

Answers for 8.1

For use with pages 492–494

8.1 Skill Practice

1. order of magnitude
2. When powers have the same base, their product is the base raised to the sum of the exponents.
3. 4^8 4. 8^7 5. 3^4
6. 9^6 7. $(-7)^9$ 8. $(-6)^7$
9. 2^{14} 10. $(-3)^{14}$ 11. 3^{10}
12. 7^{12} 13. $(-5)^{12}$ 14. $(-8)^{18}$
15. $15^3 \cdot 29^3$ 16. $17^4 \cdot 16^4$
17. $132^6 \cdot 9^6$ 18. $(-14)^5 \cdot 22^5$
19. x^6 20. y^{10} 21. z^6
22. a^{17} 23. x^{10} 24. y^{24}
25. $(b - 2)^{12}$ 26. $(d + 9)^{21}$
27. $25x^2$ 28. $-25x^2$
29. $49x^2y^2$ 30. $125p^3q^3$
31. $100x^{14}$ 32. $64m^{11}$
33. $96d^{22}$ 34. $-400x^{13}$
35. $12p^{19}$ 36. $2y^{23}$
37. $108x^{29}$ 38. $-6400n^{11}$
39. *Sample answer:* The exponents should be added, not multiplied;
 $c^1 \cdot c^4 \cdot c^5 = c^{1+4+5} = c^{10}$.
40. B 41. D 42. 1
43. 2 44. 5 45. 2
46. 10^7 people 47. $-3267x^{12}y^{13}$
48. $x^{13}y^{12}z^{17}$ 49. $1000r^{17}s^6t^{17}$
50. *Sample answer:* $3x^2 \cdot 4x^6$,
 $12(x^4)^2$, $3(2x^4)^2$
51. *Sample answer:* $(ab)^n = (ab) \cdot (ab) \cdot \dots \cdot (ab)$ so that there are n total terms (ab) . By the commutative property, the n a 's can be grouped as a repeated multiplication equal to a^n and the n b 's can be grouped as a repeated multiplication equal to b^n . $(ab)^n$ is equal to the product of these two groups, or $a^n \cdot b^n$.

8.1 Problem Solving

52. 10^9 air bubbles
53. 10^{26} m
54. 10^{16} grains of sand
55. a. 10^{24} , 10^{25} , 10^{26} , 10^{27} , 10^{28}
b. $10^5 \cdot 10^{23}$; 10^{28} atoms
56. a. 10^3 times
b. 10^5 nanometers
57. 10^{27}

Answers for 8.1 *continued*
 For use with pages 492–494

58. a. 10^4

b. 10^{10}

c. Increases the volume by 10^8 .

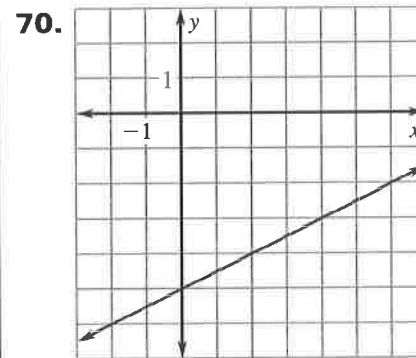
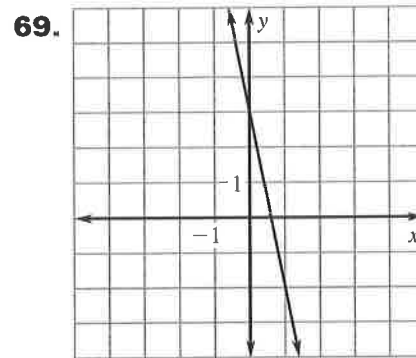
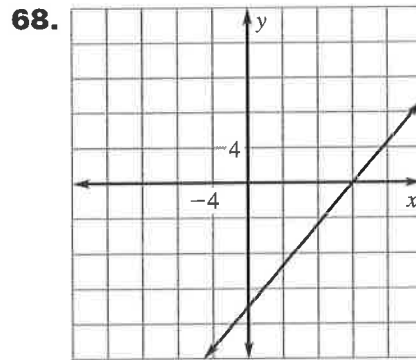
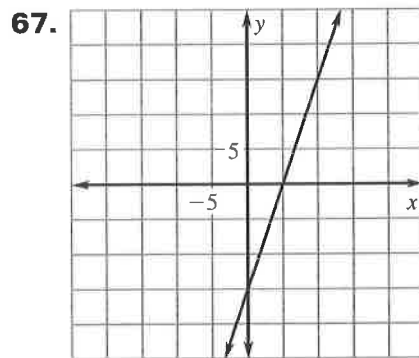
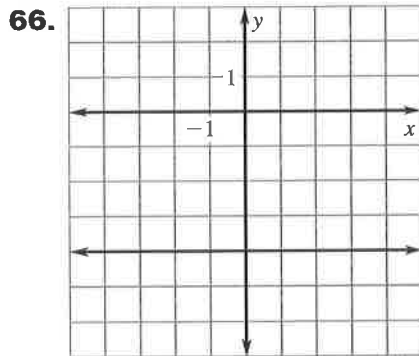
Sample answer: Since the radius is squared in the formula for volume, multiplying the radius by 10 would raise the volume by a factor of $10 \cdot 10$, or 10^2 .

