Name _____ Date _____

LESSON 5.1

Practice B

For use with pages 318–323

Evaluate the expression. Tell which properties of exponents you used.

1. $2^5 \cdot 2^3$
2. $(-7)^2(-7)$
3. $4^{-6} \cdot 4^{-1}$
4. $(5^{-2})^2$
5. $\frac{4^{-7}}{4^{-3}}$
6. $\frac{8^{-4}}{8^2}$
7. $\left(\frac{2}{3}\right)^3$
8. $\left(\frac{4}{5}\right)^{-3}$

Write the answer in scientific notation.

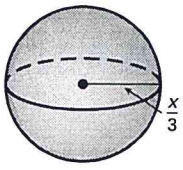
9. $(6.1 \times 10^5)(2.2 \times 10^6)$
10. $(2.6 \times 10^{-7})(1.3 \times 10^2)$
11. $(3.4 \times 10^{-1})(3.1 \times 10^{-2})$
12. $(5.8 \times 10^{-7})(8.1 \times 10^{12})$
13. $(4.5 \times 10^4)^2$
14. $(3.7 \times 10^{-5})^2$
15. $(7.2 \times 10^{-3})^3$
16. $\frac{9.9 \times 10^9}{1.5 \times 10^8}$
17. $\frac{8.4 \times 10^{-6}}{2.4 \times 10^9}$

Simplify the expression. Tell which properties of exponents you used.

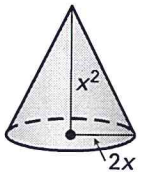
18. $\frac{x^8}{x^4}$
19. $\frac{y^4}{y^{-7}}$
20. $(3^2s^3)^6$
21. $(4^0w^2)^{-5}$
22. $(y^4z^2)(y^{-3}z^{-5})$
23. $(2m^3n^{-1})(8m^4n^{-2})$
24. $(7c^7d^2)^{-2}$
25. $(5g^4h^{-3})^{-3}$
26. $\frac{x^5y^{-8}}{x^5y^{-6}}$
27. $\frac{16q^0r^{-6}}{4q^{-3}r^{-7}}$
28. $\frac{12a^{-3}b^9}{21a^2b^{-5}}$
29. $\frac{8e^{-4}f^{-2}}{18ef^{-5}}$

Write an expression for the surface area or volume in terms of *x*.

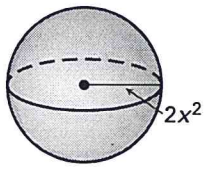
30. $S = 4\pi r^2$



31. $V = \frac{1}{3}\pi r^2 h$



32. $V = \frac{4}{3}\pi r^3$



33. **Birds** Some scientists estimate that there are about 8600 species of birds in the world. The mean number of birds per species is approximately 12,000,000. About how many birds are there in the world? Write your answer in scientific notation.

34. **Biology** A red blood cell has a diameter of approximately 0.00075 centimeter. If one of the arteries in your body has a diameter of 0.0456 centimeter, how many red blood cells could fit across the artery? Write your answer in scientific notation.

Name _____ Date _____

LESSON 5.2

Practice B

For use with pages 324–333

Decide whether the function is a polynomial function. If it is, write the function in standard form and state the degree, type, and leading coefficient.

1. $f(x) = 7 - 2x$
2. $g(x) = 2x - x^3 + 8$
3. $h(x) = x^4 - x^{-3}$

Use direct substitution to evaluate the polynomial function for the given value of *x*.

4. $f(x) = 6x^4 - x^3 + 3x^2 - 5x + 9; x = -1$
5. $g(x) = 7x - x^4 + 1; x = -4$

Use synthetic substitution to evaluate the polynomial function for the given value of *x*.

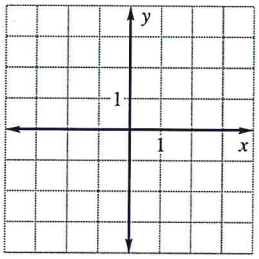
6. $f(x) = 7x^4 - 3x^3 + x^2 + 5x - 9; x = 2$
7. $g(x) = x^3 - 8x + 6; x = -3$

Describe the end behavior of the graph of the polynomial function by completing these statements: $f(x) \to$? as $x \to -\infty$ and $f(x) \to$? as $x \to +\infty$.

