

5.2 EXERCISES

In Problems 1–10, approximate each number using a calculator. Express your answer rounded to three decimal places.

- | | | | |
|--------------------|-------------------|---------------------|--------------------|
| 1. (a) $3^{2.2}$ | (b) $3^{2.23}$ | (c) $3^{2.236}$ | (d) $3^{\sqrt{5}}$ |
| 2. (a) $5^{1.7}$ | (b) $5^{1.75}$ | (c) $5^{1.732}$ | (d) $5^{\sqrt{3}}$ |
| 3. (a) $2^{3.14}$ | (b) $2^{3.141}$ | (c) $2^{3.1415}$ | (d) 2^π |
| 4. (a) $2^{2.7}$ | (b) $2^{2.71}$ | (c) $2^{2.718}$ | (d) 2^e |
| 5. (a) $3.1^{2.7}$ | (b) $3.14^{2.71}$ | (c) $3.141^{2.718}$ | (d) π^e |
| 6. (a) $2.7^{3.1}$ | (b) $2.71^{3.14}$ | (c) $2.718^{3.141}$ | (d) e^π |
| 7. $e^{1.2}$ | 8. $e^{-1.3}$ | 9. $e^{-0.85}$ | 10. $e^{2.1}$ |

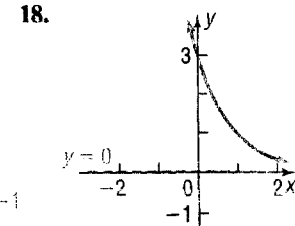
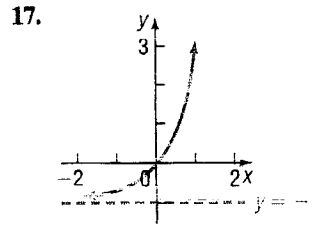
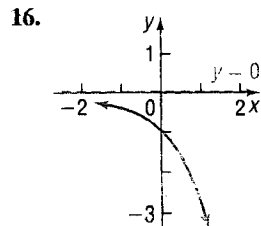
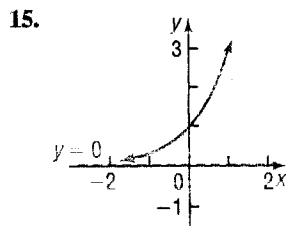
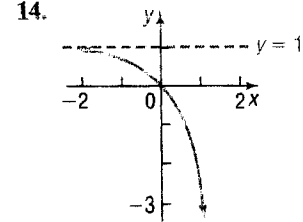
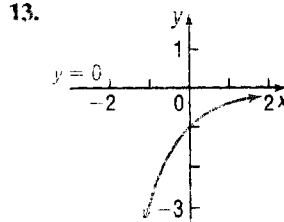
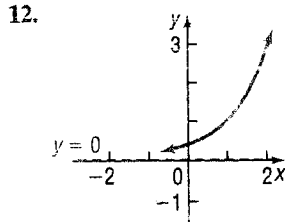
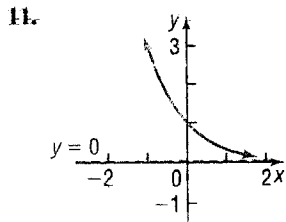
In Problems 11–18, the graph of an exponential function is given. Match each graph to one of the following functions without the aid of a graphing utility.

A. $y = 3^x$
E. $y = 3^x - 1$

B. $y = 3^{-x}$
F. $y = 3^{x-1}$

C. $y = -3^x$
G. $y = 3^{1-x}$

D. $y = -3^{-x}$
H. $y = 1 - 3^x$



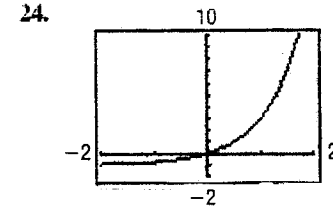
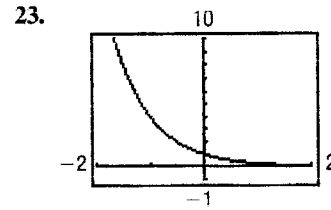
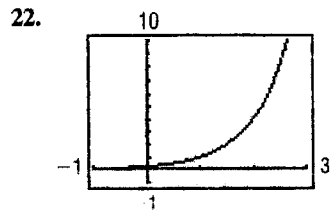
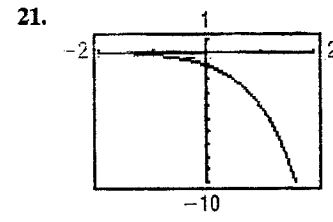
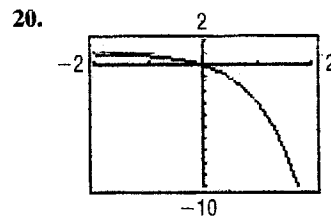
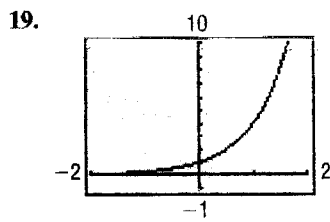
In Problems 19–24, the graph of an exponential function is given. Match each graph to one of the following functions:

A. $y = 4^x$
E. $y = -4^x$

B. $y = 4^{-x}$
F. $y = 1 - 4^x$

C. $y = 4^{x-1}$

D. $y = 4^x - 1$



In Problems 25–42, use transformations to graph each function. Determine the domain, range, and horizontal asymptote of each function. Verify your results using a graphing utility.

