Name _____ Class _____ Date _____

Practice 8-1

Zero and Negative Exponents

Simplify each expression.

1. 16^0
2. 4^{-2}
3. 3^{-3}
4. 8^{-4}
5. $\frac{1}{2^{-5}}$
6. $\frac{4}{4^{-3}}$
7. $\frac{3}{6^{-1}}$
8. $\frac{2^{-1}}{2^{-5}}$
9. $3 \cdot 8^0$
10. $16 \cdot 2^{-2}$
11. 12^{-1}
12. -7^{-2}
13. $16 \cdot 4^0$
14. 9^0
15. $\frac{32^{-1}}{8^{-1}}$
16. $\frac{9}{2^{-1}}$
17. $\frac{8^{-2}}{4^0}$
18. $\frac{9^{-1}}{3^{-2}}$
19. $5(-6)^0$
20. $(3.7)^0$
21. $(-9)^{-2}$
22. $(-4.9)^0$
23. $-6 \cdot 3^{-4}$
24. $\frac{7^{-2}}{4^{-1}}$

Evaluate each expression for $a = -2$ and $b = 6$.

25. b^{-2}
26. a^{-3}
27. $(-a)^{-4}$
28. $-b^{-3}$
29. $4a^{-3}$
30. $2b^{-2}$
31. $(3a)^{-2}$
32. $(-b)^{-2}$
33. $2a^{-1}b^{-2}$
34. $-4a^{-2}b^{-3}$
35. $3^{-2}a^{-2}b^{-1}$
36. $(3ab)^{-2}$

Simplify each expression.

37. x^{-8}
38. xy^{-3}
39. $a^{-5}b$
40. m^2n^{-9}
41. $\frac{1}{x^{-7}}$
42. $\frac{3}{a^{-4}}$
43. $\frac{5}{d^{-3}}$
44. $\frac{6}{r^{-5}s^{-1}}$
45. $3x^{-6}y^{-5}$
46. $8a^{-3}b^2c^{-2}$
47. $15s^{-9}t^{-1}$
48. $-7p^{-5}q^{-3}r^2$
49. $\frac{d^{-4}}{e^{-7}}$
50. $\frac{3m^{-4}}{n^{-8}}$
51. $\frac{6m^{-8}n}{p^{-1}}$
52. $\frac{a^{-2}b^{-1}}{cd^{-3}}$

Write each number as a power of 10 using a negative exponent.

53. $\frac{1}{10{,}000}$
54. $\frac{1}{1{,}000{,}000}$
55. $\frac{1}{10{,}000{,}000}$
56. $\frac{1}{1{,}000{,}000{,}000}$

Write each expression as a decimal.

57. 10^{-5}
58. 10^{-8}
59. $4 \cdot 10^{-1}$
60. $6 \cdot 10^{-4}$

Evaluate each expression for $m = 4$, $n = 5$, and $p = -2$.

61. m^p
62. n^m
63. p^p
64. n^p
65. m^pn
66. m^{-n}
67. p^{-n}
68. mn^p
69. p^{-m}
70. $\frac{m}{n^p}$
71. $\frac{1}{n^{-m}}$
72. $-n^{-m}$

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Practice 8-2

Scientific Notation

Write each number in standard notation.

1. 7×10^4
2. 3×10^{-2}
3. 2.6×10^5
4. 7.1×10^{-4}
5. 5.71×10^{-5}
6. 4.155×10^7
7. 3.0107×10^2
8. 9.407×10^{-5}
9. 31.3×10^6
10. 83.7×10^{-4}
11. 0.018×10^{-1}
12. 0.016×10^5
13. 8.0023×10^{-3}
14. 6.902×10^8
15. 1005×10^2
16. 0.095×10^{-1}

Write each number in scientific notation.

17. 51,000,000
18. 975,000,000,000
19. 0.00000012
20. 0.000005008
21. 1560 billion
22. 0.5 million
23. 2 thousandths
24. 1095 millionths
25. 194×10^3
26. 154×10^{-3}
27. 0.05×10^6
28. 0.031×10^{-4}
29. 790 thousand
30. 25 hundredths
31. 0.000000000159
32. 5,000,900,000,000

Order the numbers in each list from least to greatest.

33. $7 \times 10^{-7}, 6 \times 10^{-8}, 5 \times 10^{-6}, 4 \times 10^{-10}$
34. $5.01 \times 10^{-4}, 4.8 \times 10^{-3}, 5.2 \times 10^{-2}, 5.6 \times 10^{-2}$
35. $62{,}040, 6.2 \times 10^2, 6.207 \times 10^3, 6.34 \times 10^{-1}$
36. $10^{-3}, 5 \times 10^{-3}, 8 \times 10^{-2}, 4 \times 10^{-1}$

Simplify. Write each answer using scientific notation.

37. $4(3 \times 10^5)$
38. $5(7 \times 10^{-2})$
39. $8(9 \times 10^9)$
40. $7(9 \times 10^6)$
41. $3(1.2 \times 10^{-4})$
42. $2(6.1 \times 10^{-8})$
43. $3(1.2 \times 10^{-4})$
44. $3(4.3 \times 10^{-4})$
45. $3(3.2 \times 10^{-2})$

Complete the table.

	Units of Area in Square Feet		
	Unit	**Standard Form**	**Scientific Notation**
46.	1 in.^{2} =		6.9444×10^{-3}
47.	1 link^2 =	0.4356	
48.	1 rod^2 =	272.25	
49.	1 mi^2 =		2.78×10^7
50.	1 cm^2 =	0.001076	
51.	1 hectare =		1.08×10^7

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Practice 8-3

Multiplication Properties of Exponents

Simplify each expression.

1. $(3d^{-4})(5d^8)$
2. $(-8m^4)(4m^8)$
3. $n^{-6} \cdot n^{-9}$
4. $a^3 \cdot a$
5. $3^8 \cdot 3^5$
6. $(3p^{-15})(6p^{11})$
7. $p^7 \cdot q^5 \cdot p^6$
8. $(-1.5a^5b^2)(6a)$
9. $(-2d^3e^3)(6d^4e^6)$
10. $\frac{1}{b^{-7} \cdot b^5}$
11. $p^5 \cdot q^2 \cdot p^4$
12. $\frac{1}{n^7 \cdot n^{-5}}$
13. $(8d^4)(4d^7)$
14. $x^{-9} \cdot x^3 \cdot x^2$
15. $2^3 \cdot 2^2$
16. $r^7 \cdot s^4 \cdot s \cdot r^3$
17. $b^7 \cdot b^{13}$
18. $(7p^4)(5p^9)$
19. $2^8 \cdot 2^{-9} \cdot 2^3$
20. $(6r^4s^3)(9rs^2)$
21. $4^3 \cdot 4^2$
22. $m^{12} \cdot m^{-14}$
23. $s^7 \cdot t^4 \cdot t^8$
24. $(-3xy^6)(3.2x^5y)$
25. $5^{-7} \cdot 5^9$
26. $\frac{1}{h^7 \cdot h^3}$
27. $\frac{1}{t^{-5} \cdot t^{-3}}$
28. $f^5 \cdot f^2 \cdot f^0$
29. $r^6 \cdot r^{-13}$
30. $5^{-6} \cdot 5^4$

Simplify each expression. Write each answer in scientific notation.

31. $(7 \times 10^7)(5 \times 10^{-5})$
32. $(3 \times 10^8)(3 \times 10^4)$
33. $(9.5 \times 10^{-4})(2 \times 10^{-5})$
34. $(4 \times 10^9)(4.1 \times 10^8)$
35. $(7.2 \times 10^{-7})(2 \times 10^{-5})$
36. $(5 \times 10^7)(4 \times 10^3)$
37. $(6 \times 10^{-6})(5.2 \times 10^4)$
38. $(4 \times 10^6)(9 \times 10^8)$
39. $(6.1 \times 10^9)(8 \times 10^{14})$
40. $(2.1 \times 10^{-4})(4 \times 10^{-7})$
41. $(1.6 \times 10^5)(3 \times 10^{11})$
42. $(9 \times 10^{12})(0.3 \times 10^{-18})$
43. $(4 \times 10^9)(11 \times 10^3)$
44. $(5 \times 10^{13})(9 \times 10^{-9})$
45. $(7 \times 10^6)(4 \times 10^9)$
46. $(6 \times 10^{-8})(12 \times 10^{-7})$
47. $(6 \times 10^{15})(3.2 \times 10^2)$
48. $(5 \times 10^8)(2.6 \times 10^{-16})$

49. In 1990, the St. Louis metropolitan area had an average of 82×10^{-6} g/m^3 of pollutants in the air. How many grams of pollutants were there in 2×10^3 m^3 of air?