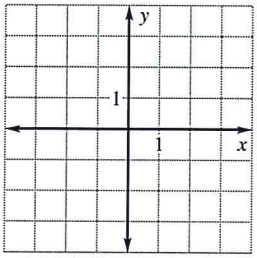
8. $f(x) = -5x^3$
9. $f(x) = 2x^5 - 7x^2 - 4x$
10. $f(x) = 2x^8 + 9x^7 + 10$
11. $f(x) = -12x^6 - 2x + 5$

Graph the polynomial function.

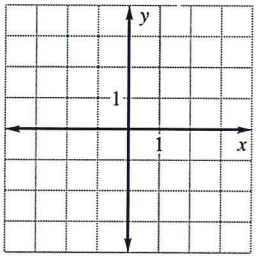
12. $f(x) = -x^3 - 2$



13. $g(x) = x^4 + 2x$



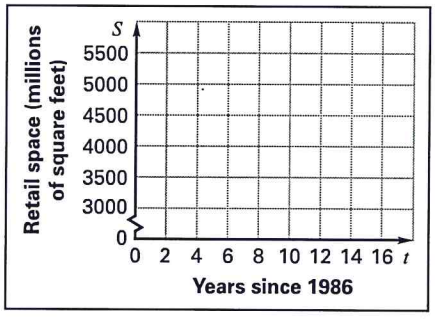
14. $h(x) = -x^4 + 2x^3 - 5x + 1$



15. **Shopping** The retail space in shopping centers in the United States from 1986 to 2003 can be modeled by

$S = -0.0388t^4 + 1.723t^3 - 28t^2 + 309t + 3481$

where S is the amount of retail space (in millions of square feet) and t is the number of years since 1986.



a. Describe the end behavior of the graph of the function.

b. Graph the function on the domain $0 \le t \le 17$.

c. Use the graph to estimate the first year that the amount of retail space was greater than 5000 million square feet.

d. Use the model to predict the amount of retail space in the year 2010. Is it appropriate to use the model to make this prediction? *Explain.*

Name _____ Date _____

LESSON 5.3

Practice B

For use with pages 334–340

Find the sum or difference.

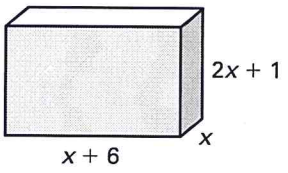
1. $(2y^2 - 5y + 1) + (y^2 - y - 4)$
2. $(12x^2 + 8x - 3) - (11x^2 - x + 5)$
3. $(6m^3 - 5) - (m^3 + 4m^2 - 9m - 2)$
4. $(5s^4 - 2s^3 + 9) - (-2s^4 + 8s^2 - s + 2)$
5. $(7q - 3q^3) + (16 - 8q^3 + 5q^2 - q)$
6. $(-4z^4 + 6z - 9) + (11 - z^3 + 3z^2 + z^4)$
7. $(10v^4 - 2v^2 + 6v^3 - 7) - (9 - v + 2v^4)$
8. $(4x^5 + 3x^4 - 5x + 1) - (x^3 + 2x^4 - x^5 + 1)$

Find the product.

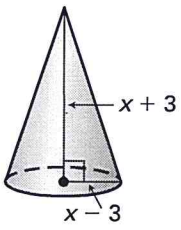
9. $2x^3(5x - 1)$
10. $(w - 8)(w - 1)$
11. $(c + 4)(c + 10)$
12. $(g + 9)(g - 2)$
13. $(y - 1)(y^2 + 6y - 2)$
14. $(n + 5)(2n^2 - n - 7)$
15. $(x - 3)^2$
16. $(4t + 1)^2$
17. $(z - 5)^3$
18. $(2f + 1)^3$

Write the volume of the figure as a polynomial in standard form.

19. $V = \ell wh$



20. $V = \frac{1}{3}\pi r^2 h$



21. **Bottled Water** From 1990 to 1999, the per person consumption B of bottled water (in gallons) and the population P of the United States (in thousands) can be modeled by

$B = 0.0977t^2 + 0.186t + 7.86$ and

$P = 3226t + 250{,}359$

where t is the number of years since 1990. Write a model for the total consumption C of bottled water (in thousands of gallons). What was the total consumption of bottled water in 1998?

Name _____ Date _____

LESSON 5.4

Practice B

For use with pages 341–347

Factor the sum or difference of cubes.

1. $x^3 + 125$
2. $y^3 - 8$
3. $64n^3 - 27$
4. $27g^3 + 343$
5. $2w^3 + 54$
6. $40v^3 - 625$

Factor the polynomial by grouping.

