

Honors PreCalculus



Extra Practice Problems

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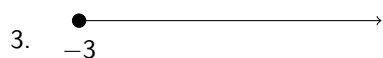
Chapter 1

Basic Set Theory and Interval Notation

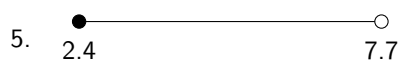
You are given either interval notation, set-builder notation, or a graph. Write each of the following in its other 2 forms.

1. $(-5, 8]$

2. $\{x|x \leq 1\}$



4. $\{x|x \neq 4, 11\}$



6. $(9, \infty)$

Write each using interval notation and graph on a number line.

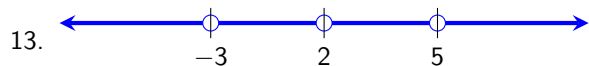
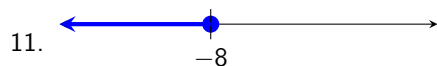
7. $\{x|x \geq 2\}$

8. $\{x|x < -8\}$

9. $\{x|x \neq 3\}$

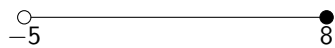
10. $\{x|x \neq -2, 5\}$

You are given the graph of an interval. Write the interval and set-builder notation for it.



1.1 Answer Key

1. $\{x | -5 < x \leq 8\}$

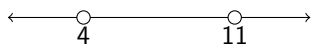


2. $(-\infty, 1]$



3. $[-3, \infty)$ $\{x | x \geq -3\}$

4. $(-\infty, 4) \cup (4, 11) \cup (11, \infty)$

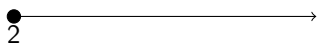


5. $[2.4, 7.7)$ $\{x | 2.4 \leq x < 7.7\}$

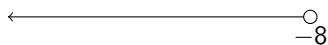
6. $\{x | x > 9\}$



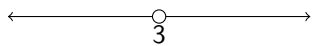
7. $[2, \infty)$



8. $(-\infty, -8)$



9. $(-\infty, 3) \cup (3, \infty)$



10. $(\infty, -2) \cup (-2, 5) \cup (5, \infty)$



11. $(-\infty, -8]$ $\{x | x \leq -8\}$

12. $(-\infty, 7) \cup (7, 12) \cup (12, \infty)$ $\{x | x \neq 7, 12\}$

13. $(-\infty, -3) \cup (-3, 2) \cup (2, 5) \cup (5, \infty)$ $\{x | x \neq -3, 2, 5\}$

Chapter 2

Functions and Their Graphs

2.1 Evaluating Functions

Given $f(x) = -3x^2 + 4x$ and $g(x) = \frac{1}{x} - 5$, evaluate each.

- | | | |
|-----------------------|-----------------------|-----------------|
| 1. $f(5)$ | 2. $f(-2)$ | 3. $f(0)$ |
| 4. $g(1)$ | 5. $g(-5)$ | 6. $g(1/4)$ |
| 7. $f(-x)$ | 8. $g(-x)$ | 9. $f(2x)$ |
| 10. $g(2x)$ | 11. $f(x - 3)$ | 12. $g(x - 3)$ |
| 13. $f(\frac{1}{3}x)$ | 14. $g(\frac{1}{3}x)$ | 15. $f(2x + 1)$ |
| 16. $g(2x + 1)$ | 17. $f(-x + 7)$ | 18. $g(-x + 7)$ |

2.2 Domain of Functions

Find the domain of each write your answers in interval notation.

- | | | |
|--|--|--|
| 1. $f(x) = -8x^2 - 7x + 1$ | 2. $g(x) = \sqrt{5x + 12} - 2$ | 3. $h(x) = \frac{x+2}{9x-7}$ |
| 4. $f(x) = -5x + 4$ | 5. $f(x) = x^2 + 2$ | 6. $f(x) = \frac{2x+1}{3x-5}$ |
| 7. $f(x) = \sqrt{3x - 12}$ | 8. $f(x) = \frac{x}{x^2-16}$ | 9. $f(x) = \frac{x+4}{x^3-4x}$ |
| 10. $f(x) = \frac{x}{\sqrt{x-4}}$ | 11. $f(x) = \frac{x^2+1}{2x^2+8}$ | 12. $f(x) = -\frac{x+7}{x^2-5x-6}$ |
| 13. $g(x) = \sqrt{2x+3}$ | 14. $h(x) = \sqrt[3]{2x+3}$ | 15. $f(x) = -\frac{7x-10}{x^2+3x+2}$ |
| 16. $g(x) = \sqrt{-9x+8}$ | 17. $h(x) = -\sqrt[3]{4x+1}$ | 18. $f(x) = \sqrt[3]{8x+1}$ |
| 19. $g(x) = \frac{x^2-1}{\sqrt{x+3}}$ | 20. $h(x) = \frac{3}{9+\frac{4}{x+7}}$ | 21. $f(x) = \frac{x+1}{\sqrt{10x+8}}$ |
| 22. $g(x) = \frac{5}{1+\frac{3}{x+2}}$ | 23. $i(x) = \frac{7}{3-\frac{4}{x+1}}$ | 24. $n(x) = \frac{7x+14}{\sqrt{2x-1}}$ |
| 25. $a(x) = \frac{\frac{x}{x-2}}{\frac{3}{x-2}+6}$ | 26. $d(x) = \frac{7x-5}{\sqrt[3]{5x+2}}$ | |

2.3 Answer Key

Evaluating Functions

- | | | |
|--------------------------------------|---|--------------------------|
| 1. -55 | 2. -20 | 3. 0 |
| 4. -4 | 5. -5.2 | 6. -1 |
| 7. $-3x^2 - 4x$ | 8. $-\frac{1}{x} - 5 = \frac{-1-5x}{x}$ | 9. $-12x^2 + 8x$ |
| 10. $\frac{1-10x}{2x}$ | 11. $-3x^2 + 22x - 39$ | 12. $\frac{16-5x}{x-3}$ |
| 13. $-\frac{1}{3}x^2 + \frac{4}{3}x$ | 14. $\frac{3-5x}{x}$ | 15. $-12x^2 - 4x + 1$ |
| 16. $-\frac{10x+4}{2x+1}$ | 17. $-3x^2 + 38x - 119$ | 18. $\frac{5x-34}{-x+7}$ |

Domain of Functions

- | | | |
|---|---|--|
| 1. $(-\infty, \infty)$ | 2. $[\frac{-12}{5}, \infty)$ | 3. $(-\infty, \frac{7}{9}) \cup (\frac{7}{9}, \infty)$ |
| 4. $(-\infty, \infty)$ | 5. $(-\infty, \infty)$ | 6. $(-\infty, \frac{5}{3}) \cup (\frac{5}{3}, \infty)$ |
| 7. $[4, \infty)$ | 8. $(-\infty, -4) \cup (-4, 4) \cup (4, \infty)$ | 9. $(-\infty, -2) \cup (-2, 0) \cup (0, 2) \cup (2, \infty)$ |
| 10. $(4, \infty)$ | 11. $(-\infty, \infty)$ | 12. $(-\infty, -1) \cup (-1, 6) \cup (6, \infty)$ |
| 13. $[-\frac{3}{2}, \infty)$ | 14. $(-\infty, \infty)$ | 15. $(-\infty, -2) \cup (-2, -1) \cup (-1, \infty)$ |
| 16. $(-\infty, \frac{8}{9}]$ | 17. $(-\infty, \infty)$ | 18. $(-\infty, \infty)$ |
| 19. $(-3, \infty)$ | 20. $(-\infty, -\frac{67}{9}) \cup (-\frac{67}{9}, -7) \cup (-7, \infty)$ | 21. $(-\frac{4}{5}, \infty)$ |
| 22. $(\infty, -5) \cup (-5, -2) \cup (-2, \infty)$ | 23. $(-\infty, -1) \cup (-1, \frac{1}{3}) \cup (\frac{1}{3}, \infty)$ | 24. $(\frac{1}{2}, \infty)$ |
| 25. $(-\infty, \frac{3}{2}) \cup (\frac{3}{2}, 2) \cup (2, \infty)$ | 26. $(-\infty, -\frac{2}{5}) \cup (-\frac{2}{5}, \infty)$ | |

Properties of Functions

3.1 Maxima and Minima

Find the coordinates of the any relative maxima or minima. Round to 3 decimal places when necessary.

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

2. $g(x) = -0.4x^3 + 0.6x^2 + 3x - 2$

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

4. $g(x) = 0.25x^5 - 0.1x^4 + 2x^2 - 6x$

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

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

7. The concentration C of a medication in the bloodstream t hours after being administered can be modeled by

$$C(t) = -0.002t^4 + 0.039t^3 - 0.285t^2 + 0.766t + 0.085, \quad t \geq 0$$

After how many hours will the concentration be the highest?

3.2 Increasing, Decreasing, and Constant Intervals

Find the intervals in which each is increasing or decreasing. Round to 3 decimal places when necessary.

