Chapter 2 Practice Exercises (*Optional)

2-01 Complex Numbers

1. Explain how to add complex numbers.

Plot the complex numbers on the complex plane.

2. (a) $4 - 3i$, (b) $-5i$
3. (a) $-2 + 5i$, (b) 3

Simplify. Write the result in standard form.

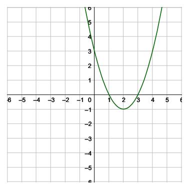
4. $\sqrt{-25} + 2\sqrt{-9}$
5. $\frac{\sqrt{-50}-\sqrt{-8}}{4}$
6. $(1 - 9i) + (-3 - 5i)$
7. $(4 - 6i) - (2 - 7i)$
8. $(2i)(3 - i)$
9. $(2 + 4i)(1 + i)$
10. $(-1 + 2i)(4 + 3i)$
11. $\frac{3-5i}{2i}$
12. $\frac{-4+i}{2-9i}$

Evaluate the function for the given complex number.

13. If $f(x) = x^2 + x$, evaluate $f(-2i)$.
14. If $f(x) = x^2 - 2x + 7$, evaluate $f(3 - 4i)$.
15. If $f(x) = \frac{x+1}{x-2}$, evaluate $f(2 + 5i)$.

Mixed Review

16. (1-05) Find zeros of $f(x) = x^2 - 9$.
17. (1-05) Find the (a) domain, (b) range, (c) interval where the graph is increasing and (d) decreasing.



18. (1-07) Describe how the graph of the function is a transformation of the graph of a parent function: $f(x) = -(x + 2)^2 - 5$
19. (1-10) Draw a scatter plot for the data provided. Find the equation of the best fitting line.

1	2	3	4	5
10	8	6	4	2

20. (1-10) y varies inversely with the square of x. When $x = 2$, then $y = 1$. Find y when x is 8.

2-02 Quadratic Equations

1. What is the advantage of writing a quadratic function in standard form?

Rewrite the quadratic functions in standard form and give the vertex.

2. $f(x) = x^2 - 6x + 10$
3. $g(x) = 2x^2 + 8x + 3$
4. $h(x) = 3x^2 - 24x + 55$

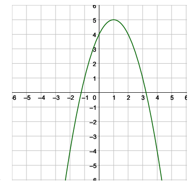
Determine whether there is a minimum or maximum value for the quadratic function. Then find the value and the axis of symmetry.

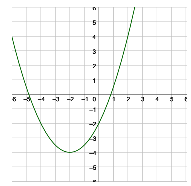
5. $j(x) = -x^2 - 2x - 5$
6. $k(x) = 3x^2 - 54x + 244$
7. $m(x) = -2x^2 - 4x + 8$

Solve the equation.

8. $x^2 + 24 = 0$
9. $x^2 - 4x + 1 = 0$
10. $x^2 - 8x + 17 = 0$
11. $4x^2 - 4x + 13 = 0$

Find the general form of the equation of the quadratic function shown in the graph.

12. 

13. 

Graph the quadratic function and give the vertex, axis of symmetry, and intercepts.

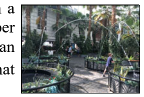
14. $g(x) = -x^2 + 2x + 3$
15. $h(x) = -2x^2 - 4x$
16. $j(x) = \frac{1}{2}x^2 + x - 4$

Use the vertex of the graph of the quadratic function and the direction the graph opens to find the domain and range of the function.

17. Vertex (7, 18), opens down

Problem Solving

18. Find the dimensions of the rectangular dog run with the greatest enclosed area if there is 50 feet of fencing and one side will be a side of the house and not need fence.
19. A fountain shoots a stream of water from a height of 3 feet at a speed of 24 feet per second. The height in feet of the water can be modeled by $h(t) = -16t^2 + 24t + 3$. What is the maximum height of the water?



20. Coveleski stadium in South Bend, Indiana, holds 5,000 spectators. With a ticket price of \$15, the average attendance has been 1,050. When the price dropped to \$12, the average attendance rose to 1,200. Assuming that attendance is linearly related to ticket price, what ticket price would maximize revenue?

Mixed Review

21. (2-01) Simplify $(2 + i)(1 - 2i)$
22. (2-01) Simplify $\frac{2i}{3-i}$
23. (1-10) The drag, D, of a body falling through a fluid varies directly with the square of the speed, s. If the drag is 90 N at a speed of 30 m/s, find an equation relating D and s. Then what is the drag at 50 m/s?
24. (1-09) Find the inverse of $f(x) = x^5 - 32$
25. (1-05) Find the zeros of $k(t) = 2t^2 - t - 1$

2-03 Polynomial Equations

1. What is the end behavior of a polynomial function with odd degree if the leading coefficient is positive?
2. If the graph of a polynomial just touches the x-axis and then changes direction, what can be concluded about the factored form of the polynomial?