59. 2^{13} ways; 2^{10} ways; 2^{23} ways

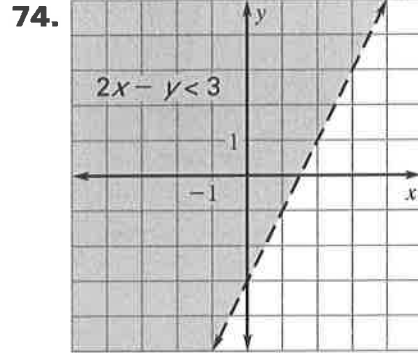
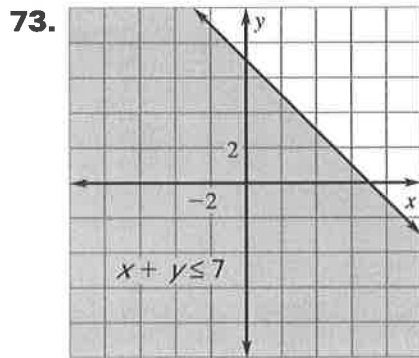
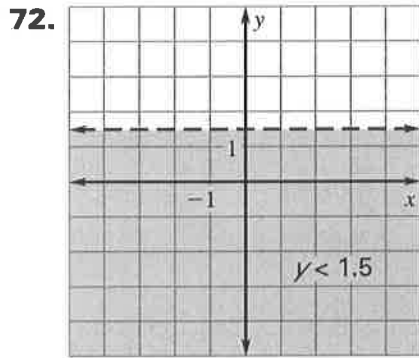
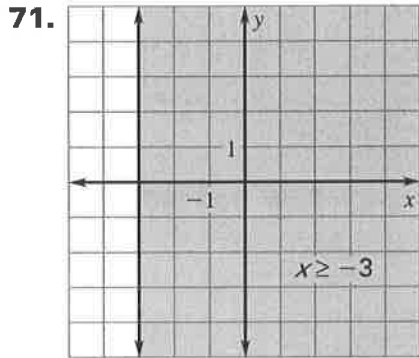
8.1 Mixed Review

60. $-\frac{2}{5}$ 61. $1\frac{1}{6}$ 62. $\frac{9}{20}$

63. 81 64. 4.84 65. $\frac{27}{64}$



Answers for 8.1 *continued*
 For use with pages 492–494



Answers for 8.2

For use with pages 498–501

8.2 Skill Practice

1. base, exponent
2. When powers have the same base, their quotient is the base raised to the difference of the exponents.
3. 5^4 4. 2^5 5. 3^4
6. $(-6)^3$ 7. $(-4)^3$ 8. $(-12)^6$
9. 10^6 10. 6^5 11. $\frac{1}{3^5}$
12. $\frac{3^4}{2^4}$ 13. $\frac{5^4}{4^4}$ 14. $-\frac{2^5}{5^5}$
15. 7^7 16. 9^6 17. 3^8
18. -4^4 19. C
20. *Sample answer:* When using the quotient of powers property, the base is raised to the difference of the exponents, not the sum;
 $\frac{9^8}{9^4} = 9^{(8-4)} = 9^4$.
21. y^7 22. z 23. $\frac{a^9}{y^9}$
24. $\frac{j^{11}}{k^{11}}$ 25. $\frac{p^4}{q^4}$ 26. $-\frac{1}{x^5}$
27. $-\frac{64}{x^3}$ 28. $\frac{a^4}{b^4}$ 29. $\frac{64c^3}{d^6}$
30. $\frac{a^{35}}{32b^5}$ 31. $\frac{x^4}{9y^6}$ 32. $\frac{27x^{15}}{343y^6}$
33. $\frac{9x^4}{4y^2}$ 34. $\frac{4x^6}{3y^3}$ 35. $\frac{3m^7}{8n^6}$
36. $\frac{100x^6}{y^6}$ 37. D 38. 4

39. 8 40. 14 41. 4

42. $\frac{16f^4g^8}{81}$ 43. $54s^3t^3$
44. $\frac{m^8n^8}{100}$ 45. $\frac{27x^{11}y^5}{25}$
46. *Sample answer:* $\frac{14^8}{14}$, $\frac{14^{10}}{14^3}$, $\frac{14^{14}}{14^7}$
47. Identity property of multiplication;
 Multiply fractions.;
 Quotient of powers property
48. $x = 8, y = -1$; *Sample answer:*
 Using the quotient of a power property, write two equations for x and y : $x - y = 9$, and $x + 2 - 3y = 13$. Solve the equations.