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

2. $g(x) = -0.4x^3 + 0.6x^2 + 3x - 2$

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

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

5. $h(x) = \sqrt{x+1} - 2$

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

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

3.3 Piecewise Functions

Find the value of each given the piecewise function below. Use exact answers when possible.

$$f(x) = \begin{cases} x^2 - 1 & \text{if } x < -3 \\ 0.2x + 7 & \text{if } -3 \leq x < 2 \\ \sqrt{5x} & \text{if } x \geq 2 \end{cases}$$

1. $f(3)$

2. $f(0)$

3. $f(-2)$

4. $f(-3)$

5. $f(0.5)$

Find each of the following given the piecewise function

$$f(x) = \begin{cases} x^2 - 7 & x \leq -4 \\ \sqrt{2x+7} & -4 < x < 0 \\ |-x-1| & x \geq 0 \end{cases}$$

6. $f(3)$

7. $f(-2)$

8. $f(0)$

9. $f(-5)$

Find the value of each given the piecewise function below. Round to 3 decimal places when necessary.

$$f(x) = \begin{cases} x^2 - 5 & \text{if } x \leq -3 \\ \sqrt{-4x+1} & \text{if } -3 < x \leq 0 \\ \frac{5x^2}{x+7} & \text{if } x > 0 \end{cases}$$

10. $f(7)$

11. $f(-3)$

12. $f(1)$

13. $f(0)$

14. $f(-1)$

15. $f(-3/2)$

Find the value of each given the piecewise function below. Round to 3 decimal places where applicable.

$$f(x) = \begin{cases} |-3x-5| & \text{if } x \leq -2 \\ 5e^{2x+1} & \text{if } -2 < x < 1 \\ \log_2(x^2 - 3x + 4) & \text{if } 1 \leq x \leq 4 \\ -3\sin(3\pi x) + 7 & \text{if } x > 4 \end{cases}$$

16. $f(-1)$

17. $f(8)$

18. $f(-3)$

19. $f(3)$

20. $f(-1.2)$

3.4 Miscellaneous

Use the graph of $y = f(x)$ below to answer the following questions. Write your answers using interval notation.



- | | |
|---------------------------|---------------------------|
| 1. Domain of f | 2. Range of f |
| 3. Relative Minimum | 4. Relative Maximum |
| 5. $f(1)$ | 6. $f(0)$ |
| 7. Increasing Interval(s) | 8. Decreasing Interval(s) |
| 9. Absolute Maximum | 10. Absolute Minimum |

Find each of the following given $f(x) = -2x^3 + 6x^2 - 5x + 1$. Round to 3 decimal places and use interval notation when applicable.

- | | | | |
|----------------|----------------|----------------------------|----------------------------|
| 11. $f(7)$ | 12. $f(-2)$ | 13. Rel. Max | 14. Rel. Min |
| 15. Global Max | 16. Global Min | 17. Increasing Interval(s) | 18. Decreasing Interval(s) |

Use the graph of $f(x)$ to answer each.



- | | | |
|-------------------------------|---------------------------------------|---------------------------------------|
| 19. Relative maxima of $f(x)$ | 20. Relative minima of $f(x)$ | 21. Absolute maxima of $f(x)$ |
| 22. Absolute minima of $f(x)$ | 23. Intervals where f is increasing | 24. Intervals where f is decreasing |
| 25. Zeros of f | | |

Given the labeled points A through G on the graph of $f(x)$ below, find each of the following.



26. Increasing interval(s)

27. Decreasing interval(s)

28. Relative max

29. Relative min

30. Global max

31. Global min

32. Zeros of f

33. Number of solutions to $f(x) = 1$

Answer each of the following about the function $f(x)$ below.



34. Domain of f

35. Range of f

36. Relative maxima

37. Relative minima

38. Absolute maximum

39. Absolute minimum

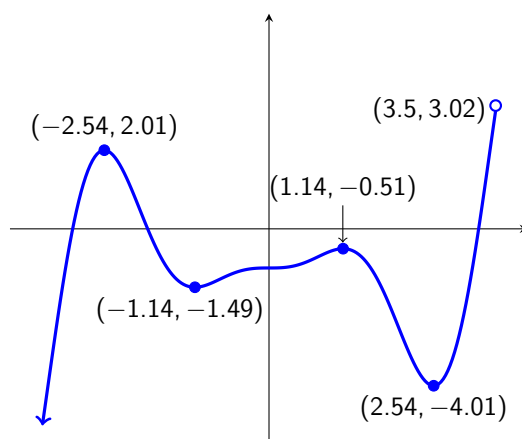
40. Increasing intervals

41. Decreasing intervals

42. Zeros of $f(x)$

43. Number of solutions to $f(x) = 2$

Find each of the following given the graph of $g(x)$ below.



- | | | |
|---------------------|--------------------------|----------------------------|
| 44. Domain of g | 45. Range of g | 46. Number of zeros of g |
| 47. Relative maxima | 48. Relative minima | 49. Global maximum |
| 50. Global minimum | 51. Increasing intervals | 52. Decreasing intervals |

3.5 Answer Key

Maxima and Minima

1. Rel max @ $(0, 5)$; No rel min
2. Rel max @ $(2.158, 3.248)$; Rel min @ $(-1.158, -4.048)$
3. Rel Max $(-1.366, 10.848)$ and $(1, 6)$; Rel Min $(0.366, 5.652)$
4. Rel Max $(-1.716, 11.598)$; Rel Min $(1.132, -3.929)$
5. Rel Max: $(1.095, 12.096)$; Rel Min $(-0.761, -0.680)$
6. Rel Max: $(1.366, 0.348)$; Rel Min: $(-0.366, -4.848)$ and $(2, 0)$
7. About 2.16 hours

Increasing, Decreasing, and Constant Intervals

1. Increasing: $(-\infty, 0)$ Decreasing: $(0, \infty)$
2. Increasing: $(-1.158, 2.158)$ Decreasing: $(-\infty, -1.158) \cup (2.158, \infty)$
3. Inc: $(-\infty, -2) \cup (\frac{2}{3}, \infty)$ Dec: $(-2, \frac{2}{3})$
4. Inc: $(-1, 0) \cup (1, \infty)$ Dec: $(-\infty, -1) \cup (0, 1)$
5. Inc: $(-1, \infty)$ No intervals where it is decreasing
6. Inc: $(-0.761, 1.095)$; Dec: $(-\infty, -0.761) \cup (1.095, \infty)$
7. Inc: $(-0.366, 1.366) \cup (2, \infty)$; Dec: $(-\infty, -0.366) \cup (1.366, 2)$

Piecewise Functions

- | | | |
|------------------------------|------------------------------|------------------------------|
| 1. $\sqrt{15} \approx 3.873$ | 2. 7 | 3. 6.6 |
| 4. 6.4 | 5. 7.1 | 6. 4 |
| 7. $\sqrt{3} \approx 1.732$ | 8. 1 | 9. 18 |
| 10. 17.5 | 11. 4 | 12. $\frac{5}{8}$ |
| 13. 1 | 14. $\sqrt{5} \approx 2.236$ | 15. $\sqrt{7} \approx 2.646$ |
| 16. 1.839 | 17. 7 | 18. 4 |
| | 19. 2 | 20. 1.233 |

Miscellaneous

1. $[-2, \infty)$
2. $[-4, \infty)$
3. $(0, -4)$
4. $(-1, -1)$
5. -1
6. $-4)$
7. $(-2, -1) \cup (0, \infty)$
8. $(-1, 0)$
9. $(0, -4)$
10. None
11. -426
12. 51
13. $(1.408, 0.272)$
14. $(0.592, -0.272)$
15. None
16. None
17. $(0.592, 1.408)$
18. $(-\infty, 0.592) \cup (1.408, \infty)$
19. $(b, f(b))$ and $(m, f(m))$
20. $(c, f(c))$
21. $(m, f(m))$
22. None
23. $(-\infty, b) \cup (c, m)$
24. $(b, c) \cup (m, p)$
25. $x = a, x = c, x = n$
26. $(\infty, B) \cup (D, F)$
27. $(B, D) \cup (F, \infty)$
28. B and F
29. D
30. B
31. None
32. A, C, E, G
33. 2
34. $(-\infty, 2)$
35. $(-\infty, 3.6]$
36. $(-1.2, 3)$ and $(1.3, 3.6)$
37. $(0, 1)$
38. $(1.3, 3.6)$
39. Does not exist
40. $(-\infty, -1.2) \cup (0, 1.3)$
41. $(-1.2, 0) \cup (1.3, 2)$
42. $(-1.8, 0)$ and $(1.9, 0)$
43. 4
44. $(-\infty, 3.5)$
45. $(-\infty, 3.02)$
46. 3
47. $(-2.54, 2.01)$ and $(1.14, -0.51)$
48. $(-1.14, -1.49)$ and $(2.54, -4.01)$
49. None
50. None
51. $(-\infty, -2.54) \cup (-1.14, 1.14) \cup (2.54, 3.5)$
52. $(-2.54, -1.14) \cup (1.14, 2.54)$

Chapter 4

Linear Functions and Slope

4.1 Equations of Lines

Write the equation of each line **in point-slope form** that goes through each pair of points.

1. $(-2, 1), (7, 8)$
2. $(0, 4), (9, -15)$
3. $(-1, -2), (-3, -13)$

4.2 Average Rate of Change

For the function $f(x) = x^2$, compute the average rate of change for each interval.