Find the degree and leading coefficient for the given polynomial.

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

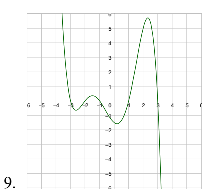
Describe the end behavior of the functions.

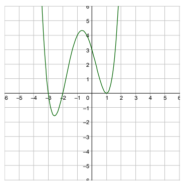
4. $f(x) = -x^4 + x^3$
5. $g(x) = 2x^3 + 3x^2 + 5x - 17$

Find the intercepts of the functions.

6. $h(t) = 3(t + 2)(t - 1)(t + 3)$
7. $f(x) = x^4 - 81$
8. $g(r) = r^3 + 3r^2 - 10r$

Determine the least possible degree of the polynomial function shown.

9. 

10. 

Graph the polynomial function using a graphing calculator. Based on the graph, determine the intercepts and the end behavior.

11. $f(x) = x^2(x + 2)(x - 2)$

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

Use the information about the graph of a polynomial function to determine the function. Assume the leading coefficient is 1 or –1. There may be more than one correct answer.

13. The y-intercept is (0, 4). The x-intercepts are (−2, 0), (2, 0). Degree is 2. End behavior: Falls to the left and falls to the right.

14. The y-intercept is (0, 0). The x-intercepts are (0, 0), (3, 0). Degree is 3. End behavior: Rises to the left, falls to the right.

Find the zeros and give the multiplicity of each.

15. $f(x) = x^4 + 6x^3 + 5x^2$

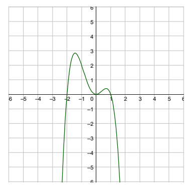
16. $f(x) = -2x^4 + 20x^3 - 50x^2$

Graph the polynomial functions. Identify the x- and y-intercepts, multiplicity, and end behavior.

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

18. $k(x) = (x - 3)(x + 2)^2$

Use the graph to write the polynomial function of least degree.

19. 

Use the given information about the polynomial graph to write the function.

20. Degree 5. Zeros of multiplicity 2 at $x = 2$ and $x = -1$, and a zero of multiplicity 1 at $x = 3$. y-intercept at (0, 6).

Problem Solving: Use the written statements to construct a polynomial function that represents the required information.

21. An ripple is expanding as a circle on a pond when a pebble was thrown into it. The radius of the circle is increasing at the rate of 8 inches per second. Express the area of the circle as a function of t, the number of seconds after the pebble hit the water.

22. A rectangle has a length of 20 units and a width of 16 units. Squares of x by x units are cut out of each corner, and then the sides are folded up to create an open box. Express the volume of the box as a polynomial function in terms of x.

Mixed Review

23. (2-02) Sketch the graph of $f(x) = -x^2 - 3x + 4$.

24. (2-02) Rewrite the following quadratic function in standard form and give the vertex. $g(x) = 2x^2 - 28x + 90$

25. (2-01) Solve $0 = x^2 - 4x + 5$.

2-04 Dividing Polynomials

1. What is true if division results in a remainder of zero?

Use long division to divide. State whether the divisor is a factor of the dividend.

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

3. $(x^3 + 2x^2 - 19x + 12) \div (x - 3)$

4. $(3x^3 + 2x^2 - 10x + 19) \div (x + 4)$

5. $(6x^3 + 11x^2 - 13x - 24) \div (2x + 3)$

6. $(3x^4 - 5x^3 + 5x^2 + 12x - 16) \div (x^2 - 2x + 4)$

Use synthetic division to divide. State whether the divisor is a factor of the dividend.

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

8. $(3x^3 + 15x^2 - 5x - 25) \div (x + 5)$

9. $(5x^3 + 2x - 10) \div (x - 2)$

10. $(4x^4 + 3x^3 - 7x^2 + 15x) \div (x + 3)$

11. $(x^4 + 2x - 5) \div (x - 4)$

Use synthetic division to divide with a complex number.

12. $(x^2 + 4) \div (x - 2i)$

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

Problem Solving

14. The volume of a box is $2x^3 + 7x^2 - 4x$, the width is x, and the length is $x + 4$. What is the height of the box?

15. The area of an ellipse is $\pi(2x^3 + 5x^2 + 3x + 2)$, and the minor axis is $x + 2$. If the area of an ellipse can be found with $A = \pi ab$ where a is the major axis and b is the minor axis, what is an expression for the length of the major axis?