50. Light travels approximately 5.87×10^{12} mi in one year. This distance is called a light-year. Suppose a star is 2×10^4 light-years away. How many miles away is that star?

51. The weight of 1 m^3 of air is approximately 1.3×10^3 g. Suppose that the volume of air inside of a building is 3×10^6 m^3. How much does the air inside the building weigh?

52. Light travels 1.18×10^{10} in. in 1 second. How far will light travel in 1 nanosecond or 1×10^{-9} s?

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Practice 8-4

More Multiplication Properties of Exponents

Simplify each expression.

1. $(4a^5)^3$
2. $(2^{-3})^4$
3. $(m^{-3}n^4)^{-4}$
4. $(x^5)^2$
5. $2^5 \cdot (2^4)^2$
6. $(4x^4)^3(2xy^3)^2$
7. $x^4 \cdot (x^4)^3$
8. $(x^5y^3)^3(xy^5)^2$
9. $(5^2)^2$
10. $(a^4)^{-5} \cdot a^{13}$
11. $(3f^4g^{-3})^3(f^2g^{-2})^{-1}$
12. $x^3 \cdot (x^3)^5$
13. $(d^2)^{-4}$
14. $(a^3b^4)^{-2}(a^{-3}b^{-5})^{-4}$
15. $(x^2y)^4$
16. $(12b^{-2})^2$
17. $(m^{-5})^{-3}$
18. $(x^{-4})^5(x^3y^2)^5$
19. $(y^6)^{-3} \cdot y^{21}$
20. $n^6 \cdot (n^{-2})^5$
21. $(m^5)^{-3}(m^4n^5)^4$
22. $(a^3)^6$
23. $b^{-9} \cdot (b^2)^4$
24. $(4^{-1}s^3)^{-2}$
25. $(5a^3b^5)^4$
26. $(b^{-3})^6$
27. $(y^6)^3$
28. $a^{-4} \cdot (a^4b^3)^2$
29. $(x^4y)^3$
30. $d^3 \cdot (d^2)^5$

Simplify. Write each answer in scientific notation.

31. $10^{-9} \cdot (2 \times 10^2)^2$
32. $(3 \times 10^{-6})^3$
33. $10^4 \cdot (4 \times 10^6)^3$
34. $(9 \times 10^7)^2$
35. $10^{-3} \cdot (2 \times 10^3)^5$
36. $(7 \times 10^5)^3$
37. $(5 \times 10^5)^4$
38. $(2 \times 10^{-3})^3$
39. $(5 \times 10^2)^{-3}$
40. $(3 \times 10^5)^4$
41. $(4 \times 10^8)^{-3}$
42. $(1 \times 10^{-5})^{-5}$
43. $10^5 \cdot (8 \times 10^7)^3$
44. $(10^2)^3(6 \times 10^{-3})^3$
45. $10^7 \cdot (2 \times 10^2)^4$

46. The kinetic energy, in joules, of a moving object is found by using the formula $E = \frac{1}{2}mv^2$, where m is the mass and v is the speed of the object. The mass of a car is 1.59×10^3 kg. The car is traveling at 2.7×10^1 m/s. What is the kinetic energy of the car?

47. The moon is shaped somewhat like a sphere. The surface area of the moon is found by using the formula $S = 12.56r^2$. What is the surface area of the moon if the radius is 1.08×10^3 mi?

48. Because of a record corn harvest, excess corn is stored on the ground in a pile. The pile is shaped like a cone. The height of the pile is 25 ft, and the radius of the pile is 1.2×10^2 ft. Use the formula $V = \frac{1}{3}\pi r^2 h$ to find the volume.

49. Suppose the distance in feet that an object travels in t seconds is given by the formula $d = 64t^2$. How far would the object travel after 1.5×10^3 seconds?

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Practice 8-5

Division Properties of Exponents

Simplify each expression.

1. $\frac{c^{15}}{c^9}$
2. $\left(\frac{x^3y^{-2}}{z^{-5}}\right)^{-4}$
3. $\frac{x^7y^9z^3}{x^4y^7z^8}$
4. $\left(\frac{a^2}{b^3}\right)^5$
5. $\frac{3^7}{3^4}$
6. $\left(\frac{a^3}{b^2}\right)^4$
7. $\left(\frac{2}{3}\right)^{-2}$
8. $\left(\frac{p^{-3}q^{-2}}{q^{-3}r^5}\right)^4$
9. $\frac{a^6b^{-5}}{a^{-2}b^7}$
10. $\frac{7^{-4}}{7^{-7}}$
11. $\frac{a^7b^6}{a^5b}$
12. $\left(\frac{a^2b^{-4}}{b^2}\right)^5$
13. $\left(-\frac{3}{2^3}\right)^{-2}$
14. $\frac{z^7}{z^{-3}}$
15. $\left(\frac{5a^0b^4}{c^{-3}}\right)^2$
16. $\frac{x^4y^{-8}z^{-2}}{x^{-1}y^6z^{-10}}$
17. $\frac{m^6}{m^{10}}$
18. $\left(\frac{2^3m^4n^{-1}}{p^2}\right)^0$
19. $\left(\frac{s^{-4}}{t^{-1}}\right)^{-2}$
20. $\left(\frac{2a^3b^{-2}}{c^3}\right)^5$
21. $\left(\frac{x^{-3}y}{xz^{-4}}\right)^{-2}$
22. $\frac{h^{-13}}{h^{-8}}$
23. $\frac{4^6}{4^8}$
24. $\left(\frac{1}{3}\right)^3$
25. $\frac{x^5y^3}{x^2y^9}$
26. $\left(\frac{m^{-3}n^4}{n^{-2}}\right)^4$
27. $\frac{4^{-1}}{4^2}$
28. $\left(\frac{a^8b^6}{a^{11}}\right)^5$
29. $\frac{n^9}{n^{15}}$
30. $\left(\frac{r^3s^{-1}}{r^2s^6}\right)^{-1}$
31. $\frac{n^{-8}}{n^4}$
32. $\frac{m^8n^3}{m^{10}n^5}$

Simplify each quotient. Write each answer in scientific notation.

33. $\frac{3.54 \times 10^{-9}}{6.15 \times 10^{-5}}$
34. $\frac{9.35 \times 10^{-3}}{3.71 \times 10^{-5}}$
35. $\frac{495 \text{ billion}}{23.9 \text{ million}}$
36. $\frac{8 \times 10^9}{4 \times 10^5}$
37. $\frac{9.5 \times 10^9}{5 \times 10^{12}}$
38. $\frac{6.4 \times 10^9}{8 \times 10^7}$
39. $\frac{298 \text{ billion}}{49 \text{ million}}$
40. $\frac{1.8 \times 10^{-8}}{0.9 \times 10^3}$
41. $\frac{3.6 \times 10^6}{9 \times 10^{-3}}$
42. $\frac{8.19 \times 10^7}{4.76 \times 10^{-2}}$
43. $\frac{65 \text{ million}}{19.5 \text{ billion}}$
44. $\frac{4.9 \times 10^{12}}{7 \times 10^3}$
45. $\frac{36.2 \text{ trillion}}{98.5 \text{ billion}}$
46. $\frac{3.9 \times 10^3}{1.3 \times 10^8}$
47. $\frac{5.6 \times 10^{-5}}{8 \times 10^{-7}}$
48. $\frac{40 \text{ million}}{985 \text{ million}}$

49. The half-life of uranium-238 is 4.5×10^9 years. The half-life of uranium-234 is 2.5×10^5 years. How many times greater is the half-life of uranium-238 than that of uranium-234.