7. $r^3 - 3r^2 + 6r - 18$
8. $x^3 + 6x^2 + 7x + 42$
9. $c^3 + 4c^2 - 9c - 36$
10. $z^3 - 2z^2 - 16z + 32$
11. $25p^3 - 25p^2 - p + 1$
12. $9m^3 + 18m^2 - 4m - 8$

Factor the polynomial in quadratic form.

13. $x^4 - 36$
14. $c^4 - 81$
15. $x^4 + x^2 - 20$
16. $6y^6 - 5y^3 - 4$

Factor the polynomial completely.

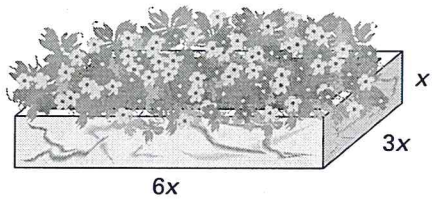
17. $x^6 - 4$
18. $d^4 - 7d^2 + 10$
19. $24q^3 - 81$
20. $a^6 + 7a^3 + 6$
21. $-4x^4 + 26x^2 - 30$
22. $2b^4 + 14b^3 - 16b - 112$

Find the real-number solutions of the equation.

23. $n^4 + 6n^3 = 0$
24. $4k^3 = 9k^2$
25. $x^3 + 2x^2 - 25x - 50 = 0$
26. $6w^3 + 30w^2 - 18w - 90 = 0$
27. $y^4 - 14y^2 + 45 = 0$
28. $3r^5 + 15r^3 - 18r = 0$

29. Write a binomial that can be factored either as the difference of two squares or as the difference of two cubes. Show the complete factorization of your binomial.

30. **City Park** You are designing a marble planter for a city park. You want the length of the planter to be six times the height, and the width to be three times the height. The sides should be one foot thick. Because the planter will be on the sidewalk, it does not need a bottom. What should the outer dimensions of the planter be if it is to hold 4 cubic feet of dirt?



Name _____ Date _____

LESSON 5.5

Practice B

For use with pages 350–356

Divide.

1. $(4x^4 + 2x^3 - 6x + 2) \div 2x$
2. $(5x^5 - 4x^3 + x^2 + 3x - 2) \div 2x^2$
3. $(10x^3 + 8x^2 - 4x + 3) \div 4x$

Divide using polynomial long division.

4. $(x^2 + 5x - 14) \div (x - 2)$
5. $(x^3 + x + 30) \div (x + 3)$
6. $(8x^3 + 5x^2 - 12x + 10) \div (x^2 - 3)$

Divide using synthetic division.

7. $(x^2 + 7x + 12) \div (x + 4)$
8. $(x^3 - 3x^2 + 8x - 5) \div (x - 1)$
9. $(x^4 - 7x^2 + 9x - 10) \div (x - 2)$
10. $(2x^4 - x^3 + 4) \div (x + 1)$
11. $(2x^4 - 11x^3 + 15x^2 + 6x - 18) \div (x - 3)$
12. $(x^4 - 6x^3 - 40x + 33) \div (x - 7)$

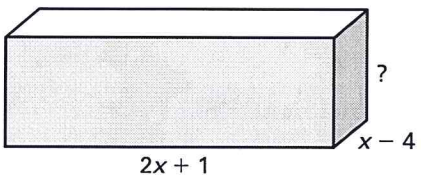
A polynomial *f* and a factor of *f* are given. Factor *f* completely.

13. $f(x) = x^3 - 3x^2 - 16x - 12; x - 6$
14. $f(x) = x^3 - 12x^2 + 12x + 80; x - 10$
15. $f(x) = x^3 - 18x^2 + 95x - 126; x - 9$
16. $f(x) = x^3 - x^2 - 21x + 45; x + 5$
17. $f(x) = 4x^3 - 4x^2 - 9x + 9; x - 1$
18. $f(x) = 3x^3 - 16x^2 - 103x + 36; x + 4$

A polynomial *f* and one zero of *f* are given. Find the other zeros of *f*.

19. $f(x) = x^3 + 2x^2 - 20x + 24; -6$
20. $f(x) = x^3 + 11x^2 - 150x - 1512; -14$
21. $f(x) = 2x^3 + 3x^2 - 39x - 20; 4$
22. $f(x) = 15x^3 - 119x^2 - 10x + 16; 8$
23. $f(x) = x^3 - 3x^2 - 45x + 175; -7$
24. $f(x) = x^3 - 9x^2 - 5x + 45; 9$

25. **Geometry** The volume of the box shown at the right is given by $V = 2x^3 - 11x^2 + 10x + 8$. Find an expression for the missing dimension.



