Chapter 8

8.1 Skill Practice **1.** monomial **3.** $9m^5$; 5, 9 **5.** $2x^2y^2 - 8xy$; 4, 2 **7.** $3z^4 + 2z^3 - z^2 + 5z$; 4, 3 **11.** not a polynomial; variable exponent **13.** polynomial; 1, binomial **15.** polynomial; 3, trinomial **17.** $13a^2 - 4$ **19.** $m^2 + 9m + 9$ **21.** $6c^2 + 14$ **23.** $-2n^3 + n - 12$ **25.** $-15d^3 + 3d^2 - 3d + 2$ **27.** Two unlike terms, $-4x^2$ and $8x$, were combined; $-2x^3 - 4x^2 + 8x + 1$. **29.** $3x^5$, $x + 2x^3 + x^2$, $1 - 3x + 5x^2$, $12x + 1$ **31.** $12x - 3$ **33.** $-x^2 + 10xy + y^2$ **35.** $6a^2b - 6a + 4b - 19$

8.1 Problem Solving **37.** about 39,800,000 people **39. a.** $T = 9.5t^3 - 73t^2 + 130t + 860$ **b.** 1998; substitute $t = 0$ into the equation for T to find the number of books sold in 1998 to get 860 million books. Substitute 4 into the equation for T to find the number of books sold in 2002 to get 820 million books. More books were sold in 1998. **41. a.** $D = -0.44t^2 + 49t + 19.7$ **b.** about 855 decisions **c.** about 61%; Cy Young's career lasted $1911 - 1890 = 21$ years. To find the number of wins in his career, find the value of W when $t = 21$; about 525 wins. From part (b), we know that the total number of decisions in his career is about 855, so to find the percent of the decisions that were wins, find $525 \div 855 \approx 0.614$, or about 61%.

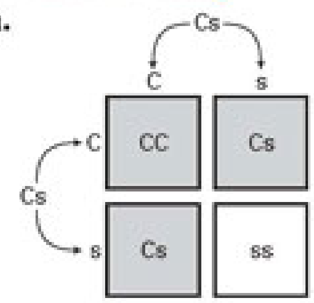
8.1 Graphing Calculator Activity
1. $7x^2 + 2x + 1$ **3.** correct

8.2 Skill Practice **1.** binomials **3.** $2x^3 - 3x^2 + 9x$ **5.** $4z^6 + z^5 - 11z^4 - 6z^2$ **7.** $9a^7 - 5a^6 - 13a^5$ **9.** $x^2 - x - 6$ **11.** $4b^2 - 31b + 21$ **13.** $12k^2 + 23k - 9$ **15.** The second term of the first binomial is -5, not 5, so the entries in the second row of the diagram should be $-15x$ and -5; $3x^2 - 14x - 5$. **17.** $y^2 + y - 30$ **19.** $77w^2 + 34w - 15$ **21.** $s^3 + 10s^2 + 19s - 20$ **23.** $-15x^3 + 14x^2 + 3x - 2$ **25.** $54z^3 - 21z^2 - 14z + 5$ **27.** $10r^2 + r - 3$ **29.** $8m^2 + 46m + 63$ **31.** $48x^2 - 88x + 35$ **33.** $3p^2 - 3p - 9$ **35.** $-3c^3 - 45c^2 + 23c - 10$ **37.** $2x^2 + x - 45$ **39.** $x^2 + 8x + 15$ **41.** $80 - 6x^2$ **43.** $2x^2 - 10x - 132$ **45.** $2x^4 - 11x^3 - 20x^2 - 7x$; graph $Y_1 = (x^2 - 7x)(2x^2 + 3x + 1)$ and $Y_2 = 2x^4 - 11x^3 - 20x^2 - 7x$ in the same viewing window. Because the graphs coincide, the expressions for Y_1 and Y_2 must be equivalent.

