CP Algebra 2

Unit 3 – Chapter 6

Polynomials and Polynomial Functions

Worksheet Packet

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Learning Targets:

Polynomials: The Basics	1. I can classify polynomials by degree and number of terms. 2. I can use polynomial functions to model real life situations and make predictions 3. I can identify the characteristics of a polynomial function, such as the intervals of increase/decrease, intercepts, domain/range, relative minimum/maximum, and end behavior.
Factors and Zeros	4. I can write standard form polynomial equations in factored form and vice versa. 5. I can find the zeros (or x-intercepts or solutions) of a polynomial in factored form and identify the multiplicity of each zero. 6. I can write a polynomial function from its real roots.
Dividing Polynomials	7. I can use long division to divide polynomials. 8. I can use synthetic division to divide polynomials. 9. I can use synthetic division and the Remainder Theorem to evaluate polynomials.
Solving Polynomials	10. I can use the fundamental theorem of algebra to find the *expected* number of roots. 11. I can solve polynomials by graphing (with a calculator). 12. I can solve polynomials by factoring.
Finding and Using Roots	13. I can find all of the roots of a polynomial. 14. I can write a polynomial function from its complex roots.
Graphing	15. I can graph polynomials.

NAME _____ PERIOD _____

CP Algebra 2 DYR #1 Name_____

DO YOU REMEMBER

Factor each polynomial completely. Write PRIME if it cannot be factored.

1) $6a^2x^2 + 15a^2x$

2) $2x^2 + 3xy – 10x – 15y$

3) $(x-3)^2 - 4$

4) $5x^2 + 15x + 10$

5) $3x^2 + 6x + 15$

6) $16a^4 – 1$

7) $16x^2 – 8x + 1$

8) $4x^2 + 3x + 6$

9) $6x^2 + 11x – 10$

10) $3a^2 + 21b + ab + 7b$

11) $8x^2 – 2x – 15$

12) $2x^2 – 11x – 15$

13) $4x^2 + 9$

**14) $8x^3 – 27$

15) $10k^2 – 4k + 15hk – 6h$

16) $2x(x+4) – 3(x+ 4)$

17) $18x^2y – 24xy + 8y$

18) $2x^2y + 16y$

19) $9x^2 – 4y^2$

20) $4x^2 + 20x + 25$

21) $3x^2 + 13x + 14$

22) $12x^2 – 75$

Answers:

1) $3a^2x(2x + 5)$ 2) $(x - 5)(2x + 3y)$ 3) $(x - 1)(x - 5)$ 4) $5(x + 2)(x + 1)$

5) $3(x^2 + 2x + 5)$ 6) $(4a^2 + 1)(2a + 1)(2a - 1)$ 7) $(4x - 1)^2$ 8) PRIME 9) $(2x+5)(3x-2)$

10) $(3a + b)(a + 7)$ 11) $(2x-3)(4x+5)$ 12) $(x-3)(2x - 5)$ 13) PRIME

14) $(2x - 3)(4x^2 + 6x + 9)$ 15) $(2k+3h)(5k-2)$ 16) $(x + 4)(2x - 3)$ 17) $2y(3x - 2)^2$

18) $2y(x + 2)(x^2 - 2x + 4)$ 19) $(3x+2y)(3x-2y)$ 20) $(2x + 5)^2$ 21) $(x+2)(3x+7)$ 22) $3(2x+5)(2x-5)$

CP Algebra 2 DYR#2 **Name**_____

Do You Remember ?

1) Factor: $\mathbf{2x^3 - 2x^2 + 3x - 3}$

2) Solve by factoring: $2x^3 + 9x^2 = 5x$

3) Find the vertex of $y = 3(x-2)^2 + 7$

4) Find the discriminant and the number of solutions:

$\mathbf{2x^2 - 4x - 5} = 0$

5) Solve: $\mathbf{x^2 + 49} = 0$

6) Solve: $\mathbf{9x^2} = 49$

7) Write an equation of the line parallel to $y = \frac{3}{4}x + 7$ that goes through the point (2, 1).

8) Use the quadratic formula to solve:

$\mathbf{5x^2 - 2x = -1}$

Answers:

1)$(2x^2+3)(x-1)$ 2) 2 3) (2, 7) 4) Discrim. = 56, 2 solutions 5) $\pm 7i$

6) $\pm\frac{7}{3}$ 7) $y = \frac{3}{4}x - \frac{1}{2}$ 8) $\frac{1 \pm 2i}{5}$

Name _____ **Class** _____ **Date** _____

LT 1. I can classify polynomials by degree and number of terms.
LT 2. I can use polynomial functions to model real life situations and make predictions
LT 3. I can identify the characteristics of a polynomial function, such as the intervals of increase/decrease, intercepts, domain/range, relative minimum/maximum, and end behavior.

WS # 3 Practice 6-1 Polynomial Functions

Find a cubic model for each function.

Then use your model to estimate the value of y when $x = 7$.

1.

x	0	2	4	6	8	10
y	25	21	20	23	19	17

2.

x	0	2	4	6	8	10
y	3.1	4.2	4.3	4.4	5.1	6.7

Write each polynomial in standard form. Then classify it by degree and by number of terms.

3. $4x + x + 2$
4. $-3 + 3x - 3x$
5. $6x^4 - 1$
6. $1 - 2s + 5s^4$
7. $5m^2 - 3m^2$
8. $x^2 + 3x - 4x^3$
9. $-1 + 2x^2$
10. $5m^2 - 3m^3$
11. $5x - 7x^2$
12. $2 + 3x^3 - 2$
13. $6 - 2x^3 - 4 + x^3$
14. $6x - 7x$
15. $a^3(a^2 + a + 1)$
16. $x(x + 5) - 5(x + 5)$
17. $p(p - 5) + 6$
18. $(3c^2)^2$
19. $-(3 - b)$
20. $6(2x - 1)$
21. $\frac{2}{3} + s^2$
22. $\frac{2x^4 + 4x - 5}{4}$
23. $\frac{3 - z^5}{3}$

24. The lengths of the sides of a triangle are $x + 4$ units, x units, and $x + 1$ units. Express the perimeter of the triangle as a polynomial in standard form.

25. Find a cubic function to model the data below. (Hint: Use the number of years past 1940 for x.) Then use the function to estimate the average monthly Social Security Benefit for a retired worker in 2010.

Average Monthly Social Security Benefits, 1940–2003

Year	1940	1950	1960	1970	1980	1990	2000	2003
Amount (in dollars)	22.71	29.03	81.73	123.82	321.10	550.50	844.60	922.10

Source: *www.infoplease.com*

26. Find a cubic function to model the data below. (Hint: Use x to represent the gestation period.) Then use the function to estimate the longevity of an animal with a gestation period of 151 days.

Gestation and Longevity of Certain Animals

Animal	Rat	Squirrel	Pig	Cow	Elephant
Gestation (in days)	21	44	115	280	624
Longevity (in years)	3	9	10	12	40

Practice 6-2

Find the relative maximum, relative minimum, and zeros of each function. Then state the intervals on which the function is increasing or decreasing. Then state domain and range.

23. $f(x) = x^3 - 7x^2 + 10x$

24. $f(x) = x^3 - x^2 - 9x + 9$

Name _____ **Class** _____ **Date** _____

LT 4. I can write standard form polynomial equations in factored form and vice versa.
LT 5. I can find the zeros (or x-intercepts or solutions) of a polynomial in factored form and identify the multiplicity of each zero.
LT 6. I can write a polynomial function from its real roots.

WS #4 Practice 6-2 Polynomials and Linear Factors

For each function, determine the zeros. State the multiplicity of any multiple zeros.

1. $y = (x - 5)^3$
2. $y = x(x - 8)^2$
3. $y = (x - 2)(x + 7)^3$

4. $f(x) = x^4 - 8x^3 + 16x^2$
5. $f(x) = 9x^3 - 81x$
6. $y = (2x + 5)(x - 3)^2$

Write each function in standard form.

7. $y = (x - 5)(x + 5)(2x - 1)$
8. $y = (2x + 1)(x - 3)(5 - x)$

Write each expression as a polynomial in standard form.

