Skill Building

In Problems 11–20, approximate each number using a calculator. Express your answer rounded to three decimal places.

11. (a) $3^{2.2}$ (b) $3^{2.23}$ (c) $3^{2.236}$ (d) $3^{\sqrt{5}}$

12. (a) $5^{1.7}$ (b) $5^{1.73}$ (c) $5^{1.732}$ (d) $5^{\sqrt{3}}$

13. (a) $2^{3.14}$ (b) $2^{3.141}$ (c) $2^{3.1415}$ (d) 2^{π}

14. (a) $2^{2.7}$ (b) $2^{2.71}$ (c) $2^{2.718}$ (d) 2^{e}

15. (a) $3.1^{2.7}$ (b) $3.14^{2.71}$ (c) $3.141^{2.718}$ (d) π^{e}

16. (a) $2.7^{3.1}$ (b) $2.71^{3.14}$ (c) $2.718^{3.141}$ (d) e^{π}

17. $e^{1.2}$

18. $e^{-1.3}$

19. $e^{-0.85}$

20. $e^{2.1}$

In Problems 21–28, determine whether the given function is exponential or not. For those that are exponential functions, identify the value of the base a. [**Hint:** *Look at the ratio of consecutive values.*]

21.

x	f(x)
−1	3
0	6
1	12
2	18
3	30

22.

x	g(x)
−1	2
0	5
1	8
2	11
3	14

23.

x	H(x)
−1	$\frac{1}{4}$
0	1
1	4
2	16
3	64

24.

x	F(x)
−1	$\frac{2}{3}$
0	1
1	$\frac{3}{2}$
2	$\frac{9}{4}$
3	$\frac{27}{8}$

25.

x	f(x)
−1	$\frac{3}{2}$
0	3
1	6
2	12
3	24

26.

x	g(x)
−1	6
0	1
1	0
2	3
3	10

27.

x	H(x)
−1	2
0	4
1	6
2	8
3	10

28.

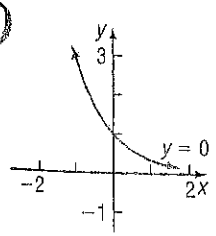
x	F(x)
−1	$\frac{1}{2}$
0	$\frac{1}{4}$
1	$\frac{1}{8}$
2	$\frac{1}{16}$
3	$\frac{1}{32}$

In Problems 29–36, the graph of an exponential function is given. Match each graph to one of the following functions.

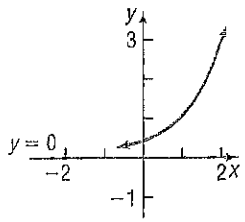
A. $y = 3^x$ B. $y = 3^{-x}$ C. $y = -3^x$ D. $y = -3^{-x}$

E. $y = 3^x - 1$ F. $y = 3^{x-1}$ G. $y = 3^{1-x}$ H. $y = 1 - 3^x$

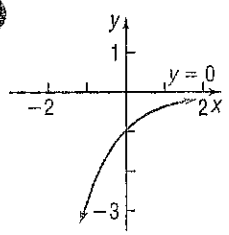
29.



30.



31.



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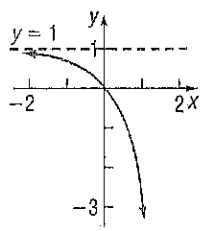
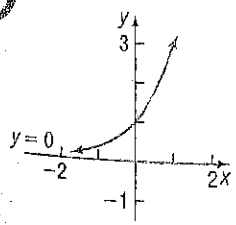


33.



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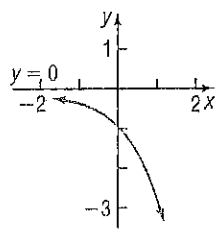

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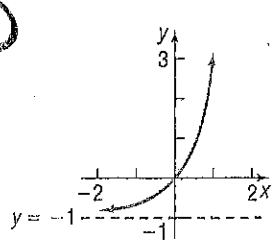
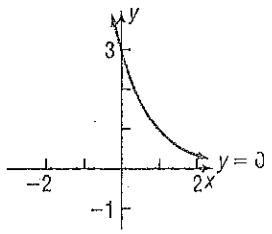


36.