1. $[1, 1.1]$
2. $[1, 1.01]$
3. $[1, 1.001]$
4. $[1, 1.0001]$
5. For your answers in the previous four problems, what value do your average rates of change get closer and closer to?

Find the average rate of change of the function $f(x) = -6x^2 + 7x + 4$ over each specified interval.

6. $[-2, -1]$
7. $[5, 6]$
8. $[0, 1]$
9. $[5, 5.001]$
10. $[5, 5.0001]$
11. $[5, 5.00001]$
12. What value are your last 3 answers getting closer to?

For the function $f(x) = -3x^2 + 5$, determine the average rate of change of each over the given interval.

13. $[7, 7.001]$
14. $[7, 7.0001]$
15. $[7, 7.00001]$
16. For your answers in the previous three problems, what value do your average rates of change get closer and closer to?

Given $f(x) = \sqrt{x}$, find the average rate of change of each over the given interval.

17. $[1, 1.0001]$

18. $[1, 1.00001]$

19. $[1, 1.000001]$

20. For your answers in the previous three problems, what value do your average rates of change get closer and closer to?

Given $f(x) = 6\sqrt{x}$, find the average rate of change of each over the given interval.

21. $[25, 25.1]$

22. $[25, 25.01]$

23. $[25, 25.001]$

24. For your answers in the previous three problems, what value do your average rates of change get closer and closer to?

Find the average rate of change of the function $f(x) = -7x^3 + 6\sqrt{3x} + 4$ over each interval. Round your answers to 4 decimal places.

25. $[0, 1]$

26. $[10, 11]$

27. $[8, 15]$

4.3 Answer Key

Equations of Lines

1. $y - 1 = \frac{7}{9}(x + 2)$ or $y - 8 = \frac{7}{9}(x - 7)$
2. $y - 4 = -\frac{19}{9}(x - 0)$ or $y + 15 = -\frac{19}{9}(x - 9)$
3. $y + 2 = \frac{11}{2}(x + 1)$ or $y + 13 = \frac{11}{2}(x + 3)$

Average Rate of Change

- | | | |
|-----------------|-----------------|----------------|
| 1. 2.1 | 2. 2.01 | 3. 2.001 |
| 4. 2.0001 | 5. 2 | 6. 25 |
| 7. -59 | 8. 1 | 9. -53.006 |
| 10. -53.0006 | 11. -53.00006 | 12. -53 |
| 13. -42.003 | 14. -42.0003 | 15. -42.00003 |
| 16. -42 | 17. -0.499988 | 18. -0.4999988 |
| 19. -0.49999988 | 20. -0.5 | 21. 0.5994 |
| 22. 0.59999 | 23. 0.6 | 24. 0.6 |
| 25. 3.3923 | 26. -2,315.3960 | 27. -2861.4492 |

Chapter 5

Function Transformations

Write the function for $g(x)$ if it is the result of $f(x)$ after the following ordered sequence of transformations.

1. (1) Vertical stretch by 3
(2) Shift left 1 unit
(3) Reflect across y -axis
2. (1) Horizontal compression by 2
(2) Shift up 1 unit
3. (1) Reflect across x -axis
(2) Vertical compression by 4
(3) Move right 7 units

Write the function $g(x)$ that is a result of the following ordered sequence of transformations to $f(x) = |x|$.

4. (1) Reflect across x -axis
(2) Shift right 3 units
(3) Horizontal stretch by factor of 5
5. (1) Shift down 2 units
(2) Reflect across y -axis
(3) Shift up 1 unit
6. (1) Horizontal compression by factor of 7
(2) Vertical compression by factor of 4
(3) Shift left 9 units

Given $f(x) = \sqrt{x}$, determine the resulting function $g(x)$ after the following ordered sequence of transformations.

7. (1) Shift up 2 units
(2) Horizontal stretch by 5
(3) Shift left 3 units
8. (1) Vertical compression by factor of 3
(2) Reflect across y -axis
(3) Horizontal compression by 5
9. (1) Shift right 8 units
(2) Reflect across x -axis
(3) Horizontal compression by factor of 4

Write the final equation of $g(x)$ if it is found by taking $f(x) = \sqrt{x}$ after the following ordered sequence of transformations.

10. (1) Shift right 2 units
(2) Horizontal stretch by factor 3
(3) Shift down 2 units
(4) Reflect across x -axis
11. (1) Horizontal stretch by factor 3
(2) Shift left 1 unit
(3) Shift up 2 units
(4) Reflect across y -axis
12. (1) Vertical stretch by factor 5
(2) Horizontal stretch by factor 2
(3) Shift up 3 units
(4) Reflect across x -axis

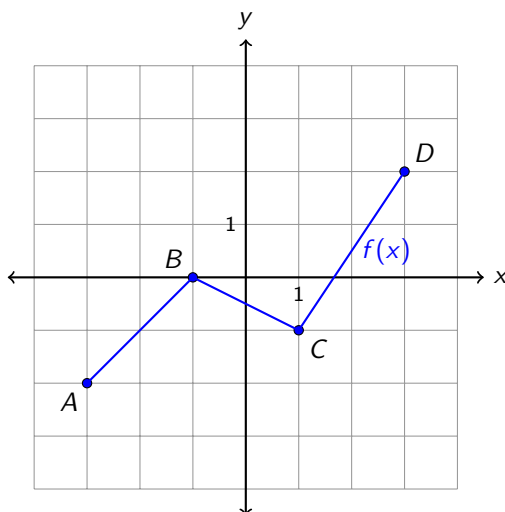
Find the equation for $g(x)$ if $g(x)$ is found by performing the following *ordered* sequence of transformations to $f(x) = \frac{1}{x}$.

13. (1) Shift left 3 spaces
(2) Reflect across y -axis
(3) Shift down 5 spaces
(4) Vertical stretch by factor of 7
14. (1) Shift up 3 spaces
(2) Reflect across x -axis
(3) Shift right 5 spaces
(4) Horizontal compression by factor of 7

Given $f(x) = x^3$, determine the equation for $g(x)$ after the following *ordered* sequence of transformations to $f(x)$.

15. (1) Vertical stretch by factor of 4
(2) Shift up 3 units
(3) Reflect across y -axis
(4) Shift down 5 units
16. (1) Horizontal compression by factor of 3
(2) Shift right 4 units
(3) Shift up 1 unit
17. (1) Reflect across x -axis
(2) Shift down 5 units
(3) Vertical compression by factor of 5
(4) Horizontal stretch by factor of 9

Given the graph of $f(x)$ below, find the new coordinates of each point after the following transformations.



18. $-2f(x+1)$

19. $f\left(-\frac{1}{2}x\right) - 3$

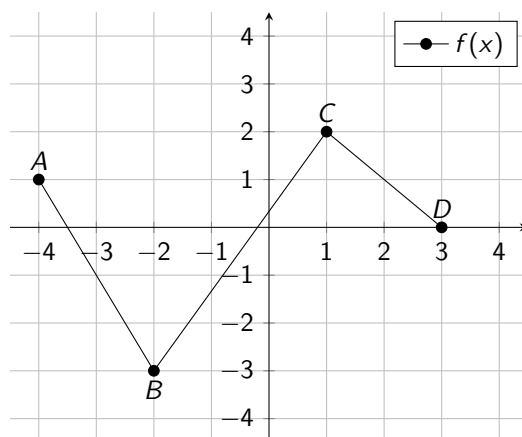
20. $\frac{1}{2}f(-x-2) + 2$

21. $f(2x+2) - 1$

22. $-3f(-x+1) + 2$

23. $5f\left(-\frac{1}{2}x\right)$

Given $f(x)$ below, determine the coordinates of A' , B' , C' , and D' after the final transformations done to f .