8.2 Problem Solving

49. a.

Step	Number of new squares	Side length of new square
1	$4 = 4^1$	$\frac{1}{2} = \left(\frac{1}{2}\right)^1$
2	$16 = 4^2$	$\frac{1}{4} = \left(\frac{1}{2}\right)^2$
3	$64 = 4^3$	$\frac{1}{8} = \left(\frac{1}{2}\right)^3$
4	$256 = 4^4$	$\frac{1}{16} = \left(\frac{1}{2}\right)^4$

b. $\frac{4^4}{4^2}$; 16 times

50. about 10^5 dollars

Answers for 8.2 *continued*
For use with pages 498–501

51. about 31,710 yr

52. 2.512^3 times

53. 31^3 times greater

54. a. 2^{30} kilobytes

b. 2^{30} megabytes

c. Multiply the number of bytes in each unit by 8, or 2^3 .

8.2 Mixed Review

55. 12 **56.** -10 **57.** -21

58. 14 **59.** $-3\frac{1}{3}$ **60.** $\frac{1}{2}$

61. $y = -3x - 5$

62. $y = \frac{1}{2}x + 3$ **63.** $y = -3$

64. $y = 3x - 9$

65. $y = -\frac{1}{2}x + 3$

66. $y = -2x - 5$

Answers for 8.3

For use with pages 506–511

8.3 Skill Practice

- Product of powers property and definition of zero exponent; the expression simplifies using the product of powers property to 3^0 , which by definition equals 1.
- Sample answer:* The definition of negative exponents is defined only for nonzero bases.
- $\frac{1}{64}$
- $\frac{1}{343}$
- $-\frac{1}{3}$
- $\frac{1}{64}$
- 1
- 1
- 1
- 1
- 1
- $\frac{49}{4}$
- $\frac{27}{64}$
- undefined
- undefined
- $\frac{1}{32}$
- $\frac{1}{49}$
- $\frac{1}{32}$
- $\frac{1}{81}$
- 27
- 36
- $\frac{1}{243}$
- 36
- $\frac{8}{3}$
- $\frac{1}{2}$
- 16
- $\frac{5}{9}$
- 3^0 is not equivalent to 0, but to 1; $-6 \cdot 3^0 = -6 \cdot 1 = -6$.
- $\frac{1}{x^4}$
- $\frac{2}{y^3}$
- $\frac{1}{64g^3}$
- $\frac{1}{121h^2}$
- $\frac{x^2}{y^3}$
- $\frac{5}{m^3n^4}$
- $\frac{x^6}{216y^9}$
- 1
- $\frac{s^4}{r^2}$
- $\frac{1}{x^5y^2}$
- $\frac{x^2y^6}{8}$
- $\frac{y^8}{15x^{10}}$
- $4z^2$
- $243d^3$
- $-\frac{y^{10}}{27x^5}$
- $\frac{3x^{12}y^5}{4}$
- D
- D
- Not true.
Sample answer: $\frac{2^{-3}}{2^{-4}} = 2$
- true
- Not true. *Sample answer:* $2^{-1} + 2^{-1} = 1$
- Sample answer:* It approaches 0.

8.3 Problem Solving

- about 10^6 grains of salt
- about 10^5 grains of rice
- about 10^8 times greater
- about 10^{11} red blood cells
- No. *Sample answer:* The giant fan palm has a mass of about 10^4 grams or 10,000 grams, which equals 10 kilograms.
- a. $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}$ b. $\left(\frac{1}{2}\right)^x$
- a. 0.0005 sec
b. $\frac{(\text{cm})^2}{\text{cm}^2} = \text{cm}^2 \cdot \frac{\text{sec}}{\text{cm}^2} = \text{sec}$
- a. 112.5 watts b. $I = 9d^{-2}$
c. The intensity is divided by 4.

Answers for 8.3 *continued*
For use with pages 506–511

58. a. 10^5 BTUs b. 0.01 lb

8.3 Mixed Review

59. 1,000,000 60. 10,000,000

61. 100 62. 1000

63. $(\frac{1}{2}, -4\frac{1}{2})$ 64. (4, 4)

65. (8, 0) 66. $(6, \frac{1}{4})$

67. (1, -2) 68. $(-4\frac{1}{2}, 2\frac{1}{3})$

8.1–8.3 Mixed Review of Problem Solving

1. 1000 times;

	1	0	0	0
		/	/	

		0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

2. a. $\frac{729}{8}$ in.³

b. Power of a quotient property

3. a. 10^{-12} b. 10^{-6}

c. *Sample answer:* Divide the order of magnitude of the

volume of the raindrop by the order of magnitude of the volume of the droplet; 10^2 droplets, Quotient of a power property.