Mixed Review

16. (2-03) Find the zeros and give the multiplicity of each zero: $f(x) = x^3 - x^2 - 9x + 9$

17. (2-03) Graph the polynomial functions. Note x- and y-intercepts, multiplicity, and end behavior: $f(x) = x^3 - x^2 - 9x + 9$

18. (2-02) Find the dimensions of the rectangular corral producing the greatest enclosed area given 150 feet of fencing and using the barn for one side of the corral.

19. (2-01) Multiply $(3 - 2i)(4 + 5i)$

20. (1-07) Sketch a graph of the function as a transformation of the graph of one of the parent functions: $f(x) = -(x + 2)^2 + 3$

2-05 Rational Zeros of Polynomial Functions

1. What is the difference between rational zeros and real zeros?

Use the Remainder Theorem to find the remainder.

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

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

Use the Factor Theorem to find all real zeros for the given polynomial function and one factor.

4. $f(x) = x^3 - 4x^2 + x + 6;\ x - 3$

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

6. $f(x) = x^3 + 2x^2 - 3x - 6;\ x + 2$

7. $f(x) = 2x^3 + x^2 - 12x + 9;\ x + 3$

8. $f(x) = 6x^3 + 25x^2 + 21x - 10;\ 2x + 5$

List all possible rational zeros for the functions.

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

10. $f(x) = 8x^4 - 5x^2 - 1x + 4$

Problem Solving

11. Find the dimensions of the box where the length is four inches greater than the width. The height is three times the width. The volume is 675 cubic inches.

Mixed Review

12. (2-04) Using synthetic division, decide if the first expression is a factor of the second: $(x + 3)$, $(2x^3 + 7x^2 + 4x + 3)$.

13. (2-04) Divide using long division: $(2x^3 + 7x^2 + 4x + 3) \div (x + 3)$.

14. (2-03) Find the zeros and multiplicity of each zero for $h(x) = x^4 - 6x^3 + 9x^2$.

15. (2-02) Find the minimum of $x^2 - 4x + 6$.

16. (2-01) Simplify $\frac{2+\sqrt{-27}}{1-\sqrt{-9}}$.

17. (1-10) Find the equation of the best-fitting line for the following table:

x	1	3	5	7
y	1.5	0.5	−0.5	−1.5

18. (1-05) Find the zeros of $f(x) = -3x + 6$.

19. (1-04) Given the function $g(x) = 2x^2$, evaluate $\frac{g(x+h)-g(x)}{h}$.

20. (1-03) Find the equation of the line perpendicular to $y = -3x$ and passing through the point (2, 4).

2-06 Zeros of Polynomial Functions

1. If synthetic division reveals a zero, why could we try that value again as a possible solution?

Use the Rational Zero Theorem to find all zeros.

2. $f(x) = x^3 - 5x^2 - 2x + 24$

3. $f(x) = x^3 - 6x^2 + 3x + 10$

4. $2x^3 - 5x^2 - 11x - 4 = 0$

5. $3x^4 - 2x^3 - 9x^2 + 12x - 4 = 0$

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

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

8. $f(x) = x^3 - x^2 + 15x + 17$

9. $2x^4 - 9x^3 + 11x^2 + 7x - 15 = 0$

Use Descartes' Rule of Signs to determine the possible number of positive and negative solutions.

10. $f(x) = 3x^4 - 5x^2 + 1$

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

12. $f(x) = 12x^5 - 3x^4 + 2x^2 - 5x + 1$

Write a polynomial function of least degree possible using the given information.

13. Zeros: 2 (with multiplicity 2) and –3; $f(1) = 12$

14. Zeros: $\frac{1}{2}$, 2, –3*i*; $f(0) = 36$

Problem Solving: Find the dimensions of the box described.

15. Find the dimensions of the box with the length is 4 inches more than the width. The width is 1 inch more than the height. The volume is 300 cubic inches.

Mixed Review

16. (2-05) Use the factor theorem to find all real zeros for the given polynomial function and one factor: $f(x) = x^3 + 5x^2 - 2x - 24$; $x + 4$.

17. (2-05) List all the possible rational zeros of $h(x) = 4x^4 + x^3 - 2x - 6$.

18. (2-04) Divide with long division: $(2x^3 - 5x^2 - x + 1) \div (2x + 1)$.

19. (2-03) Determine the end behavior of $j(x) = -x^3 + 510$.

20. (2-02) Use the vertex (3, 2) and a point on the graph (2, 1) to find the general form of the equation of the quadratic function.

2-07 Asymptotes of Rational Functions

Find the domain of the rational functions.

1. $f(x) = \frac{x-3}{x^2-49}$

2. $g(x) = \frac{x^2+7x+12}{x^4-5x^2+4}$

Find the domain, vertical asymptotes, and horizontal asymptote of the functions.

