20. 0

21. $b = -2/3$ and $b = 1$

22. 4

23.

Function	Interval [0, 1]	(0, 1]	[0, 1)	(0, 1)
$f(x) = \frac{1}{x}$	No	Yes	No	Yes
$g(x) = \frac{2x^2}{x-1}$	No	No	Yes	Yes
$H(x) = \sqrt{x}$	Yes	Yes	Yes	Yes
$K(x) = \frac{2x^3}{2x-1}$	No	No	No	No

24. $y = -5$

Appendix 1

Section 1.A, page 934

1. 36
2. -36
3. 73
4. 3
5. -5
6. 3
7. $-125/64$
8. $-25/4$
9. 1/3
10. 29/49
11. -112
12. $\frac{59,048}{2187}$
13. $\frac{81}{16}$
14. $\frac{6400}{9}$
15. $-211/216$
16. 144/25
17. $\frac{129}{8}$
18. 84
19. x^{10}
20. y^{11}
21. $.03y^9$
22. $1.3z^8$
23. $24x^7$
24. $405y^{14}$
25. $9x^6y^2$
26. $8x^3y^9$
27. $-21a^6$
28. $-3b^6$
29. $384w^6$
30. $1620d^7$
31. ab^3
32. cd^3
33. $8x^{-1}y^3$
34. $3^{-3}2^{-1}x^{-2}y^{-2}$ or $\frac{1}{54x^2y^2}$
35. a^2x^{-3}
36. $\frac{8y^5}{9}$
37. $3xy$
38. 1
39. 2^{12}
40. 2^{-9}
41. 2^{-12}
42. 2^{12}
43. x^7
44. $\frac{z^{23}}{t^{17}}$
45. e^9c
46. $\frac{x^{10}}{y^4}$
47. $b^2c^2d^6$
48. $\frac{9x}{8}$
49. $a^{12}b^8$
50. $\frac{y^4}{x^8}$
51. $\frac{1}{c^{10}d^6}$
52. $\frac{x}{8y}$
53. $\frac{1}{108x}$
54. $-\frac{50u^3}{27v^2}$
55. $\frac{a^7c}{b^6}$
56. $-\frac{200d^6}{c^3e}$
57. c^3d^6
58. $\frac{y^6}{x^{12}}$
59. $a + \frac{1}{a}$
60. $\frac{2b^2}{a^2}$
61. negative
62. positive
63. negative
64. positive
65. negative
66. negative
67. 3^t
68. $\frac{1}{64}$
69. $a^{6t}b^{4t}$
70. $\frac{G^2b^t}{c^t}$
71. $\frac{b^{r+s}}{c^{2rt}}$
72. $\frac{b^{2st}c^{rt}}{a^{rt}}$
73. Many possible examples, including this one. If $a = 3$, $b = 4$, and $r = 2$, then $a^2 + b^2 = 3^2 + 4^2 = 9 + 16 = 25$, but $(a + b)^2 = (3 + 4)^2 = 7^2 = 49$
74. If $a = 2$, $r = 3$, $s = 4$, then $a^r a^s = 2^3 2^4 = (8)(16) = 128$, but $a^{rs} = 2^{12} = 4096$.
75. If $a = 2$, $b = 3$, $r = 1$, $s = 1$, then $a^r b^s = (2^1)(3^1) = 6$ but $(ab)^{r+s} = [(2)(3)]^{1+1} = 6^2 = 36$.
76. If $c = 2$, $r = 2$, then $c^{-r} = 2^{-2} = 1/4$ but $-c^r = -2^2 = -4$.
77. If $c = 2$, $r = 3$, $s = 1$, then $\frac{c^r}{c^s} = \frac{2^3}{2^1} = 2^2 = 4$ but $c^{r/s} = 2^{3/1} = 2^3 = 8$.
78. If $a = 1$ and $b = 1$, then $(a + 1)(b + 1) = 4$, but $ab + 1 = 2$.
79. False for all nonzero a. For instance, $(-3)^2 = (-3)(-3) = 9$, but $-3^2 = -9$.
80. If $a = 1$ and $b = 1$, then $(-a)(-b) = (-1)(-1) = 1$, but $-ab = -(1 \cdot 1) = -1$.