14. $x(x - 1)^2$
15. $(x + 3)^2(x + 1)$
16. $(x + 4)(2x - 5)(x + 5)^2$

9. A rectangular box is 24 in. long, 12 in. wide, and 18 in. high. If each dimension is increased by x in., write a polynomial function in standard form modeling the volume V of the box.

WS# 4

Write a polynomial function in standard form with the given zeros.

10. $-1, 3, 4$ 11. $1, 1, 2$ 12. $-3, 0, 0, 5$ 13. -2 multiplicity 3

Write each function in factored form. Check by multiplication.

17. $y = 2x^3 + 10x^2 + 12x$ 18. $y = x^4 - x^3 - 6x^2$ 19. $y = -3x^3 + 18x^2 - 27x$

25. $x^3 - 6x^2 - 16x$ 26. $x^3 + 7x^2 + 12x$ 27. $x^3 - 8x^2 + 15x$

28. A rectangular box has a square base. The combined length of a side of the square base, and the height is 20 in. Let x be the length of a side of the base of the box.
    a. Write a polynomial function in factored form modeling the volume V of the box.

    b. What is the maximum possible volume of the box?

Name _____ **Class** _____ **Date** _____

LT 7. I can use long division to divide polynomials.
LT 8. I can use synthetic division to divide polynomials.
LT 9. I can use synthetic division and the Remainder Theorem to evaluate polynomials.

WS# 7 Practice 6-3 Dividing Polynomials

Divide using long division. Check your answers.

19. $(x^2 - 13x - 48) \div (x + 3)$

20. $(2x^2 + x - 7) \div (x - 5)$

21. $(x^3 + 5x^2 - 3x - 1) \div (x - 1)$

22. $(3x^3 - x^2 - 7x + 6) \div (x + 2)$

WS #7

Divide using synthetic division.

5. $(x^3 - 8x^2 + 17x - 10) \div (x - 5)$

6. $(x^3 + 5x^2 - x - 9) \div (x + 2)$

7. $(-2x^3 + 15x^2 - 22x - 15) \div (x - 3)$

8. $(x^3 + 7x^2 + 15x + 9) \div (x + 1)$

9. $(x^3 + 2x^2 + 5x + 12) \div (x + 3)$

10. $(x^3 - 5x^2 - 7x + 25) \div (x - 5)$

WS# 7

11. $(x^4 - x^3 + x^2 - x + 1) \div (x - 1)$

12. $\left(x^4 + \frac{5}{3}x^3 - \frac{2}{3}x^2 + 6x - 2\right) \div \left(x - \frac{1}{3}\right)$

13. $(x^4 - 5x^3 + 5x^2 + 7x - 12) \div (x - 4)$

14. $(2x^4 + 23x^3 + 60x^2 - 125x - 500) \div (x + 4)$

Divide using an appropriate method.

25. $(6x^3 + 2x^2 - 11x + 12) \div (3x + 4)$

26. $(x^4 + 2x^3 + x - 3) \div (x - 1)$

27. $(2x^4 + 3x^3 - 4x^2 + x + 1) \div (2x - 1)$

28. $(x^5 - 1) \div (x - 1)$

Divide using an appropriate method.

29. $(x^4 - 3x^2 - 10) \div (x - 2)$

30. $(3x^3 - 2x^2 + 2x + 1) \div \left(x + \frac{1}{3}\right)$

Determine whether each binomial is a factor of $x^3 + 3x^2 - 10x - 24$.

1. $x + 4$
2. $x - 3$
3. $x + 6$
4. $x + 2$

Use synthetic division and the Remainder Theorem to find $P(a)$.

15. $P(x) = 3x^3 - 4x^2 - 5x + 1$; $a = 2$

16. $P(x) = x^3 + 7x^2 + 12x - 3$; $a = -5$

WS# 7

17. $P(x) = x^3 + 6x^2 + 10x + 3$; $a = -3$

18. $P(x) = 2x^4 - 9x^3 + 7x^2 - 5x + 11$; $a = 4$

Use synthetic division and the given factor to completely factor each polynomial function.

23. $y = x^3 + 3x^2 - 13x - 15$; $(x + 5)$

24. $y = x^3 - 3x^2 - 10x + 24$; $(x - 2)$

31. A box is to be mailed. The volume in cubic inches of the box can be expressed as the product of its three dimensions: $V(x) = x^3 - 16x^2 + 79x - 120$. The length is $x - 8$. Find linear expressions for the other dimensions. Assume that the width is greater than the height.

CP Algebra 2 Unit 3 **Name _____**

WS# 8

LT 7. I can use long division to divide polynomials.
LT 8. I can use synthetic division to divide polynomials.
LT 9. I can use synthetic division and the Remainder Theorem to evaluate polynomials.

Use long division:

1) $(3x^3 + x^2 – 4x + 2) \div (x - 1)$

Ans._____

2) $(2x^3 + 3x^2 – 4x - 7) \div (x^2 – 2)$

Ans._____

3) $(12x^4 - 5x^2 – 3) \div (x – 2)$

Ans._____

Use synthetic division:

4) $(3x^4 + 12x^3 –5x^2 – 18x + 8) \div (x + 4)$

Ans._____

WS# 8 continued

Use synthetic division:

5) $(x^3 – 2x^2 – 19) \div (x - 3)$

Ans._____

Use the remainder theorem to evaluate the function.

6) $f(x) = 3x^3 – 7x^2 + 4x – 2$ when $x = -2$

f( ) =_____

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7) $f(x) = 2x^3 + 6x^2 – 8$ when $x = 1$

f( ) =_____

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8) Given $f(x) = x^3 + 3x^2 – 4$ and one factor is $(x + 2)$. Find:

a) remaining factors

b) all of the zeros/roots

ANSWERS:

1) $2x^2 + 3x – 1 + 1/(x-1)$ 2) $2x + 3 + -1/(x^2 – 2)$ 3) $12x^3 + 24x^2 + 43x + 86 + 169/(x-2)$
4) $3x^3 – 5x + 2$ 5) $x^2 + x + 3 + -10/(x-3)$ 6) –62 7) 0 8a) (x+2)(x-1) 8b) -2,-2,1

Name _____ **Class** _____ **Date** _____

10. I can use the fundamental theorem of algebra to find the *expected* number of roots.
11. I can solve polynomials by graphing (with a calculator).
12. I can solve polynomials by factoring.

WS# 9 Practice 6-4 Solving Polynomial Equations

Factor each expression.

25. $x^3 - 125$

26. $x^4 - 8x^2 + 15$

27. $x^4 + x^2 - 2$

28. $x^3 + 1$

29. $x^4 - 2x^2 - 24$

30. $x^4 + 10x^2 + 9$

31. $x^3 + 27$

32. $x^4 + 7x^2 - 18$

Factor the expression on the left side of each equation. Then solve the equation.

1. $8x^3 - 27 = 0$

2. $x^3 + 64 = 0$

3. $2x^3 + 54 = 0$

4. $2x^3 - 250 = 0$

WS# 9

Factor the expression on the left side of each equation. Then solve the equation.

5. $4x^3 - 32 = 0$

6. $27x^3 + 1 = 0$

7. $64x^3 - 1 = 0$

8. $x^3 - 27 = 0$

9. $x^4 - 5x^2 + 4 = 0$

10. $x^4 - 12x^2 + 11 = 0$

11. $x^4 - 10x^2 + 16 = 0$

12. $x^4 - 8x^2 + 16 = 0$

13. $x^4 - 9x^2 + 14 = 0$

14. $x^4 + 13x^2 + 36 = 0$

15. $x^4 - 10x^2 + 9 = 0$

16. $x^4 + 3x^2 - 4 = 0$

Solve each equation.

33. $x^4 - x = 0$

34. $3x^4 + 18 = 21x^2$

35. $2x^4 - 26x^2 - 28 = 0$

36. $5x^4 + 50x^2 + 80 = 0$

WS#9

Solve each equation.

37. $x^4 - 81 = 0$

38. $x^4 = 25$

39. $x^5 = x^3 + 12x$

40. $x^4 + 12x^2 = 8x^3$

17. Over 3 yr, Lucia saved \$550, \$600, and \$650 from baby-sitting jobs. The polynomial $550x^3 + 600x^2 + 650x$ represents her savings, with interest, after 3 yr. The annual interest rate equals $x - 1$. Find the interest needed so she will have \$2000 after 3 yr.