4. 1000 watts per square meter;

	1	0	0	0
		/	/	

		0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

5. a. 10^{-6} in. b. 10 in.³

c. *Sample answer:* Multiply the surface area 10^x square inches by the thickness of the oil 10^{-6} inches to calculate the volume of oil in cubic inches needed. $10^x \cdot 10^{-6} = 10^{x-6}$ in.³

6. a. *Sample answer:* How many milliseconds are in a gigasecond?

b. *Sample answer:* How many megaseconds are in 1 gigasecond?

Answers for 8.4

For use with pages 515–518

8.4 Skill Practice

1. No; 0.5 is not a number greater than or equal to 1.0 and less than 10.
2. Greater than 1; the exponent is positive.
3. 8.5×10^1 4. 7.2×10^{-1}
5. 8.24×10^1 6. 5×10^{-3}
7. 7.2×10^7 8. 4.06×10^{-3}
9. 1.06525×10^6
10. 4.5×10^{-5} 11. 1.06×10^9
12. 5.26×10^{-6} 13. 9×10^{14}
14. 7.008×10^{-8}
15. C 16. 2600
17. 75,000,000 18. 111
19. 30,300 20. 4,709,000
21. 15,440,000,000
22. 0.0061
23. 0.00000000044
24. 0.00000223
25. 0.0000000852
26. 0.0000000064111
27. 0.0000012034
28. The decimal point should be moved to the left, not the right;
 $1.24 \times 10^{-3} = 0.00124$.
29. 6.7×10^3 ; 12,439;
 2×10^4 ; 45,000
30. 6.07×10^6 ; 6.2×10^6 ;
 3.557×10^7 ; 55,004,000;
65,000,000
31. 9.8×10^{-6} ; 0.00008; 0.0005;
 5×10^{-3} ; 8.2×10^{-3} ; 0.04065
32. 0.000005; 5.08×10^{-6} ;
 2.4×10^{-5} ; 0.0000395;
0.00010068
33. < 34. < 35. =
36. = 37. > 38. >
39. 6.6×10^{-4} 40. 4.234×10^{-2}
41. 7.29×10^{-9} 42. 7.5×10^2
43. 3×10^{-3} 44. 5×10^{-5}
45. 1.25×10^{-22}
46. 2.401×10^{-17}
47. 1.96×10^6
48. B
49. *Sample answer:*
 2.8×10^1 and 1×10^3 ;
 11.2×10^5 and 4.0×10^1
50. 4.27×10^5 ; *Sample answer:*
Rewrite 6.7×10^4 as 0.67×10^5 ,
then add $3.6 + 0.67 = 4.27$. Since
the answer is between 1 and 10,
the exponent does not change, so
the answer is 4.27×10^5 .

Answers for 8.4 *continued*
For use with pages 515–518

8.4 Problem Solving

51. a. 1.4×10^{-4} ; 2.5×10^{-1} ;
 1.67×10^2 ; 555

b. the elephant beetle and the walking stick

52. Voyager 1

53. 1406 pounds per acre

54. 14; the flow rate of the Amazon River is about 14 times faster than the flow rate of the Mississippi River.

55. a. About 3.67; the radius of the Earth is about 3.67 times greater than the radius of the moon.

b. About 49.30; the volume of the Earth is about 49.30 times greater than the volume of the moon.

c. The ratio of the volumes is the cube of the ratio of the radii.

56. a. about 1×10^{10} locusts

b. 2×10^{10} kg

57. 4 in. by 6 in.

58. a. $\frac{1.863 \times 10^5 \text{ mi}}{1 \text{ sec}} \cdot \frac{60 \text{ sec}}{1 \text{ min}}$
 $\cdot \frac{60 \text{ min}}{1 \text{ h}} \cdot \frac{24 \text{ h}}{1 \text{ day}} \cdot \frac{365 \text{ days}}{1 \text{ yr}}$
 $\approx 5.875 \times 10^{12} \text{ mi/yr}$

b.

Years	1	10
Miles traveled	5.875×10^{12}	5.875×10^{13}
Years	100	1000
Miles traveled	5.875×10^{14}	5.875×10^{15}
Years	10,000	100,000
Miles traveled	5.875×10^{16}	5.875×10^{17}

59. a. 4.9 L

b. about 2.58×10^6 L,
about 2.58×10^7 L,
about 2.06×10^8 L

c. Underestimates.