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Practice 8-6

Geometric Sequences

Find the next three terms of each sequence.

1. $4, 12, 36, 108, \ldots$
2. $2, -8, 32, -128, \ldots$
3. $18, 9, \frac{9}{2}, \frac{9}{4}, \ldots$
4. $1, -\frac{1}{3}, \frac{1}{9}, -\frac{1}{27}, \ldots$
5. $-2, 20, -200, 2000, \ldots$
6. $30, -10, \frac{10}{3}, -\frac{10}{9}, \ldots$
7. $\frac{1}{3}, 1\frac{1}{3}, 5\frac{1}{3}, 21\frac{1}{3}, \ldots$
8. $20, 4, \frac{4}{5}, \frac{4}{25}, \ldots$
9. $-100, -40, -16, -6.4, \ldots$
10. $40, 20, 10, 5, \ldots$

Determine whether each sequence is arithmetic or geometric.

11. $-8, -10, -12.5, -15.625, \ldots$
12. $5, 1, -3, -7, \ldots$
13. $1, \frac{2}{5}, \frac{4}{25}, \frac{8}{125}, \ldots$
14. $-0.2, -0.02, -0.002, -0.0002, \ldots$
15. $-10, -5, 0, 5, \ldots$
16. $6, -3, \frac{3}{2}, -\frac{3}{4}, \ldots$

Write a rule for each sequence.

17. $4, 12, 36, 108, \ldots$
18. $2, -8, 32, -128, \ldots$
19. $18, 9, \frac{9}{2}, \frac{9}{4}, \ldots$
20. $1, -\frac{1}{3}, \frac{1}{9}, -\frac{1}{27}, \ldots$
21. $-2, 20, -200, 2000, \ldots$
22. $30, -10, \frac{10}{3}, -\frac{10}{9}, \ldots$
23. $1, 4, 16, 64, \ldots$
24. $6, 12, 24, 48, \ldots$
25. $125, 25, 5, 1, \ldots$
26. $50, 25, 12.5, 6.25, \ldots$

Find the first, fourth, and eighth terms of each sequence.

27. $A(n) = 2 \cdot 3^{n-1}$
28. $A(n) = 3 \cdot 4^{n-1}$
29. $A(n) = 3 \cdot 2^{n-1}$
30. $A(n) = -1 \cdot 5^{n-1}$
31. $A(n) = 4 \cdot 2^{n-1}$
32. $A(n) = \frac{1}{2} \cdot 2^{n-1}$
33. $A(n) = 0.1 \cdot 4^{n-1}$
34. $A(n) = -2.1 \cdot 3^{n-1}$
35. $A(n) = 10 \cdot 5^{n-1}$

Write a rule and find the given term in each geometric sequence described below.

36. What is the sixth term when the first term is 4 and the common ratio is 3?
37. What is the fifth term when the first term is -2 and the common ratio is $-\frac{1}{2}$?
38. What is the tenth term when the first term is 3 and the common ratio is -1.2?
39. What is the fourth term when the first term is 5 and the common ratio is 6?
40. Suppose a manufacturer invented a computer chip in 1978 that had a computational speed of s. The company improves its chips so that every 3 years, the chip doubles in speed. What would the chip's speed have been for the year 2002? Write your solution in terms of s.

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Practice 8-7

Exponential Functions

Complete the table for each exercise.

1. Investment increases by 1.5 times every 5 yr.

Time	Value of Investment
Initial	\$800
5 yr	\$1200
10 yr	\$1800
15 yr	\$2700
20 yr	
25 yr	

2. The number of animals doubles every 3 mo.

Time	Number of Animals
Initial	18
3 mo	36
6 mo	72
9 mo	
12 mo	

3. The amount of matter halves every year.

Time	Amount of Matter
Initial	3200 g
1 yr	1600 g
2 yr	800 g
3 yr	

Evaluate each function for the domain {–2, 0, 1, 2, 4}.

4. $y = 2^x$
5. $y = 3.1^x$
6. $y = 0.8^x$
7. $y = 2 \cdot 4^x$
8. $y = 10 \cdot 3^x$
9. $y = 25 \cdot 5^x$
10. $y = \left(\frac{2}{3}\right)^x$
11. $y = 100 \cdot \left(\frac{1}{10}\right)^x$
12. $y = \frac{1}{4} \cdot 8^x$

Graph each function.

13. $y = 3^x$
14. $y = 6^x$
15. $y = 1.5^x$
16. $y = 7^x$
17. $y = 10 \cdot 5^x$
18. $y = 16 \cdot 0.5^x$
19. $y = \frac{1}{8} \cdot 2^x$
20. $y = \frac{1}{2} \cdot 4^x$
21. $y = 8 \cdot \left(\frac{5}{2}\right)^x$

Evaluate each function rule for the given values.

22. $y = 5.5^x$ for $x = 1, 3,$ and 4
23. $y = 4 \cdot 1.5^x$ for $x = 2, 4,$ and 5
24. $y = 3 \cdot 4^x$ for $x = 1, 3,$ and 5
25. $y = 6^x$ for $x = 2, 3,$ and 4
26. $y = 0.7^x$ for $x = 1, 3,$ and 4
27. $y = 3.1^x$ for $x = 1, 2,$ and 3
28. $y = 180 \cdot 0.5^x$ for $x = 0, -2,$ and $-\frac{1}{2}$
29. $y = 4.3^x$ for $x = -2, -1,$ and 0
30. $y = 100 \cdot 0.1^x$ for $x = -4, -1,$ and 2
31. $y = 5^x$ for $x = -2, -3,$ and 4

Solve each equation.

32. $5^x = 625$
33. $2 \cdot 4^x = 128$
34. $4^x = \frac{1}{64}$
35. $4 \cdot 5^x = \frac{4}{125}$

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Practice 8-8

Exponential Growth and Decay

Write an exponential function to model each situation. Find each amount after the specified time.

1. Suppose one of your ancestors invested $500 in 1800 in an account paying 4% interest compounded annually. Find the account balance in each of the following years.

   a. 1850 b. 1900 c. 2000 d. 2100

2. Suppose you invest $1500 in an account paying 4.75% annual interest. Find the account balance after 25 yr with the interest compounded the following ways.

   a. annually b. semiannually c. quarterly d. monthly

3. The starting salary for a new employee is $25,000. The salary for this employee increases by 8% per year. What is the salary after each of the following?

   a. 1 yr b. 3 yr c. 5 yr d. 15 yr

4. Carbon-14 has a half-life of 5,700 years. Scientists use this fact to determine the age of things made of organic material. Suppose the average page of a book containing approximately 0.5 mg of carbon-14 is put into a time capsule. How much carbon-14 will each page contain after each of the following numbers of years?

   a. 5700 b. 11,400 c. 22,800 d. 34,200

5. The tax revenue that a small city receives increases by 3.5% per year. In 1990, the city received $250,000 in tax revenue. Determine the tax revenue in each of the following years.

   a. 1995 b. 1998 c. 2000 d. 2006

6. Suppose the acreage of forest is decreasing by 2% per year because of development. If there are currently 4,500,000 acres of forest, determine the amount of forest land after each of the following.

   a. 3 yr b. 5 yr c. 10 yr d. 20 yr

7. A $10,500 investment has a 15% loss each year. Determine the value of the investment after each of the following.

   a. 1 yr b. 2 yr c. 4 yr d. 10 yr

8. A city of 2,950,000 people has a 2.5% annual decrease in population. Determine the city's population after each of the following.

   a. 1 yr b. 5 yr c. 15 yr d. 25 yr

9. A $25,000 purchase decreases 12% in value per year. Determine the value of the purchase after each of the following.

   a. 1 yr b. 3 yr c. 5 yr d. 7 yr

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Reteaching 8-1

Zero and Negative Exponents

OBJECTIVE: Evaluating and simplifying expressions in which zero and negative numbers are used as exponents

MATERIALS: None

- When a nonzero number a has a zero exponent, then $a^0 = 1$.
- For any nonzero number a and any integer n, $a^{-n} = \frac{1}{a^n}$.