Section 1.B, page 938

1. $8x$
2. $9w$
3. $-2a^2b$
4. $-16x^3\sqrt{t}$
5. $-x^3 + 4x^2 + 2x - 3$
6. $2u^4 + u^3 + 6$
7. $5u^2 + u - 4$
8. $6a^2b - 6ab^2 + ab\sqrt{c} - 3ab + 3a\sqrt{c}$
9. $6z^3w^2 - zw^3 - 12z^2w + 4z + 8$
10. $2x^2y + xy^2$
11. $-3x^3 + 15x + 8$
12. $x - 3\sqrt{y} - z$
13. $-5xy - x$
14. $2x^3 + 4x$
15. $15y^3 - 5y$
16. $x^3y^2 - 6x^3y^3$
17. $12a^2x^2 - 6a^3xy + 6a^2xy$
18. $2x^3 - 6x^2y + 4xy^2$
19. $12z^4 + 30z^3$
20. $-36x^8 + 21x^2$
21. $12a^2b - 18ab^2 + 6a^2b^2$
22. $-12a^2y^2 + 15ay^2$
23. $x^2 - x - 2$
24. $2x^2 - x - 10$
25. $2x^2 + 2x - 12$
26. $2y^2 - 10y - 12$
27. $y^2 + 7y + 12$
28. $3w^2 - 5w - 2$
29. $-6x^2 + x + 35$
30. $a^2b - 2ab + a - 2$
31. $3y^3 - 9y^2 + 4y - 12$
32. $y^2 - 64$
33. $x^2 - 16$
34. $9x^2 - y^2$
35. $16a^2 - 25b^2$
36. $x^2 + 12x + 36$
37. $y^2 - 22y + 121$
38. $4x^2 + 12xy + 9y^2$
39. $25x^2 - 10bx + b^2$
40. $4s^4 - 81y^2$
41. $16x^6 - 8x^3y^4 + y^8$
42. $16x^6 - 25y^4$
43. $9x^4 - 12x^2y^4 + 4y^8$
44. $2c^3 - 7c^2 + 7c - 2$
45. $2y^3 + 9y^2 + 7y - 3$
46. $2x^3 + 3x^2y - xy^2 + 2y^3$
47. $-15w^3 + 2w^2 + 9w - 18$
48. $5x^3 - 12x^2y + 19xy^2 - 6y^3$

49. $24x^3 - 4x^2 - 4x$
50. $-9y^3 + 15y^2 + 6y$
51. $x^3 - 6x^2 + 11x - 6$
52. $3y^3 + 2y^2 - 12y - 8$
53. $-3x^3 - 5x^2y + 26xy^2 - 8y^3$
54. $-6x^3 + 5x^2y + 3xy^2 - 2y^3$
55. 3
56. 1
57. -6
58. -1
59. 6
60. 0
61. 1
62. 0
63. 5
64. 2
65. $x - 25$
66. $4x - 2y$
67. $9 + 6\sqrt{y} + y$
68. $49w^2 - 14w\sqrt{2x} + 2x$
69. $\sqrt{3}x^2 + 4x + \sqrt{3}$
70. $2\sqrt{5}y^2 + (-2 + \sqrt{15})y - \sqrt{3}$
71. $3ax^2 + (2a + 3b)x + 2b$
72. $4dx^2 + (4c - dc)x - c^2$
73. $abx^2 + (a^2 + b^2)x + ab$
74. $12r^2x^3 + (4r - 3r^3)x^2 - r^2x$
75. $x^3 - (a + b + c)x^2 + (ab + ac + bc)x - abc$
76. $6cdx^2 + (2d^2 - 3c^2)x - cd$
77. $16x^{s+k}$
78. $x^{m+n} - 3x^m + 2x^n - 6$
79. $y^{r+s} - 4y^r + y^s - 4$
80. $(4 - \pi)x^2$
81. $4x^2 + 32x$
82. $\pi x^2 + 4\pi x$
83. The statement $3(y + 2) = 3y + 2$ is false when $y = 1$, since $3(1 + 2) = 9$ but $3(1) + 2 = 5$. The mistake is the value 2. The correct statement is $3(y + 2) = 3y + 6$.
84. The statement $x - (3y + 4) = x - 3y + 4$ is false when $x = 1$ and $y = 2$, since $1 - [3(2) + 4] = -9$ but $1 - 3(2) + 4 = -1$. The mistake is the sign on the 4. The correct statement is $x - (3y + 4) = x - 3y - 4$.
85. The statement $(x + y)^2 = x + y^2$ is false when $x = 1$ and $y = 2$, since $(1 + 2)^2 = 9$ but $1 + 2^2 = 5$. The mistake is the first part of the expression $x + y^2$. The correct statement is $(x + y)^2 = x^2 + 2xy + y^2$.
86. The statement $(2x)^3 = 2x^3$ is false when $x = 1$, since $[2(1)]^3 = 8$ but $2(1)^3 = 2$. The mistake is the value 2. The correct statement is $(2x)^3 = 8x^3$.
87. The statement $(7x)(7y) = 7xy$ is false when $x = 1$ and $y = 1$, since $(7 \cdot 1)(7 \cdot 1) = 7^2 = 49$, but $7 \cdot 1 \cdot 1 = 7$. The mistake is dropping a 7 on the left side. The correct statement is $(7x)(7y) = 49xy$.
88. The statement $(x + y)^2 = x^2 + y^2$ is false when $x = 1$ and $y = 2$, since $(1 + 2)^2 = 3^2 = 9$, but $1^2 + 2^2 = 1 + 4 = 5$. The mistake is omitting the middle term when squaring $x + y$. The correct statement is $(x + y)^2 = x^2 + 2xy + y^2$.
89. The statement $y + y + y = y^3$ is false when $y = 1$, since $1 + 1 + 1 = 3$ but $1^3 = 1$. The mistake is the use of 3 as an exponent. The correct statement is $y + y + y = 3y$.
90. The statement $(a - b)^2 = a^2 - b^2$ is false when $a = 2$ and $b = 1$, since $(2 - 1)^2 = 1$ but $2^2 - 1^2 = 3$. The mistake is the second part of the expression $a^2 - b^2$. The correct statement is $(a - b)^2 = a^2 - 2ab + b^2$.
91. The statement $(x - 3)(x - 2) = x^2 - 5x - 6$ is false when $x = 3$, since $(3 - 3)(3 - 2) = 0$ but $3^2 - 5(3) - 6 = -12$. The mistake is the sign on the 6. The correct statement is $(x - 3)(x - 2) = x^2 - 5x + 6$.
92. The statement $(a + b)(a^2 + b^2) = a^3 + b^2$ is false when $a = 2$ and $b = 1$, since $(2 + 1)(2^2 + 1^2) = 15$ but $2^3 + 1^3 = 9$. The mistake is the omission of terms of the product. The correct statement is $(a + b)(a^2 + b^2) = a^3 + a^2b + ab^2 + b^3$.
93. If x represents the number chosen, the values at each step are x, $x + 1$, $(x + 1)^2 = x^2 + 2x + 1$, $x - 1$, $(x - 1)^2 = x^2 - 2x + 1$, $(x^2 + 2x + 1) - (x^2 - 2x + 1) = 4x$; $\frac{4x}{x} = 4$.
94. If x represents the number chosen, the values at each step are x, $x + 4$, $x(x + 4) = x^2 + 4x$, $x^2 + 4x + 4$, $\sqrt{x^2 + 4x + 4} = x + 2$, $x + 2 - x = 2$.
95. Answers will vary.