3. $y = \frac{3}{2x-5}$

4. $f(x) = \frac{2x}{x^2+6x-27}$

5. $g(x) = \frac{2x-3}{x^3-4x}$

6. $k(x) = \frac{x^2-25}{2x^2+9x-5}$

7. $y = \frac{4-2x}{5x+4}$

Describe the end behavior of the functions.

8. $f(x) = \frac{2x}{x+1}$

9. $y = \frac{2x^2-32}{6x^2-13x-5}$

Find the slant asymptote of the functions.

10. $f(x) = \frac{x^2-4}{x+1}$

11. $g(x) = \frac{4x^3+6x^2-x+12}{2x^2-4x+1}$

Identify the removable discontinuity.

12. $y = \frac{x^2-25}{x+5}$

13. $f(x) = \frac{x^2-x-6}{x^2+x-12}$

14. $g(x) = \frac{2x^3+4x^2-16x}{x^3-x^2-2x}$

Problem Solving

15. To produce the next popular toy, a company has to pay a factory \$50,000 to set up the production line. They also have to pay \$5 per item for the raw materials and labor. Write a function for the average cost to produce *x* items. Then describe what happens to the average cost as the factory produces a large number of toys.

Mixed Review

16. (2-06) Find all the zeros of $m(x) = x^3 - 2x^2 + 16x - 32$.

17. (2-06) Find all the zeros of $n(x) = x^4 - 2x^3 - 6x^2 + 6x + 9$.

18. (2-05) Divide with long division: $(x^3 + 2x^2 - 7) \div (x^2 + x + 1)$.

19. (2-03) Graph $q(x) = x^3 + 2x^2 - 7$.

20. (1-06) Identify the parent function, then use a graphing utility to graph the function. Be sure to choose an appropriate viewing window. $r(x) = \frac{2}{x+1} - 2$.

2-08 Graphs of Rational Functions

1. Can a graph of a rational function have no *x*-intercepts? If so, how?

Find the *x*- and *y*-intercepts for the functions.

2. $f(x) = \frac{x}{x^2+2x}$

3. $f(x) = \frac{x^2-3x+2}{x^2-x-6}$

Find the (a) *x*-intercepts, (b) the *y*-intercept, (c) the vertical asymptotes, and (d) the horizontal or slant asymptote of the functions. (e) Use that information to sketch a graph.

4. $m(x) = \frac{2x-3}{x+1}$

5. $r(x) = \frac{1}{(x-2)^2}$

6. $s(x) = \frac{2x^2+5x-3}{2x^2-2x-4}$

7. $t(x) = \frac{x^2+3x-4}{x^2-3x+2}$

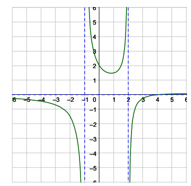
8. $w(x) = \frac{x^2-2x-3}{x-1}$

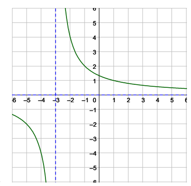
9. $g(x) = \frac{(x-4)(x-1)(x+2)}{(x-2)^2(x+1)}$

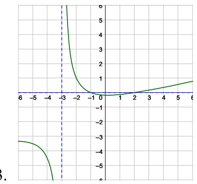
Write an equation for a rational function with the given characteristics.

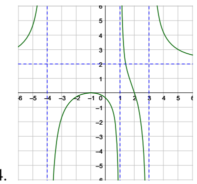
10. Vertical asymptotes at $x = 3$ and $x = -4$, *x*-intercept at (1, 0), *y*-intercept at $\left(0, \frac{1}{6}\right)$

Use the graphs to write an equation for the function.

11. 

12. 

13. 

14. 

Problem Solving: Write a rational function that describes the situation.

15. A large mixing tank at a frosting factory currently contains 500 gallons of water, into which 12 pounds of sugar have been mixed. A tap will open, pouring 15 gallons of water per minute into the tank at the same time sugar is poured into the tank at a rate of 2 pounds per minute. Find the concentration (pounds per gallon) of sugar in the tank after *t* minutes.

Mixed Review

16. (2-07) Find the slant asymptote of $f(x) = \frac{x^2+4}{x-3}$.

17. (2-06) Use Descartes' Rule of Signs to determine the possible number of positive and negative solutions: $g(x) = x^4 - 6x^3 + 10x^2 + 2x - 15$.

18. (2-06) Find all the complex zeros (real and non-real): $g(x) = x^4 - 6x^3 + 10x^2 + 2x - 15$.

19. (2-01) Simplify $(2 - i)(3 + 3i)$.

20. (1-07) Identify the parent function and describe the transformations: $h(x) = \frac{3}{x-2} + 1$.

2-09 Nonlinear Inequalities

1. When do you use brackets instead of parentheses when writing intervals?

Find the critical numbers.