24. $f(-2x-5) + 4$

25. $\frac{1}{3}f(x+4) - 1$

26. $-3f\left(-\frac{1}{2}x-3\right)$

27. $f(4x+3) + 8$

5.1 Answer Key

1. $g(x) = 3f(-x + 1)$
2. $g(x) = f(2x) + 1$
3. $g(x) = -\frac{1}{4}f(x - 7)$
4. $g(x) = -\left|\frac{1}{5}x - 3\right|$
5. $g(x) = |-x| - 1$
6. $g(x) = \frac{1}{4}|7(x + 9)| = \frac{1}{4}|7x + 63|$
7. $g(x) = \sqrt{\frac{1}{5}(x + 3)} + 2 = \sqrt{\frac{1}{5}x + \frac{3}{5}} + 2$
8. $g(x) = \frac{1}{3}\sqrt{-5x}$
9. $g(x) = -\sqrt{4x - 8}$
10. $g(x) = -\left(\sqrt{\frac{1}{3}x - 2} - 2\right) = -\sqrt{\frac{1}{3}x - 2} + 2$
11. $g(x) = \sqrt{\frac{1}{3}(-x + 1)} + 2 = \sqrt{-\frac{1}{3}x + \frac{1}{3}} + 2$
12. $g(x) = -\left(5\sqrt{\frac{1}{2}x + 3}\right) = -5\sqrt{\frac{1}{2}x + 3}$
13. $g(x) = \frac{7}{-x+3} - 35$
14. $g(x) = -\frac{1}{7x-5} - 3$
15. $g(x) = 4(-x)^3 - 2$
16. $g(x) = (3(x - 4))^3 + 1$
17. $g(x) = \frac{1}{5}\left(-\frac{1}{9}x\right)^3 - 5$
18. $A'(-4, 4), B'(-2, 0), C'(0, 2), D'(2, -4)$
19. $A'(6, -5), B'(2, -3), C'(-2, -4), D'(-6, -1)$
20. $A'(1, 1), B'(-1, 2), C'(-3, 1.5), D'(-5, 3)$
21. $A'(-2.5, -3), B'(-1.5, -1), C'(-0.5, -2), D'(0.5, 1)$
22. $A'(4, 8), B'(2, 2), C'(0, 5), D'(-2, -4)$
23. $A'(6, -10), B'(2, 0), C'(-2, -5), D'(-6, 10)$
24. $A'\left(-\frac{1}{2}, 5\right), B'\left(-\frac{3}{2}, 1\right), C'(-3, 6), D'(-4, 4)$
25. $A'\left(-8, -\frac{2}{3}\right), B'(-6, -2), C'\left(-3, -\frac{1}{3}\right), D'(-1, -1)$
26. $A'(2, -3), B'(-2, 9), C'(-8, -6), D'(-12, 0)$
27. $A'\left(-\frac{7}{4}, 9\right), B'\left(-\frac{5}{4}, 5\right), C'\left(-\frac{1}{2}, 10\right), D'(0, 8)$

Chapter 6

Function Operations

6.1 Adding, Subtracting, Multiplying, and Dividing Functions

Given $f(x) = x + 5$, $g(x) = x^2 - 1$, and $h(x) = \sqrt{x - 10}$, simplify or evaluate each.

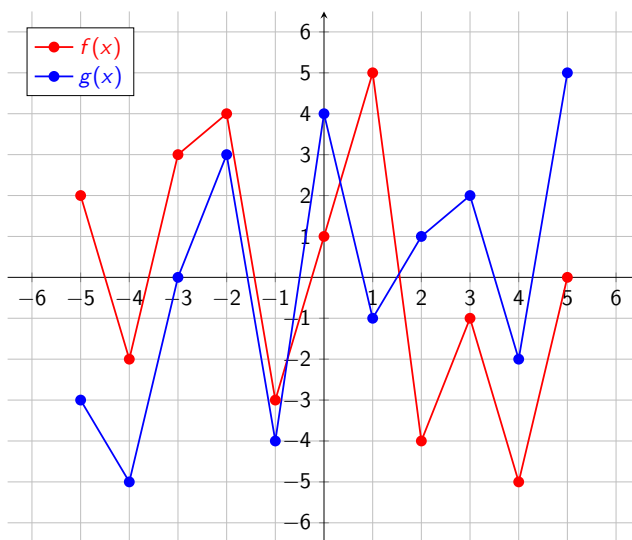
1. $(g - f)(x)$
2. $(fh)(14)$
3. $(f + g)(x)$

Find each of the following given the table below.

| x | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|--------|----|----|----|----|---|----|----|----|----|
| $f(x)$ | -3 | 0 | -1 | 3 | 1 | 2 | 4 | -4 | -2 |
| $g(x)$ | 3 | -1 | 0 | 1 | 4 | -2 | -4 | 2 | -3 |

4. $(f + g)(-2)$
5. $(f - g)(0)$
6. $(fg)(1)$
7. $\left(\frac{f}{g}\right)(3)$
8. $(f + f)(-4)$

Find each of the following given the graphs of $f(x)$ (in red) and $g(x)$ (in blue) below:



9. $(f + g)(2)$
10. $(f - g)(1)$
11. $(g - f)(-3)$
12. $(fg)(4)$
13. $\left(\frac{f}{g}\right)(0)$

Use the table below to find each.

| | | | | | | | | | | | |
|--------|----|----|----|----|----|---|----|----|----|----|---|
| x | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
| $f(x)$ | -1 | 3 | -4 | 5 | 0 | 4 | -5 | 2 | -2 | -3 | 1 |
| $g(x)$ | 4 | -2 | -4 | 1 | -1 | 3 | 0 | -3 | -5 | 2 | 5 |

14. $(f + g)(-1)$ 15. $(f - g)(2)$ 16. $(fg)(-3)$ 17. $\left(\frac{f}{g}\right)(5)$ 18. $(ff)(-4)$

6.2 Operations with Functions: Domain

Given $f(x) = \sqrt{2x+7}$ and $g(x) = 3x+3$, find the domain of each.

- $(f + g)(x)$
- $\left(\frac{f}{g}\right)(x)$
- $\left(\frac{g}{f}\right)(x)$

6.3 Difference Quotient

Write the difference quotient for each.

- $f(x) = 2x - 7$
- $g(x) = x^2 + 4x$
- $h(x) = -1$
- $f(x) = \frac{3}{x+2}$
- $g(x) = \sqrt{3x}$
- $f(x) = x^2 - 2x + 5$
- $g(x) = \frac{5}{x}$
- $f(x) = -2x^2 + 3x - 5$
- $g(x) = \frac{6}{2x+3}$
- $h(x) = \sqrt{7x+5}$
- $f(x) = -x^2 + x$
- $f(x) = 3x - 1$
- $f(x) = x^3 + 5x$
- $f(x) = \frac{6}{x+7}$
- $g(x) = \frac{9}{x}$
- $h(x) = \frac{5}{2x-1}$

6.4 Answer Key

Adding, Subtracting, Multiplying, and Dividing Functions

- | | |
|------------------|-------------------|
| 1. $x^2 - x - 6$ | 10. 6 |
| 2. 38 | 11. -3 |
| 3. $x^2 + x + 4$ | 12. 10 |
| 4. -1 | 13. $\frac{1}{4}$ |
| 5. -3 | 14. -1 |
| 6. -4 | 15. 5 |
| 7. -2 | 16. 16 |
| 8. -6 | 17. $\frac{1}{5}$ |
| 9. -3 | 18. 9 |

Operations with Functions: Domain

- $[-\frac{7}{2}, \infty)$
- $[-\frac{7}{2}, -1) \cup (-1, \infty)$
- $(-\frac{7}{2}, \infty)$

Difference Quotient

- | | | |
|--|---------------------------------------|----------------------------------|
| 1. 2 | 2. $2x + h + 4$ | 3. 0 |
| 4. $\frac{-3}{(x+2)(x+h+2)}$ | 5. $\frac{3}{\sqrt{3x+3h}+\sqrt{3x}}$ | 6. $2x + h - 2$ |
| 7. $\frac{-5}{x(x+h)}$ | 8. $-4x - 2h + 3$ | 9. $\frac{-12}{(2x+3)(2x+2h+3)}$ |
| 10. $\frac{7}{\sqrt{7x+7h+5}+\sqrt{7x+5}}$ | 11. $-2x - h + 1$ | 12. 3 |
| 13. $3x^2 + 3xh + h^2 + 5$ | 14. $\frac{-6}{(x+7)(x+h+7)}$ | 15. $\frac{-9}{x(x+h)}$ |
| 16. $\frac{-10}{(2x-1)(2x+2h-1)}$ | | |

Chapter 7

Polynomials and Their Graphs

Find the degree, leading term, leading coefficient, and constant term of the following polynomials.

1. $f(x) = -x^5 + \sqrt{7}x^3 - 2x^2$

2. $g(x) = 4x^2 - 16x^6 + 3x$

3. $h(x) = 1 + x^{11} - 4x^8$

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

5. $g(x) = 0.25x^5 - 0.1x^4 + 2x^2 - 6x$

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

7. $g(x) = \frac{1}{3}x^3 - \frac{\pi}{8}x^2 + x\sqrt{2} - 3^4$

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

9. $j(x) = -\frac{1}{2}(3x+2)^2(x-1)^5$

Determine the end behavior of each.

10. $f(x) = -x^5 + \sqrt{7}x^3 - 2x^2$

11. $g(x) = 4x^2 - 16x^6 + 3x$

12. $h(x) = 1 + x^{11} - 4x^8$

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

14. $g(x) = 0.25x^5 - 0.1x^4 + 2x^2 - 6x$

15. $f(x) = -6x^3 + 2x^2 + 7x^4 - 1$

16. $g(x) = \frac{1}{3}x^3 - \frac{\pi}{8}x^2 + x\sqrt{2} - 3^4$

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

18. $j(x) = -\frac{1}{2}(3x+2)^2(x-1)^5$

Find the zeros of each. Round to 2 decimal places when necessary.