Section 1.C, page 944

1. $(x + 2)(x - 2)$
2. $(x + 3)^2$
3. $(3y + 5)(3y - 5)$
4. $(y - 2)^2$
5. $(9x + 2)^2$
6. $(2x - 3)^2$
7. $(\sqrt{5} + x)(\sqrt{5} - x)$
8. $(1 + 6u)(1 - 6u)$
9. $(7 + 2z)^2$
10. $(5u - 2v)^2$
11. $(x^2 + y^2)(x + y)(x - y)$
12. $\left(x + \frac{1}{3}\right)\left(x - \frac{1}{3}\right)$
13. $(x + 3)(x - 2)$
14. $(y + 5)(y + 6)$
15. $(z + 3)(z + 1)$
16. $(x - 5)(x - 3)$
17. $(y + 9)(y - 4)$
18. $(z - 7)(z - 2)$
19. $(x - 3)^2$
20. $(2y + 9)(2y - 9)$
21. $(x + 5)(x + 2)$
22. $(w - 8)(w + 2)$
23. $(x + 9)(x + 2)$
24. $(x + 7y)(x - 4y)$
25. $(3x + 1)(x + 1)$
26. $(2y + 1)^2$
27. $(2z + 3)(z + 4)$
28. $(2x - 3)(5x - 1)$
29. $9x(x - 8)$
30. $(2x - 3)(2x + 1)$
31. $2(5x + 1)(x - 1)$
32. $(7z + 2)(z + 3)$
33. $(4u - 3)(2u + 3)$
34. $2(y - 1)^2$
35. $(2x + 5y)^2$
36. $(9u - 4v)(7u - 2v)$
37. $(x - 5)(x^2 + 5x + 25)$
38. $(y + 4)(y^2 - 4y + 16)$
39. $(x + 2)^3$
40. $(y - 1)^3$
41. $(2 + x)(4 - 2x + x^2)$
42. $(x - 3)^3$
43. $(-x + 5)^3$
44. $(3 - t)(9 + 3t + t^2)$
45. $(x + 1)(x^2 - x + 1)$
46. $(x - 1)(x^2 + x + 1)$
47. $(2x - y)(4x^2 + 2xy + y^2)$
48. $x(x^2 - 3x + 3)$

49. $(x+2)(x^2-2x+4)(x-2)(x^2+2x+4)$
50. $x^2(x-2)(x^2+2x+4)$ 51. $(y^2+5)(y^2+2)$
52. $(z+\sqrt{2})(z-\sqrt{2})(z+\sqrt{3})(z-\sqrt{3})$
53. $(9+y^2)(3+y)(3-y)$ 54. $(x+2)^2(x^2-2x+4)^2$
55. $(z+1)(z^2-z+1)(z-1)(z^2+z+1)$
56. $(y+3)(y^2-3y+9)(y-1)(y^2+y+1)$
57. $(x^2+3y)(x^2-y)$
58. $(x^2+4)(x+2)(x-2)(x^2+1)(x+1)(x-1)$
59. $(x+z)(x-y)$ 60. $(x^4-8)(x^2-2)$
61. $(a+2b)(a^2-b)$ 62. $(u-2w)(uv+w)$
63. $(x+\sqrt{8})(x-\sqrt{8})(x+4)$
64. $(z^7+2)(z-5)$
65. If $x^2+1=(x+c)(x+d)=x^2+(c+d)x+cd$, then $c+d=0$ and $cd=1$. But $c+d=0$ implies that $c=-d$ and hence that $1=cd=(-d)d=-d^2$, or equivalently, that $d^2=-1$. Since there is no real number with this property, x^2+1 cannot possibly factor in this way.