8.2 Problem Solving **49. a.** $4x^2 + 84x + 440$ **b.** 840 in.^{2} **51. a.** \$12,300 million, 0.171; for $t = 0$, the amount of money (in millions of dollars) people between 15 and 19 years old spent on sound recordings in the U.S. in 1997 **b.** $R \cdot P \approx -1.18t^4 + 14.4t^3 - 57.4t^2 - 10.4t + 2100$ **c.** about \$1680 million **53. a.** *Sample answer:* $T = t + 90$; use the data points from 1995–1999: (5, 95), (6, 96), (7, 97), (8, 98), (9, 99). All these points lie on a line with slope $m = 1$; use any one of the points to find the y-intercept $b = 90$. The other data points, (0, 92), (10, 101), and (11, 102), lie close to the line $T = t + 90$. **b.** $V = -0.0015t^3 - 0.103t^2 + 2.949t + 6.21$ **c.** about 24.2 million households, about 22.2 million households

8.3 Skill Practice **1.** *Sample answer:* $x - 5$, $x + 5$ **3.** $x^2 + 16x + 64$ **5.** $4y^2 + 20y + 25$ **7.** $n^2 - 22n + 121$ **9.** The middle term of the product, $2(s)(-3) = -6s$, was left out; $s^2 - 6s + 9$. **11.** $t^2 - 16$ **13.** $4x^2 - 1$ **15.** $49 - w^2$ **19.** Use the sum and difference pattern to find the product $(20 - 4)(20 + 4)$. **21.** Use the square of a binomial pattern to find the product $(20 - 3)^2$. **23.** $r^2 + 18rs + 81s^2$ **25.** $9m^2 - 121n^2$ **27.** $9m^2 - 42mn + 49n^2$ **29.** $9f^2 - 81$ **31.** $9x^2 + 48xy + 64y^2$ **33.** $4a^2 - 25b^2$ **35.** $9x^2 - 0.25$ **37.** $9x^2 - 3x + 0.25$

8.3 Problem Solving
41. a.



b. $0.25C^2 + 0.5Cs + 0.25s^2$ **c.** 75%

43. a. 88.1%; the areas of the four regions are: 2 complete passes: $0.655^2 \approx 0.429$ square units; 1 complete pass, 1 incomplete pass: $0.655(0.345) \approx 0.226$ square units; 1 incomplete pass, 1 complete pass: $0.345(0.655) \approx 0.226$ square units; and 2 incomplete passes: $0.345^2 \approx 0.119$ square units. The regions that involve at least one complete pass cover $0.429 + 0.226 + 0.226 = 0.881$ square units, or 88.1% of the whole square region. **b.** The outcome of each attempted pass is modeled by $0.655C + 0.345I$, so the possible outcomes of two attempted passes is modeled by $(0.655C + 0.345I)^2 = 0.429C^2 + 0.452CI + 0.119I^2$. Because any combination of outcomes with a C results in at least one completed pass, the coefficients of the first two terms show that 42.9% + 45.2% = 88.1% of the outcomes will have at least one completed pass, and the coefficient of the last term shows that 11.9% of the outcomes will have two incomplete passes.

8.4 Skill Practice **1.** The vertical motion model is the equation $h = -16t^2 + vt + s$, where h is the height (in feet) of a projectile after t seconds in the air, given an initial vertical velocity of v feet per second and an initial height of s feet. **3.** 5, −3 **5.** 13, 14 **7.** 7, $-\frac{4}{3}$ **9.** ±3 **11.** $-\frac{11}{3}$, −1 **13.** $-\frac{5}{2}, \frac{5}{7}$ **17.** $2(x + y)$ **19.** $s(3s^3 + 16)$ **21.** $7w^2(w^3 - 5)$ **23.** $5n(3n^2 + 5)$ **25.** $\frac{1}{2}x^4(5x^2 - 1)$ **27.** 0, −6 **29.** 0, $\frac{7}{2}$ **31.** 0, $-\frac{1}{3}$ **33.** 0, 2 **35.** 0, $\frac{5}{2}$ **37.** 0, $-\frac{2}{7}$ **41.** $2ab(4a - 3b)$ **43.** $v(v^2 - 5v + 9)$ **45.** $3q^2(2q^3 - 7q^2 - 5)$ **47.** 0, $\frac{1}{2}$