Example

Write each expression as an integer or a simple fraction.

a. 2.7^0

1 ← **Rewrite, using the property of zero as an exponent.**

b. 5^{-2}

$\frac{1}{5^2}$ ← **Rewrite as a fraction, using the property of negative exponents.**

$\frac{1}{25}$ ← **Simplify.**

Exercises

Write each expression as an integer, a simple fraction, or an expression that contains only positive exponents. Simplify.

1. 10^{-3} **2.** 1.67^0 **3.** 5^{-4}

4. 7^{-3} **5.** $\left(-\frac{3}{2}\right)^{-2}$ **6.** $(5x)^{-4}$

7. 4^{-1} **8.** 376.5^0 **9.** b^{-5}

Write each expression so that it contains only positive exponents.

10. $\left(\frac{2}{7}\right)^{-4}$ **11.** $3ab^0$ **12.** -4^{-3}

13. $a^{-3}b^{-4}$ **14.** $\frac{3x^{-2}}{y}$ **15.** $12xy^{-3}$

16. $\frac{8}{4^{-2}}$ **17.** $\frac{(3x)^{-1}}{4}$ **18.** $\frac{(2x)^{-2}}{3y^{-1}}$

19. $\frac{(4x)^{-2}}{2^{-3}}$ **20.** $\frac{(3a)^2b^{-3}}{b^{-2}}$ **21.** $\frac{4^0 5^3}{2^{-3}}$

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Reteaching 8-2

Scientific Notation

OBJECTIVE: Writing numbers in scientific notation

MATERIALS: None

To write a number in **scientific notation**, follow these steps:

- Move the decimal to the right of the first integer.
- If the original number is greater than 1, multiply by 10^n, where n represents the number of places the decimal was moved to the left.
- If the original number is less than 1, multiply by 10^{-n}, where n represents the number of places the decimal was moved to the right.

Examples

Write each number in scientific notation.

a. 9,040,000,000 ← **standard form**

9.040 000 000. ← **Move the decimal to the left nine places.**

9.04×10^9 ← **Drop all insignificant 0's. Multiply by the appropriate power of 10.**

b. 0.000 000 8 ← **standard form**

0.000 000 8. ← **Move the decimal to the right seven places.**

8.0×10^{-7} ← **Multiply by the appropriate power of 10.**

Exercises

Write each number in scientific notation.

1. 420,000
2. 5,100,000,000
3. 260 billion
4. 830 million
5. 0.00075
6. 0.004005

Write each number in standard notation.

7. 6.345×10^8
8. 3.2×10^{-5}
9. 4.081×10^6
10. 2.581×10^{-3}
11. 3.07×10^{-2}
12. 1.526×10^6
13. 8.04×10^{-4}
14. 7.625×10^5
15. 6.825×10^4
16. 3.081×10^{-5}
17. 8.3847×10^2
18. 3.6245×10^{-2}

Name _____ Class _____ Date _____

Reteaching 8-3

Multiplication Properties of Exponents

OBJECTIVE: Multiplying powers with the same base

MATERIALS: None

- A power is an expression in the form a^n.
- To multiply powers with the same base, add the exponents
  $a^m \cdot a^n = a^{m+n}$

Example

Simplify $4^6 \cdot 4^3$.

$4^6 \cdot 4^3$

$= 4^{6+3}$ ← **Rewrite as one base with the exponents added.**

$= 4^9$ ← **Add the exponents.**

So $4^6 \cdot 4^3 = 4^9$.

Exercises

Complete each equation.

1. $8^2 \cdot 8^3 = 8^{\square}$
2. $2^{\square} \cdot 2^6 = 2^9$
3. $a^{12} \cdot a^{\square} = a^{15}$
4. $x^{\square} \cdot x^5 = x^6$
5. $b^{-4} \cdot b^3 = b^{\square}$
6. $6^4 \cdot 6^{\square} = 6^2$
7. $3^4 \cdot 3^8 = 3^{\square}$
8. $c^{\square} \cdot c^{-7} = c^{11}$
9. $10^{-6} \cdot 10^{-3} = 10^{\square}$

Simplify each expression.

10. $3x^2 \cdot 4x \cdot 2x^3$
11. $m^2 \cdot 3m^4 \cdot 6a \cdot a^{-3}$
12. $p^3q^{-1} \cdot p^2q^{-8}$
13. $5x^2 \cdot 3x \cdot 8x^4$
14. $x^2 \cdot y^5 \cdot 8x^5 \cdot y^{-2}$
15. $7y^2 \cdot 3x^2 \cdot 9$
16. $2y^2 \cdot 3y^2 \cdot 4y^5$
17. $x^4 \cdot x^{-5} \cdot x^4$
18. $x^{12} \cdot x^{-8} \cdot y^{-2} \cdot y^3$
19. $6a^2 \cdot b \cdot 2a^{-1}$
20. $r^6 \cdot s^{-3} \cdot r^{-2} \cdot s$
21. $3p^{-2} \cdot q^3 \cdot p^3 \cdot q^{-2}$

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Reteaching 8-4

More Multiplication Properties of Exponents

OBJECTIVE: Using two more multiplication properties of exponents

MATERIALS: None

- To raise a power to a power, multiply the exponents.
- Every number and variable inside parentheses is being raised to the power to the right of the parentheses.

Example

Simplify $(4x^3)^2$.

$(4x^3)^2$

$(4^1x^3)^2$ ← **Rewrite each number and variable with an exponent.**

$(4^1x^3)^2$ ← **Draw arrows from the exponent outside the parentheses to each exponent inside the parentheses.**

$4^{2 \cdot 1}x^{2 \cdot 3}$ ← **Rewrite, showing the exponents to be multiplied.**

4^2x^6 ← **Multiply the exponents.**

$16x^6$ ← **Simplify.**

Exercises

Draw arrows from the exponent outside the parentheses to each exponent inside the parentheses. Then simplify each expression.

1. $(5^2)^4$
2. $(a^5)^4$
3. $(2^3)^2$
4. $(4x)^3$
5. $(7a^4)^2$
6. $(3g^2)^3$
7. $(g^2h^3)^5$
8. $(s^6)^2$

Simplify each expression.

9. $(x^2y^4)^3$
10. $(3r^5)^0$
11. $g^9 \cdot g^{-7}$
12. $(c^4)^7$
13. $(3.2)^5 \cdot (3.2)^{-5}$
14. $(8ab^6)^3$
15. $(x^2y^3)^2$
16. $(x^7)^2$
17. $(3x^2y)^2$
18. $(-2x^2)^3$
19. $(x^3y^4)^3$
20. $(3x^2y)^3$
21. $(-4x^2y^3)^3$
22. $(xyz)^0$
23. $x^5 \cdot x^{-7}$

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Reteaching 8-5

Division Properties of Exponents

OBJECTIVE: Applying division properties of exponents

MATERIALS: None

To divide powers with the same base, subtract exponents.

Example

Simplify $\frac{4^3}{4^5}$.

Method 1

$\frac{4 \cdot 4 \cdot 4}{4 \cdot 4 \cdot 4 \cdot 4 \cdot 4}$ ← **Expand the numerator and the denominator.**

$\frac{\cancel{4} \cdot \cancel{4} \cdot \cancel{4}}{\cancel{4} \cdot \cancel{4} \cdot \cancel{4} \cdot 4 \cdot 4}$ ← **Draw lines through terms that are in both the numerator and the denominator.**

$\frac{1}{4 \cdot 4}$ ← **Cancel.**

$\frac{1}{4^2}$ or 4^{-2} ← **Rewrite with exponents.**

Method 2

$3 - 5 = -2$ ← **Subtract the exponents from the original equation. Compare this to the exponent in the first answer.**

So $\frac{4^3}{4^5} = 4^{3-5} = 4^{-2}$. ← **Subtract the exponents from the original equation. Compare this to the exponent in the first answer.**

$\frac{1}{4^2}$ ← **Write with positive exponents.**

To raise a quotient to a power use repeated multiplication.