19. $f(x) = -x^5 + \sqrt{7}x^3 - 2x^2$

20. $g(x) = 4x^2 - 16x^6 + 3x$

21. $h(x) = 1 + x^{11} - 4x^8$

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

23. $g(x) = 0.25x^5 - 0.1x^4 + 2x^2 - 6x$

24. $f(x) = -6x^3 + 2x^2 + 7x^4 - 1$

25. $g(x) = \frac{1}{3}x^3 - \frac{\pi}{8}x^2 + x\sqrt{2} - 3^4$

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

27. $j(x) = -\frac{1}{2}(3x+2)^2(x-1)^5$

7.1 Answer Key

1. Degree = 5, Leading Term = $-x^5$, Leading Coefficient = -1 , Constant = none (or 0)
2. Degree = 6, Leading Term = $-16x^6$, Leading Coefficient = -16 , Constant = none (or 0)
3. Degree = 11, Leading Term = x^{11} , Leading Coefficient = 1, Constant = 1
4. Degree = 4, Leading Term = $-x^4$, Leading Coefficient = -1 , Constant = 6
5. Degree = 5, Leading Term = $0.25x^5$, Leading Coefficient = 0.25, Constant = none (or 0)
6. Degree = 3, Leading Term = $-6x^3$, Leading Coefficient = -6 , Constant = -1
7. Degree = 3, Leading Term = $\frac{1}{3}x^3$, Leading Coefficient = $\frac{1}{3}$, Constant = 3^4
8. Degree = 5, Leading Term = $7x^5$, Leading Coefficient = 7, Constant = -56
9. Degree = 7, Leading Term = $-\frac{9}{2}x^7$, Leading Coefficient = $-\frac{9}{2}$, Constant = 2
10. $\lim_{x \rightarrow -\infty} f(x) = \infty$ $\lim_{x \rightarrow \infty} f(x) = -\infty$
11. $\lim_{x \rightarrow -\infty} g(x) = -\infty$, $\lim_{x \rightarrow \infty} g(x) = \infty$
12. $\lim_{x \rightarrow -\infty} h(x) = -\infty$ $\lim_{x \rightarrow \infty} h(x) = \infty$
13. $\lim_{x \rightarrow -\infty} f(x) = -\infty$ $\lim_{x \rightarrow \infty} f(x) = -\infty$
14. $\lim_{x \rightarrow -\infty} g(x) = -\infty$ $\lim_{x \rightarrow \infty} g(x) = \infty$
15. $\lim_{x \rightarrow -\infty} f(x) = \infty$ $\lim_{x \rightarrow \infty} f(x) = -\infty$
16. $\lim_{x \rightarrow -\infty} g(x) = -\infty$ $\lim_{x \rightarrow \infty} g(x) = \infty$
17. $\lim_{x \rightarrow -\infty} h(x) = -\infty$ $\lim_{x \rightarrow \infty} h(x) = \infty$
18. $\lim_{x \rightarrow -\infty} j(x) = \infty$ $\lim_{x \rightarrow \infty} j(x) = -\infty$
19. $(-1.92, 0)$, $(0, 0)$
20. $(0, 0)$, $(0.83, 0)$
21. $(-0.83, 0)$, $(0.86, 0)$, $(1.58, 0)$
22. $(-2.25, 0)$, $(1.90, 0)$
23. $(-2.48, 0)$, $(0, 0)$, $(1.85, 0)$
24. $(-0.42, 0)$, $(0.79, 0)$
25. $(6.42, 0)$
26. $(-1, 0)$, $(2, 0)$
27. $(-\frac{2}{3}, 0)$, $(1, 0)$

Dividing Polynomials

8.1 Dividing Polynomials

Divide each.

1. $(28x^3 - 26x^2 + 41x - 15) \div (7x - 3)$
2. $(44y^2 + 12y^3 + 61y - 37) \div (3y + 5)$
3. $(4x^3 - 3x^2 + x + 1) \div (x + 2)$
4. $(5x^4 - x^2 + x - 2) \div (x^2 + 2)$
5. $(10x^3 + 27x^2 + 8x - 11) \div (2x + 3)$
6. $(7x^3 + 23x^2 + 12x + 1) \div (x^2 + 3x + 1)$
7. $(28x^3 - 27x^2 - 4x + 17) \div (4x + 3)$
8. $(7x^3 - 27x + 4) \div (x^2 - 5)$
9. $(11x^6 - 24x^5 + 15x^4 - 19x^3 - 16x^2 + 21x - 8) \div (x - 2)$
10. $(12x^5 - 15x^4 - 11x^3 + 16x^2 - 15x + 17) \div (3x^2 - 5)$
11. $(6x^4 + 20x^3 - 13x^2 + 20x + 25) \div (x + 4)$
12. $(24x^5 + 30x^4 - 21x^3 - 4x^2 + 3x - 25) \div (6x^3 + 3x^2 + 3)$
13. $(3x^5 - 22x^4 + 12x^3 + 10x^2 - 7x + 24) \div (3x^2 - x - 4)$
14. $(3x^4 - 23x^2 - 15x^3 + 28x + 24) \div (x - 6)$
15. $(-29x^2 + 6x^6 - 29x^3 + 25x^4 - 15x^5 - 25 - 29x) \div (3x^3 - 6x^2 - 3 - x)$
16. $(12x^6 + 16x^5 - 5x^4 + 12x^3 - 17x^2 - x - 23) \div (x + 2)$

8.2 Remainder and Factor Theorems

Determine the remainder of each.

1. $(2x^{53} - 9x^{44} + 13x^8) \div (x - 1)$
2. $(x^{71} + 15x^{58} - 3x^{14} + 2) \div (x + 1)$
3. $(x^{23} - 5x^{20} + 17x^8 - 5) \div (x + 2)$
4. $(-7x^{17} + 40x^{15} - 6x^8 + 4x^3) \div (x - 3)$

8.3 Answer Key

Dividing Polynomials

1. $4x^2 - 2x + 5$
2. $4y^2 + 8y + 7 - \frac{72}{3y+5}$
3. $4x^2 - 11x + 23 - \frac{45}{x+2}$
4. $5x^2 - 11 + \frac{x+20}{x^2+2}$
5. $5x^2 + 6x - 5 + \frac{4}{2x+3}$
6. $7x + 2 + \frac{-x-1}{x^2+3x+1}$
7. $7x^2 - 12x + 8 - \frac{7}{4x+3}$
8. $7x + \frac{8x+4}{x^2-5}$
9. $11x^5 - 2x^4 + 11x^3 + 3x^2 - 10x + 1 - \frac{6}{x-2}$
10. $4x^3 - 5x^2 + 3x - 3 + \frac{2}{3x^2-5}$
11. $6x^3 - 4x^2 + 3x + 8 - \frac{7}{x+4}$
12. $4x^2 + 3x - 5 + \frac{-x^2-6x-10}{6x^3+3x^2+3}$
13. $x^3 - 7x^2 + 3x - 5 + \frac{4}{3x^2-x-4}$
14. $3x^3 + 3x^2 - 5x - 2 + \frac{12}{x-6}$
15. $2x^3 - x^2 + 7x + 6 + \frac{11x^2-2x-7}{3x^3-6x^2-3-x}$
16. $12x^5 - 8x^4 + 11x^3 - 10x^2 + 3x - 7 - \frac{9}{x+2}$

Remainder and Factor Theorems

1. 6
2. 13
3. -13, 627, 141
4. -330, 064, 119

Chapter 9

Rational Functions and Their Graphs

Find the domain, coordinates of any holes, and equations of all asymptotes.

$$1. f(x) = \frac{2x^2+5x-3}{2x^2-15x+7}$$

$$2. g(x) = \frac{3x^3+7x^2-20x}{x^2-x-12}$$

$$3. f(x) = \frac{3x}{x+4}$$

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

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

$$6. f(x) = \frac{2x^3-13x^2+6x+45}{x^2-4x-5}$$

$$7. g(x) = \frac{5x^2-19x-4}{x^3+2x^2-24x}$$

$$8. h(x) = \frac{2x^2-x-3}{8x^2+51x+18}$$

$$9. f(x) = \frac{6x^3-21x^2-51x+30}{3x^2+7x+2}$$

$$10. g(x) = \frac{10x^2-29x-21}{10x^3-33x^2-7x}$$

$$11. f(x) = \frac{x^3+x^2-6x}{3x^2-3x-6}$$

$$12. f(x) = \frac{x^2-4x+3}{2x^2+2x-12}$$

$$13. f(x) = \frac{x-4}{-2x^2+4x+16}$$

$$14. f(x) = \frac{x^3-2x^2-8x}{x^3-2x^2-3x}$$

$$15. f(x) = \frac{x^2+x-2}{3x^2+3x-18}$$

$$16. f(x) = \frac{x^2-3x+2}{4x^2-12x}$$

$$17. f(x) = \frac{8x^2+26x+15}{2x^2-x-15}$$

$$18. g(x) = \frac{x^2-1}{2+2x}$$

State the end behavior of each.