Solve each equation by graphing. Where necessary, round to the nearest hundredth. (Use 2nd calc zero or 2nd calc intersect)

18. $2x^4 = 9x^2 - 4$

19. $x^2 - 16x = -1$

20. $6x^3 + 10x^2 + 5x = 0$

21. $36x^3 + 6x^2 = 9x$

22. $15x^4 = 11x^3 + 14x^2$

23. $x^4 = 81x^2$

24. The product of three consecutives integers $n - 1$, n, and $n + 1$ is -336. Write and solve an equation to find the numbers.

CP Algebra 2 Name_____ Pd _____
WS# 10 LT

LT 1. I can classify polynomials by degree and number of terms.
Perform the indicated operations. Put your answers in standard form. Then classify the polynomial by degree and number of terms

1. $\left(3n^2+5n-6\right)+\left(-n^2-3n+3\right)$

2. $\left(3x^2-4x-2\right)-\left(-x^2-4x+7\right)$

3. $3x\left(x^2-2x+4\right)$

4. $\left(2x-1\right)\left(x-5\right)$

5. $\left(2x-1\right)\left(x^2-x+3\right)$

6. $\left(x-5\right)^3$

Put each polynomial in standard form, state its degree, leading term and whether it is a monomial, binomial, trinomial or polynomial (more than 4 terms).

	Standard Form	**degree**	**Leading term**	**classify**
7. $5x+7x^3-2x$				
8. $4x^2+10+2x-2x^2$				
9. $8y^5-5y^6+7y^5-15y^5$				

CP Algebra 2 Name_____ Pd _____

WS# 11 LT12 and review

LT12. I can solve polynomials by factoring and LT Review: Practice Factoring

Factor completely. If the expression is prime, say so.

9. $18y^3 + 24y^2 + 8y$

10. $6c^3 - 16c^2 + 10c$

11. $5u^2 - 6u - 2$

12. $y^4 + 8y^2 - 20$

13. $p^3 - 2p^2 + 4p - 8$

14. $8x^3 + 27$

15. $a^2bc - 4bc + a^2b - 4b$
(Hint: GCF, then factor by grouping)

16. $-4n^4 + 40n^3 - 100n^2$
(Hint: Use a negative GCF)

17. $125x^3 - 64$

18. $x^5 + 14x^3 + 13x$

Solve each equation for all zeros in the complex plane.

19. $y^2 - 3y + 2 = 0$

20. $4x^3 - 12x^2 + 8x = 0$

21. $k^2 + 9 = 10k$

22. $y^4 - 10y^2 + 9 = 0$

23. $4x^4 - 2x^2 - 4 = 2$

24. $64x^3 + 8 = 0$

Name _____ **Class** _____ **Date** _____

LT 13. I can find all of the roots of a polynomial.
LT 14. I can write a polynomial function from its complex roots.

WS# 12 Practice 6-5 Theorems About Roots of Polynomial Equations

A polynomial equation with rational coefficients has the given roots. Find two additional roots.

1. $2 + 3i$ and $\sqrt{7}$

2. $3 - \sqrt{2}$ and $1 + \sqrt{3}$

3. $-4i$ and $6 - i$

4. $5 - \sqrt{6}$ and $-2 + \sqrt{10}$

Find a fourth-degree polynomial equation with integer coefficients that has the given numbers as roots.

5. $2i$ and $4 - i$

6. $\sqrt{2}$ and $2 - \sqrt{3}$

7. $3i$ and $\sqrt{6}$

8. $2 + i$ and $1 - \sqrt{5}$

Find the roots of each polynomial equation.

9. $x^3 - 5x^2 + 2x + 8 = 0$

10. $x^3 + x^2 - 17x + 15 = 0$

WS#12

11. $2x^3 + 13x^2 + 17x - 12 = 0$

12. $x^3 - x^2 - 34x - 56 = 0$

13. $x^3 - 18x + 27 = 0$

14. $x^4 - 5x^2 + 4 = 0$

15. $x^3 - 6x^2 + 13x - 10 = 0$

16. $x^3 - 5x^2 + 4x + 10 = 0$

17. $x^3 - 5x^2 + 17x - 13 = 0$

18. $x^3 + x + 10 = 0$

19. $x^3 - 5x^2 - x + 5 = 0$

20. $x^3 - 12x + 16 = 0$

21. $x^3 - 2x^2 - 5x + 6 = 0$

22. $x^3 - 8x^2 - 200 = 0$

WS#12

23. $x^3 + x^2 - 5x + 3 = 0$

24. $4x^3 - 12x^2 - x + 3 = 0$

25. $x^3 + x^2 - 7x + 2 = 0$

26. $12x^3 + 31x^2 - 17x - 6 = 0$

Use the Rational Root Theorem to list all possible rational roots for each polynomial equation. Then find any actual rational roots.

27. $x^3 + 5x^2 - 2x - 15 = 0$

28. $36x^3 + 144x^2 - x - 4 = 0$

29. $2x^3 + 5x^2 + 4x + 1 = 0$

30. $12x^4 + 14x^3 - 5x^2 - 14x - 4 = 0$

31. $5x^3 - 11x^2 + 7x - 1 = 0$

32. $x^3 + 81x^2 - 49x - 49 = 0$

Find a third-degree polynomial equation with rational coefficients that has the given numbers as roots. (Hint: conjugate pairs)

33. $3, 2 - i$

34. $5, 2i$

35. $-1, 3 + i$

36. $-7, i$

37. $-4, 4i$

38. $6, 3 - 2i$

Name _____ **Class** _____ **Date** _____

LT 13. I can find all of the roots of a polynomial.

WS# 13 Practice 6-6 The Fundamental Theorem of Algebra

Find all the zeros of each function.

1. $y = 5x^3 - 5x$

2. $f(x) = x^3 - 16x$

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

4. $y = 6x^3 + x^2 - x$

5. $f(x) = 5x^3 + 6x^2 + x$

6. $y = -4x^3 + 100x$

For each equation, state the number of complex roots, the possible number of real roots, and the possible rational roots.

7. $2x^2 + 5x + 3 = 0$

8. $3x^2 + 11x - 10 = 0$

9. $2x^4 - 18x^2 + 5 = 0$

10. $4x^3 - 12x + 9 = 0$

11. $6x^5 - 28x + 15 = 0$

12. $x^3 - x^2 - 2x + 7 = 0$

WS#13

13. $x^3 - 6x^2 - 7x - 12 = 0$

14. $2x^4 + x^2 - x + 6 = 0$

15. $4x^5 - 5x^4 + x^3 - 2x^2 + 2x - 6 = 0$

16. $7x^6 + 3x^4 - 9x^2 + 18 = 0$

17. $5 + x + x^2 + x^3 + x^4 + x^5 = 0$

18. $6 - x + 2x^3 - x^3 + x^4 - 8x^5 = 0$

Find all the zeros of each function.

19. $f(x) = x^3 - 9x^2 + 27x - 27$

20. $y = 2x^3 - 8x^2 + 18x - 72$

21. $y = x^3 - 10x - 12$

22. $y = x^3 - 4x^2 + 8$

WS# 13

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

24. $y = x^3 - 2x^2 - 11x + 12$

25. $g(x) = x^3 + 4x^2 + 7x + 28$

26. $f(x) = x^3 + 3x^2 + 6x + 4$

27. $g(x) = x^4 - 5x^2 - 36$

28. $y = x^4 - 7x^2 + 12$

29. $y = 9x^4 + 5x^2 - 4$

30. $y = 4x^4 - 11x^2 - 3$

WS# 14 CP Algebra 2 Name_____

LT 13. I can find all of the roots of a polynomial.
LT 14. I can write a polynomial function from its complex roots.