Exercises

Use both methods shown in the example to simplify each expression. Use only positive exponents.

1. $\frac{z^6}{z^3}$
2. $\left(\frac{3^2}{4}\right)^3$
3. $\frac{m^{-3}}{m^{-4}}$
4. $\frac{5^3}{5^4}$
5. $\left(\frac{b^7}{b^5}\right)^3$
6. $\frac{5a^5}{15a^2}$
7. $\frac{2^2}{2^5}$
8. $\frac{d^8}{d^3}$
9. $\frac{x^7}{x^5}$
10. $\left(\frac{10^8}{10^2}\right)^3$
11. $\frac{14x^{11}}{7x^{10}}$
12. $\frac{8x^9}{12x^6}$
13. $\frac{x^{12}}{x^5}$
14. $\frac{6x^4}{4x^2}$
15. $\frac{x^3}{x^8}$
16. $\left(\frac{x^5}{x^3}\right)^4$

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Reteaching 8-6

Geometric Sequences

OBJECTIVE: Finding the next terms of a geometric sequence

MATERIALS: None

- Multiplying a term in the sequence by a fixed number to find the next term forms a geometric sequence.
- The fixed number is called the common ratio.

Example

Find the next three terms of the sequence $3, -9, 27, -81, \ldots$

$3, -9, 27, -81, \ldots$

$-\frac{9}{3} = -3$

The common ratio is -3.

Note that each term in the given sequence is -3 times the previous term.

Let $A(n)$ = the value of the nth term in the sequence.

$A(5) = -3 \cdot -81 = 243$ ← **the common ratio times the fourth term**

$A(6) = -3 \cdot 243 = -729$ ← **the common ratio times the fifth term**

$A(7) = -3 \cdot -729 = 2187$ ← **the common ratio times the sixth term**

The next three terms in the sequence are $243, -729, 2187$.

Exercises

Find the next three terms in each of the following sequences.

1. $2, 8, 32, 128, \ldots$
2. $-3, 6, -12, 24, \ldots$
3. $1, -1, 1, -1, \ldots$
4. $12, 6, 3, \frac{3}{2}, \ldots$
5. $20, -10, 5, -\frac{5}{2}, \ldots$
6. $100, 10, 1, 0.1, \ldots$
7. $3, 15, 75, 375, \ldots$
8. $-8, -12, -18, -27, \ldots$
9. $1.5, 4.5, 13.5, 40.5, \ldots$
10. $8, -\frac{8}{3}, \frac{8}{9}, -\frac{8}{27}, \ldots$
11. $7, -14, 28, -56, \ldots$
12. $100, 50, 25, 12.5, \ldots$
13. $8, 32, 128, 512, \ldots$
14. $76, -38, 19, -9.5, \ldots$

Name _____ Class _____ Date _____

Reteaching 8-7

Exponential Functions

OBJECTIVE: Examining patterns in exponential functions

MATERIALS: None

To express exponential changes as a function of a variable, follow these steps:

Step 1 Make a table of the data.

Step 2 Find the pattern.

Step 3 Write an equation with exponents.

Example

You have ten CDs. That number doubles every year. How many CDs will you have at the end of 5 yr?

Step 1 Make a table.

Time	No. of CDs
0	10
1 yr	$10 \cdot 2$
2 yr	$10 \cdot 2 \cdot 2$
3 yr	$10 \cdot 2 \cdot 2 \cdot 2$

Step 2 Find the pattern.

$10 \cdot 2 \longrightarrow$ After 1 yr

$10 \cdot 2^2 \longrightarrow$ After 2 yr

$10 \cdot 2^3 \longrightarrow$ After 3 yr

$10 \cdot 2^n \longrightarrow$ After n yr

Step 3 Write an equation with exponents and solve.

$y = 10 \cdot 2^n \longleftarrow$ **Write the equation.**

$y = 10 \cdot 2^5 \longleftarrow$ **Substitute 5 for n.**

$y = 320 \longleftarrow$ **Use a calculator.**

You will have 320 CDs at the end of 5 yr.

Exercises

Follow the above steps to write and evaluate the function.

1. Your science class is collecting cans. You start with 150 cans. Your collection triples every week. How many cans will you have collected after 7 wk?

2. A population of 2500 triples in size every 10 yr. What will the population be in 30 yr?

3. Your parents invested $2000 in a college fund for you when you were 4 yr old. It has doubled in value every 4 yr. If you are now 16, how much is in your college fund?

4. A bacteria culture doubles in size every 8 h. The culture starts with 150 cells. How many will there be after 24 h? After 72 h?

Name _____ Class _____ Date _____

Reteaching 8-8

Exponential Growth and Decay

OBJECTIVE: Modeling exponential growth and decay

MATERIALS: None

To write an exponential function to find growth, follow these steps.

Step 1 Find the initial amount a.

Step 2 Multiply by the growth factor b, which occurs over x time periods. Remember that if your growth factor b is $0 < b < 1$, then b is your decay factor, and the function expresses negative growth, that is, a decay function.

Step 3 After the x time periods, the new amount will be $a \times b^x$.

The function is written $y = a \cdot b^x$.

Example

The cost of a car is $10,000. Suppose the price increases 5% each year. What will the cost be at the end of 10 yr? What if the price decreases 7% each year? Use the table below to find the amounts.

a (initial amount)	b (growth factor)	x (number of increases)	y (new amount)
10,000	$100\% + 5\% = 105\%$ $= 1.05$	10	$10{,}000 \cdot 1.05^{10} = y$
10,000	$100\% - 7\% = 93\%$ $= 0.93$	10	$10{,}000 \cdot 0.93^{10} = y$

The cost at the end of 10 yr with a growth factor of 5% will be $16,289; with a decay factor of 7%, it will be $4839.82.

Exercises

Write an exponential function to model each situation. Find each amount at the end of the specified time. Round your answers to the nearest whole number.

1. A town with a population of 5,000 grows 3% per year. Find the population at the end of 10 yr.

2. The price of a bicycle is $100. It increases 8% per year. What will the price be at the end of 5 yr?

3. A 2 ft-tall tree grows 10% per year. How tall will the tree be at the end of 8 yr?

4. $1,000 purchase
   10% loss in value each year
   5 yr

5. $5,000 investment
   13.5% loss each year
   8 yr

6. 20,000 population
   12.5% annual decrease
   10 yr

Name _____ Class _____ Date _____

Enrichment 8-1

Operations Involving Exponents

Solve the problems at the top of the page. Locate the answer at the bottom of the page and place the corresponding letter in the appropriate blank to spell out the name of a famous mathematician. Not all answers will be used. This mathematician is the person considered to be the inventor of logarithms. The mathematician published a table of logarithms in the early 1600s. Logarithms are useful in solving exponential functions.