In Problems 37–44, use transformations to graph each function. Determine the domain, range, and horizontal asymptote of each function.

37. $f(x) = 2^x + 1$
38. $f(x) = 2^{x+2}$
39. $f(x) = 3^{-x} - 2$
40. $f(x) = -3^x + 1$
41. $f(x) = 2 + 3(4^x)$
42. $f(x) = 1 - 3(2^x)$
43. $f(x) = 2 + 3^{x/2}$
44. $f(x) = 1 - 2^{-x/3}$

In Problems 45–52, begin with the graph of $y = e^x$ (Figure 30 (a)) and use transformations to graph each function. Determine the domain, range, and horizontal asymptote of each function.

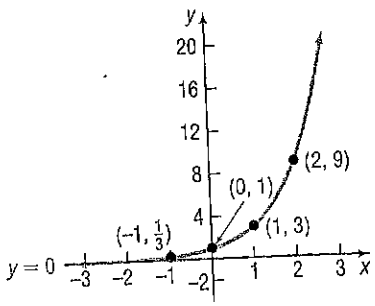
45. $f(x) = e^{-x}$
46. $f(x) = -e^x$
47. $f(x) = e^{x+2}$
48. $f(x) = e^x - 1$
49. $f(x) = 5 - e^{-x}$
50. $f(x) = 9 - 3e^{-x}$
51. $f(x) = 2 - e^{-x/2}$
52. $f(x) = 7 - 3e^{2x}$

In Problems 53–66, solve each equation.

53. $2^{2x+1} = 4$
54. $5^{1-2x} = \frac{1}{5}$
55. $3^{x^3} = 9^x$
56. $4^{x^2} = 2^x$
57. $8^{x^2-2x} = \frac{1}{2}$
58. $9^{-x} = \frac{1}{3}$
59. $2^x \cdot 8^{-x} = 4^x$
60. $\left(\frac{1}{2}\right)^{1-x} = 4$
61. $\left(\frac{1}{5}\right)^{2-x} = 25$
62. $4^x - 2^x = 0$
63. $4^x = 8$
64. $9^{2x} = 27$
65. $e^{x^2} = (e^{3x}) \cdot \frac{1}{e^2}$
66. $(e^4)^x \cdot e^{x^2} = e^{12}$
67. If $4^x = 7$, what does 4^{-2x} equal?
68. If $2^x = 3$, what does 4^{-x} equal?
69. If $3^{-x} = 2$, what does 3^{2x} equal?
70. If $5^{-x} = 3$, what does 5^{3x} equal?

In Problems 71–74, determine the exponential function whose graph is given.

71.



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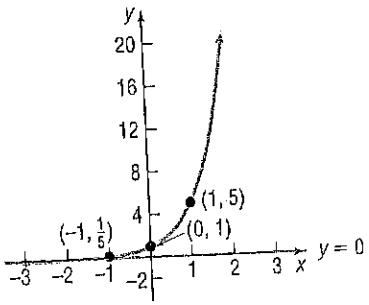
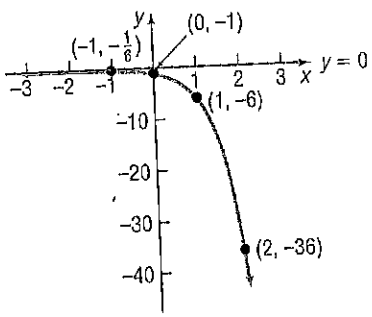
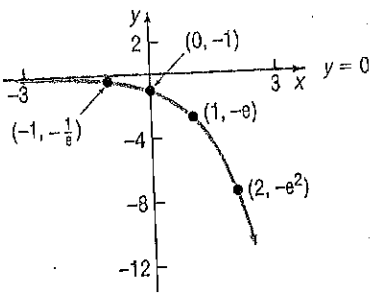


73.



74.



Applications and Extensions

75. **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

$$p(n) = 100(0.97)^n$$

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

76. **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 height h (in kilometers) 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)?