I. List all the possible rational zeros of the function.

1. $f(x) = 5x^3 - 5x^2 - 19x + 81$ _____

II. Decide whether the given x-value is a zero of the function. Explain and SHOW WORK!

2. $f(x) = 2x^3 + 5x^2 + x + 10; x = -2$ _____

III. Find all rational zeros of the function. SHOW WORK!

3. $f(x) = x^4 + 4x^3 - 6x^2 - 36x - 27$ _____

4. $f(x) = 15x^3 - 119x^2 - 10x + 16$ _____

III. Find all real zeros of the function. SHOW WORK!

6. $f(x) = x^3 - 14x^2 + 47x - 18$ _____

WS#14

IV. Find all zeros of the function. SHOW WORK!

7. $f(x) = x^4 - x^3 - 5x^2 - x - 6$ _____

V. Write a polynomial function of least degree that has real coefficients, the given zeros, and a leading coefficient of one. SHOW WORK!

8. -5,2,-2 _____

9. 8, i, -i _____

VI. Using the graphing calculator, find the zeros of the function. Round two places after the decimal. Show some work.

10. $f(x) = x^4 - 7x^3 - 3x^2 + x + 1$ _____

Answers: **3. -3, -3, 3, -1** **4. 8,** $\frac{-2}{5}, \frac{1}{3}$ **6. 9,** $\frac{5 \pm \sqrt{17}}{2}$ **7.-2, 3, i, -i**

8. $f(x) = x^3 + 5x^2 - 4x - 20$ 9. $f(x) = x^3 - 8x^2 + x - 8$

CP Algebra 2 Review WS #15 Name_____

LT 1. I can classify polynomials by degree and number of terms.
LT 7. I can use long division to divide polynomials.
LT 8. I can use synthetic division to divide polynomials.
LT 5. I can find the zeros (or x-intercepts or solutions) of a polynomial in factored form and identify the multiplicity of each zero.
LT 6. I can write a polynomial function from its real roots

LT1. I can classify polynomials by degree and number of terms.

Put each polynomial in standard form, state its degree, leading term and whether it is a monomial, binomial, trinomial or polynomial (more than 4 terms).

	standard form	degree	leading term	classify # of terms
1. $10+3x^2-8x^3$				
2. $5-8x-2x^3+2x^5+9x$				

3. Perform the indicated operations. Put your answers in standard form. Classify by degree and number of terms

a. $\left(6x^3-7x+8\right)-\left(3x^3-2\right)$ b. $x\left(2x\right)\left(x+3\right)$ c. $\left(x^2+2\right)^2$

Hint: Avoid the common mistake!

LT 7. I can use long division to divide polynomials.
LT 8. I can use synthetic division to divide polynomials.

4. Use long division:

$24x^4+31x^3+7x^2+4x+10 \div 3x+2$

5. Use synthetic division and the Remainder Theorem to find P(a).

$P\left(x\right)=-2x^4+14x^2+6\ ;\ P\left(-3\right)$

$P\left(-3\right)=$ _____

Hint: Find P(-3) some other way to see if you got it right!

WS#15

LT 5. I can find the zeros (or x-intercepts or solutions) of a polynomial in factored form and identify the multiplicity of each zero.

6. Find the zeros algebraically, showing work if it is needed. Include the multiplicity of any multiple zeros. For example, if the zeros are 4, 4, 5, 6, then write "4 (mult. of 2), 5, 6."

a. $f(x) = (x+1)^2(x+7)$ _____

b. $f(x) = 4x^3 - 4x$ _____

LT 6. I can write a polynomial function from its real roots

7. Write a polynomial having the given zeros, first in factored form, then multiply it out and put it in standard form. Show your multiplication work.

zeros: $-2,$ and 3 with a multiplicity of 2

f(x)=_____
(factored form)

f(x)=_____
(standard form)

8. The volume of a box has a width of $(x-2)$ inches. The volume is expressed as a product of the length of its dimensions and is expressed by $V(x) = x^3 + 2x^2 - 5x - 6$. Use synthetic division and the given width to completely factor $V(x)$. Put the dimensions in the blanks.

The dimensions of the box are $(x-2)$, _____, & _____ in.

CP Algebra 2 Review WS #16 **Name_____**

LT12. I can solve polynomials by factoring.
LT 3. I can identify the characteristics of a polynomial function, such as the intervals of increase/decrease, intercepts, domain/range, relative minimum/maximum, and end behavior.
LT1. I can classify polynomials by degree and number of terms
LT 13. I can find all of the roots of a polynomial.
LT 14. I can write a polynomial function from its complex roots.

LT12. I can solve polynomials by factoring.

Solve the following polynomial equations with factoring and the Zero Product Property. Show your work. Find all complex solutions. Find exact answers, using simplified radical form and/or the standard form for complex numbers when necessary.

1. $x^4 - 4x^2 - 45 = 0$

2. $8x^3 - 125 = 0$

LT 3. I can identify the characteristics of a polynomial function, such as the intervals of increase/decrease, intercepts, domain/range, relative minimum/maximum, and end behavior.
LT 13. I can find all of the roots of a polynomial.

3. Completely factor $f(x) = x^3 - 4x^2 - 20x + 48$ given that $(x+4)$ is a factor. Show the work.

Write f(x) in factored form. $f(x) =$ _____

List the zeros of f(x). The zeros are: _____

Confirm your zeros by checking the graph on your calculator. Then use the calculator to find the relative minimum and relative maximum values of the function (remember - y-values!), rounding to the nearest hundredth.

relative minimum value: _____

relative maximum value: _____

interval(s) decreasing _____

interval(s) increasing _____

WS# 16
LT1. I can classify polynomials by degree and number of terms

4. Perform the indicated operations. Put your answers in standard form. Then classify by degree and number of terms

a. $(2+5x)^2$

b. $(2y-3)(y^2+2y+1)$

LT 13. I can find all of the roots of a polynomial.
LT 14. I can write a polynomial function from its complex roots.

5. If $-7-8i$ is a root of a polynomial equation, what does the Imaginary Root Theorem tell you?

6. If $4+\sqrt{7}$ is a root of a polynomial equation, what does the Irrational Root Theorem tell you?

7. Given the polynomial equation $4x^6 + rx^5 + sx^4 + tx^3 + ux^2 + vx + 12 = 0$

a) How many complex roots will it have?

b) List the possible combinations of how many real and imaginary roots it could have.

c) Use the Rational Root Theorem to list the set of all possible rational roots.

CP Algebra 2 Review WS #17 **Name_____**

LT 12. I can solve polynomials by factoring.
LT 13. I can find all of the roots of a polynomial.

Solve the following polynomial equations with factoring and the Zero Product Property. Show your work. Find all complex solutions. Find exact answers, using simplified radical form and/or the standard form for complex numbers when necessary.

1. a) $3x^3 - 5x^2 + 24x - 40 = 0$ b) $64x^3 + 1 = 0$

2. Solve the following polynomial equations for all complex solutions. The following steps must be part of your work:

Use the Rational Root Theorem to list the set of potential rational zeros.
Use your graphing calculator to find at least one actual rational zero.
Use synthetic division to confirm at least one rational zero.
Use any other steps needed to find all complex zeros, & put them all in a box.

a. $x^3 + 4x^2 + 15x + 22 = 0$

b. $x^4 + 4x^3 - 17x^2 - 20x + 60 = 0$

WS# 18 CP Algebra 2 Name _____

LT 15. I can graph polynomials

Please enter the equation into your calculator and graph. Using the graph and you knowledge of zeroes, please answer the questions that follow.

1. $y=(x-3)^3(x+1)^2$

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

2. $y=(x-4)(x+5)$

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

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

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

4. $y=x^3(x-1)(x-5)^2$

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

5. $y=(x+2)^3(x+6)x^2$

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

zero: _____ multiplicity: _____ behavior: touch / cross

WS # 19 CP Algebra 2 Polynomial Graphing **Name _____**

LT 15. I can graph polynomials

For each of the following:

a) find left and right behaviors

b) find zeros – real and complex (factor p/q)

c) Find y-intercept

d) Graph using above information

11) $f(x) = (x + 2)(x - 2)(x - 4)$

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

13) $f(x) = (x - 1)(x - 4)(x - 3)^2$

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

15) $f(x) = x^3 - x^2 - 6x$

16) $f(x) = -x^3 + x^2 + x - 1$

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

18) $f(x) = -x^4 - 4x^3 + 12x^2 + 44x - 51$

19) $f(x) = -x^4 + 18x^2 - 81$

20) $f(x) = x^4 - 7x^3 + 9x^2 + 11x - 6$

21) $f(x) = 2x^4 + 7x^3 + 14x^2 + 63x - 36$

CP Algebra 2 Chapter 6 Review WS#20 **Name** _____
Unit 3 Review

Chapter 6 Review

Solve by factoring.