1	2	3	4	5	6	7	8	9	10
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Problems

1. $3 \cdot 2^{-2}$

2. xy^{-4}

3. $(2ab)^{-3}$

4. $(-b)^{-4}$

5. $(b^{-2})^2$

6. $5 \cdot 10^{-2}$

7. $\frac{3m^{-2}}{n^{-4}}$

8. $6^0 \cdot 9^{-1}$

9. $-6 \cdot 2^{-4}$

10. $-\frac{a^{-5}}{b^5}$

Answers

A. $\frac{1}{20}$

B. $\frac{1}{xy^4}$

C. -9

D. 0

E. $-\frac{3}{8}$

F. $\frac{3m}{n^2}$

G. $-\frac{1}{ab}$

H. $\frac{1}{8a^3b^3}$

I. $\frac{1}{9}$

J. $\frac{3}{4}$

K. $\frac{1}{6ab^3}$

L. $-\frac{a}{b}$

M. $\frac{1}{36}$

N. $\frac{1}{b^4}$

O. $\frac{x}{y^4}$

P. $\frac{3n^4}{m^2}$

Q. -15

R. $-\frac{1}{a^5b^5}$

S. -20736

T. b^4

U. $-\frac{3}{4}$

V. $\frac{n^4}{3m^2}$

W. -54

X. $\frac{3}{8}$

Y. -15000

Z. $-\frac{1}{b^4}$

Chapter 8 Answers

Practice 8-1

1. 1 **2.** $\frac{1}{16}$ **3.** $\frac{1}{27}$ **4.** $\frac{1}{4096}$ **5.** 32 **6.** 256 **7.** 18 **8.** 16
9. 3 **10.** 4 **11.** $\frac{1}{12}$ **12.** $-\frac{1}{49}$ **13.** 16 **14.** 1 **15.** $\frac{1}{4}$
16. 18 **17.** $\frac{1}{64}$ **18.** 1 **19.** 5 **20.** 1 **21.** $\frac{1}{81}$ **22.** 1
23. $-\frac{2}{27}$ **24.** $\frac{4}{49}$ **25.** $\frac{1}{36}$ **26.** $-\frac{1}{8}$ **27.** $\frac{1}{16}$ **28.** $-\frac{1}{216}$
29. $-\frac{1}{2}$ **30.** $\frac{1}{18}$ **31.** $\frac{1}{36}$ **32.** $\frac{1}{36}$ **33.** $-\frac{1}{36}$ **34.** $-\frac{1}{216}$
35. $\frac{1}{216}$ **36.** $\frac{1}{1296}$ **37.** $\frac{1}{x^8}$ **38.** $\frac{x}{y^3}$ **39.** $\frac{b}{a^5}$ **40.** $\frac{m^2}{n^9}$
41. x^7 **42.** $3a^4$ **43.** $5d^3$ **44.** $6r^5s$ **45.** $\frac{3}{x^6y^5}$ **46.** $\frac{8b^2}{a^3c^2}$
47. $\frac{15}{s^9t}$ **48.** $-\frac{7r^2}{p^5q^3}$ **49.** $\frac{e^7}{d^4}$ **50.** $\frac{3n^8}{m^4}$ **51.** $\frac{6np}{m^8}$ **52.** $\frac{d^3}{a^2bc}$
53. 10^{-4} **54.** 10^{-6} **55.** 10^{-7} **56.** 10^{-9} **57.** 0.00001
58. 0.00000001 **59.** 0.4 **60.** 0.0006 **61.** $\frac{1}{16}$ **62.** 625
63. $\frac{1}{4}$ **64.** $\frac{1}{25}$ **65.** $\frac{5}{16}$ **66.** $\frac{1}{1024}$ **67.** $-\frac{1}{32}$ **68.** $\frac{4}{25}$
69. $\frac{1}{16}$ **70.** 100 **71.** 625 **72.** $-\frac{1}{625}$

Practice 8-2

1. 70,000 **2.** 0.03 **3.** 260,000 **4.** 0.00071 **5.** 0.0000571
6. 41,550,000 **7.** 301.07 **8.** 0.00009407 **9.** 31,300,000
10. 0.00837 **11.** 0.0018 **12.** 1600 **13.** 0.0080023
14. 690,200,000 **15.** 100,500 **16.** 0.0095 **17.** 5.1×10^7
18. 9.75×10^{11} **19.** 1.2×10^{-7} **20.** 5.008×10^{-6}
21. 1.56×10^{12} **22.** 5×10^5 **23.** 2×10^{-3}
24. 1.095×10^{-3} **25.** 1.94×10^5 **26.** 1.54×10^{-1}
27. 5×10^4 **28.** 3.1×10^{-6} **29.** 7.9×10^5
30. 2.5×10^{-1} **31.** 1.59×10^{-10} **32.** 5.0009×10^{12}
33. $4 \times 10^{-10}, 6 \times 10^{-8}, 7 \times 10^{-7}, 5 \times 10^{-6}$
34. $5.01 \times 10^{-4}, 4.8 \times 10^{-3}, 5.2 \times 10^{-2}, 5.6 \times 10^{-2}$
35. $6.34 \times 10^{-1}, 6.2 \times 10^2, 6.207 \times 10^3$, 62,040
36. $10^{-3}, 5 \times 10^{-3}, 8 \times 10^{-2}, 4 \times 10^{-1}$
37. 1.2×10^6 **38.** 3.5×10^{-1} **39.** 7.2×10^{10}
40. 6.3×10^7 **41.** 3.6×10^{-4} **42.** 1.22×10^{-7}
43. 3.6×10^{-4} **44.** 1.29×10^{-3} **45.** 9.6×10^{-2}
46. .0069444 **47.** 4.356×10^{-1} **48.** 2.7225×10^2
49. 27,878,400 **50.** 1.076×10^{-3} **51.** 10,800,000

Practice 8-3

1. $15d^4$ **2.** $-32m^{12}$ **3.** $\frac{1}{n^{15}}$ **4.** a^4 **5.** 3^{13} **6.** $\frac{18}{p^4}$ **7.** $p^{13}q^5$
8. $-9a^6b^2$ **9.** $-12d^7e^9$ **10.** b^2 **11.** p^9q^2 **12.** $\frac{1}{n^2}$ **13.** $32d^{11}$
14. $\frac{1}{x^4}$ **15.** 2^5 **16.** $r^{10}s^5$ **17.** b^{20} **18.** $35p^{13}$ **19.** 2^2
20. $54r^5s^5$ **21.** 4^5 **22.** $\frac{1}{m^2}$ **23.** s^7t^{12} **24.** $-9.6x^6y^7$
25. 5^2 **26.** $\frac{1}{h^{10}}$ **27.** t^8 **28.** f^5 **29.** $\frac{1}{r^7}$ **30.** $\frac{1}{5^2}$
31. 3.5×10^3 **32.** 9×10^{12} **33.** 1.9×10^{-8}
34. 1.64×10^{18} **35.** 1.44×10^{-11} **36.** 2×10^{11}
37. 3.12×10^{-1} **38.** 3.6×10^{15} **39.** 4.88×10^{24}
40. 8.4×10^{-11} **41.** 4.8×10^{16} **42.** 2.7×10^{-6}
43. 4.4×10^{13} **44.** 4.5×10^5 **45.** 2.8×10^{16}
46. 7.2×10^{-14} **47.** 1.92×10^{18} **48.** 1.3×10^{-7}
49. 1.64×10^{-1} g **50.** 1.174×10^{17} mi **51.** 3.9×10^9 g
52. 1.18×10^1 in.

Practice 8-4

1. $64a^{15}$ **2.** $\frac{1}{2^{12}}$ **3.** $\frac{m^{12}}{n^{16}}$ **4.** x^{10} **5.** 2^{13} **6.** $256x^{14}y^6$
7. x^{16} **8.** $x^{17}y^{19}$ **9.** 5^4 **10.** $\frac{1}{a^7}$ **11.** $\frac{27f^{10}}{g^7}$ **12.** x^{18}
13. $\frac{1}{d^8}$ **14.** a^6b^{12} **15.** x^8y^4 **16.** $\frac{144}{b^4}$ **17.** m^{15} **18.** $\frac{y^{10}}{x^5}$
19. y^3 **20.** $\frac{1}{n^4}$ **21.** mn^{20} **22.** a^{18} **23.** $\frac{1}{b}$ **24.** $\frac{16}{s^6}$
25. $625a^{12}b^{20}$ **26.** $\frac{1}{b^{18}}$ **27.** y^{18} **28.** a^4b^6 **29.** $x^{12}y^3$
30. d^{13} **31.** 4×10^{-5} **32.** 2.7×10^{-17} **33.** 6.4×10^{23}
34. 8.1×10^{15} **35.** 3.2×10^{13} **36.** 3.43×10^{17}
37. 6.25×10^{22} **38.** 8×10^{-9} **39.** 8×10^{-9}
40. 8.1×10^{21} **41.** 1.5625×10^{-26} **42.** 1×10^{25}
43. 5.12×10^{28} **44.** 2.16×10^{-1} **45.** 1.6×10^{16}
46. 5.79555×10^5 J **47.** 1.46×10^7 mi^2
48. 3.8×10^5 ft^3 **49.** 1.44×10^8 ft