2. $f(x) = x^2 + 5x - 24$

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

4. $h(x) = \frac{x^2+4x+4}{x-1}$

Solve inequalities algebraically.

5. $x^3 - 4x^2 - 11x < -30$

6. $2 \geq 6x^2 - x$

7. $0 \leq \frac{2x}{2x^2+x-1}$

8. $1 > \frac{3}{x+1}$

9. $0 \le \frac{x^2+2x-35}{x-2}$

Solve by graphing.

10. $0 \ge x^2 + 6x + 9$

11. $0 < x^3 - 7x + 6$

12. $0 \le \frac{x}{x^2-3x+2}$

13. $0 > \frac{x^2+4x+3}{x-3}$

14. $0 < \frac{x+1}{x^3+2x^2-8x}$

Problem Solving

15. It costs a computer software company $13,000 to code a new piece of office software and $2.00 to print and package each disc.
   a. Write a function for the average cost of each disk.
   b. How many discs do they have to sell to make the average cost less than $15?

Mixed Review

16. (2-08) Graph $f(x) = \frac{1}{x^2+4}$.

17. (2-06) Find the zeros of $2x^3 + 5x^2 - x - 6$.

18. (2-04) Divide $(2x^3 - x + 10) \div (x^2 + 2x - 1)$.

19. (2-02) Find the vertex of $y = 2x^2 - 4x + 3$.

20. (2-01) Multiply $(3 + i)(1 - 3i)$.

2-Review

Take this test as you would take a test in class. When you are finished, check your work against the answers.

Simplify

1. $(2 - i) + (-4 + 3i)$

2. $(2 - i)(-4 + 3i)$

3. $\frac{2-i}{-4+3i}$

4. Write the equation of the parabola with a maximum at (9, 1) and goes through the point (8, −1).

5. Describe how the graph of $g(x) = 2(x + 3)^2 + 4$ is transformed from $f(x) = x^2$.

6. Describe the left and right-hand end behavior of $f(x) = x^9 - 16x$.

7. Divide with long division $(3x^3 + 2x - 4) \div (3x + 1)$.

8. Divide with synthetic division $(2x^3 + x^2 - 3x + 10) \div (x - 1)$.

9. Use the Factor Theorem to find all the real zeros for the given polynomial function and one factor: $x^3 + x^2 - 14x - 24$; $x + 2$

For the following questions use $f(x) = x^4 + x^3 - 3x^2 + 9x - 108$.

10. List all the *p*'s, *q*'s, and possible rational zeros of $f(x)$.

11. Find all the rational zeros of $f(x)$.

12. Find the rest of the zeros of $f(x)$ including any complex zeros.

13. Find a polynomial function with real coefficients that has the following zeros: 1 (with multiplicity 2) and −2 and (2, *f*(2)) = (2, 8).

Find the intercepts and asymptotes of the following functions.

14. $f(x) = \frac{x+3}{x^2-4x+3}$

15. $f(x) = \frac{x^2-64}{x^2-4}$

16. $f(x) = \frac{x^2+7x+12}{x-2}$

Graph the following functions.

17. $f(x) = \frac{x+3}{x^2-4x+3}$

18. $f(x) = \frac{x^2-64}{x^2-4}$

19. $f(x) = \frac{x^2+7x+12}{x-2}$

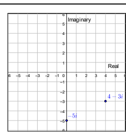
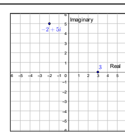
Solve the nonlinear inequalities.

20. $x^2 + 5x + 9 > 5$

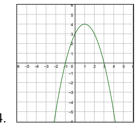
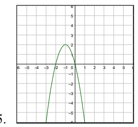
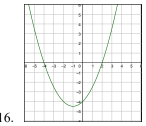
21. $\frac{x+10}{x-7} + 1 \le 0$

Answers

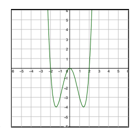
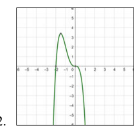
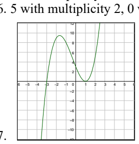
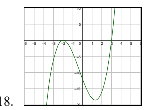
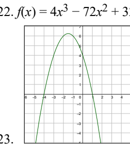
2-01

1. Add the real parts together and the imaginary parts together; combine like terms.
2. 
3. 
4. $11i$
5. $\frac{3\sqrt{2}}{4}i$
6. $-2 - 14i$
7. $2 + i$
8. $2 + 6i$
9. $-2 + 6i$
10. $-10 + 5i$
11. $-\frac{5}{2} - \frac{3}{2}i$
12. $-\frac{1}{5} - \frac{2}{5}i$
13. $-4 - 2i$
14. $-6 - 16i$
15. $1 - \frac{3}{5}i$
16. −3, 3
17. (−∞, ∞); [−1, ∞); (2, ∞); (−∞, 2)
18. Reflected over the *x*-axis, shifted left 2 and down 5.
19. $y = -2x + 12$
20. $\frac{1}{16}$