1. $(3x+2)(x-5)=0$

2. $4x^2-2x=0$

3. $3x^2+9x=-6$

4. $x^3+2x^2-7x-14=0$

Use long division.

5. $(16x^3-12x^2-4)\div(4x^2+1)$

Use synthetic division.

6. $(2x^4+5x^3+6x-9)\div(x+2)$

7. **Write the polynomial function whose zeros are 2 and $\pm 3i$.**

CP Algebra 2 Unit 3 Review WS# 20

8. Write the polynomial function whose x-intercepts are $(-1,0),(3,0),(4,0)$.

9. Find all the zeros. $f(x)=x^4-x^3-11x^2+5x+30$

10. Write as a product of linear factors. $f(x)=30x^3-19x^2-14x+8$

Answers

1. $\left\{-\frac{2}{3},5\right\}$
2. $\left\{0,\frac{1}{2}\right\}$
3. $\{-2,-1\}$
4. $\{-2,\pm\sqrt{7}\}$
5. $4x-3+\frac{-4x-1}{4x^2+1}$
6. $2x^3+x^2-2x+10-\frac{29}{x+2}$
7. $f(x)=x^3-2x^2+9x-18$
8. $f(x)=x^3-6x^2+5x+12$
9. $\{\pm\sqrt{5},-2,-3\}$
10. $f(x)=(x-4)(3x+2)(2x-1)$

CP Algebra 2 Chapter 6 Review WS# 21 **Name _____**
ARE YOU REALLY READY FOR THE TEST

Use long division:

1) $(x^4 - 3x^3 + 3x^2 - 6x + 2) \div (x^2 + 2)$

Ans._____

2) $(4x^3 - 7x + 8) \div (2x - 1)$

Ans._____

Use synthetic division:

3) $(2x^3 - 7x^2 - x - 12) \div (x - 4)$

Ans._____

4) $(x^4 - 5x^3 + 4x - 17) \div (x - 5)$

Ans._____

5) Use the remainder theorem to evaluate $f(x) = 4x^2 - 16x + 9$ at $x = 5$.

ARE YOU REALLY READY FOR THE TEST WS 21

6) Write the polynomial function given the zeros are $-2, \pm i$.

$f(x) =$ _____

7) Write the polynomial function given the zeros are 3, 1 (double root).

$f(x) =$ _____

8) Write the polynomial function given the x- intercepts are $(-1,0)$, $(2,0)$, and $(4,0)$.

$f(x) =$ _____

9) Find all the zeros of $f(x) = 2x^3 - 5x^2 - 4X + 10$. (Hint: p/q)

ARE YOU REALLY READY FOR THE TEST WS 21

10) Find all the zeros of $f(x) = 2x^4 + 3x^3 - 6x^2 - 6x + 4$.

Ans. _____

11) Write as a product of prime factors: $2x^3 + 3x^2 - 11x - 6$.

Ans. _____

ARE YOU REALLY READY FOR THE TEST WS 21

12) Write as the product of prime factors:
$3x^4 + 11x^3 + 8x^2 + 44x - 16.$

Ans. _____

Solve by factoring.

13) $(4X - 5)(7X + 2) = 0$

14) $3X^2 + 12X = 0$

15) $4X^2 + 4X = 24$

16) $X^3 + 8X^2 = -16X$

17) $4X^2 + 11X = 3$

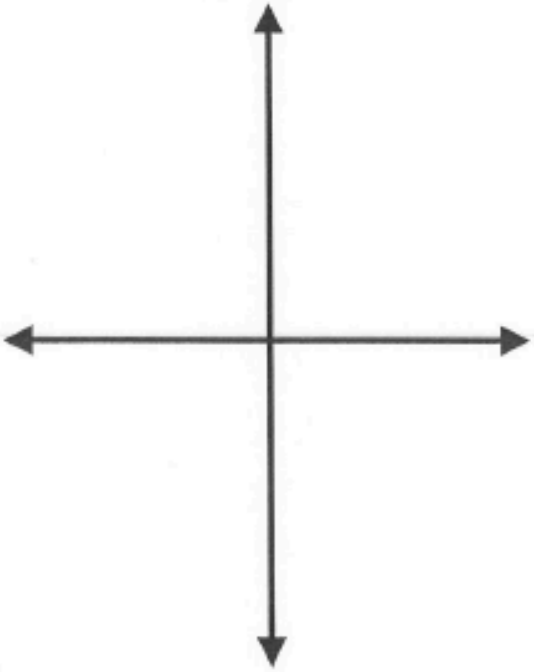
18) $X^3 + 2X^2 - 9X - 18 = 0$

ARE YOU REALLY READY FOR THE TEST WS 21

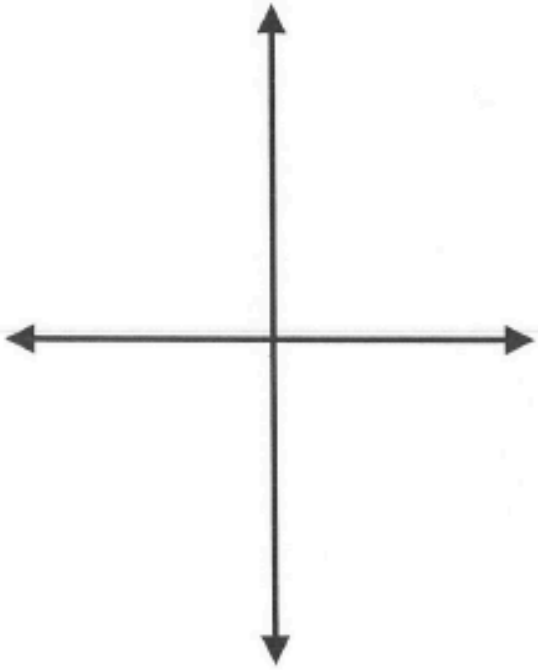
GRAPH EACH OF THE FOLLOWING & FIND:

a) End behavior b) y-intercept c) x-intercepts d) # of turns

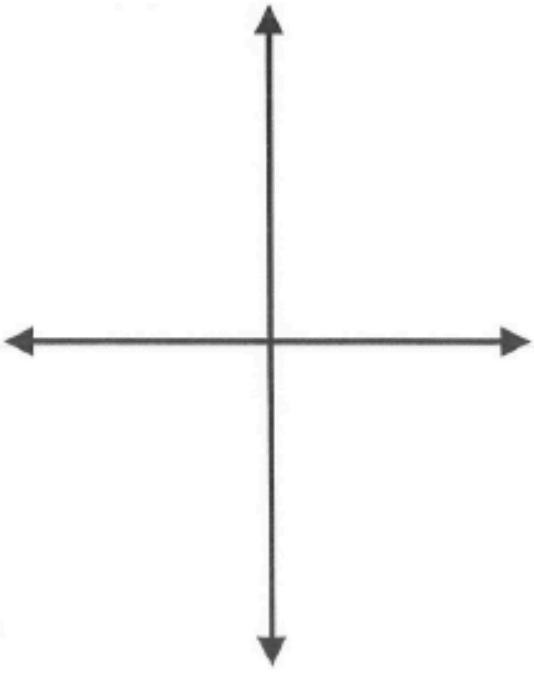
19) $f(x) = x(x+4)(x-3)$



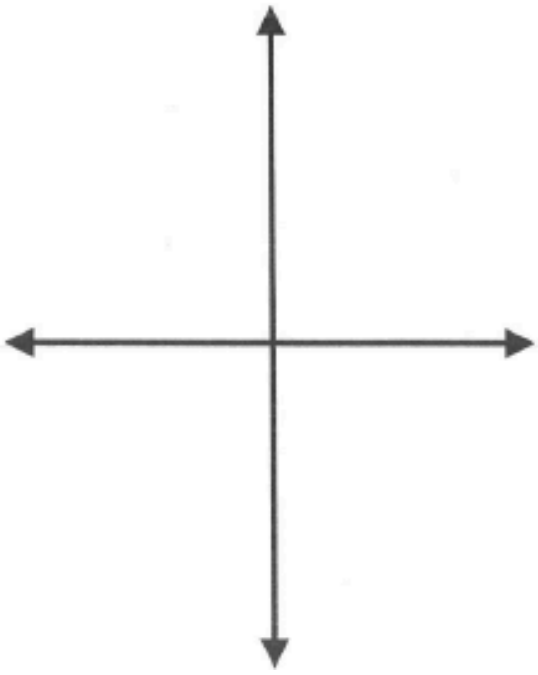
20) $f(x) = (x+1)^2(x-2)(x+3)$



21) $f(x) = -(x-1)^2(x+2)^2(x-3)^2$



22) $f(x) = -3x(x+3)^2(2x-3)$



WS# 21 Warm Up WS Practice 6-2 Name _____

LT 15. I can graph polynomials.