8.4 Problem Solving **51.** about 0.69 sec **53.** 0, about 0.28; the zero $t = 0$ seconds means that the penguin begins at a height of 0 feet in the air as it leaves the water; the zero $t \approx 0.28$ second means that the penguin lands back in the water (at a height of 0 feet in the air) after about 0.28 second. **55. a.** $h = -4.9t^2 + 4.9t$ **b.** $0 \le t \le 1$; a reasonable domain for the function will cover the time from when the rabbit leaves the ground until the rabbit lands back on the ground; these times t are the zeros of the function, 0 seconds and 1 second. **57. a.** $w(w + 2) = w(10 - w)$ **b.** 4 ft **c.** 48 ft^2

8.5 Skill Practice **1.** factors **3.** $(x + 3)(x + 1)$ **5.** $(b - 9)(b - 8)$ **7.** $(z + 12)(z - 4)$ **9.** $(y - 9)(y + 2)$ **11.** $(x + 10)(x - 7)$ **13.** $(m - 15)(m + 8)$ **15.** $(p + 16)(p + 4)$ **17.** $(c + 11)(c + 4)$ **19.** In order to have a product of +24, p and q must have the same sign; $(m - 6)(m - 4)$. **21.** 10, −3 **23.** −10, 5 **25.** −5, −4 **27.** −22, −1 **31.** −3, −2 **33.** 9, 5 **35.** 17, −3 **37.** 14, 2 **39.** −9, 8 **41.** −17, −2 **43.** 20 in., 5 in. **45.** 26 yd, 6 yd **47.** $(x - 2y)^2$ **49.** $(c + 9d)(c + 4d)$ **51.** $(a + 5b)(a - 3b)$ **53.** $(m - 7n)(m + 6n)$ **55.** $(g + 10h)(g - 6h)$

8.5 Problem Solving **59.** 10 cm^2 **61.** 40 in.; the side lengths of the rectangular picture can be represented by $x - 5$ and $x - 6$; the area of the picture is 20 square inches, so to find the side length x of the original square picture, solve the equation $(x - 5)(x - 6) = 20$. The equation has two solutions, 10 and 1, but when $x = 1$ inch, both $x - 5$ and $x - 6$ are negative, which does not make sense in this situation. So, $x = 10$ inches, and the perimeter of the original picture was $4(10) = 40$ inches.

8.5 Problem Solving Workshop **1.** 2 ft **3.** 9 ft

8.6 Skill Practice **1.** roots **3.** To factor the polynomial that has a leading coefficient of 1, $x^2 - x - 2$, you only need to find factors of the constant term, −2, that add to the coefficient of the middle term, −1. To factor the polynomial that has a leading coefficient that is not 1, $6x^2 - x - 2$, you must also take into account how the factors of the leading coefficient, 6, affect the coefficient of the middle term. **5.** $-(y - 4)(y + 2)$ **7.** $(5w - 1)(w - 1)$ **9.** $(6s + 5)(s - 1)$ **11.** $(2c - 1)(c - 3)$ **13.** $-(2h + 1)(h - 3)$ **15.** $(2x + 3)(5x - 9)$ **17.** $(3z + 7)(z - 2)$ **19.** $(2n + 3)(2n + 5)$ **21.** $(3y - 4)(2y + 1)$ **23.** $-\frac{7}{2}$, 5 **25.** $\frac{1}{4}$, −3 **27.** $\frac{3}{4}, -\frac{1}{2}$ **29.** $-\frac{1}{4}, \frac{2}{5}$ **31.** $\frac{1}{3}$, −5 **33.** $\frac{2}{5}$, 1 **35.** $\frac{11}{2}$, −3 **37.** $-\frac{4}{3}, \frac{1}{2}$ **39.** The factorization of the polynomial should be $(3x + 2)(4x - 1)$ instead of $(3x - 1)(4x + 2)$; $-\frac{2}{3}, \frac{1}{4}$. **41.** $9\frac{1}{2}$ in.; to find the width, solve the equation $w(4w + 1) = 3$ to get $w = \frac{3}{4}$ or $w = -1$. The width cannot be negative, so the width is $\frac{3}{4}$ inch. Then the length is $4\left(\frac{3}{4}\right) + 1 = 4$ inches, and the perimeter is $2\left(\frac{3}{4}\right) + 2(4) = 9\frac{1}{2}$ inches. **43.** 5, 7 **45.** $-\frac{7}{3}$, 2 **47.** $\frac{7}{2}, -\frac{3}{2}$ **49.** $-\frac{1}{4}, \frac{5}{2}$ **53.** $2x^2 - 9x - 5 = 0$; any root $x = \frac{r}{s}$ of $ax^2 + bx + c = 0$ comes from setting the factor $sx - r$ equal to 0 after $ax^2 + bx + c$ is written in factored form; so, the roots $-\frac{1}{2}$ and 5 come from the factors $2x - (-1)$, or $2x + 1$, and $x - 5$. The product of these factors is $(2x + 1)(x - 5) = 2x^2 - 10x + x - 5 = 2x^2 - 9x - 5$.