Sample answer: They are calculated when a person is at rest. When a person is not resting, the rate will go up.

60. a. 500 times greater

b. about 18 h

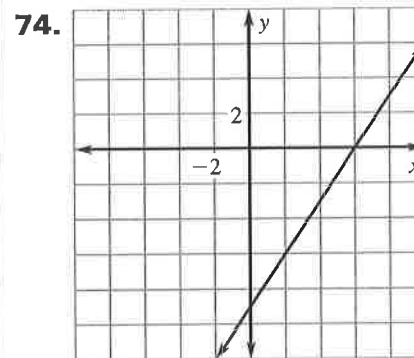
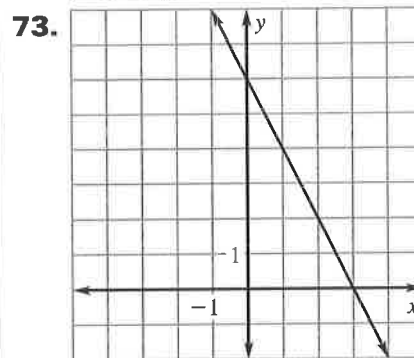
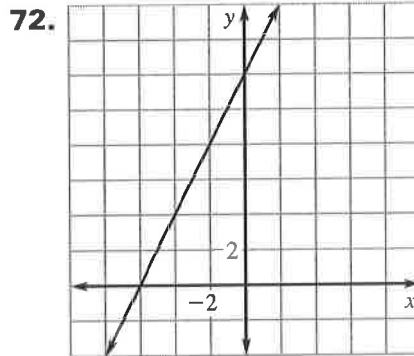
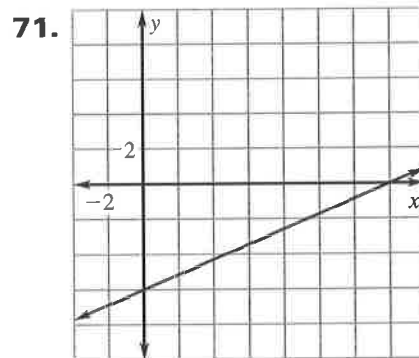
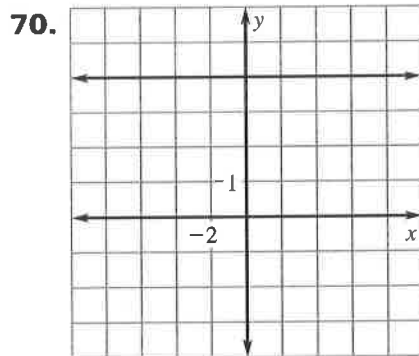
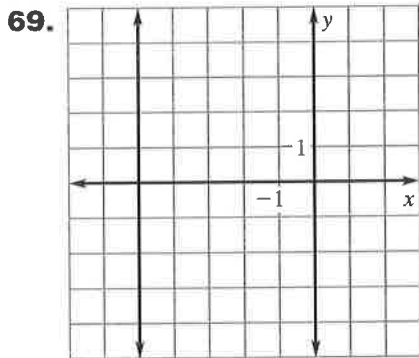
8.4 Mixed Review

