^{0.4x}$$

A) 0.825
B) 2.063
C) 3.029
D) 0.644
E) 4.024
Ans: E

67. Solve the exponential equation. Give the answer correct to 3 decimal places.

$$68 = 150 - 150e^{-0.07x}$$

A) –0.604
B) 11.302
C) 8.627
D) –11.302
E) –5.341
Ans: C

68. Solve the exponential equation. Give the answer correct to 3 decimal places.

$$47 = \frac{73}{1+4e^{-0.1x}}$$

A) –1.978
B) –1.383
C) 4.490
D) –0.449
E) 19.783
Ans: E

69. Solve the logarithmic equation $\log_3(5x+1)=4$. Round your answer to three decimal places.
A) $x \approx 7.426$
B) $x \approx 7.826$
C) $x \approx 16.400$
D) $x \approx 16.200$
E) $x \approx 16.000$
Ans: E

70. Solve the logarithmic equation $9+\log(81x)=19-3\log x$. Round your answer to three decimal places.
A) $x \approx 316.228$
B) $x \approx 105.409$
C) $x \approx 5{,}105.889$
D) $x \approx 4.061$
E) $x \approx 39.461$
Ans: B

71. Solve the logarithmic equation $\ln(x+3)+\ln x=\ln(x+24)$.
A) $x = -6$
B) $x = 6; x = -4$
C) $x = -6; x = 4$
D) $x = 4$
E) $x = 6$
Ans: D

72. The monthly sales *S* for a product is given by $S = 50{,}000e^{-0.8x}$, where *x* is the number of months that have passed since the end of a promotional campaign. Determine the monthly sales 5 months after the promotional campaign.
A) $45,304.70
B) $915.78
C) $35,826.57
D) $2,729,907.50
E) $69,780.62
Ans: B

73. The monthly sales *S* for a product is given by $S = 50{,}000e^{-0.8x}$, where *x* is the number of months that have passed since the end of a promotional campaign. How many months after the end of the campaign will sales drop below 5500, if no new campaign is initiated?
A) 2.76 months
B) 4.12 months
C) 5.73 months
D) 5.84 months
E) 7.50 months
Ans: A

74. The purchasing power P (in dollars) of an annual amount of A dollars after t years of 3% inflation decays according to $P = Ae^{-0.03t}$. How long will it be before a pension of $40,000 per year has a purchasing power of $20,000?
A) 1 year
B) 12.6 years
C) 15.8 years
D) 47.2 years
E) 23.1 years
Ans: E

75. The purchasing power P (in dollars) of an annual amount of A dollars after t years of 9% inflation decays according to $P = Ae^{-0.09t}$. Determine how large a pension A needs to be so that the purchasing power P is $70,000 after 10 years?
A) $235,876
B) $172,172
C) $109,782
D) $181,468
E) $86,087
Ans: B

76. An initial amount of 200 g of the radioactive isotope thorium-234 decays according to $Q(t) = 200e^{-0.02828t}$, where t is in years. How long does it take for half of the initial amount to disintegrate? This time is called the half-life of this isotope.
A) 229.3 years
B) 162.8 years
C) 24.5 years
D) 29.0 years
E) 245.1 years
Ans: C

77. The population y of a certain county was 100,000 in 1990 and 164,872 in 2000. Assume the formula $y = P_0e^{ht}$ applies to the growth of the county's population. Estimate the population of the county in 2010.
A) 164,872
B) 448,169
C) 271,828
D) 60,653
E) 36,788
Ans: C

78. For selected years from 1960 to 2001, the national health care expenditures *H*, in billions of dollars, can be modeled by $H = 29.57e^{0.097t}$,
where *t* is the number of years past 1960 (*Source:* U.S. Department of Health and Human Services). If this model remains accurate, in what year will national health care expenditures reach $6 trillion (that is, $6000 billion)?
A) in the year 2015
B) in the year 2025
C) in the year 2020
D) in the year 2018
E) in the year 2016
Ans: A

79. The demand function for a certain commodity is given by $p = 100e^{-q/2}$. At what price per unit will the quantity demanded equal 7 units?
A) $0.09
B) $1.10
C) $3.31
D) $3.02
E) $1.03
Ans: D

80. The demand function for a certain commodity is given by $p = 100e^{-q/2}$. If the price is $5.32 per unit, how many units will be demanded, to the nearest unit?
A) 7 units
B) 5 units
C) 9 units
D) 8 units
E) 10 units
Ans: A

81. If the supply function for a product is given by $p = 100e^{q}/(q+1)$, where *q* represents the number of hundreds of units, what will be the price when the producers are willing to supply 900 units?
A) $54,020.56
B) $121,546.26
C) $162,884.67
D) $81,030.84
E) $244,738.51
Ans: D

82. If the total cost function for a product is $C(x) = e^{0.1x} + 700$, where *x* is the number of items produced, what is the total cost of producing 80 units?
A) $712.59
B) $3680.96
C) $82.01
D) $702.23
E) $721.75
Ans: B