Find the zeros of each function. Then graph the function.

20. $y = (x + 1)(x - 1)(x - 3)$ 21. $y = (x + 2)(x - 3)$ 22. $y = x(x - 2)(x + 5)$

What Happens to People Who Don't Know Toothpaste From Putty ?

Factor completely each polynomial. Find your answer below and notice the letter next to it. Write this letter in each box containing the number of that exercise.

(1) $3x^3 + 21x^2 + 30x$
(2) $x^4 + x^3 - 56x^2$
(3) $x^2 + 5x + xy + 5y$
(4) $36x^3 - 64x$
(5) $x^2 - xd + 7x - 7d$
(6) $35x^2 - 100x - 15$
(7) $xy + 8x - y^2 - 8y$
(8) $2ax^2 - 22ax + 60a$
(9) $x^4 - y^4$
(10) $x^3 - 9x + 5x^2 - 45$
(11) $2ax^2 + 8ax + x + 4$
(12) $x^4 - 29x^2 + 100$
(13) $x^2y^2 - y^2 - 15x^2 + 15$
(14) $8x^4 + 56x^3 + 98x^2$

Answers:

(V) $x^2(x + 28)(x + 2)$
(N) $(x + y)(x + 5)$
(F) $(x - y)(y + 8)$
(R) $3x(x + 5)(x + 2)$
(S) $(x + 7)(x - d)$
(M) $(x - 2y)(y + 4)$
(A) $x^2(x + 8)(x - 7)$
(E) $5(7x + 1)(x - 3)$
(K) $(x - 7)(x^2 + d)$
(T) $4x(3x + 4)(3x - 4)$
(Y) $5(7x - 1)(2x + 3)$

Answers:

(D) $(2ax + 1)(x + 4)$
(B) $(x + 5)(x - 5)(x^2 + 3)$
(W) $2x^2(2x + 7)^2$
(U) $(x^2 + y^2)(x + y)(x - y)$
(L) $(x + 2)(x - 2)(x + 5)(x - 5)$
(H) $2a(x - 6)(x - 5)$
(P) $(2ax - 4)(x + 1)$
(O) $(y^2 - 15)(x + 1)(x - 1)$
(I) $(x + 5)(x + 3)(x - 3)$
(G) $(y^2 - 15)(x + 5)(x - 2)$
(C) $2a(x + 15)(x - 2)$

4	8	6	10	1	14	10	3	11	13	14	5	7	2	12	12	13	9	4

CP Algebra 2 WS# 23 Practice Factoring Name

What Should You Say If You See a Tall, Wrought-Iron Tower in Paris, France?

Factor completely each polynomial. Find your answer below and notice the two letters next to it. Write these letters in the two boxes above the exercise number at the bottom of the page.

(1) $3n^2 - 17n + 24$

(2) $4x^3y - 49xy^3$

(3) $5x^2 + 20xy - 60y^2$

(4) $3x^3 - x^2y + 12x - 4y$

(5) $2x^4y - 3x^3y - 20x^2y$

(6) $9x^3y + 33x^2y^2 + 30xy^3$

(7) $16a^3b^4 + 40a^2b^5 + 8ab^3$

(8) $t^4 - 37t^2 + 36$

(9) $2a^7b^3 - 288ab$

(10) $35a^2b - 5a - 7ab^2 + b$

(11) $6a^4b^2 - 11a^3b^3 + 4a^2b^4$

(12) $t^2(t+3) + 6t(t+3) + 9(t+3)$

Answers:

(AD) $5(x + 4y)(x + 3y)$

(AN) $x^2y(2x + 5)(x - 4)$

(OL) $(3n - 6)(n + 4)$

(UI) $xy(2x - 7y)(2x + 7y)$

(TH) $3xy(3x + 5y)(x + 2y)$

(EF) $5(x + 6y)(x - 2y)$

(ET) $(x^2 + 2)(3x + 2y)$

(SR) $(3n - 8)(n - 3)$

(FO) $xy(9x + 5y)(x - 7y)$

(LL) $(x^2 + 4)(3x - y)$

(NT) $x^2y(2x + 1)(x + 10)$

Answers:

(IS) $2ab(a^2b^2 + 12)(a^4b^2 + 12)$

(OT) $(t + 3)^2(t - 1)^2$

(TE) $8ab^3(2a^2b + 5ab^2 + 1)$

(AT) $2ab(a^3b + 12)(a^3b - 12)$

(EY) $(t + 3)^3$

(EP) $a^2b^2(2a + b)(3a - 2b)$

(YQ) $(t + 1)(t - 1)(t + 6)(t - 6)$

(UL) $(5a - b)(7ab - 1)$

(LS) $8ab^3(2ab^2 + 5ab^3 + 1)$

(IX) $(5a - 2b)(7ab - 5)$

(EA) $a^2b^2(2a - b)(3a - 4b)$

6	9	1	11	4	8	2	7	5	12	3	10

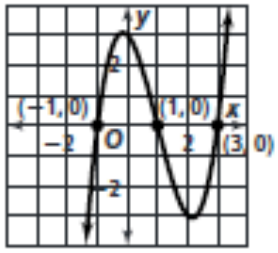
Chapter 6 Answers

Practice 6-1

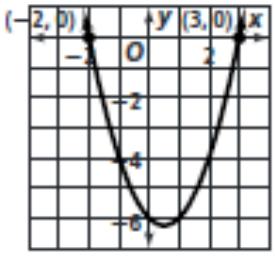
1. $y = -0.0439814815x^3 + 0.6507936508x^2 - 2.935185185x + 24.84126984$; 21.098 **2.** $y = 0.0130787037x^3 - 0.1743055556x^2 + 0.7951058201x + 3.125396825$; 4.6362
3. $5x + 2$; linear binomial **4.** -3; constant monomial
5. $6x^4 - 1$; quartic binomial **6.** $5s^4 - 2s + 1$; quartic trinomial **7.** $2m^2$; quadratic monomial **8.** $-4x^3 + x^2 + 3x$; cubic trinomial **9.** $2x^2 - 1$; quadratic binomial **10.** $-3m^3 + 5m^2$; cubic binomial **11.** $-7x^2 + 5x$; quadratic binomial
12. $3x^3$; cubic monomial **13.** $-x^3 + 2$; cubic binomial
14. $-x$; linear monomial **15.** $a^5 + a^4 + a^3$; quintic trinomial
16. $x^2 - 25$; quadratic binomial **17.** $p^2 - 5p + 6$; quadratic trinomial **18.** $9c^4$; quartic monomial
19. $b - 3$; linear binomial **20.** $12x - 6$; linear binomial
21. $s^2 + \frac{2}{3}$; quadratic binomial **22.** $\frac{1}{2}x^4 + x - \frac{5}{4}$; quartic trinomial **23.** $-\frac{1}{3}z^5 + 1$; quintic binomial **24.** $3x + 5$ units
25. $0.0008797x^3 + 0.2229900x^2 - 3.1465532x + 29.0544437$; about \$1203.18
26. $0.0000006x^3 - 0.0005101x^2 + 0.1270416x + 2.0612682$; about 12 yr