61. 0.33 **62.** 0.627 **63.** 0.009

64. 0.0004 **65.** 0.0395 **66.** 0.0025

67. 0.025 **68.** 1.33

Answers for 8.4 *continued*
 For use with pages 515–518

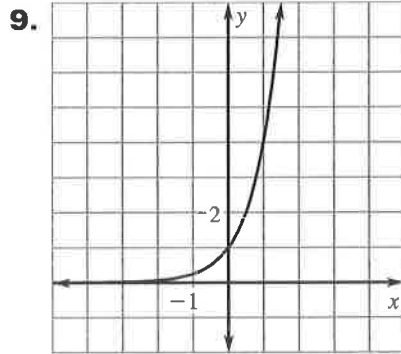


Answers for 8.5

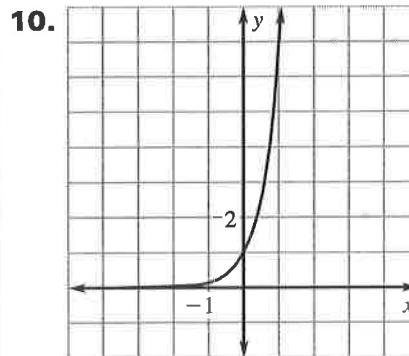
For use with pages 523–527

8.5 Skill Practice

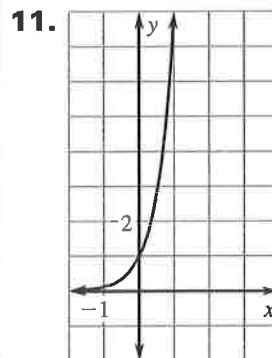
1. growth factor 2. $b > 1$
3. The graph would be a vertical stretch. *Sample answer:* Since the y -values of $y = 2 \cdot 5^x$ are double those of $y = 5^x$.
4. $y = 4 \cdot 2^x$ 5. $y = 125 \cdot 5^x$
6. $y = \frac{1}{2} \cdot 2^x$ 7. $y = \frac{1}{9} \cdot 3^x$
8. *Sample answer:* If the difference between successive terms is constant, the function is linear and if the ratio of successive terms is constant, the function is exponential.



domain: all real numbers
range: all positive real numbers

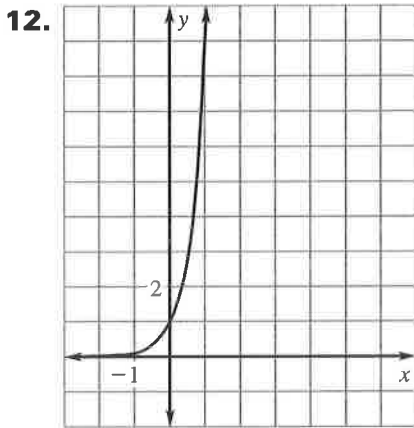


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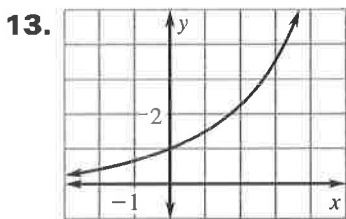


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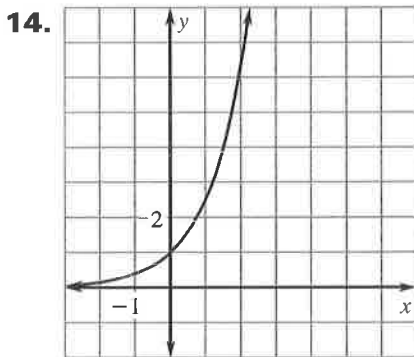
Answers for 8.5 *continued*
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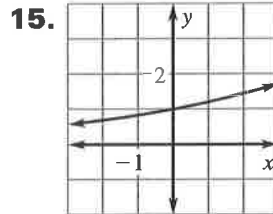
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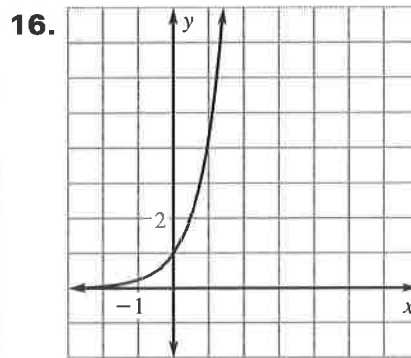
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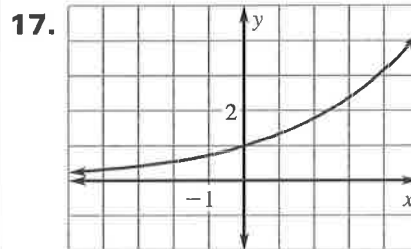
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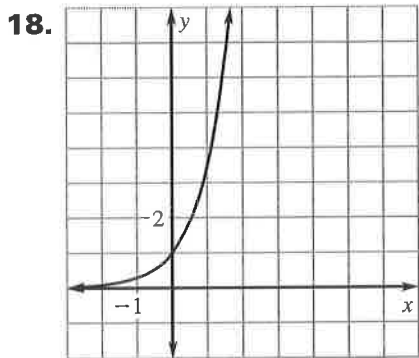


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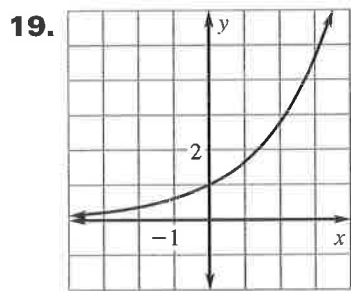


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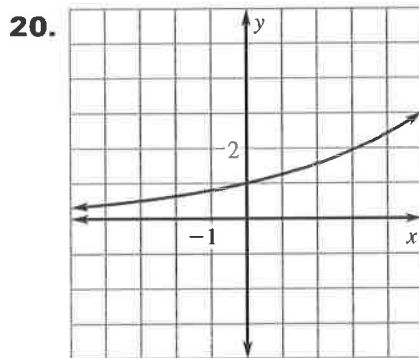
Answers for 8.5 *continued*
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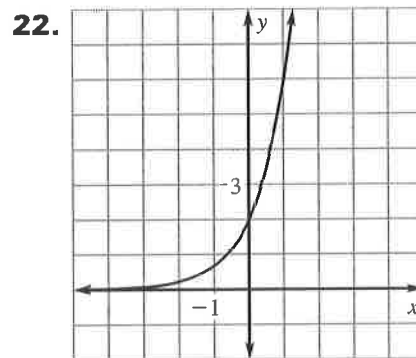