Section 1.D, page 951

1. $\frac{9}{7}$ 2. $\frac{11}{3}$ 3. $\frac{195}{8}$ 4. $x-2$
5. $\frac{x-2}{x+1}$ 6. $\frac{1}{z^2-z+1}$ 7. $\frac{a+b}{a^2+ab+b^2}$
8. $\frac{x^2-3}{x}$ 9. $\frac{1}{x}$ 10. $\frac{x+y}{x}$
11. $\frac{29}{35}$ 12. $\frac{1}{24}$ 13. $\frac{121}{42}$ 14. $\frac{b-2a^2}{ab}$
15. $\frac{ce+3cd}{de}$ 16. $\frac{r^2t+s^2r+t^2s}{rst}$ 17. $\frac{b^2-c^2}{bc}$
18. $\frac{ab^2+2ab+3a}{b^3}$ 19. $\frac{-1}{x(x+1)}$
20. $\frac{4x}{(2x+1)(2x-1)}$ 21. $\frac{x+3}{(x+4)^2}$
22. $\frac{y^2+y+1}{xy^2}$ 23. $\frac{2x-4}{x(3x-4)}$ 24. $\frac{7x-1}{(x+1)(x-1)}$
25. $\frac{x^2-xy+y^2+x+y}{x^3+y^3}$ 26. $\frac{5x^2+8x-18}{15(x-1)^2(x-2)^3}$
27. $\frac{-6x^5-38x^4-84x^3-71x^2-14x+1}{4x(x+1)^3(x+2)^3}$
28. $\frac{x^3+3x^2y+3xy^2+y^3-2x^2+2xy}{x(x-y)^3(x+y)^2}$
29. 2 30. $\frac{1}{21}$ 31. $\frac{2}{3c}$ 32. $\frac{y}{7}$
33. $\frac{3y}{x^2}$ 34. $\frac{d^2}{bc^3}$ 35. $\frac{12x}{x-3}$ 36. $\frac{8}{3}$
37. $\frac{5y^2}{3(y+5)}$ 38. $8x$ 39. $\frac{u+1}{u}$
40. $\frac{(t+2)(t-1)}{(t-3)(t-5)}$ 41. $\frac{(u+v)(4u-3v)}{(2u-v)(2u-3v)}$
42. $\frac{6x}{3x-4y}$ 43. $\frac{35}{24}$
44. $\frac{50}{27}$ 45. $\frac{u^2}{vw}$
46. $\frac{x}{yz}$ 47. $\frac{x+3}{2x}$
48. $\frac{(x+2)^2}{x(x-2)}$ 49. $\frac{x^2y^2}{(x+y)(x+2y)}$
50. $\frac{u+v}{u-v}$ 51. $\frac{cd(c+d)}{c-d}$
52. $\frac{-3x^2+8x-4}{14x-20}$ 53. $\frac{y-x}{xy}$
54. $\frac{x^2+x+1}{2x+1}$ 55. $\frac{-3(y-1)}{y}$
56. $\frac{4xy-3x^2}{10y+12x^2}$ 57. $\frac{-1}{x(2x+2h)}$
58. $\frac{-2x-h}{(x+h)^2x^2}$ 59. $\frac{xy}{x+y}$
60. $\frac{xy}{(x+y)^2}$ 61. $\pi/4$
62. 1/36 63. 1/25 64. 1/18
65. The statement $\frac{1}{a}+\frac{1}{b}=\frac{1}{a+b}$ is false when $a=1$ and $b=1$, since $1/1+1/1=2$ but $\frac{1}{1+1}=\frac{1}{2}$. The correct statement is $\frac{1}{a}+\frac{1}{b}=\frac{a+b}{ab}$.
66. The statement $\frac{x^2}{x^2+x^6}=1+x^3$ is false when $x=1$, since $\frac{1}{1+1}=\frac{1}{2}$ but $1+1=2$. The correct statement is $\frac{x^2}{x^2+x^6}=\frac{1}{1+x^4}$.
67. The statement $\left(\frac{1}{\sqrt{a}+\sqrt{b}}\right)^2=\frac{1}{a+b}$ is false when $a=1$ and $b=1$, since $\left(\frac{1}{\sqrt{1}+\sqrt{1}}\right)^2=\frac{1}{4}$ but $\frac{1}{1+1}=\frac{1}{2}$. The correct statement is $\left(\frac{1}{\sqrt{a}+\sqrt{b}}\right)^2=\frac{1}{a+2\sqrt{ab}+b}$.
68. The statement $\frac{r+s}{r+t}=1+\frac{s}{t}$ is false when $r=1$, $s=1$, and $t=1$, since $\frac{1+1}{1+1}=1$ but $1+\frac{1}{1}=2$. The expression $\frac{r+s}{r+t}$ is already in simplest form.
69. The statement $\frac{u}{v}+\frac{v}{u}=1$ is false when $u=1$ and $v=2$, since $\frac{u}{v}+\frac{v}{u}=\frac{1}{2}+\frac{2}{1}=2\frac{1}{2}$, not 1. The correct statement is $\frac{u}{v}+\frac{v}{u}=\frac{u^2+v^2}{vu}$.