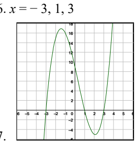
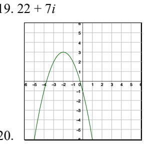
2-02

1. The vertex can be easily identified.
2. $f(x) = (x - 3)^2 + 1$, Vertex (3, 1)
3. $g(x) = 2(x + 2)^2 - 5$, Vertex (−2, −5)
4. $h(x) = 3(x - 4)^2 + 7$, Vertex (4, 7)
5. Maximum is −4 and occurs at (−1, −4); Axis of symmetry is $x = -1$
6. Minimum is 1 and occurs at (9, 1); Axis of symmetry is $x = 9$
7. Maximum is 10 and occurs at (−1, 10); Axis of symmetry is $x = -1$
8. $-2\sqrt{6}i, 2\sqrt{6}i$
9. $2 - \sqrt{3}, 2 + \sqrt{3}$
10. $4 - i, 4 + i$
11. $\frac{1-2\sqrt{3}i}{2}, \frac{1+2\sqrt{3}i}{2}$
12. $f(x) = -x^2 + 2x + 4$
13. $f(x) = \frac{1}{2}x^2 + 2x - 2$
14. , Vertex: (1, 4), Axis of symmetry: $x = 1$, Intercepts: (−1, 0), (3, 0), (0, 3)
15. , Vertex: (−1, 2), Axis of symmetry: $x = -1$, Intercepts: (−2, 0), (0, 0)
16. , Vertex: $\left(-1, -\frac{9}{2}\right)$, Axis of symmetry: $x = -1$, Intercepts: (−4, 0), (2, 0), (0, −4)
17. Domain: (−∞,∞), Range: (−∞, 18].
18. 12.5 feet by 25 feet
19. 12 feet
20. $18
21. $4 - 3i$
22. $-\frac{1}{5} + \frac{3}{5}i$
23. $D = \frac{1}{10}s^2$; 250 N
24. $f^{-1}(x) = \sqrt[5]{x + 32}$
25. $t = -\frac{1}{2}, 1$

2-03

1. Falls to the left, rises to the right.
2. There will be a factor raised to an even power.
3. Degree: 4, Coefficient: 4
4. Falls to the left, falls to the right
5. Falls to the left, rises to the right
6. *y*-intercept is (0, −18); *t*-intercepts are (−3, 0), (−2, 0), and (1, 0)
7. *y*-intercept is (0, −81); *x*-intercepts are (3, 0) and (−3, 0)
8. *y*-intercept is (0, 0); *x*-intercepts are (−5, 0), (0, 0), and (2, 0)
9. 5
10. 4
11. ; *y*-intercept (0, 0); *x*-intercepts (−2, 0), (0, 0), (2, 0); Rises to the left, rises to the right
12. ; *y*-intercept (0, 0); *x*-intercepts (−2, 0), (0, 0); Falls to the left, falls to the right
13. $f(x) = -x^2 + 4$
14. $f(x) = -x^3 + 3x^2$
15. −5 with multiplicity 1, −1 with multiplicity 1, 0 with multiplicity 2
16. 5 with multiplicity 2, 0 with multiplicity 2
17. ; *x*-intercepts (−3, 0) with multiplicity 1 and (1, 0) with multiplicity 2; *y*-intercept (0, 3); Falls to the left, rises to the right.
18. ; *x*-intercepts (3, 0) with multiplicity 1, (−2, 0) with multiplicity 2; *y*-intercept (0, −12); Falls to the left, rises to the right.
19. $f(x) = -x^4 - x^3 + 2x^2$
20. $f(x) = -\frac{1}{2}x^5 + \frac{5}{2}x^4 - \frac{3}{2}x^3 - \frac{13}{2}x^2 + 4x + 6$
21. $A = 64\pi t^2$
22. $f(x) = 4x^3 - 72x^2 + 320x$
23. 
24. $g(x) = 2(x - 7)^2 - 8$
25. $x = 2 - i, 2 + i$

2-04

1. The divisor and quotient are factors of the dividend.
2. $x - \frac{5}{x+2}$; No
3. $x^2 + 5x - 4$; Yes
4. $3x^2 - 10x + 30 + \frac{-101}{x+4}$; No
5. $3x^2 + x - 8$; Yes
6. $3x^2 + x - 5 + \frac{-2x+4}{x^2-2x+4}$; No
7. $2x^2 + 3x - 1$; Yes
8. $3x^2 - 5$; Yes
9. $5x^2 + 10x + 22 + \frac{34}{x-2}$; No
10. $4x^3 - 9x^2 + 20x - 45 + \frac{135}{x+3}$; No
11. $x^3 + 4x^2 + 16x + 66 + \frac{259}{x-4}$; No
12. $x + 2i$
13. $x^3 + (-4 - i)x^2 + (4 + 4i)x - 4i$
14. $2x - 1$
15. $2x^2 + x + 1$
16. $x = -3, 1, 3$
17. ; *x*-intercepts: (−3, 0), (1, 0), (3, 0) with multiplicity 1; *y*-intercept: (0, 9); End behavior fall to left and rises to right.
18. 37.5 ft × 75 ft
19. $22 + 7i$
20. 