8.6 Problem Solving **59. a.** $24x^2 + 48x + 24$ **b.** 4 cm, 2 cm **61.** 70 m, 31 m

8.7 Skill Practice **1.** perfect square **3.** $(x + 5)(x - 5)$ **5.** $(9c + 2)(9c - 2)$ **7.** $-3(m + 4n)(m - 4n)$ **9.** $(x - 2)^2$ **11.** $(7a + 1)^2$ **13.** $\left(m + \frac{1}{2}\right)^2$ **15.** $4(c + 10)(c - 10)$ **17.** $(2s + 3r)(2s - 3r)$ **19.** $8(3 + 2y)(3 - 2y)$ **21.** $(2x)^2 - 3^2$ is in the form $a^2 - b^2$, so it must be factored using the difference of two squares pattern, not the perfect square trinomial pattern; $9(2x + 3)(2x - 3)$. **25.** −4 **27.** ±3 **29.** −2 **31.** ±12 **33.** $\pm\frac{7}{2}$ **35.** $\frac{5}{6}$ **37.** $\pm\frac{4}{3}$ **39.** 0, 1

8.7 Problem Solving **47.** 2.5 sec **49.** Once; the ball's height (in feet) is modeled by the equation $h = -16t^2 + 56t + 5$, where t is the time (in seconds) since it was thrown. To find when the height is 54 feet, substitute 54 for h and solve the equation $54 = -16t^2 + 56t + 5$, or $16t^2 - 56t + 49 = 0$.

Because the left side of the equation factors as a perfect square trinomial, $(4t - 7)^2$, the equation has only one solution, 1.75; so, the ball reaches a height of 54 feet only once, after 1.75 seconds.
51. a. $4d^2 - 9$ **b.** 10 in.

8.8 Skill Practice **1.** The polynomial is written as a monomial or as a product of a monomial and one or more prime polynomials.
3. $(x - 8)(x + 1)$ **5.** $(z - 4)(6z - 7)$ **7.** $(b + 5)(b^2 - 3)$
9. $(x + 13)(x - 1)$ **11.** $(z - 1)(12 + 5z^2)$
13. $(x + 1)(x^2 + 2)$ **15.** $(z - 4)(z^2 + 3)$
17. $(a + 13)(a^2 - 5)$ **19.** $(5n - 4)(n^2 + 5)$
21. $(y + 1)(y + 5x)$ **23.** $x^2(x - 1)(x + 1)$
25. $3n^3(n - 4)(n + 4)$ **27.** $3c^7(5c - 1)(5c + 1)$
29. $8s^2(2s - 1)(2s + 1)$ **31.** cannot be factored
33. $3w^2(w + 4)^2$ **35.** $(b - 5)(b - 2)(b + 2)$
37. $(9t - 1)(t^2 + 2)$ **39.** $7ab^3(a - 3)(a + 3)$ **43.** $-1, \pm 2$
45. $\frac{7}{4}, \pm 2$ **47.** $0, -5, -3$ **49.** $0, \pm 9$ **51.** $0, \pm 2$ **53.** $-\frac{1}{3}, \pm 1$
55. No; when the polynomial is factored completely, the equation becomes $(x + 2)(x^2 + 3) = 0$. When the factor $x^2 + 3$ is set equal to 0, the resulting equation, $x^2 + 3 = 0$, or $x^2 = -3$, has no real number solutions because x^2 cannot be negative. **57.** 12 yd, 4 yd, 2 yd
59. $(2b - a)(2b - 3)(2b + 3)$ **61.** $(3x + 4)(2x - 1)$
63. $(4n - 3)(3n - 1)$ **65.** $(3w + 2)(7w - 2)$