EXERCISES 1.A

In Exercises 1–18, evaluate the expression.

1. $(-6)^2$
2. -6^2
3. $5 + 4(3^2 + 2^3)$
4. $(-3)2^2 + 4^2 - 1$
5. $\dfrac{(-3)^2 + (-2)^4}{-2^2 - 1}$
6. $\dfrac{(-4)^2 + 2}{(-4)^2 - 7} + 1$
7. $\left(\dfrac{-5}{4}\right)^3$
8. $-\left(\dfrac{7}{4} + \dfrac{3}{4}\right)^2$
9. $\left(\dfrac{1}{3}\right)^3 + \left(\dfrac{2}{3}\right)^3$
10. $\left(\dfrac{5}{7}\right)^2 + \left(\dfrac{2}{7}\right)^2$
11. $2^4 - 2^7$
12. $3^3 - 3^{-7}$
13. $(2^{-2} + 2)^2$
14. $(3^{-1} - 3^3)^2$
15. $2^2 \cdot 3^{-3} - 3^2 \cdot 2^{-3}$
16. $4^3 \cdot 5^{-2} + 4^2 \cdot 5^{-1}$
17. $\dfrac{1}{2^3} + \dfrac{1}{2^{-4}}$
18. $3^2\left(\dfrac{1}{3} + \dfrac{1}{3^{-2}}\right)$

In Exercises 19–38, simplify the expression. Each letter represents a nonzero real number and should appear at most once in your answer.

19. $x^2 \cdot x^3 \cdot x^5$
20. $y \cdot y^4 \cdot y^6$
21. $(.03)y^2 \cdot y^7$
22. $(1.3)z^3 \cdot z^5$
23. $(2x^2)^3 3x$
24. $(3y^3)^4 5y^2$
25. $(3x^2y)^2$
26. $(2xy^3)^3$
27. $(a^2)(7a)(-3a^3)$
28. $(b^3)(-b^2)(3b)$
29. $(2w)^3(3w)(4w)^2$
30. $(3d)^4(2d)^2(5d)$
31. $a^{-2}b^3a^3$
32. $c^4d^5c^{-3}$
33. $(2x)^{-2}(2y)^3(4x)$
34. $(3x)^{-3}(2y)^{-2}(2x)$
35. $(-3a^4)^2(9z^3)^{-1}$
36. $(2y^2)^3(3y^2)^{-2}$
37. $(2x^2y)^0(3xy)$
38. $(3x^2y^4)^0$

In Exercises 39–42, express the given number as a power of 2.

39. $(64)^2$
40. $(1/8)^3$
41. $(2^4 \cdot 16^{-2})^3$
42. $(1/2)^{-8}(1/4)^4(1/16)^{-3}$

In Exercises 43–60, simplify and write the given expression without negative exponents. All letters represent nonzero real numbers.

43. $\dfrac{x^4(x^2)^3}{x^3}$
44. $\left(\dfrac{z^2}{t^3}\right)^4 \cdot \left(\dfrac{z^3}{t}\right)^5$
45. $\left(\dfrac{e^6}{c^4}\right)^2 \cdot \left(\dfrac{c^3}{e}\right)^3$
46. $\left(\dfrac{x^7}{y^6}\right)^2 \cdot \left(\dfrac{y^2}{x}\right)^4$
47. $\left(\dfrac{ab^2c^3d^4}{abc^2d}\right)^2$
48. $\dfrac{(3x)^2(y^2)^3x^2}{(2xy^2)^3}$
49. $\left(\dfrac{a^5}{b^{-4}}\right)^2$
50. $\left(\dfrac{x^{-2}}{y^{-2}}\right)^2$
51. $\left(\dfrac{c^5}{d^{-3}}\right)^{-2}$
52. $\left(\dfrac{x^{-1}}{2y^{-1}}\right)\left(\dfrac{2y}{x}\right)^{-2}$
53. $\left(\dfrac{3x}{y^2}\right)^{-3}\left(\dfrac{-x}{2y^3}\right)^2$
54. $\left(\dfrac{5u^2v}{2uv^2}\right)^2\left(\dfrac{-3uv}{2u^2v}\right)^{-3}$
55. $\dfrac{(a^{-3}b^2c)^{-2}}{(ab^{-2}c^3)^{-1}}$
56. $\dfrac{(-2cd^2e^{-1})^3}{(5c^{-3}de)^{-2}}$
57. $(c^{-1}d^{-2})^{-3}$
58. $[(x^2y^{-1})^2]^{-3}$
59. $a^2(a^{-1} + a^{-3})$
60. $\dfrac{a^{-2}}{b^{-2}} + \dfrac{b^2}{a^2}$

In Exercises 61–66, determine the sign of the given number without calculating the product.