$$19. k(x) = \frac{5x^3-7x^2+8}{-3x^3+6x-4}$$

$$20. m(x) = \frac{2x-1}{3x^2+7x+1}$$

Answer each of the following given $h(x) = \frac{6x^3+40x^2-14x}{3x^2+11x-4}$

21. End behavior

22. Domain of h

23. Equation(s) for any vertical asymptotes

24. Exact coordinates of any holes

25. What is the approximate value of $h(5^{933})$?

9.1 Answer Key

1. Domain: $x \neq \frac{1}{2}, 7$; V.A.: $x = \frac{1}{2}, x = 7$; H.A.: $y = 1$
2. Domain: $x \neq -3, 4$; V.A.: $x = -3, x = 4$; Obl. Asymp: $y = 3x + 10$
3. Domain: $x \neq -4$; V.A.: $x = -4$; H.A.: $y = 3$
4. Domain: $x \neq 1$; V.A.: $x = 1$; Obl. Asymp: $y = x + 4$
5. Domain: $x \neq 0, 1$; V.A.: $x = 0$ and $x = 1$; H.A.: $y = 0$
6. Domain: $x \neq -1, 5$; V.A. $x = -1$; Hole @ $(5, \frac{13}{3})$; Obl. Asym $y = 2x - 5$
7. Domain: $x \neq -6, 0, 4$; V.A. $x = -6, x = 0$; Hole @ $(4, \frac{21}{40})$; H.A. $y = 0$
8. Domain: $x \neq -6, -\frac{3}{8}$; V.A. $x = -6, x = -\frac{3}{8}$; H.A. $y = \frac{1}{4}$
9. Domain: $x \neq -2, -\frac{1}{3}$; Hole @ $(-2, -21)$; V.A.: $x = -\frac{1}{3}$; Obl. Asymp: $y = 2x - \frac{35}{3}$
10. Domain: $x \neq -\frac{1}{5}, 0, \frac{7}{2}$; Hole @ $(\frac{7}{2}, \frac{82}{259})$; V.A. $x = -\frac{1}{5}$ and $x = 0$; H.A. $y = 0$
11. Domain: $x \neq -1, 2$; V.A. $x = -1$; Hole @ $(2, \frac{10}{9})$; Obl. Asymp: $y = \frac{1}{3}x + \frac{2}{3}$
12. Domain: $x \neq -3, 2$; V.A. $x = -3$ and $x = 2$; H.A. $y = \frac{1}{2}$
13. Domain: $x \neq -2, 4$; V.A. $x = 2$; Hole @ $(4, -\frac{1}{12})$; H.A. $y = 0$
14. Domain: $x \neq -1, 0, 3$; V.A. $x = -1$ and $x = 3$; Hole @ $(0, \frac{8}{3})$; H.A. $y = 1$
15. Domain: $x \neq -3, 2$; V.A. $x = -3$ and $x = 2$; H.A. $y = \frac{1}{3}$
16. Domain: $x \neq 0, 3$; V.A. $x = 0$ and $x = 3$; H.A. $y = \frac{1}{4}$
17. Domain: $x \neq -\frac{5}{2}, 3$; V.A. $x = 3$; Hole @ $(-\frac{5}{2}, \frac{14}{11})$; H.A. $y = 4$
18. Domain: $x \neq -1$; No vertical asymptote; Hole @ $(-1, -1)$; Obl. Asymp: $y = \frac{1}{2}x - \frac{1}{2}$
19. $\lim_{x \rightarrow -\infty} k(x) = \infty$ $\lim_{x \rightarrow \infty} k(x) = -\frac{5}{3}$
20. $\lim_{x \rightarrow -\infty} m(x) = \infty$ $\lim_{x \rightarrow \infty} m(x) = 0$
21. $y = 2x + 6$
22. $x \neq -4, \frac{1}{3}$
23. $x = -4$
24. $(\frac{1}{3}, \frac{44}{39})$
25. $2(5^{933}) + 6$

Chapter 10

Polynomial and Rational Inequalities

10.1 Polynomial Inequalities

Solve each. Write your answers using interval notation.

1. $6x^3 - 4x^2 - 10x \geq 0$
2. $x^4 < 9x^2$
3. $3x^3 - 7x^2 - 22x + 8 < 0$
4. $3x^2 - 4x + 1 \leq 0$
5. $12x^4 + 76x^3 + 43x^2 - 346x - 280 \geq 0$
6. $-2x^4 + 49x^2 + 21x^3 - 1029x + 2401 \geq 0$
7. $-x^2 - 7x - 6 \leq 0$
8. $x^2 + 4x + 4 < 0$
9. $-x^4 - 6x^3 + 61x^2 + 234x - 1008 \geq 0$
10. $-x^2 + 3x + 1 > 3$
11. $-3x^4 + 123x^3 + 142x^2 - 424x + 320 \leq 122x^3$
12. $-x^4 - 1120 + 77x^2 - 36x + 15x^3 \geq 15x^3$
13. $-3x^4 - 22x^3 + 271x^2 + 152x - 96 \geq 267x^2$
14. $15x^3 + 27x^2 + 8x \leq 14x$
13. $x^3 + 6x^2 > -2x^2 + 64x + 512$

10.2 Domain

State the domain of each. Write your answers using interval notation.

1. $b(x) = \sqrt{21x^2 - 23x - 20}$
2. $f(x) = \frac{3}{\sqrt{3x^2 + 2x - 1}}$
3. $g(x) = \sqrt[4]{2x^3 + 9x^2 + 12x + 4}$

10.3 Rational Inequalities

Solve each. Write your answers using interval notation.

1. $\frac{3x-4}{x+1} < 0$
2. $\frac{x^2+3x+2}{x-7} \leq 0$
3. $\frac{x^2-4x+4}{x^2-1} \geq 0$
4. $\frac{x+2}{x-4} \leq 1$
5. $\frac{x^2-7x-8}{x^2-4x-32} \geq 0$
6. $\frac{4+3x}{5-x} \leq 2$
7. $\frac{x-4}{x+7} < 0$
8. $\frac{x+5}{x+7} < 0$
9. $\frac{2x-26}{5x+20} > -3$

$$10. \frac{2x-50}{5x+15} \leq -1$$

$$13. -\frac{3}{x+6} > -\frac{4}{x+7}$$

$$16. \frac{6x^2+5x-21}{x-4} < 0$$

$$11. \frac{x+5}{x^2-2x-15} \leq 0$$

$$14. \frac{2x^2+3x-2}{x^2+5x+6} < 0$$

$$17. \frac{2x+1}{4x-3} \geq x-1$$

$$12. -\frac{2}{x} \geq -\frac{3}{x+1}$$

$$15. \frac{x-4}{2x+4} \geq 1$$

10.4 Answer Key

Polynomial Inequalities

1. $[-1, 0] \cup [\frac{5}{3}, \infty)$
2. $(-3, 0) \cup (0, 3)$
3. $(-\infty, -2) \cup (\frac{1}{3}, 4)$
4. $[\frac{1}{3}, 1]$
5. $(-\infty, -4] \cup [-\frac{7}{2}, -\frac{5}{6}] \cup [2, \infty)$
6. $[-7, \frac{7}{2}] \cup 7$
7. $(-\infty, -6] \cup [-1, \infty)$
8. \emptyset
9. $[-8, -7] \cup [3, 6]$
10. $(1, 2)$
11. $(-\infty, -8] \cup [\frac{4}{3}, 2] \cup [5, \infty)$
12. $[-8, -4] \cup [5, 7]$
13. $[-6, -4] \cup [\frac{2}{3}, 2]$
14. $(-\infty, -2] \cup [0, \frac{1}{5}]$
15. $(8, \infty)$

Domain

1. $(-\infty, -\frac{12}{21}] \cup [\frac{5}{3}, \infty)$
2. $(-\infty, -1) \cup (\frac{1}{3}, \infty)$
3. $\{-2\} \cup [-\frac{1}{2}, \infty)$

Rational Inequalities

1. $(-1, \frac{4}{3})$
2. $(-\infty, -2] \cup [-1, 7)$
3. $(-\infty, -1) \cup (1, \infty)$
4. $(-\infty, 4)$
5. $(-\infty, -4) \cup [-1, 8) \cup (8, \infty)$
6. $(-\infty, 1.2] \cup (5, \infty)$
7. $(-7, 4)$
8. $(-7, -5)$
9. $(-\infty, -4) \cup (-2, \infty)$
10. $(-3, 5]$
11. $(-\infty, -5] \cup (-3, 5)$
12. $(-1, 0) \cup [2, \infty)$
13. $(-7, -6) \cup (-3, \infty)$
14. $(-3, -2) \cup (-2, \frac{1}{2})$
15. $[-8, -2)$
16. $(-\infty, -\frac{7}{3}) \cup (\frac{3}{2}, 4)$
17. $(-\infty, \frac{1}{4}] \cup (\frac{3}{4}, 2]$

Chapter 11

Function Compositions

Given $f(x) = x - 5$, $g(x) = 4 + \sqrt{2x + 1}$, and $h(x) = \frac{3}{x + 7}$, simplify each and state the domain.

1. $(f \circ g)(x)$
2. $(g \circ f)(x)$
3. $h(h(x))$

Find each of the following given the table below.

| x | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|--------|----|----|----|----|---|----|----|----|----|
| $f(x)$ | -3 | 0 | -1 | 3 | 1 | 2 | 4 | -4 | -2 |
| $g(x)$ | 3 | -1 | 0 | 1 | 4 | -2 | -4 | 2 | -3 |

4. $(f \circ g)(-1)$
5. $(g \circ g)(0)$
6. $(f \circ f)(2)$
7. $(g \circ g)(-3)$
8. $f(g(0))$

Use the table below to answer each.