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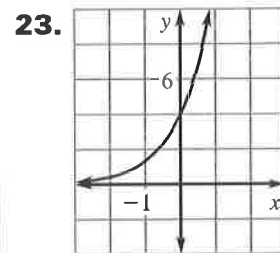


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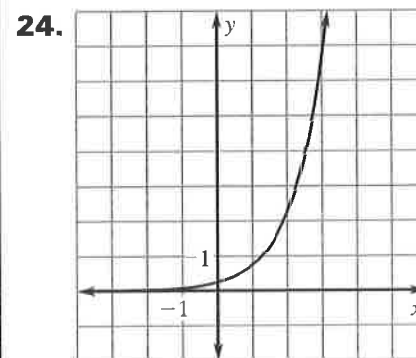
21. The percent increase was not written as a decimal;
 $0.27(1 + 0.02)^3 = 0.27(1.02)^3$
 $= \$29.$



The graph is a vertical stretch.

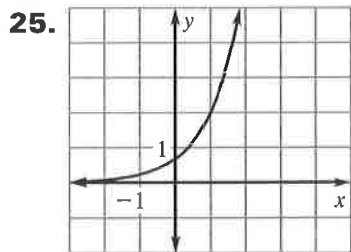


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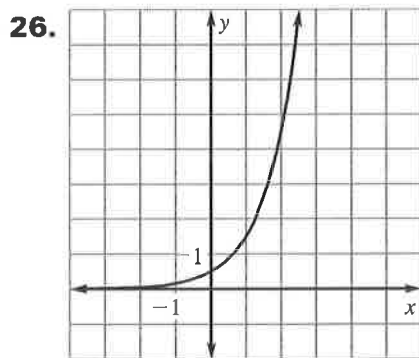


The graph is a vertical shrink.

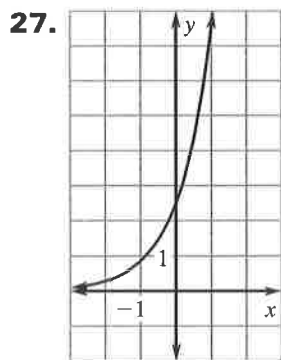
Answers for 8.5 *continued*
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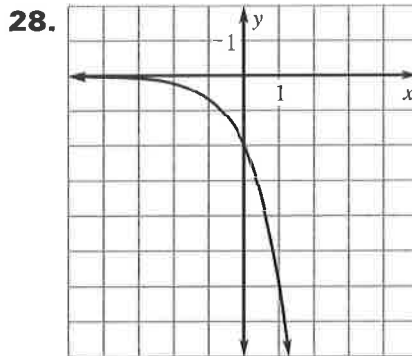
The graph is a vertical shrink.



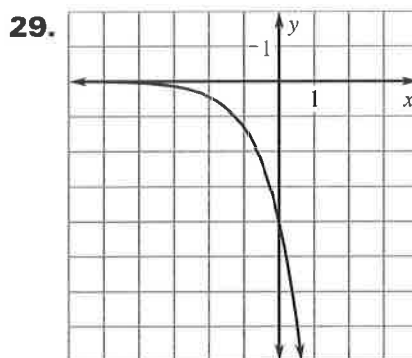
The graph is a vertical shrink.



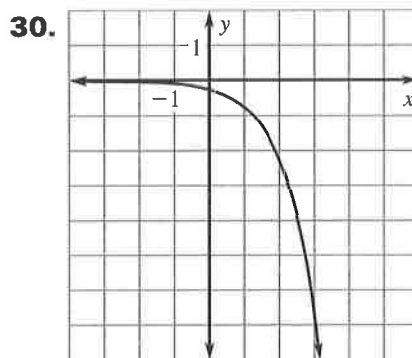
The graph is a vertical stretch.



The graph is a vertical stretch with a reflection in the x -axis.

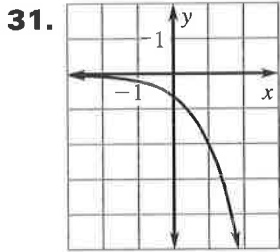


The graph is a vertical stretch with a reflection in the x -axis.