61. $(-2.6)^3(-4.3)^{-2}$
62. $(4.1)^{-2}(2.5)^{-3}$
63. $(-1)^9(6.7)^5$
64. $(-4)^{12}6^9$
65. $(-3.1)^{-3}(4.6)^{-6}(7.2)^7$
66. $(45.8)^{-7}(-7.9)^{-9}(-8.5)^{-4}$

In Exercises 67–72, r, s, and t are positive integers and a, b, and c are nonzero real numbers. Simplify and write the given expression without negative exponents.

67. $\dfrac{3^{-r}}{3^{s-r}}$
68. $\dfrac{4^{-(r+1)}}{4^{2-r}}$
69. $\left(\dfrac{a^6}{b^{-4}}\right)^r$
70. $\dfrac{c^{-t}}{(6b)^{-t}}$
71. $\dfrac{(c^{-r}b^s)^t}{(c^tb^{-r})^s}$
72. $\dfrac{(a^tb^{-s})^{-t}}{(b^tc^s)^{-s}}$

EXERCISES 1.B

In Exercises 1–54, perform the indicated operations and simplify your answer.

1. $x + 7x$
2. $5w + 7w - 3w$
3. $6a^2b + (-8b)a^2$
4. $-6x^3\sqrt{t} + 7x^3\sqrt{t} + 15x^3\sqrt{t}$
5. $(x^2 + 2x + 1) - (x^3 - 3x^2 + 4)$
6. $\left[u^4 - (-3)u^3 + \dfrac{u}{2} + 1\right] + \left(u^4 - 2u^3 + 5 - \dfrac{u}{2}\right)$
7. $\left[u^4 - (-3)u^3 + \dfrac{u}{2} + 1\right] - \left(u^4 - 2u^3 + 5 - \dfrac{u}{2}\right)$
8. $(6a^2b + 3a\sqrt{c} - 5ab\sqrt{c}) + (-6ab^2 - 3ab + 6ab\sqrt{c})$
9. $[4z - 6z^2w - (-2)z^3w^2] + (8 - 6z^2w - zw^3 + 4z^3w^2)$
10. $(x^3y - 2x + 3xy^3) - (-2x - x^3y + 2xy^3)$
11. $(9x - x^3 + 1) - [2x^3 + (-6)x + (-7)]$
12. $(x - \sqrt{y} - z) - (x + \sqrt{y} - z) - (\sqrt{y} + z - x)$
13. $(x^2 - 3xy) - (x + xy) - (x^2 + xy)$
14. $2x(x^2 + 2)$
15. $(-5y)(-3y^2 + 1)$
16. $x^2y(xy - 6xy^2)$
17. $3ax(4ax - 2a^2y + 2ay)$
18. $2x(x^2 - 3xy + 2y^2)$
19. $6z^3(2z + 5)$
20. $-3x^2(12x^6 - 7x^5)$
21. $3ab(4a - 6b + 2a^2b)$
22. $(-3ay)(4ay - 5y)$
23. $(x + 1)(x - 2)$
24. $(x + 2)(2x - 5)$
25. $(-2x + 4)(-x - 3)$
26. $(y - 6)(2y + 2)$
27. $(y + 3)(y + 4)$
28. $(w - 2)(3w + 1)$
29. $(3x + 7)(-2x + 5)$
30. $(ab + 1)(a - 2)$
31. $(y - 3)(3y^2 + 4)$
32. $(y + 8)(y - 8)$
33. $(x + 4)(x - 4)$
34. $(3x - y)(3x + y)$
35. $(4a + 5b)(4a - 5b)$
36. $(x + 6)^2$
37. $(y - 11)^2$
38. $(2x + 3y)^2$
39. $(5x - b)^2$
40. $(2s^2 - 9y)(2s^2 + 9y)$
41. $(4x^3 - y^4)^2$
42. $(4x^3 - 5y^2)(4x^3 + 5y^2)$
43. $(-3x^2 + 2y^4)^2$
44. $(c - 2)(2c^2 - 3c + 1)$
45. $(2y + 3)(y^2 + 3y - 1)$
46. $(x + 2y)(2x^2 - xy + y^2)$
47. $(5w + 6)(-3w^2 + 4w - 3)$
48. $(5x - 2y)(x^2 - 2xy + 3y^2)$
49. $2x(3x + 1)(4x - 2)$
50. $3y(-y + 2)(3y + 1)$
51. $(x - 1)(x - 2)(x - 3)$
52. $(y - 2)(3y + 2)(y + 2)$
53. $(x + 4y)(2y - x)(3x - y)$
54. $(2x - y)(3x + 2y)(y - x)$

In Exercises 55–64, find the coefficient of x^2 in the given product. Avoid doing any more multiplying than necessary.

55. $(x^2 + 3x + 1)(2x - 3)$
56. $(x^2 - 1)(x + 1)$
57. $(x^3 + 2x - 6)(x^2 + 1)$
58. $(\sqrt{3} + x)(\sqrt{3} - x)$
59. $(x + 2)^3$
60. $(x^2 + x + 1)(x - 1)$
61. $(x^2 + x + 1)(x^2 - x + 1)$
62. $(2x^2 + 1)(2x^2 - 1)$
63. $(2x - 1)(x^2 + 3x + 2)$
64. $(1 - 2x)(4x^2 + x - 1)$

In Exercises 65–70, perform the indicated multiplication, and simplify your answer if possible.