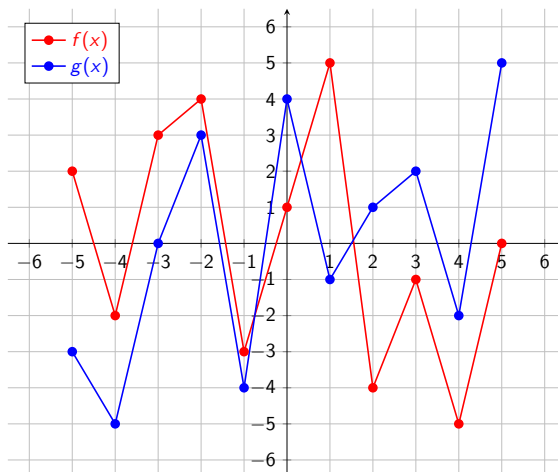
| x | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|--------|----|----|----|----|----|----|----|---|---|
| $f(x)$ | 1 | -1 | -2 | 4 | 0 | -4 | -3 | 3 | 2 |
| $g(x)$ | 0 | -2 | 1 | -4 | -3 | 2 | -1 | 4 | 3 |

9. $(f \circ g)(-1)$
10. $f(g(3))$
11. $(g \circ f)(0)$
12. $f(f(4))$
13. $g(f(g(1)))$

Given $f(x) = \sqrt{3x + 2}$, $g(x) = x^2 - 1$, and $h(x) = 9x - 2$, find each of the following.

14. $(g \circ f)(x)$
15. $f(g(x))$
16. $(h \circ h)(x)$

Find each of the following given the graphs of $f(x)$ (in red) and $g(x)$ (in blue) below:



17. $(f \circ g)(-1)$ 18. $(g \circ f)(-4)$ 19. $f(g(3))$ 20. $g(g(-2))$ 21. $(f \circ f)(-5)$

Given $f(x) = \sqrt{2x-9}$ and $g(x) = \frac{2x}{x-3}$, simplify each and state the domain of the composition.

22. $f(g(x))$ 23. $(g \circ f)(x)$ 24. $g(g(x))$

Given $f(x) = \sqrt{3x-4}$, $g(x) = \frac{2x}{x+1}$, and $h(x) = 5x-9$, simplify each of the following and state the domain.

25. $(g \circ f)(x)$ 26. $(h(g(x)))$ 27. $(f \circ h)(x)$

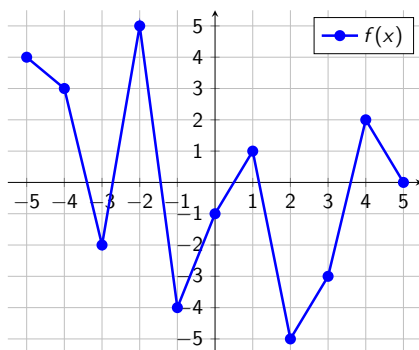
Given $f(x) = \frac{5x}{2x-7}$ and $g(x) = \frac{x}{x+8}$, simplify each and state the domain of the composition.

28. $(f \circ g)(x)$ 29. $g(f(x))$ 30. $(g \circ g)(x)$

Given $f(x) = x^2 - 5$, $g(x) = \frac{x}{2x-3}$, and $h(x) = \sqrt{6x+7}$, find the composition of each. Then state the domain of the composition using interval notation.

31. $(f \circ f)(x)$ 32. $(g \circ h)(x)$ 33. $h(g(x))$

Given the graph of $f(x)$, the table of $g(x)$, and $h(x) = \sqrt{x+12}$, find the value of each.



| x | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
|--------|----|----|----|----|----|----|---|----|---|---|----|
| $g(x)$ | 5 | 4 | -3 | 0 | -4 | -1 | 1 | -2 | 2 | 3 | -5 |

34. $(f \circ g)(-2)$ 35. $(h \circ h)(4)$ 36. $(g \circ f)(-5)$ 37. $f(g(h(13)))$ 38. $(g \circ g \circ f)(3)$

11.1 Answer Key

1. $-1 + \sqrt{2x+1}$ Domain: $[-\frac{1}{2}, \infty)$
2. $4 + \sqrt{2x-9}$ Domain: $[\frac{9}{2}, \infty)$
3. $\frac{3x+21}{7x+52}$ Domain: $(-\infty, -\frac{52}{7}) \cup (-\frac{52}{7}, -7) \cup (-7, \infty)$
4. 2
5. -3
6. -2
7. 1
8. -2
9. 1
10. 2
11. -3
12. -3
13. -2
14. $3x+1$
15. $\sqrt{3x^2-1}$
16. $81x-20$
17. -2
18. 3
19. -4
20. 2
21. -4
22. $f(g(x)) = \sqrt{\frac{-5x+27}{x-3}}; \quad (3, \frac{27}{5}]$
23. $(g \circ f)(x) = \frac{2\sqrt{2x-9}}{\sqrt{2x-9}-3}; \quad [\frac{9}{2}, 9) \cup (9, \infty)$
24. $g(g(x)) = \frac{4x}{9-x}; \quad (-\infty, 3) \cup (3, 9) \cup (9, \infty)$
25. $\frac{2\sqrt{3x-4}}{\sqrt{3x-4}+1}; \quad [\frac{4}{3}, \infty)$
26. $\frac{x-9}{x+1}; \quad (-\infty, -1) \cup (-1, \infty)$
27. $\sqrt{15x-31}; \quad [\frac{31}{15}, \infty)$
28. $\frac{5x}{-5x-56}, (-\infty, -\frac{56}{5}) \cup (-\frac{56}{5}, -8) \cup (-8, \infty)$
29. $\frac{5x}{21x-56}, (-\infty, \frac{8}{3}) \cup (\frac{8}{3}, \frac{7}{2}) \cup (\frac{7}{2}, \infty)$
30. $\frac{x}{9x+64}, (-\infty, -8) \cup (-8, -\frac{64}{9}) \cup (-\frac{64}{9}, \infty)$
31. $x^4 - 10x^2 + 20; (-\infty, \infty)$
32. $\frac{\sqrt{6x+7}}{2\sqrt{6x+7}-3}; [-\frac{7}{6}, -\frac{19}{24}) \cup (-\frac{19}{24}, \infty)$
33. $\sqrt{\frac{20x-21}{2x-3}}; (-\infty, \frac{21}{20}] \cup (\frac{3}{2}, \infty)$

34. -1

35. 4

36. 3

37. 4

38. -3

Chapter 12

Inverse Functions

Find the inverse of each. Then state the domain and range of the function and the inverse.

1. $f(x) = \sqrt{-2x+3} + 1$

2. $g(x) = (x+4)^2 - 1, x \leq -4$

3. $h(x) = \frac{9x}{4x-1}$

4. $f(x) = \sqrt{x} - 3$

5. $g(x) = \frac{1}{1-x}$

6. $h(x) = x^2 + 6x + 4, x \leq -3$

7. $f(x) = \sqrt{5x-4}$

8. $g(x) = x^2 - 2x + 3, x \leq 1$

9. $h(x) = \frac{3}{x-1}$

10. $f(x) = 5 - \sqrt{2x}$

11. $g(x) = \frac{5}{x+1}$

12. $h(x) = \frac{3x}{x-2}$

12.1 Answer Key

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

| | Domain | Range |
|-------------|------------------|------------------|
| $f(x)$ | $(-\infty, 1.5]$ | $[1, \infty)$ |
| $f^{-1}(x)$ | $[1, \infty)$ | $(-\infty, 1.5]$ |

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

| | Domain | Range |
|-------------|-----------------|-----------------|
| $g(x)$ | $(-\infty, -4]$ | $[-1, \infty)$ |
| $g^{-1}(x)$ | $[-1, \infty)$ | $(-\infty, -4]$ |

3. $h^{-1}(x) = \frac{-x}{9-4x}$

| | Domain | Range |
|-------------|-------------------------------------|-------------------------------------|
| $h(x)$ | $(-\infty, 1/4) \cup (1/4, \infty)$ | $(\infty, 9/4) \cup (9/4, \infty)$ |
| $h^{-1}(x)$ | $(\infty, 9/4) \cup (9/4, \infty)$ | $(-\infty, 1/4) \cup (1/4, \infty)$ |

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

| | Dom | Ran |
|-------------|----------------|----------------|
| $f(x)$ | $[0, \infty)$ | $[-3, \infty)$ |
| $f^{-1}(x)$ | $[-3, \infty)$ | $[0, \infty)$ |

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

| | Dom | Ran |
|-------------|---------------------------------|---------------------------------|
| $g(x)$ | $(-\infty, 1) \cup (1, \infty)$ | $(-\infty, 0) \cup (0, \infty)$ |
| $g^{-1}(x)$ | $(-\infty, 0) \cup (0, \infty)$ | $(-\infty, 1) \cup (1, \infty)$ |

6. $h^{-1}(x) = -\sqrt{x+5} - 3$

| | Dom | Ran |
|-------------|-----------------|-----------------|
| $h(x)$ | $(-\infty, -3]$ | $[-5, \infty)$ |
| $h^{-1}(x)$ | $[-5, \infty)$ | $(-\infty, -3]$ |

7. $f^{-1}(x) = \frac{1}{5}x^2 + \frac{4}{5}$

| | Dom | Ran |
|-------------|-------------------------|-------------------------|
| $f(x)$ | $[\frac{4}{5}, \infty)$ | $[0, \infty)$ |
| $f^{-1}(x)$ | $[0, \infty)$ | $[\frac{4}{5}, \infty)$ |