Practice 6-2

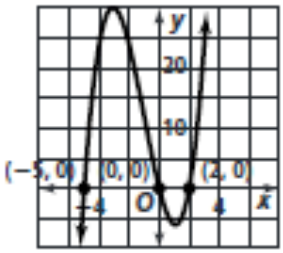
1. 5, multiplicity 3 **2.** 0; 8, multiplicity 2 **3.** 2; -7, multiplicity 3 **4.** 0, multiplicity 2; 4, multiplicity 2 **5.** $-3, 0, 3$
6. $-\frac{5}{2}$; 3, multiplicity 2 **7.** $y = 2x^3 - x^2 - 50x + 25$
8. $y = -2x^3 + 15x^2 - 22x - 15$
9. $V = x^3 + 54x^2 + 936x + 5184$
10. $y = x^3 - 6x^2 + 5x + 12$
11. $y = x^3 - 4x^2 + 5x - 2$ **12.** $y = x^4 - 2x^3 - 15x^2$
13. $y = x^3 + 6x^2 + 12x + 8$ **14.** $x^3 - 2x^2 + x$
15. $x^3 + 7x^2 + 15x + 9$
16. $2x^4 + 23x^3 + 60x^2 - 125x - 500$
17. $y = 2x(x + 2)(x + 3)$
18. $y = x^2(x + 2)(x - 3)$ **19.** $y = -3x(x - 3)^2$
20. $-1, 1, 3$;



21. $-2, 3$;



22. $-5, 0, 2$;



23. rel. max.: 4.06; rel. min.: -8.21; zeros: 0, 2, 5
24. rel. max.: 16.9; rel. min.: -5.05; zeros: $-3, 1, 3$
25. $x(x + 2)(x - 8)$ **26.** $x(x + 3)(x + 4)$
27. $x(x - 3)(x - 5)$ **28a.** $V = x^2(20 - x)$
28b. about 1185 in.^{3}

Practice 6-3

1. yes **2.** yes **3.** no **4.** yes **5.** $x^2 - 3x + 2$
6. $x^2 + 3x - 7$, R 5 **7.** $-2x^2 + 9x + 5$ **8.** $x^2 + 6x + 9$
9. $x^2 - x + 8$, R -12 **10.** $x^2 - 7$, R -10 **11.** $x^3 + x$, R 1
12. $x^3 + 2x^2 + 6$ **13.** $x^3 - x^2 + x + 11$, R 32
14. $2x^3 + 15x^2 - 125$ **15.** -1 **16.** -13 **17.** 0 **18.** 39
19. $x - 16$ **20.** $2x + 11$, R 48 **21.** $x^2 + 6x + 3$, R 2
22. $3x^2 - 7x + 7$, R -8 **23.** $(x + 1)(x - 3)(x + 5)$
24. $(x - 2)(x + 3)(x - 4)$ **25.** $2x^2 - 2x - 1$, R 16
26. $x^3 + 3x^2 + 3x + 4$, R 1 **27.** $x^3 + 2x^2 - x$, R 1
28. $x^4 + x^3 + x^2 + x + 1$ **29.** $x^3 + 2x^2 + x + 2$, R -6
30. $3x^2 - 3x + 3$ **31.** width: $x - 3$; height: $x - 5$

Practice 6-4

1. $(2x - 3)(4x^2 + 6x + 9)$; $\frac{3}{2}, \frac{-3 \pm 3i\sqrt{3}}{4}$
2. $(x + 4)(x^2 - 4x + 16)$; $-4, 2 \pm 2i\sqrt{3}$
3. $2(x + 3)(x^2 - 3x + 9)$; $-3, \frac{3 \pm 3i\sqrt{3}}{2}$
4. $2(x - 5)(x^2 + 5x + 25)$; $5, \frac{-5 \pm 5i\sqrt{3}}{2}$
5. $4(x - 2)(x^2 + 2x + 4)$; $2, -1 \pm i\sqrt{3}$
6. $(3x + 1)(9x^2 - 3x + 1)$; $-\frac{1}{3}, \frac{1 \pm i\sqrt{3}}{6}$
7. $(4x - 1)(16x^2 + 4x + 1)$; $\frac{1}{4}, \frac{-1 \pm i\sqrt{3}}{8}$
8. $(x - 3)(x^2 + 3x + 9)$; $3, \frac{-3 \pm 3i\sqrt{3}}{2}$
9. $(x + 1)(x - 1)(x + 2)(x - 2)$; $-2, -1, 1, 2$
10. $(x + 1)(x - 1)(x^2 - 11)$; $-1, 1, -\sqrt{11}, \sqrt{11}$
11. $(x^2 - 2)(x^2 - 8)$; $-\sqrt{2}, \sqrt{2}, -\sqrt{8}, \sqrt{8}$
12. $(x + 2)^2(x - 2)^2$; $-2, 2$
13. $(x^2 - 7)(x^2 - 2)$; $-\sqrt{7}, \sqrt{7}, -\sqrt{2}, \sqrt{2}$
14. $(x^2 + 4)(x^2 + 9)$; $-2i, 2i, -3i, 3i$
15. $(x + 1)(x - 1)(x + 3)(x - 3)$; $-1, 1, -3, 3$
16. $(x + 1)(x - 1)(x^2 + 4)$; $-1, 1, -2i, 2i$
17. 5.52% **18.** $-2, 2, -0.71, 0.71$ **19.** 0.06, 15.94 **20.** 0

21. $-0.59, 0, 0.42$ **22.** $-0.67, 0, 1.4$ **23.** $-9, 0, 9$
24. $(n-1)n(n+1) = -336$; $-8, -7, -6$
25. $(x-5)(x^2+5x+25)$ **26.** $(x^2-3)(x^2-5)$
27. $(x+1)(x-1)(x^2+2)$ **28.** $(x+1)(x^2-x+1)$
29. $(x^2-6)(x^2+4)$ **30.** $(x^2+1)(x^2+9)$
31. $(x+3)(x^2-3x+9)$ **32.** $(x^2-2)(x^2+9)$
33. $0, 1, \frac{-1 \pm i\sqrt{3}}{2}$ **34.** $-1, 1, -\sqrt{6}, \sqrt{6}$
35. $-\sqrt{14}, \sqrt{14}, -i, i$ **36.** $-i\sqrt{2}, i\sqrt{2}, -2i\sqrt{2}, 2i\sqrt{2}$
37. $-3, 3, -3i, 3i$ **38.** $-\sqrt{5}, \sqrt{5}, -i\sqrt{5}, i\sqrt{5}$
39. $0, -2, 2, -i\sqrt{3}, i\sqrt{3}$ **40.** $0, 2, 6$

Practice 6-5

1. $2-3i, -\sqrt{7}$ **2.** $3+\sqrt{2}, 1-\sqrt{3}$ **3.** $4i, 6+i$
4. $5+\sqrt{6}, -2-\sqrt{10}$ **5.** $x^4-8x^3+21x^2-32x+68$
6. $x^4-4x^3-x^2+8x-2$ **7.** x^4+3x^2-54
8. $x^4-6x^3+9x^2+6x-20$ **9.** $4, 2, -1$ **10.** $3, 1, -5$
11. $-4, -3, \frac{1}{2}$ **12.** $7, -2, -4$ **13.** $3; \frac{-3\pm3\sqrt{5}}{2}$
14. $-2, -1, 1, 2$ **15.** $2, 2 \pm i$ **16.** $-1, 3 \pm i$ **17.** $1, 2 \pm 3i$
18. $-2, 1 \pm 2i$ **19.** $1, -1, 5$ **20.** $-4, 2$ **21.** $-2, 1, 3$
22. $10, -1 \pm i\sqrt{19}$ **23.** $1, -3$ **24.** $3, \frac{1}{2}, -\frac{1}{2}$
25. $2, \frac{-3\pm\sqrt{13}}{2}$ **26.** $-3, \frac{2}{3}, -\frac{1}{4}$
27. $\pm1, \pm3, \pm5, \pm15$; none **28.** $\pm1, \pm2, \pm4, \pm\frac{1}{2}, \pm\frac{1}{3}, \pm\frac{2}{3}, \pm\frac{4}{3}, \pm\frac{1}{4}, \pm\frac{1}{6}, \pm\frac{1}{9}, \pm\frac{2}{9}, \pm\frac{4}{9}, \pm\frac{1}{12}, \pm\frac{1}{18}, \pm\frac{1}{36}$; $-4, -\frac{1}{6}, \frac{1}{6}$
29. $\pm1, \pm\frac{1}{2}$; $-1, -\frac{1}{2}$ **30.** $\pm1, \pm2, \pm4, \pm\frac{1}{2}, \pm\frac{1}{3}, \pm\frac{2}{3}, \pm\frac{4}{3}, \pm\frac{1}{4}, \pm\frac{1}{6}, \pm\frac{1}{12}$; none **31.** $\pm1, \pm\frac{1}{5}, \frac{1}{5}, 1$ **32.** $\pm1, \pm7, \pm49$; none
33. $x^3-7x^2+17x-15=0$ **34.** $x^3-5x^2+4x-20=0$
35. $x^3-5x^2+4x+10=0$ **36.** $x^3+7x^2+x+7=0$
37. $x^3+4x^2+16x+64=0$ **38.** $x^3-12x^2+49x-78=0$