65. $(\sqrt{x} + 5)(\sqrt{x} - 5)$
66. $(2\sqrt{x} + \sqrt{2y})(2\sqrt{x} - \sqrt{2y})$
67. $(3 + \sqrt{y})^2$
68. $(7w - \sqrt{2x})^2$
69. $(1 + \sqrt{3}x)(x + \sqrt{3})$
70. $(2y + \sqrt{3})(\sqrt{5}y - 1)$

In Exercises 71–76, compute the product, and arrange the terms of your answer according to decreasing powers of x, with each power of x appearing at most once.

Example: $(ax + b)(4x - c) = 4ax^2 + (4b - ac)x - bc$.

71. $(ax + b)(3x + 2)$
72. $(4x - c)(dx + c)$
73. $(ax + b)(bx + a)$
74. $rx(3rx + 1)(4x - r)$
75. $(x - a)(x - b)(x - c)$
76. $(2dx - c)(3cx + d)$

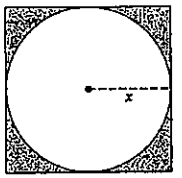
In Exercises 77–79, assume that all exponents are nonnegative integers, and find the product.

Example: $2x^k(3x + x^{n+1}) = (2x^k)(3x) + (2x^k)(x^{n+1})$
$= 6x^{k+1} + 2x^{k+n+1}$.

77. $(2x^n)(8x^k)$
78. $(x^m + 2)(x^n - 3)$
79. $(y^r + 1)(y^s - 4)$

In Exercises 80–82, express the area of the shaded region as an algebraic expression in x.

80.



EXERCISES 1.C

In Exercises 1–58, factor the expression.

1. x^2-4
2. x^2+6x+9
3. $9y^2-25$
4. y^2-4y+4
5. $81x^2+36x+4$
6. $4x^2-12x+9$
7. $5-x^2$
8. $1-36u^2$
9. $49+28z+4z^2$
10. $25u^2-20uv+4v^2$
11. x^4-y^4
12. $x^2-1/9$
13. x^2+x-6
14. $y^2+11y+30$
15. z^2+4z+3
16. $x^2-8x+15$
17. $y^2+5y-36$
18. $z^2-9z+14$
19. x^2-6x+9
20. $4y^2-81$
21. $x^2+7x+10$
22. $w^2-6w-16$
23. $x^2+11x+18$
24. $x^2+3xy-28y^2$
25. $3x^2+4x+1$
26. $4y^2+4y+1$
27. $2z^2+11z+12$
28. $10x^2-17x+3$
29. $9x^2-72x$
30. $4x^2-4x-3$
31. $10x^2-8x-2$
32. $7z^2+23z+6$
33. $8u^2+6u-9$
34. $2y^2-4y+2$
35. $4x^2+20xy+25y^2$
36. $63u^2-46uv+8v^2$
37. x^3-125
38. y^3+64
39. $x^3+6x^2+12x+8$
40. y^3-3y^2+3y-1
41. $8+x^3$
42. $z^3-9z^2+27z-27$
43. $-x^3+15x^2-75x+125$
44. $27-t^3$
45. x^3+1
46. x^3-1
47. $8x^3-y^3$
48. $(x-1)^3+1$
49. x^6-64
50. x^5-8x^2
51. y^4+7y^2+10
52. z^4-5z^2+6
53. $81-y^4$
54. x^6+16x^3+64
55. z^6-1
56. y^6+26y^3-27
57. $x^4+2x^2y-3y^2$
58. x^8-17x^4+16

In Exercises 59–64, factor by regrouping and using the distributive law (as in Example 9).

59. $x^2-yz+xz-xy$
60. $x^6-2x^4-8x^2+16$
61. $a^3-2b^2+2a^2b-ab$
62. $u^2v-2w^2-2uvw+uw$
63. $x^3+4x^2-8x-32$
64. $z^8-5z^7+2z-10$

THINKER

65. Show that there do *not* exist real numbers c and d such that $x^2+1=(x+c)(x+d)$.

EXERCISES 1.D

In Exercises 1–10, express the fraction in lowest terms.

1. $\frac{63}{49}$
2. $\frac{121}{33}$
3. $\frac{13\cdot 27\cdot 22\cdot 10}{6\cdot 4\cdot 11\cdot 12}$
4. $\frac{x^2-4}{x+2}$
5. $\frac{x^2-x-2}{x^2+2x+1}$
6. $\frac{z+1}{z^3+1}$
7. $\frac{a^2-b^2}{a^3-b^3}$
8. $\frac{x^4-3x^2}{x^3}$
9. $\frac{(x+c)(x^2-cx+c^2)}{x^4+c^2x}$
10. $\frac{x^4-y^4}{(x^2+y^2)(x^2-xy)}$

In Exercises 11–28, perform the indicated operations.