83. If the total cost (in dollars) for *x* units of a product is given by $C(x) = 200\ln(x+30)+100,$ what is the total cost of producing 170 units? Round your answer to the nearest cent.
A) $1159.66
B) $1059.66
C) $1282.70
D) $1257.62
E) $1229.66
Ans: A

84. If the demand function for a product is given by $p = 200e^{-0.02x},$ where *p* is the price per unit when *x* units are demanded, what is the total revenue when 100 units are demanded and supplied?
A) $5032.15
B) $7357.59
C) $134.76
D) $2706.71
E) $36.79
Ans: D

85. If $6000 is invested at an annual rate of 10.5% compounded continuously, the future value *S* at any time *t* (in years) is given by $S = 6000e^{0.105t}$. What is the amount after 24 months?
A) $74,571.58
B) $7395.31
C) $40,986.82
D) $7260.00
E) $7402.07
Ans: E

86. If $5500 is invested at an annual rate of 9.5% compounded continuously, the future value S at any time t (in years) is given by $S = 5500e^{0.095t}$. How long does it take for the investment to double?

A) 7.3 years
B) 5.9 years
C) 7.1 years
D) 7.6 years
E) 9.3 years
Ans: A

87. If $3000 is invested at an annual rate of 9% per year compounded monthly, the future value S at any time t (in months) is given by $S = 3000(1.0075)^t$. What is the amount after 1 year?

A) $3,240.00
B) $8,834.04
C) $3,282.52
D) $3,022.50
E) $3,281.42
Ans: E

88. If $5000 is invested at an annual rate of 12% per year compounded monthly, the future value S at any time t (in months) is given by $S = 5000(1.01)^t$. How long does it take for the investment to double?

A) 83.6 months
B) 15.1 months
C) 69.7 months
D) 78.6 months
E) 68.6 months
Ans: C

89. The securities industry experienced dramatic growth in the last two decades of the 20th century. The following models for the industry's revenue R and expenses or costs C (both in billions of dollars) were developed as functions of the years past 1980 with data from the U.S. Securities and Exchange Commission's 2000 *Annual Report* (2001). $R(t) = 21.4e^{0.131t}$ and $C(t) = 18.6e^{0.131t}$. Use the models to predict the profit for the securities industry in 2011.

A) $1.15 billion
B) $1241.89 billion
C) $1079.40 billion
D) $162.49 billion
E) $702.19 billion
Ans: D

90. By using data from the U.S. Bureau of Labor Statistics for the years 1968–2002, the purchasing power *P* of a 1983 dollar can be modeled with the function $P(t) = 3.818e^{-0.0506t}$, where *t* is the number of years past 1960. Based on this model, what is the purchasing power of a 1983 dollar in the year 1978?
A) $9.49
B) $1.54
C) $9.45
D) $30.65
E) $2.07
Ans: B

91. By using data from the U.S. Bureau of Labor Statistics for the years 1968–2002, the purchasing power *P* of a 1983 dollar can be modeled with the function $P(t) = 3.818e^{-0.0506t}$, where *t* is the number of years past 1960. In what year will the purchasing power of a 1983 dollar be $0.25?
A) 1992
B) 2008
C) 1999
D) 2034
E) 2014
Ans: E

92. Suppose the supply of *x* units of a product at price *p* dollars per unit is given by $p = 10 + 5\ln(3x + 7)$. How many units would be supplied when the price is $60 each?
A) 14679.6 units
B) 5769258.3 units
C) 54249.3 units
D) 7342.2 units
E) 7339.8 units
Ans: E

93. The president of a company predicts that sales *N* will increase after she assumes office and that the number of monthly sales will follow the curve given by $N = 3000(0.2)^{0.4^t}$, where *t* represents time in months since she assumed office. What will the sales be when she assumes office?
A) 3000
B) 625
C) 240
D) 600
E) 1200
Ans: D

94. The president of a company predicts that sales *N* will increase after she assumes office and that the number of monthly sales will follow the curve given by $N = 3000(0.1)^{0.5^t}$, where *t* represents time in months since she assumed office. What will be the sales after 9 months?
A) 2987
B) 1
C) 6
D) 1350
E) 37
Ans: A

95. The president of a company predicts that sales *N* will increase after she assumes office and that the number of monthly sales will follow the curve given by $N = 3000(0.2)^{0.6^t}$, where *t* represents time in months since she assumed office. What is the expected upper limit on sales?
A) 0
B) 3000
C) 600
D) 1800
E) infinity
Ans: B

96. Suppose that the equation $N = 400(0.02)^{0.4^t}$ represents the number of employees working *t* years after a company begins operations. How many employees are there when the company opens (at $t = 0$)?
A) 3 employees
B) 160 employees
C) 8 employees
D) 1 employee
E) 11 employees
Ans: C

97. Suppose that the equation $N = 700(0.01)^{0.4^t}$ represents the number of employees working *t* years after a company begins operations. After how many years will at least 200 employees be working?
A) after 3.25 years
B) after 1.42 years
C) after 136.72 years
D) after 0.30 year
E) after 1.19 years
Ans: B

98. The concentration y of a certain drug in the bloodstream t hours after an oral dosage (with $0 \le t \le 15$) is given by the equation $y = 100(1 - e^{-0.462t})$. What is the concentration after 5 hours?
A) 109.9
B) 907.4
C) 185.0
D) 14,741.3
E) 90.1
Ans: E