26. **Fuel Consumption** From 1995 to 2002, the total fuel consumption T (in billions of gallons) by cars in the United States and the U.S. population P (in millions) can be modeled by

$T = -0.003x^3 - 0.02x^2 + 1.3x + 68$ and $P = 3x + 267$

where x is the number of years since 1995. Write a function for the average amount of fuel consumed by each person from 1995 to 2002.

Name _____ Date _____

LESSON 5.6

Practice B

For use with pages 358–366

List the possible rational zeros of the function using the rational zero theorem.

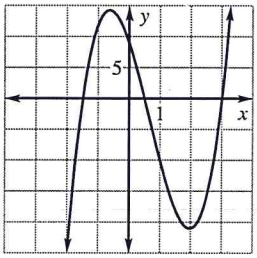
1. $f(x) = x^4 - 6x^3 + 8x^2 - 21$
2. $h(x) = 2x^3 + 7x^2 - 7x + 30$
3. $h(x) = 5x^4 + 12x^3 - 16x^2 + 10$
4. $g(x) = 9x^5 + 3x^3 + 7x - 4$

Find all real zeros of the function.

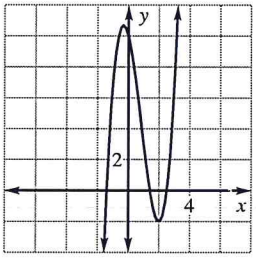
5. $f(x) = x^3 - 3x^2 - 6x + 8$
6. $g(x) = x^3 + 4x^2 - x - 4$
7. $h(x) = x^3 + 4x^2 + x - 6$
8. $g(x) = x^3 + 5x^2 - x - 5$
9. $f(x) = x^3 + 72 - 5x^2 - 18x$
10. $f(x) = x^3 + x^2 - 2x - 2$

Use the graph to shorten the list of possible rational zeros of the function. Then find all real zeros of the function.

11. $f(x) = 4x^3 - 8x^2 - 15x + 9$



12. $f(x) = 2x^3 - 5x^2 - 4x + 10$



Find all real zeros of the function.

13. $g(x) = 2x^3 + 4x^2 - 2x - 4$
14. $f(x) = 2x^3 - 5x^2 - 14x + 8$
15. $h(x) = 8x^3 - 6x^2 - 23x + 6$
16. $g(x) = 2x^4 + x^3 - x^2 - x - 1$
17. $h(x) = 2x^4 + 5x^3 - 5x^2 - 5x + 3$
18. $f(x) = 2x^4 + 3x^3 - 6x^2 - 6x + 4$

19. **Mail** From 1995 to 2003, the amount of mail M (in billions of pieces) handled by the U.S. Postal Service can be modeled by

$$M = 0.05(t^4 - 18t^3 + 89t^2 - 32t + 3680)$$

where t is the number of years since 1995. In which year was there about 204,000,000,000 pieces of mail handled?

   a. Write a polynomial equation that can be used to answer the question.

   b. List the possible whole-number solutions of the equation in part (a) that are less than or equal to 8.

   c. Use synthetic division to determine which of the possible solutions in part (b) is an actual solution. Then answer the question in the problem statement.

   d. Use a graphing calculator to graph and identify any additional real solutions of the equation that are reasonable.

Name _____ Date _____

LESSON 5.7

Practice B

For use with pages 367–374

Identify the number of solutions or zeros.

1. $f(x) = 5x^3 - 6x^2 + 2x - 3$
2. $g(s) = 8s^6 - 3s^4 - 11s^3 - 2s^2 + 4$
3. $-3y^7 + 5y^5 - 12y + 2 = 6$
4. $4 - 7x = x^2 - 3x^5$

Find all the zeros of the polynomial function.

5. $h(x) = x^3 - 3x^2 - x + 3$
6. $f(x) = x^4 - 4x^3 - 20x^2 + 48x$
7. $g(x) = x^3 + 5x^2 + x + 5$
8. $g(x) = x^4 - 9x^3 + 23x^2 - 81x + 126$
9. $f(x) = x^3 - x^2 - 11x + 3$
10. $h(x) = 2x^4 + x^3 + x^2 + x - 1$

Write a polynomial function *f* of least degree that has rational coefficients, a leading coefficient of 1, and the given zeros.