2-05

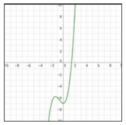
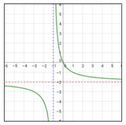
1. Rational zeros can be written as fractions, but real zeros include irrational numbers which cannot be written as fractions.

2. 38
3. 79
4. −1, 2, 3
5. −1, $\frac{1}{2}$, 4
6. −2, $-\sqrt{3}$, $\sqrt{3}$
7. −3, 1 $\frac{3}{2}$
8. $-\frac{5}{2}, -2, \frac{1}{3}$
9. $\pm 1, \pm\frac{1}{2}, \pm 7, \pm\frac{7}{2}$
10. $\pm 1, \pm\frac{1}{2}, \pm\frac{1}{4}, \pm\frac{1}{8}, \pm 2, \pm 4$
11. 9 × 5 × 15 inches
12. Yes
13. $2x^2 + x + 1$
14. 0 with multiplicity 2, 3 with multiplicity 2
15. (2, 2)
16. $\frac{2-9\sqrt{3}}{10} + \frac{6+3\sqrt{3}}{10}i$
17. $y = -0.5x + 2$
18. 2
19. $4x + 2h$
20. $y = \frac{1}{3}x + \frac{10}{3}$

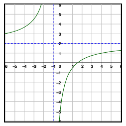
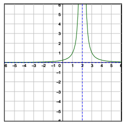
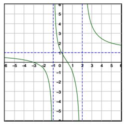
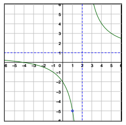
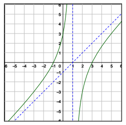
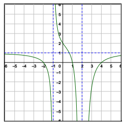
2-06

1. Polynomial functions can have repeated zeros.
2. –2, 3, 4
3. –1, 2, 5
4. –1, $-\frac{1}{2}$, 4
5. –2, $\frac{2}{3}$, 1, 1
6. –1, $\pm 2\sqrt{3}$
7. 5, $\pm i$
8. –1, $1 \pm 4i$
9. –1, $\frac{3}{2}$, $2 \pm i$
10. 2 or 0 positive, 2 or 0 negative
11. 1 positive, 2 or 0 negative
12. 4 or 2 or 0 positive, 1 negative
13. $f(x) = 3x^3 - 3x^2 - 24x + 36$
14. $f(x) = 4x^4 - 10x^3 + 40x^2 - 90x + 36$
15. 10 in. × 6 in. × 5 in.
16. –4, –3, 2
17. $\pm\frac{1}{4}, \pm\frac{1}{2}, \pm\frac{3}{4}, \pm 1, \pm\frac{3}{2}, \pm 2, \pm 3, \pm 6$
18. $x^2 - 3x + 1$
19. rises to left, falls to right
20. $y = -x^2 + 6x - 7$

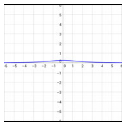
2-07

1. All real numbers $x \neq -7, 7$
2. All real numbers $x \neq -2, -1, 1, 2$
3. V.A. at $x = \frac{5}{2}$; H.A. at $y = 0$; Domain is all real numbers $x \neq \frac{5}{2}$
4. V.A. at $x = -9, 3$; H.A. at $y = 0$; Domain is all real numbers $x \neq -9, 3$
5. V.A. at $x = 0, 2, -2$; H.A. at $y = 0$; Domain is all real numbers $x \neq 0, 2, -2$
6. V.A. at $x = -5$, $\frac{1}{2}$; H.A. at y = \(\frac{1}{2}; Domain is all real numbers $x \neq -5, \frac{1}{2}$
7. V.A. at $x = -\frac{4}{5}$; H.A. at $y = -\frac{2}{5}$; Domain is all real numbers $x \neq -\frac{4}{5}$
8. As x increases or decreases without bound, $f(x)$ approaches 2
9. As x increases or decreases without bound, $f(x)$ approaches $\frac{1}{3}$
10. $y = x - 1$
11. $y = 2x + 7$
12. (−5, −10)
13. $\left(3, \frac{5}{7}\right)$
14. (0, 8) and (2, 4)
15. $C(x) = \frac{5x+50000}{x}$; The average cost approaches $5.
16. $x = 2, \pm 4i$
17. $x = -1, 3, \pm\sqrt{3}$
18. $x + 1 + \frac{-2x-8}{x^2+x+1}$
19. 
20. Reciprocal function; 