99. The concentration y of a certain drug in the bloodstream t hours after an oral dosage (with $0 \le t \le 15$) is given by the equation $y = 100(1 - e^{-0.462t})$. How long does it take for the concentration to reach 40?
A) 1.11 hours
B) 0.66 hour
C) 1.98 hours
D) 0.73 hour
E) 100.00 hours
Ans: A

100. On a college campus of 10,000 students, a single student returned to campus infected by a disease. The spread of the disease through the student body is given by $y = \dfrac{10,000}{1 + 9999e^{-0.99t}}$, where y is the total number infected at time t (in days). How many are infected after 8 days?
A) approximately 52 students
B) approximately 10 students
C) approximately 9,987 students
D) approximately 2,158 students
E) approximately 3,038 students
Ans: D

101. On a college campus of 10,000 students, a single student returned to campus infected by a disease. The spread of the disease through the student body is given by $y = \dfrac{10,000}{1 + 9999e^{-0.99t}}$, where y is the total number infected at time t (in days). The school will shut down if 40% of the students are ill. What value of t corresponds to this percentage?
A) 11.70
B) 7.90
C) 8.89
D) 3.73
E) 6.41
Ans: C

102. Suppose that the market share *y* (as a percent) that a company expects *t* months after a new product is introduced is given by $y = 30 - 30e^{-0.05t}$. What is the market share after the first month (to the nearest percent)?

A) 30.77%
B) 0.12%
C) 1.46%
D) 1.54%
E) 29.27%
Ans: C

103. Suppose that the market share *y* (as a percent) that a company expects *t* months after a new product is introduced is given by $y = 50 - 50e^{-0.05t}$. How long (to the nearest month) will it take for the market share to be 45%?

A) 46.1 months
B) 63.9 months
C) 7.7 months
D) 37.2 months
E) 69.1 months
Ans: A

104. Pollution levels in Lake Erie have been modeled by the equation $x = 0.05 + 0.18e^{-0.38t}$, where *x* is the volume of pollutants (in cubic kilometers) and *t* is the time (in years) (Adapted from R. H. Rainey, *Science* 155 (1967), 1242–1243). Find the initial pollution level; that is, find *x* when $t = 0$.

A) 0.23 km^3

B) 0.25 km^3

C) 0.13 km^3

D) 0.35 km^3

E) 0.01 km^3

Ans: A

105. For selected years from 1978 to 2002, the number of mutual funds N, excluding money market funds, can be modeled by

$N = \frac{8750}{1+80.8e^{-0.2286t}}$, where t is the number of years past 1975 (*Source:* Investment Company Institute, *Mutual Fund Fact Book (2003)*). Use the model to estimate the number of mutual funds in 1991. Round your answer to the nearest whole number.

A) 14,912
B) 153
C) 2,837
D) 26,987
E) 41,983
Ans: C

106. For selected years from 1978 to 2002, the number of mutual funds N, excluding money market funds, can be modeled by

$N = \frac{8750}{1+80.8e^{-0.2286t}}$, where t is the number of years past 1975 (*Source:* Investment Company Institute, *Mutual Fund Fact Book (2003)*). Use the model to estimate the year when the number of mutual funds will reach 7000.

A) 1993
B) 1995
C) 1997
D) 2001
E) 2003
Ans: D

107. The following table gives the percent of the U.S. population with Internet connections for the years 1997 to 2003. Use a calculator to find the logistic function that models these data. Use x as the number of years past 1995.

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Percent with Internet	22.2	32.7	39.1	44.4	53.9	55.0	56.0

Source: U.S. Department of Commerce

A) $y(x)=\dfrac{59.57}{1+5.22e^{-0.585x}}$

B) $y(x)=\dfrac{22.2}{1+5.85e^{-0.622x}}$

C) $y(x)=\dfrac{56.0}{1+5.64e^{-0.522x}}$

D) $y(x)=\dfrac{1}{1+5.64e^{-0.622x}}$

E) $y(x)=\dfrac{56.0}{1+5.95e^{-0.585x}}$

Ans: A

108. The following table gives the percent of the U.S. population with Internet connections for the years 1997 to 2003. Use a calculator to find the logistic function that models these data and then use the model to predict the percent of the U.S. population with Internet connections in 2005. Use x as the number of years past 1995.

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Percent with Internet	22.2	32.7	39.1	44.4	53.9	55.0	56.0

Source: U.S. Department of Commerce

A) 63.1%
B) 66.0%
C) 61.4%
D) 58.7%
E) 55.9%
Ans: D

109. The following table gives the percent of the U.S. population with Internet connections for the years 1997 to 2003. Use a calculator to find the logistic function that models these data and then use the model to predict when 57.8% of the U.S. population will have internet connections. Use *x* as the number of years past 1995.

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Percent with Internet	22.2	32.7	39.1	44.4	53.9	55.0	56.0

Source: U.S. Department of Commerce

A) 2002
B) 2004
C) 2007
D) 2008
E) 2010
Ans: B