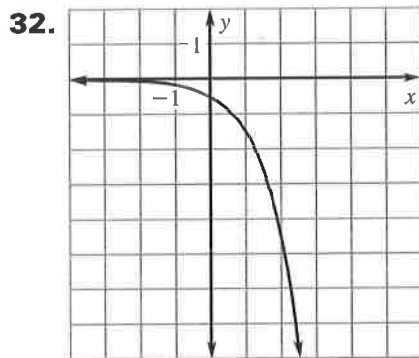


The graph is a vertical shrink with a reflection in the x -axis.

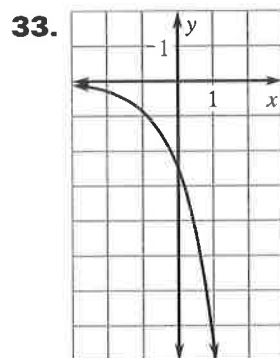
Answers for 8.5 *continued*
For use with pages 523–527



The graph is a vertical shrink with a reflection in the x -axis.



The graph is a vertical shrink with a reflection in the x -axis.



The graph is a vertical stretch with a reflection in the x -axis.

34. C

35. 200%; *Sample answer:* A growth rate of 200% would create a growth factor of $1 + 2 = 3$, which would represent the tripling of the population every year.

36. *Sample answer:* $f(x) = 4x + 2$,
 $f(x) = 2 \cdot 3^x$

37. *Sample answer:* The graphs are the same. Since by the product of a power property $2^x + 2 = 2^x \cdot 2^2$, and $2^x \cdot 2^2$ simplifies to $4 \cdot 2^x$, $2^x + 2 = 4 \cdot 2^x$.

8.5 Problem Solving

38. a. \$131.25 b. \$137.81

c. \$159.54 d. \$331.66

39. a. Let x represent the number of years since 2001 and $f(x)$ represent the number of computers (in hundreds of millions); $f(x) = 6 \cdot (1.1)^x$.

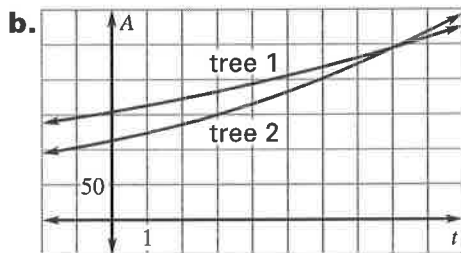
b. about 1,286,153,286 computers

40. a. Let x represent the number of years since 1985 and $f(x)$ represent the number of grills shipped;
 $f(x) = 3,173,000 \cdot (1.07)^x$.

b. about 10,022,921 gas grills

Answers for 8.5 *continued*
For use with pages 523–527

41. a. tree 1: $A = 154 \cdot (1.06)^t$,
tree 2: $A = 113 \cdot (1.1)^t$

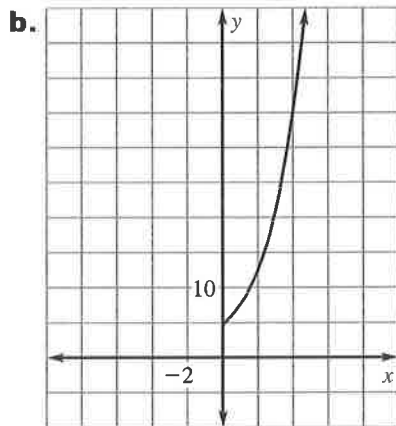


about 8.4 yr

42. Yes. *Sample answer:* The quotient of each pair of adjacent terms is the same, $\frac{7}{4}$.

43. C

44. a. initial amount: 4.67 million,
growth factor: 1.65,
growth rate: 0.65



domain: $0 \leq x \leq 10$
range: 4.67 million $\leq y \leq$ 698.5 million

c. 1994

45. $y = 25.96(1.059)^x$; about 145 Hz

46. a. $y = 834,694.9x + 12,866,020$;
834,694.9 people

b. $y = 12,866,020(1.0268)^x$;
about 2.68%

c. *Sample answer:*

The exponential model is more accurate from 1850–1890.

The exponential model underestimates the actual totals by less than 2 million in 1850 and 1870, while the linear model overestimates by more than 5 million in each year.

47. \$1266.77 48. \$1270.11

49. \$1271.24

50. Daily; in an account compounded daily, each day you earn interest on both the principal and the interest that was accrued on the previous days.

51. 4.6%

8.5 Mixed Review

52. $\frac{1}{9}$ 53. $\frac{1}{64}$ 54. $\frac{1}{64}$

55. $\frac{1}{64}$ 56. $\frac{9}{4}$ 57. $\frac{25}{49}$

58. $\frac{27}{64}$ 59. $\frac{16}{81}$

60. $y = \frac{4}{5}x - 3$ 61. $y = x + 4$