Practice 6-6

1. $-1, 0, 1$ **2.** $-4, 0, 4$ **3.** $-\frac{1}{3}, 0, \frac{1}{2}$ **4.** $-\frac{1}{2}, 0, \frac{1}{3}$
5. $-1, -\frac{1}{5}, 0$ **6.** $-5, 0, 5$ **7.** 2; 2 or 0; $\pm1, \pm3, \pm\frac{1}{2}, \pm\frac{3}{2}$
8. 2; 2 or 0; $\pm1, \pm2, \pm5, \pm10, \pm\frac{1}{3}, \pm\frac{2}{3}, \pm\frac{5}{3}, \pm\frac{10}{3}$
9. 4; 4, 2, or 0; $\pm1, \pm5, \pm\frac{1}{2}, \pm\frac{5}{2}$ **10.** 3; 3 or 1; $\pm1, \pm3, \pm9, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{9}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}, \pm\frac{9}{4}$ **11.** 5; 5, 3, or 1; $\pm1, \pm3, \pm5, \pm15, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{5}{2}, \pm\frac{15}{2}, \pm\frac{1}{3}, \pm\frac{5}{3}, \pm\frac{1}{6}, \pm\frac{5}{6}$ **12.** 3; 3 or 1; $\pm1, \pm7$ **13.** 3; 3 or 1; $\pm1, \pm2, \pm3, \pm4, \pm6, \pm12$
14. 4; 4, 2, or 0; $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{2}, \pm\frac{3}{2}$ **15.** 5; 5, 3, or 1; $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}$ **16.** 6; 6, 4, 2 or 0; $\pm1, \pm2, \pm3, \pm6, \pm9, \pm18, \pm\frac{1}{7}, \pm\frac{2}{7}, \pm\frac{3}{7}, \pm\frac{6}{7}, \pm\frac{9}{7}, \pm\frac{18}{7}$ **17.** 5; 5, 3, or 1; $\pm1, \pm5$ **18.** 5; 5, 3, or 1; $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}, \pm\frac{1}{8}, \pm\frac{3}{8}$ **19.** 3 **20.** $4, -3i, 3i$ **21.** $-2, 1 \pm \sqrt{7}$
22. $2, 1 \pm \sqrt{5}$ **23.** $1, \frac{-1 \pm i\sqrt{5}}{2}$ **24.** $-3, 1, 4$
25. $-4, -i\sqrt{7}, i\sqrt{7}$ **26.** $-1, -1 \pm i\sqrt{3}$ **27.** $-3, 3, -2i, 2i$
28. $-2, 2, -\sqrt{3}, \sqrt{3}$ **29.** $-\frac{2}{3}, \frac{2}{3}, -i, i$
30. $-\sqrt{3}, \sqrt{3}, -\frac{1}{2}i, \frac{1}{2}i$

Practice 6-7

1. combination **2.** permutation **3.** permutation **4.** combination **5.** 12 **6.** 66 **7.** 792 **8.** 12 **9.** 1 **10.** 15 **11.** 1 **12.** 84 **13.** 1 **14.** 252 **15.** 2002 **16.** 2,118,760 **17.** 40,320 **18.** 110 **19.** 17,280 **20.** 360 **21.** 479,001,600 **22.** 239,500,800 **23.** 95,040 **24.** 12 **25.** 3024 **26.** 455 **27.** 60 **28.** 360 **29.** true, comm. prop. of mult. **30.** false; Let $a = 2$. $(2^2)! = 24 \neq 4 = (2!)^2$ **31.** false, Let $a = 2$ and $b = 3$. $2 \cdot 3! = 12 \neq 720 = (2 \cdot 3)!$ **32.** true; identity prop. of add. **33.** false; Let $a = 2$ and $b = 3$. $(2+3)! = 120 \neq 8 = 2! + 3!$ **34.** false; Let $a = 2$. $(2!)! = 2 \neq 4 = (2!)^2$

Practice 6-8

1. $x^4+8x^3+24x^2+32x+16$ **2.** $a^7+14a^6+84a^5+280a^4+560a^3+672a^2+448a+128$ **3.** $x^7+7x^6y+21x^5y^2+35x^4y^3+35x^3y^4+21x^2y^5+7xy^6+y^7$
4. $d^9-18d^8+144d^7-672d^6+2016d^5-4032d^4+5376d^3-4608d^2+2304d-512$ **5.** $256x^8-3072x^7+16128x^6-48384x^5+90720x^4-108864x^3+81648x^2-34992x+6561$ **6.** $x^9-9x^8+36x^7-84x^6+126x^5-126x^4+84x^3-36x^2+9x-1$ **7.** $64x^{12}-384x^{10}y^2+960x^8y^4-1280x^6y^6+960x^4y^8-384x^2y^{10}+64y^{12}$
8. $x^{35}+14x^{30}y+84x^{25}y^2+280x^{20}y^3+560x^{15}y^4+672x^{10}y^5+448x^5y^6+128y^7$ **9.** about 1%
10a. about 99% **10b.** about 95% **10c.** about 5%
11. about 3% **12.** about 3% **13.** about 8%
14. about 0.6% **15.** $n^3-9n^2+27n-27$
16. $16n^4+64n^3+96n^2+64n+16$ **17.** $n^5-30n^4+360n^3-2160n^2+6480n-7776$ **18.** $n^6-6n^5+15n^4-20n^3+15n^2-6n+1$ **19.** $8a^3+24a^2+24a+8$ **20.** $x^8-4x^6y^2+6x^4y^4-4x^2y^6+y^8$ **21.** $32x^5+240x^4y+720x^3y^2+1080x^2y^3+810xy^4+243y^5$
22. $64x^{12}+192x^{10}y^2+240x^8y^4+160x^6y^6+60x^4y^8+12x^2y^{10}+y^{12}$ **23.** $x^6-3x^4y^2+3x^2y^4-y^6$
24. $16b^4+32b^3c+24b^2c^2+8bc^3+c^4$
25. $243m^5-810m^4n+1080m^3n^2-720m^2n^3+240mn^4-32n^5$ **26.** $x^{18}-6x^{15}y^4+15x^{12}y^8-20x^9y^{12}+15x^6y^{16}-6x^3y^{20}+y^{24}$ **27.** $x^7+7x^6+21x^5+35x^4+35x^3+21x^2+7x+1$ **28.** $x^8+32x^7+448x^6+3584x^5+17920x^4+57344x^3+114688x^2+131072x+65536$ **29.** $x^6-18x^5y+135x^4y^2-540x^3y^3+1215x^2y^4-1458xy^5+729y^6$ **30.** $x^5+10x^4+40x^3+80x^2+80x+32$
31. $x^{10}-5x^8y^2+10x^6y^4-10x^4y^6+5x^2y^8-y^{10}$
32. $y^5+15y^4+90y^3+270y^2+405y+243$
33. $x^{12}+18x^{10}+135x^8+540x^6+1215x^4$