25. $f(x) = 2^x + 1$

26. $f(x) = 2^{x+2}$

27. $f(x) = 3^{-x} - 2$

28. $f(x) = -3^x + 1$

29. $f(x) = 2 + 3(4^x)$

30. $f(x) = 1 - 3(2^x)$

31. $f(x) = 2 + 3^{x/2}$

32. $f(x) = 1 - 2^{-x/3}$

33. $f(x) = 5 - 2(3^{-(x+1)})$ 34. $f(x) = 1 + 3^{-(x-4)}$ 35. $f(x) = e^{-x}$ 36. $f(x) = -e^x$
 37. $f(x) = e^{x+2}$ 38. $f(x) = e^x - 1$ 39. $f(x) = 5 - e^{-x}$ 40. $f(x) = 9 - 3e^{-x}$
 41. $f(x) = 2 - e^{-x/2}$ 42. $f(x) = 7 - 3e^{2x}$

In Problems 43–56, solve each equation. Verify your solution using a graphing utility.

43. $2^{2x+1} = 4$ 44. $5^{1-2x} = \frac{1}{5}$ 45. $3^{x^3} = 9^x$ 46. $4^{x^2} = 2^x$
 47. $8^{x^2-2x} = \frac{1}{2}$ 48. $9^{-x} = \frac{1}{3}$ 49. $2^x \cdot 8^{-x} = 4^x$ 50. $(\frac{1}{2})^{1-x} = 4$
 51. $(\frac{1}{3})^{2-x} = 25$ 52. $4^x - 2^x = 0$ 53. $4^x = 8$ 54. $9^{2x} = 27$
 55. $e^{x^2} = (e^{3x}) \cdot \frac{1}{e^2}$ 56. $(e^4)^x \cdot e^{x^2} = e^{12}$

57. If $4^x = 7$, what does 4^{-2x} equal?

59. If $3^{-x} = 2$, what does 3^{2x} equal?

61. **Optics** If a single pane of glass obliterates 3% of the light passing through it, then the percent p of light that passes through n successive panes is given approximately by the function

$$p(n) = 100e^{-0.03n}$$

- (a) What percent of light will pass through 10 panes?
 (b) What percent of light will pass through 25 panes?

62. **Atmospheric Pressure** The atmospheric pressure p on a balloon or plane decreases with increasing height. This pressure, measured in millimeters of mercury, is related to the number of kilometers h above sea level by the function

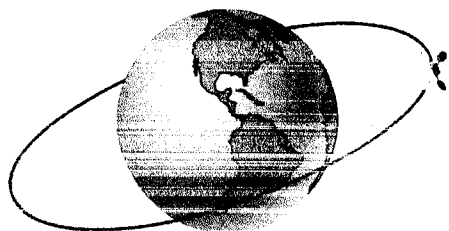
$$p(h) = 760e^{-0.145h}$$

- (a) Find the atmospheric pressure at a height of 2 kilometers (over a mile).
 (b) What is it at a height of 10 kilometers (over 30,000 feet)?

63. **Space Satellites** The number of watts w provided by a space satellite's power supply over a period of d days is given by the function

$$w(d) = 50e^{-0.004d}$$

- (a) How much power will be available after 30 days?
 (b) How much power will be available after 1 year (365 days)?



58. If $2^x = 3$, what does 4^{-x} equal?

60. If $5^{-x} = 3$, what does 5^{3x} equal?

64. **Healing of Wounds** The normal healing of wounds can be modeled by an exponential function. If A_0 represents the original area of the wound and if A equals the area of the wound after n days, then the function

$$A(n) = A_0e^{-0.35n}$$

describes the area of a wound on the n th day following an injury when no infection is present to retard the healing. Suppose that a wound initially had an area of 100 square millimeters.

- (a) If healing is taking place, how large should the area of the wound be after 3 days?
 (b) How large should it be after 10 days?

65. **Drug Medication** The function

$$D(h) = 5e^{-0.4h}$$

can be used to find the number of milligrams D of a certain drug that is in a patient's bloodstream h hours after the drug has been administered. How many milligrams will be present after 1 hour? After 6 hours?

66. **Spreading of Rumors** A model for the number of people N in a college community who have heard a certain rumor is

$$N = P(1 - e^{-0.15d})$$

where P is the total population of the community and d is the number of days that have elapsed since the rumor began. In a community of 1000 students, how many students will have heard the rumor after 3 days?

67. **Exponential Probability** Between 12:00 PM and 1:00 PM, cars arrive at Citibank's drive-thru at the rate of 6 cars per hour (0.1 car per minute). The following formula from statistics can be used to determine the probability that a car will arrive within t minutes of 12:00 PM.

$$F(t) = 1 - e^{-0.1t}$$

- (a) Determine the probability that a car will arrive within 10 minutes of 12:00 PM (that is, before 12:10 PM).