8.8 Problem Solving **69. a.** $4w^2 + 16w$ **b.** 4 in. long by 4 in. wide by 8 in. high **71. a.** 1, about -0.2
b. The zero $t \approx -0.2$ has no meaning because t, which represents time in seconds, cannot be negative in this situation. The zero $t = 1$ means that the ball lands on the ground 1 second after you throw it.
73. a. $-h^3 + 5h^2 + 36h$ **b.** 4 in. long by 9 in. wide by 5 in. high, 3 in. long by 10 in. wide by 6 in. high
c. 4 in. long by 9 in. wide by 5 in. high; the 4-inch long box has a surface area of 202 square inches and the 3-inch long box has a surface area of 216 square inches.

Chapter Review **1.** degree of the polynomial
3. A factorable polynomial with integer coefficients is factored completely if it is written as a product of unfactorable polynomials with integer coefficients. *Sample answer:* $3x(x - 4)(2x + 1)$ **5.** A
7. $x^3 - 8x^2 + 15x$ **9.** $11y^5 + 4y^2 - y - 3$ **11.** $5s^3 - 7s + 13$ **13.** $x^3 - 5x^2 + 7x - 3$ **15.** $x^2 - 2x - 8$ **17.** $z^2 - 3z - 88$ **19.** $18n^2 + 27n + 7$ **21.** $3x^2 + 10x - 8$
23. $36y^2 + 12y + 1$ **25.** $16a^2 - 24a + 9$ **27.** $9s^2 - 25$
29. 0, 11 **31.** 0, 9 **33.** $0, \frac{1}{3}$ **35.** $(s + 11)(s - 1)$
37. $(a + 12)(a - 7)$ **39.** $(x + 8)(x - 4)$ **41.** $(c + 5)(c + 3)$
43. $\frac{1}{7}, 1$ **45.** $\frac{2}{3}, -2$ **47.** $-\frac{3}{2}, -3$ **49.** 3 sec
51. $(z - 15)(z + 15)$ **53.** $12(1 - 2n)(1 + 2n)$
55. $(4p - 1)^2$ **57.** 1 sec **59.** $(y + 3)(y + x)$
61. $5s^2(s - 5)(s + 5)$ **63.** $2z(z + 6)(z - 5)$
65. $(2b + 3)(b - 2)(b + 2)$

Chapter 8 Extra Practice

1. $7x^2 - 2$ **3.** $7m^2 - 5m - 3$
5. $6b^3 - 3b^2 - 8b + 8$ **7.** $10x^7 - 15x^6 + 25x^5 - 5x^4$
9. $8x^2 + 16x + 6$ **11.** $3x^2 + 8x - 35$ **13.** $x^2 + 20x + 100$
15. $16x^2 - 4$ **17.** $36 - 9t^2$ **19.** $-8, 2$ **21.** $\frac{3}{5}, 2$
23. $-\frac{1}{4}, 0$ **25.** $(y + 3)(y + 4)$ **27.** $(x - 4)(x + 9)$
29. $(m - 25)(m - 4)$ **31.** 2, 5 **33.** 4, 9 **35.** 2, 5
37. $-(x - 3)(x - 2)$ **39.** $(2k - 1)(2k - 5)$
41. $-(3s + 1)(s + 2)$ **43.** $\frac{2}{3}, 4$ **45.** $-2, \frac{1}{2}$ **47.** $-1, \frac{1}{16}$
49. $(y + 6)(y - 6)$ **51.** $3(2y - 3)(2y + 3)$ **53.** $(2x - 3)^2$
55. $(g + 5)^2$ **57.** $(2w + 7)^2$ **59.** $(3z - 1)(z - 5)$
61. $(3y^2 + 2)(y + 5)$ **63.** $2m(7m - 3)(7m + 3)$
65. $(h + 3)(h - 3)(2h - 3)$