2-08

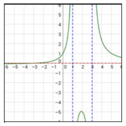
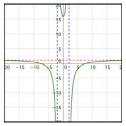
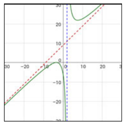
1. Yes. The numerator of the functions would have no zeros, only complex zeros, and/or factors common to both the numerator and denominator.
2. none
3. x-int: (2, 0) and (1, 0); y-int: $\left(0, -\frac{1}{3}\right)$
4. x-int: $\left(\frac{3}{2}, 0\right)$; yint: (0, −3); V.A. $x = -1$; H.A. $y =$  2;
5. x-int: none; yint: $\left(0, \frac{1}{4}\right)$; V.A. $x = 2$; H.A. $y = 0$; 
6. x-int: (−3, 0) and $\left(\frac{1}{2}, 0\right)$; yint: $\left(0, \frac{3}{4}\right)$; V.A. $x = -1$  and $x = 2$; H.A. $y = 1$;
7. x-int: (−4, 0); yint: (0, −2); V.A. $x = 2$; H.A. $y = 1$; 
8. x-int: (−1, 0) and (3, 0); yint: (0, 3); V.A. $x = 1$;  S.A. $y = x - 1$;
9. x-int: (−2, 0), (1, 0), and (4, 0); yint: (0, 2); V.A. x  $= -1$, $x = 2$; H.A. $y = 1$;
10. $y = \frac{2(x-1)}{(x-3)(x+4)}$
11. $y = \frac{x-4}{(x-2)(x+1)}$
12. $y = \frac{4}{x+3}$
13. $y = \frac{(x-2)(x+1)}{4(x+3)}$
14. $y = \frac{2(x+1)^2(x-2)}{(x+4)(x-1)(x-3)}$
15. $C(t) = \frac{2t+12}{15t+500}$
16. $y = x + 3$
17. 3 or 1 positive zeros, 1 negative zero, 0 or 2 complex zeros
18. −1, 3, $2 + i$, $2 - i$
19. $9 + 3i$
20. Reciprocal function; vertical stretch by factor of 3, shifted right 2 and up 1

2-09

1. Brackets are when the end of the interval is included such as ≤ or ≥. Parentheses are when the end of the interval is not included such as < or >.
2. −8, 3
3. −4, 0, 1
4. −2, 1
5. (−∞, −3) ∪ (2, 5)
6. [−½, ⅔]
7. (−1, 0] ∪ (½, ∞)
8. (−∞, −1) ∪ (2, ∞)
9. [−7, 2) ∪ [5, ∞)
10. −3
11. (−3, 1) ∪ (2, ∞)
12. [0, 1) ∪ (2, ∞)
13. (−∞, −3) ∪ (−1, 3)
14. (−∞, −4) ∪ (−1, 0) ∪ (2, ∞)
15. a. $C(x) = \frac{2x+13000}{x}$; b. More than 1000 discs
16. 
17. $-2, -\frac{3}{2}, 1$

18. $2x - 4 + \frac{9x+6}{x^2+2x-1}$
19. (1, 1)
20. $6 - 8i$

2-Review

1. $-2 + 2i$
2. $-5 + 10i$
3. $\frac{-11-2i}{25}$
4. $y = -2(x - 9)^2 + 1$
5. Vertical stretch by a factor of 2, shifted left 3 and up 4
6. Falls to the left, rises to the right
7. $x^2 - \frac{1}{3}x + \frac{7}{9} + \frac{-43}{9(3x+1)}$
8. $2x^2 + 3x + \frac{10}{x-1}$
9. −3, −2, 4
10. p = ±1, ±2, ±3, ±4, ±6, ±9, ±12, ±18, ±27, ±36, ±54, ±108
    $q = \pm 1$
    p/q = ±1, ±2, ±3, ±4, ±6, ±9, ±12, ±18, ±27, ±36, ±54, ±108
11. −4, 3
12. $\pm 3i$
13. $f(x) = 2x^3 - 6x + 4$
14. x-int: −3; y-int: 1; VA: $x = 1, 3$; HA: $y = 0$
15. x-int: −8, 8; y-int: 16; HA: $x = -2, 2$; HA: $y = 1$
16. x-int: −4, −3; y-int: −6; VA: $x = 2$; SlantA: $y = x + 9$
17. 
18. 
19. 
20. (−∞, −4) ∪ (−1, ∞)
21. [−³⁄₂, 7)