Practice 8-5

1. c^6 **2.** $\frac{y^8}{x^{12}z^{20}}$ **3.** $\frac{x^3y^2}{z^5}$ **4.** $\frac{a^{10}}{b^{15}}$ **5.** 27 **6.** $\frac{a^{12}}{b^8}$ **7.** $\frac{9}{4}$
8. $\frac{q^4}{p^{12}r^{20}}$ **9.** $\frac{a^8}{b^{12}}$ **10.** 343 **11.** a^2b^5 **12.** $\frac{a^{10}}{b^{30}}$ **13.** $\frac{64}{9}$
14. z^{10} **15.** $25b^8c^6$ **16.** $\frac{x^5z^8}{y^{14}}$ **17.** $\frac{1}{m^4}$ **18.** 1 **19.** $\frac{s^8}{t^2}$
20. $\frac{32a^{15}}{b^{10}c^{15}}$ **21.** $\frac{x^8}{y^2z^8}$ **22.** $\frac{1}{h^5}$ **23.** $\frac{1}{16}$ **24.** $\frac{1}{27}$ **25.** $\frac{x^3}{y^6}$
26. $\frac{n^{24}}{m^{12}}$ **27.** $\frac{1}{64}$ **28.** $\frac{b^{30}}{a^{15}}$ **29.** $\frac{1}{n^6}$ **30.** $\frac{s^7}{r}$ **31.** $\frac{1}{n^{12}}$
32. $\frac{1}{m^2n^2}$ **33.** 5.76×10^{-5} **34.** 2.52×10^2
35. 2.07×10^4 **36.** 2×10^4 **37.** 1.9×10^{-3}
38. 8×10^1 **39.** 6.08×10^3 **40.** 2×10^{-11}
41. 4×10^8 **42.** 1.72×10^9 **43.** 3.33×10^{-3}
44. 7×10^8 **45.** 3.68×10^2 **46.** 3×10^{-5}
47. 7×10^1 **48.** 4.06×10^{-2} **49.** 1.8×10^4 times longer

Practice 8-6

1. 324, 972, 2916 **2.** 512, −2048, 8192 **3.** $\frac{9}{8}, \frac{9}{16}, \frac{9}{32}$

4. $\frac{1}{81}, -\frac{1}{243}, \frac{1}{729}$ **5.** −20,000, 200,000, −2,000,000

6. $\frac{10}{27}, -\frac{10}{81}, \frac{10}{243}$ **7.** $85\frac{1}{3}, 341\frac{1}{3}, 1365\frac{1}{3}$ **8.** $\frac{4}{125}, \frac{4}{625}, \frac{4}{3125}$

9. −2.56, −1.024, −0.4096 **10.** 2.5, 1.25, 0.625 **11.** geometric

12. arithmetic **13.** geometric **14.** geometric **15.** arithmetic

16. geometric **17.** $A(n) = 4 \cdot 3^{n-1}$

18. $A(n) = 2 \cdot (-4)^{n-1}$ **19.** $A(n) = 18 \cdot \left(\frac{1}{2}\right)^{n-1}$

20. $A(n) = 1 \cdot \left(-\frac{1}{3}\right)^{n-1}$ **21.** $A(n) = -2 \cdot (-10)^{n-1}$

22. $A(n) = 30 \cdot \left(-\frac{1}{3}\right)^{n-1}$ **23.** $A(n) = 4^{n-1}$

24. $A(n) = 6 \cdot 2^{n-1}$ **25.** $A(n) = 125 \cdot \left(\frac{1}{5}\right)^{n-1}$

26. $A(n) = 50\left(\frac{1}{2}\right)^{n-1}$ **27.** 2, 54, 4374

28. 3, 192, 49152 **29.** 3, 24, 384

30. −1, −125, −78, 125 **31.** 4, 32, 512 **32.** $\frac{1}{2}$, 4, 64

33. 0.1, 6.4, 1638.4 **34.** −2.1, −56.7, −4592.7

35. 10, 1250, 781,250 **36.** $A(n) = 4 \cdot 3^{n-1}$; 972

37. $A(n) = -2 \cdot \left(-\frac{1}{2}\right)^{n-1}$; −0.125

38. $A(n) = 3 \cdot (-1.2)^{n-1}$; −15.47934

39. $A(n) = 5 \cdot 6^{n-1}$; 1080 **40.** $s \cdot 2^8 = 256s$

Practice 8-7

1.

Time	Value of Investment
Initial	$800
5 yr	$1200
10 yr	$1800
15 yr	$2700
20 yr	$4050
25 yr	$6075
30 yr	$9112.50
35 yr	$13,668.75

2.

Time	Number of Animals
Initial	18
3 mo	36
6 mo	72
9 mo	144
12 mo	288
15 mo	576
18 mo	1152
21 mo	2304

3.

Time	Amount of Matter
Initial	3200 g
1 yr	1600 g
2 yr	800 g
3 yr	400 g
4 yr	200 g
5 yr	100 g
6 yr	50 g
7 yr	25 g

4. 0.25, 1, 2, 4, 16 **5.** $\frac{100}{961}$, 1, 3.1, 9.61, 92.3521

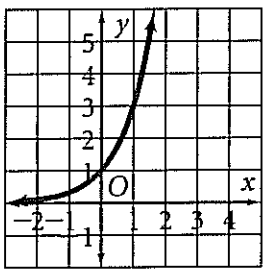
6. 1.5625, 1, 0.8, 0.64, 0.4096 **7.** 0.125, 2, 8, 32, 512

8. $\frac{10}{9}$, 10, 30, 90, 810 **9.** 1, 25, 125, 625, 15,625

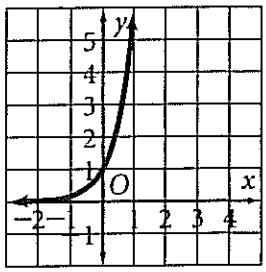
10. $\frac{9}{4}, 1, \frac{2}{3}, \frac{4}{9}, \frac{16}{81}$ **11.** 10,000, 100, 10, 1, $\frac{1}{100}$

12. $\frac{1}{256}, \frac{1}{4}$, 2, 16, 1024

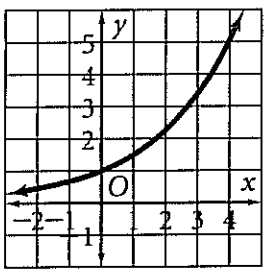
13.



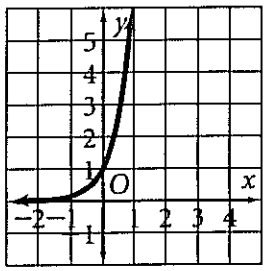
14.



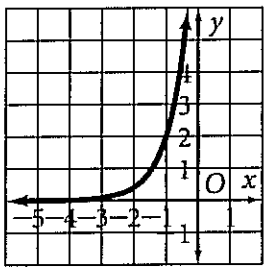
15.



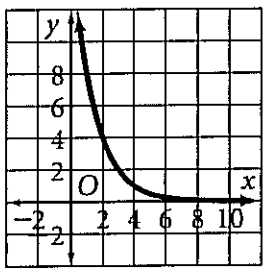
16.



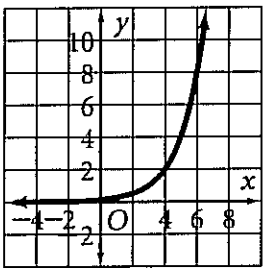
17.



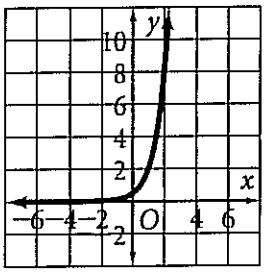
18.