11. $\frac{3}{7}+\frac{2}{5}$
12. $\frac{7}{8}-\frac{5}{6}$
13. $\left(\frac{19}{7}+\frac{1}{2}\right)-\frac{1}{3}$
14. $\frac{1}{a}-\frac{2a}{b}$
15. $\frac{c}{d}+\frac{3c}{e}$
16. $\frac{r}{s}+\frac{s}{t}+\frac{t}{r}$
17. $\frac{b}{c}-\frac{c}{b}$
18. $\frac{a}{b}+\frac{2a}{b^2}+\frac{3a}{b^3}$
19. $\frac{1}{x+1}-\frac{1}{x}$
20. $\frac{1}{2x+1}+\frac{1}{2x-1}$
21. $\frac{1}{x+4}+\frac{2}{(x+4)^2}-\frac{3}{x^2+8x+16}$
22. $\frac{1}{x}+\frac{1}{xy}+\frac{1}{xy^2}$
23. $\frac{1}{x}-\frac{1}{3x-4}$
24. $\frac{3}{x-1}+\frac{4}{x+1}$
25. $\frac{1}{x+y}+\frac{x+y}{x^3+y^3}$
26. $\frac{6}{5(x-1)(x-2)^2}+\frac{x}{3(x-1)^2(x-2)}$
27. $\frac{1}{4x(x+1)(x+2)^3}-\frac{6x+2}{4(x+1)^3}$
28. $\frac{x+y}{(x^2-xy)(x-y)^2}-\frac{2}{(x^2-y^2)^2}$

In Exercises 29–42, express in lowest terms.

29. $\frac{3}{4}\cdot\frac{12}{5}\cdot\frac{10}{9}$
30. $\frac{10}{45}\cdot\frac{6}{14}\cdot\frac{1}{2}$
31. $\frac{3a^2c}{4ac}\cdot\frac{8ac^3}{9a^2c^4}$
32. $\frac{6x^2y}{2x}\cdot\frac{y}{21xy}$
33. $\frac{7x}{11y}\cdot\frac{66y^2}{14x^3}$
34. $\frac{ab}{c^2}\cdot\frac{cd}{a^2b}\cdot\frac{ad}{bc^2}$
35. $\frac{3x+9}{2x}\cdot\frac{8x^2}{x^2-9}$
36. $\frac{4x+16}{3x+15}\cdot\frac{2x+10}{x+4}$
37. $\frac{5y-25}{3}\cdot\frac{y^2}{y^2-25}$
38. $\frac{6x-12}{6x}\cdot\frac{8x^2}{x-2}$
39. $\frac{u}{u-1}\cdot\frac{u^2-1}{u^2}$
40. $\frac{t^2-t-6}{t^2-6t+9}\cdot\frac{t^2+4t-5}{t^2-25}$
41. $\frac{2u^2+uv-v^2}{4u^2-4uv+v^2}\cdot\frac{8u^2+6uv-9v^2}{4u^2-9v^2}$
42. $\frac{2x^2-3xy-2y^2}{6x^2-5xy-4y^2}\cdot\frac{6x^2+6xy}{x^2-xy-2y^2}$

In Exercises 43–60, compute the quotient and express in lowest terms.

43. $\frac{5}{12}\div\frac{4}{14}$
44. $\frac{\frac{100}{52}}{\frac{27}{26}}$
45. $\frac{uv}{v^2w}\div\frac{uv}{u^2v}$
46. $\frac{3x^2y}{(xy)^2}\div\frac{3xyz}{x^2y}$
47. $\frac{\frac{x+3}{x+4}}{\frac{2x}{x+4}}$
48. $\frac{\frac{(x+2)^2}{(x-2)^2}}{\frac{x^2+2x}{x^2-4}}$
49. $\frac{x+y}{x+2y}+\left(\frac{x+y}{xy}\right)^2$
50. $\frac{\frac{u^3+v^3}{u^2-v^2}}{\frac{u^2-uv+v^2}{u+v}}$
51. $\frac{(c+d)^2}{\frac{c^2-d^2}{cd}}$
52. $\frac{\frac{1}{x}-\frac{3}{2}}{\frac{2}{x-2}+\frac{5}{x}}$
53. $\frac{\frac{1}{x^2}-\frac{1}{y^2}}{\frac{1}{x}+\frac{1}{y}}$
54. $\frac{\frac{x}{x+1}+\frac{1}{x}}{\frac{1}{x}+\frac{1}{x+1}}$
55. $\frac{\frac{6}{y}-3}{1-\frac{1}{y-1}}$
56. $\frac{\frac{1}{3x}-\frac{1}{4y}}{\frac{5}{6x^2}+\frac{1}{y}}$
57. $\frac{\frac{1}{2x+2h}-\frac{1}{2x}}{h}$
58. $\frac{\frac{1}{(x+h)^2}-\frac{1}{x^2}}{h}$
59. $(x^{-1}+y^{-1})^{-1}$
60. $\frac{(x+y)^{-1}}{x^{-1}+y^{-1}}$

In Exercises 61–64, a dartboard is shown. Assuming that every dart actually hits the board, find the probability that the dart will land in the shaded area. This probability is the quotient

$$\frac{\text{Area of shaded region}}{\text{Area of dartboard}}$$

61.