11. $-7, -4$
12. $1, 2, 5$
13. $-3, 0, 1$
14. $4, i, -i$
15. $-5, 0, -2i, 2i$
16. $8, 2 + i$
17. **Multiple Choice** Which is *not* a possible classification of the zeros of $f(x) = x^4 + 2x^3 - 7x^2 - 7x + 3$ according to Descartes' rule of signs?
    - **A.** 2 positive real zeros, 2 negative real zeros, and 0 imaginary zeros
    - **B.** 0 positive real zeros, 2 negative real zeros, and 2 imaginary zeros
    - **C.** 0 positive real zeros, 0, negative real zeros, and 4 imaginary zeros
    - **D.** 1 positive real zero, 1 negative real zero, and 2 imaginary zeros

Use a graphing calculator to graph the function. Then use the *zero* (or *root*) feature to approximate the real zeros of the function.

18. $g(x) = x^3 - x^2 - 5x + 3$
19. $h(x) = 2x^3 - x^2 - 3x - 1$
20. $f(x) = x^4 - 2x - 1$
21. $g(x) = x^4 - x^3 - 20x^2 + 10x + 27$
22. **Sporting Goods** For 1998 through 2005, the sales S (in billions of dollars) of sporting goods can be modeled by

    $S = 0.007t^3 + 0.1t^2 + 1.4x + 70$

    where t is the number of years since 1998. In which year were sales about \$78 billion?
23. **Grocery Store Revenue** For the 25 years that a grocery store has been open, its annual revenue R (in millions of dollars) can be modeled by

    $$R = \frac{1}{10{,}000}(-t^4 + 12t^3 - 77t^2 + 600t + 13{,}650)$$

    where t is the number of years the store has been open. In what year(s) was the revenue \$1.5 million?

Name _____ Date _____

LESSON 5.8

Practice B

For use with pages 375–380

1. Describe and correct the error in the following statement.

If -6 is a solution of the polynomial equation $f(x) = 0$, then *-6 is a factor of $f(x)$.*

State the maximum number of turns in the graph of the function.

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

3. $f(x) = -3x^3 + x^2 - x + 5$

4. $g(x) = 2x^6 + 1$

5. $g(x) = 4x^2 - 5x + 3$

6. $h(x) = 3x^7 - 6x^2 + 7$

7. $h(x) = 2x^9 - 8x^7 + 7x^5$

Determine the *x*-intercepts of the function.

8. $g(x) = (x + 3)(x - 2)(x - 5)$

9. $h(x) = (x + 4)(x - 6)(x - 8)$

10. $f(x) = (x + 3)^2(x - 2)$

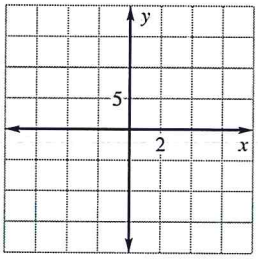
11. $f(x) = (x + 5)(x + 1)(x - 7)$

12. $g(x) = (x + 6)^3(x + 2)$

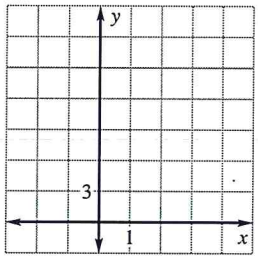
13. $h(x) = (x - 8)^5$

Graph the function.

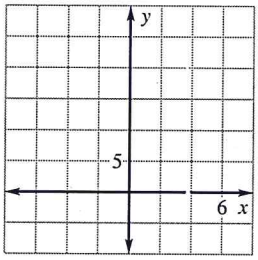
14. $f(x) = (x - 3)(x + 2)(x + 1)$



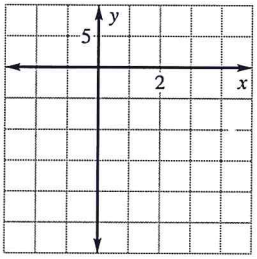
15. $g(x) = (x - 3)^2(x + 2)$



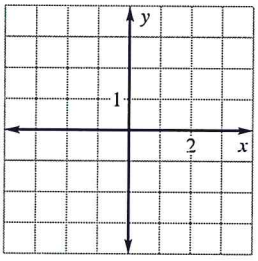
16. $h(x) = 0.3(x + 6)(x - 1)(x - 4)$



17. $g(x) = \frac{5}{6}(x + 1)^2(x - 1)(x - 4)$



18. $h(x) = (x - 1)(x^2 + x + 1)$



19. $f(x) = (x + 2)(x^2 + 2x + 2)$