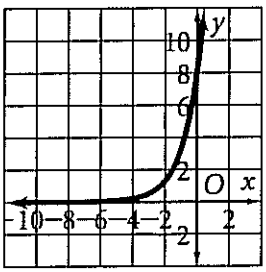
19.



20.



21.



22. 5.5; 166.375; 915.0625 **23.** 9; 20.25; 30.375
24. 12; 192; 3072 **25.** 36; 216; 1296 **26.** 0.7; 0.343; 0.2401
27. 3.1; 9.61; 29.791 **28.** 180; 720; 254.558 **29.** 0.054; 0.233; 1
30. 1,000,000; 1000; 1 **31.** 0.04; 0.008; 625 **32.** 4 **33.** 3
34. −3 **35.** −3

Practice 8-8

1a. $y = 500 \cdot 1.04^x$; \$3553.34 **1b.** \$25,252.47
1c. \$1,275,374.90 **1d.** \$64,412,743.02
2a. $y = 1500 \cdot 1.0475^x$; \$4785.66
2b. $y = 1500 \cdot \left(1 + \frac{0.0475}{2}\right)^{2x}$; \$4850.51
2c. $y = 1500 \cdot \left(1 + \frac{0.0475}{4}\right)^{4x}$; \$4884.02
2d. $y = 1500 \cdot \left(1 + \frac{0.0475}{12}\right)^{12x}$; \$4906.80
3a. $y = 25{,}000 \cdot 1.08^x$; \$27,000 **3b.** \$31,492.80
3c. \$36,733.20 **3d.** \$79,304.23 **4a.** $y = (0.5)(0.5^{\frac{x}{5700}})$; 0.25 mg
4b. 0.125 mg **4c.** 0.03125 mg **4d.** 0.0078125 mg
5a. $y = 250{,}000 \cdot 1.035^x$; \$296,921.58 **5b.** \$329,202.26
5c. \$352,649.69 **5d.** \$433,496.51 **6a.** $y = 4{,}500{,}000 \cdot 0.98^x$; 4,235,364 **6b.** 4,067,644 **6c.** 3,676,828 **6d.** 3,004,236
7a. $y = 10{,}500 \cdot 0.85^x$; \$8925 **7b.** \$7586.25 **7c.** \$5481.07
7d. \$2067.18 **8a.** $y = 2{,}950{,}000 \cdot 0.975^x$; 2,876,250
8b. 2,599,232 **8c.** 2,017,861 **8d.** 1,566,525
9a. $y = 25{,}000 \cdot 0.88^x$; \$22,000 **9b.** \$17,036.80
9c. \$13,193.30 **9d.** \$10,216.89

Reteaching 8-1

1. $\frac{1}{1000}$ **2.** 1 **3.** $\frac{1}{625}$ **4.** $\frac{1}{343}$ **5.** $\frac{4}{9}$ **6.** $\frac{1}{625x^4}$ **7.** $\frac{1}{4}$ **8.** 1
9. $\frac{1}{b^5}$ **10.** $\frac{2401}{16}$ **11.** $3a$ **12.** $-\frac{1}{64}$ **13.** $\frac{1}{a^3b^4}$ **14.** $\frac{3}{x^2y}$
15. $\frac{12x}{y^3}$ **16.** 128 **17.** $\frac{1}{12x}$ **18.** $\frac{y}{12x^2}$ **19.** $\frac{1}{2x^2}$ **20.** $\frac{9a^2}{b}$
21. 1000

Reteaching 8-2

1. 4.2×10^5 **2.** 5.1×10^9 **3.** 2.6×10^{11}
4. 8.3×10^8 **5.** 7.5×10^{-4} **6.** 4.005×10^{-3}
7. 634,500,000 **8.** 0.000032 **9.** 4,081,000 **10.** 0.002581
11. 0.0307 **12.** 1,526,000 **13.** 0.000804 **14.** 762,500
15. 68,250 **16.** 0.00003081 **17.** 838.47 **18.** 0.036245

Reteaching 8-3

1. 5 **2.** 3 **3.** 3 **4.** 1 **5.** −1 **6.** −2 **7.** 12 **8.** 18 **9.** −9
10. $24x^6$ **11.** $\frac{18m^6}{a^2}$ **12.** $\frac{p^5}{q^9}$ **13.** $120x^7$ **14.** $8x^7y^3$
15. $189x^2y^2$ **16.** $24y^9$ **17.** x^3 **18.** x^4y **19.** $12ab$
20. $\frac{r^4}{s^2}$ **21.** $3pq$

Reteaching 8-4

1. 390,625 **2.** a^{20} **3.** 64 **4.** $64x^3$ **5.** $49a^8$ **6.** $27g^6$
7. $g^{10}h^{15}$ **8.** s^{12} **9.** x^6y^{12} **10.** 1 **11.** g^2 **12.** c^{28} **13.** 1
14. $512a^3b^{18}$ **15.** x^4y^6 **16.** x^{14} **17.** $9x^4y^2$ **18.** $-8x^6$
19. x^9y^{12} **20.** $27x^6y^3$ **21.** $-64x^6y^9$ **22.** 1 **23.** $\frac{1}{x^2}$

Reteaching 8-5

1. z^3 **2.** $\frac{729}{64}$ **3.** m **4.** $\frac{1}{5}$ **5.** b^6 **6.** $\frac{a^3}{3}$ **7.** $\frac{1}{8}$ **8.** d^5 **9.** x^2
10. 10^{18} **11.** $2x$ **12.** $\frac{2x^3}{3}$ **13.** x^7 **14.** $\frac{3x^2}{2}$ **15.** $\frac{1}{x^5}$ **16.** x^8

Reteaching 8-6

1. 512, 2048, 8192 **2.** −48, 96, −192 **3.** 1, −1, 1
4. $\frac{3}{4}, \frac{3}{8}, \frac{3}{16}$ **5.** $\frac{5}{4}, -\frac{5}{8}, \frac{5}{16}$ **6.** 0.01, 0.001, 0.0001
7. 1875, 9375, 46,875 **8.** −40.5, −60.75, −91.125
9. 121.5, 364.5, 1093.5 **10.** $\frac{8}{81}, -\frac{8}{243}, \frac{8}{729}$
11. 112, −224, 448 **12.** 6.25, 3.125, 1.5625
13. 2048, 8192, 32,768 **14.** 4.75, −2.375, 1.1875

Reteaching 8-7

1. 328,050 cans **2.** 67,500 **3.** \$16,000
4. 1200 cells; 76,800 cells

Reteaching 8-8

1. $y = 5{,}000 \cdot 1.03^{10}$; 6720 **2.** $y = 100 \cdot 1.08^5$; \$147
3. $y = 2 \cdot 1.1^8$; 4 ft **4.** $y = 1000 \cdot 0.90^5$; \$590
5. $y = 5000 \cdot 0.865^8$; \$1567
6. $y = 20{,}000 \cdot 0.875^{10}$; \$5262

Enrichment 8-1

1. John Napier

Enrichment 8-2

1. 2^{10} or 1024 **2.** 2^{40} or 1,099,511,627,776 **3.** 2^{100}
4. 93.5 in.^{2} **5.** 7.3758×10^{-29} in.^{2} **6a.** 4.9907×10^{28}
6b. 4.1590×10^{27} **6c.** 1.3863×10^{27} **6d.** 7.8768×10^{23}
7. yes **8.** 9.3×10^7 mi; yes **9.** 3.9×10^8 to 5.76×10^8; yes
10. 2.7×10^8 to 1.6×10^{10}; yes

Enrichment 8-3

1. $P = 32x$; $A = 11x^2$ **2.** $P = 29y$; $A = 12y^2$
3. $P = 16b$; $A = 9b^2$ **4.** $P = 14a$; $A = 8a^2$
5. $P = 224$ units; $A = 539$ units^2
6. $P = 87$ units; $A = 108$ units^2
7. $P = 64$ units; $A = 144$ units^2
8. $P = 70$ units; $A = 200$ units^2 **9.** $96r^2$ **10.** $78v^2$