8. $g^{-1}(x) = -\sqrt{x-2} + 1$

| | Dom | Ran |
|-------------|----------------|----------------|
| $g(x)$ | $(-\infty, 1]$ | $[2, \infty)$ |
| $g^{-1}(x)$ | $[2, \infty)$ | $(-\infty, 1]$ |

9. $h^{-1}(x) = \frac{3}{x} + 1$

| | Dom | Ran |
|-------------|---------------------------------|---------------------------------|
| $h(x)$ | $(-\infty, 1) \cup (1, \infty)$ | $(-\infty, 0) \cup (0, \infty)$ |
| $h^{-1}(x)$ | $(-\infty, 0) \cup (0, \infty)$ | $(-\infty, 1) \cup (1, \infty)$ |

10. $f^{-1}(x) = \frac{1}{2}(x - 5)^2; x \leq 5$

| | Domain | Range |
|-------------|----------------|----------------|
| $f(x)$ | $[0, \infty)$ | $(-\infty, 5]$ |
| $f^{-1}(x)$ | $(-\infty, 5]$ | $[0, \infty)$ |

11. $g^{-1}(x) = \frac{5}{x} - 1$

| | Domain | Range |
|-------------|-----------------------------------|-----------------------------------|
| $g(x)$ | $(-\infty, -1) \cup (-1, \infty)$ | $(-\infty, 0) \cup (0, \infty)$ |
| $g^{-1}(x)$ | $(-\infty, 0) \cup (0, \infty)$ | $(-\infty, -1) \cup (-1, \infty)$ |

12. $h^{-1}(x) = \frac{2x}{x-3}$

| | Domain | Range |
|-------------|---------------------------------|---------------------------------|
| $h(x)$ | $(-\infty, 2) \cup (2, \infty)$ | $(-\infty, 3) \cup (3, \infty)$ |
| $h^{-1}(x)$ | $(-\infty, 3) \cup (3, \infty)$ | $(-\infty, 2) \cup (2, \infty)$ |

Chapter 13

Exponential Functions

13.1 Transforming Exponential Functions

Given $f(x) = e^x$, determine the specific transformations done to $f(x)$ to produce $g(x)$.

1. $g(x) = -3e^{x+1}$
2. $g(x) = \frac{1}{4}e^{-5x} - 2$
3. $g(x) = e^{2x+7}$
4. $g(x) = 5e^{-x-2} + 1$
5. $g(x) = 0.1e^{0.25x-3} - 4$

13.2 End Behavior

Determine the end behavior of each. Write your answers using limit notation.

1. $f(x) = 3 + e^{2x}$
2. $h(x) = 5^{-x}$
3. $h(x) = -\frac{2}{3}e^{x+7} + 1$
4. $f(x) = -7e^x + 4$
5. $g(x) = \frac{1}{3}e^{2x+1} - 5$
6. $h(x) = -\frac{1}{2}e^{-4x} + 1$
7. $f(x) = 3^{1-2x}$
8. $g(x) = \frac{2}{3}\left(\frac{1}{2}\right)^{-x+4}$
9. $h(x) = -7(10)^{5x+4} + 3$

13.3 Answer Key

Transforming Exponential Functions

1. Shift left 1 unit, vertical stretch by factor of 3, reflect across x -axis
2. Horizontal compression by factor of 5, reflect across y -axis, vertical compression by factor of 4, shift down 2 units
3. Shift left 7 units, horizontal compression by factor of 2
4. Shift right 2 units, reflect across y -axis, vertical stretch by factor of 5, shift up 1 unit
5. Shift right 3 units, horizontal compression by factor of 4, vertical compression by factor of 10, shift down 4 units

End Behavior

1. $\lim_{x \rightarrow -\infty} f(x) = 3$ $\lim_{x \rightarrow \infty} f(x) = \infty$
2. $\lim_{x \rightarrow -\infty} f(x) = \infty$ $\lim_{x \rightarrow \infty} f(x) = 0$
3. $\lim_{x \rightarrow -\infty} h(x) = 1$ $\lim_{x \rightarrow \infty} h(x) = -\infty$
4. $\lim_{x \rightarrow -\infty} f(x) = 4$ $\lim_{x \rightarrow \infty} f(x) = -\infty$
5. $\lim_{x \rightarrow -\infty} f(x) = -5$ $\lim_{x \rightarrow \infty} f(x) = \infty$
6. $\lim_{x \rightarrow -\infty} f(x) = -\infty$ $\lim_{x \rightarrow \infty} f(x) = 1$
7. $\lim_{x \rightarrow -\infty} f(x) = \infty$, $\lim_{x \rightarrow \infty} f(x) = 0$
8. $\lim_{x \rightarrow -\infty} g(x) = 0$, $\lim_{x \rightarrow \infty} g(x) = \infty$
9. $\lim_{x \rightarrow -\infty} h(x) = 3$, $\lim_{x \rightarrow \infty} h(x) = -\infty$

Chapter 14

Logarithmic Functions

Write each of the following in exponential or logarithmic form.

1. $\ln(a) = 7$

2. $\log_4(x + 1) = 9$

3. $\log(5x) = 30$

4. $\ln(w) = c$

5. $5^x = 19$

6. $8^{-3} = \frac{1}{512}$

7. $e^{14} = x$

8. $(1.1)^{-t} = 50$

Find the domain of each. Write your answers in interval notation.

9. $b(x) = \log_7(x^2 - 8x + 6)$

10. $a(x) = \ln\left(\frac{x^2 + 3x + 2}{5x + 15}\right)$

11. $f(x) = -7 \ln(x^2 + 9x + 8)$

12. $g(x) = \log(5x^2 + 13x - 6)$

13. $h(x) = 3 \log_2(x^3 + 2x^2 - x - 2)$

14. $c(x) = \ln(4x^2 - 15x - 4)$

State the end behavior of each.

15. $j(x) = 5 \log_3(2x - 5) - 2$

Write an equivalent expression for each using natural logarithms.

16. $\log_7(11)$

17. $\log_{12}(x)$

14.1 Answer Key

1. $e^7 = a$
2. $4^9 = x + 1$
3. $10^{30} = 5x$
4. $e^c = w$
5. $\log_5(19) = x$
6. $\log_8\left(\frac{1}{512}\right) = -3$
7. $\ln(x) = 14$
8. $\log_{1.1}(50) = -t$
9. $(-\infty, 0.838) \cup (7.162, \infty)$
10. $(-3, -2) \cup (-1, \infty)$
11. $(-\infty, -8) \cup (-1, \infty)$
12. $(-\infty, -3) \cup \left(\frac{2}{5}, \infty\right)$
13. $(-2, -1) \cup (1, \infty)$
14. $(-\infty, -\frac{1}{4}) \cup (4, \infty)$
15. $\lim_{x \rightarrow (5/2)^+} j(x) = -\infty \quad \lim_{x \rightarrow \infty} j(x) = \infty$
16. $\frac{\ln(11)}{\ln(7)}$
17. $\frac{\ln(x)}{\ln(12)}$

Chapter 15

Properties of Logarithms

Expand or condense each completely. Simplify numerical answers.

1. $\log_b \left(\frac{x^2}{y^8} \right)$

2. $\ln(ez)^3$

3. $\log_5(x) + \log_5(9) - 2\log_5(w)$

4. $\log_2(2^a b^3)$

5. $\ln \left(\frac{w^7}{e^6} \right)$

6. $5\log_4(m) - 3\log_4(n) + 2\log_4(p)$

Write an equivalent expression for each of the following using natural logarithms.

7. $\log_7(10)$

8. $\log_9(x)$

9. $\log_b(c)$

10. $\log_3(10)$

11. $\log_{17}(\pi)$

12. $\log_w(x)$

Suppose that $\log_a(b) = 5$, $\log_a(c) = 12$, and $\log_a(d) = 9$. Evaluate each of the following.

13. $\log_a(bc)$

14. $\log_a(c^3)$

15. $\log_a \left(\frac{d}{c} \right)$

16. $\log_a \left(\frac{bd}{c} \right)$

17. $\log_a(b^7 c)$

18. $\log_a \left(\frac{c^2}{d} \right)$

19. $\log_a(\sqrt{bc})$

20. $\log_a((bd)^2)$

21. $\log_a(\sqrt[3]{d^2})$

22. $\log_a(\sqrt{b^5})$

23. $\log_a \left(\frac{b^6 c}{d^3} \right)$

24. $\log_a(b^2 c^3 d^4)$

15.1 Answer Key

1. $2 \log_b(x) - 8 \log_b(y)$

2. $3 + 3 \ln(z)$

3. $\log_5\left(\frac{9x}{w^2}\right)$

4. $a + 3 \log_2(b)$

5. $7 \ln(w) - 6$

6. $\log_4\left(\frac{m^5 p^2}{n^3}\right)$

7. $\frac{\ln(10)}{\ln(7)}$

8. $\frac{\ln(x)}{\ln(9)}$

9. $\frac{\ln(c)}{\ln(b)}$

10. $\frac{\ln(10)}{\ln(3)}$

11. $\frac{\ln(\pi)}{\ln(17)}$

12. $\frac{\ln(x)}{\ln(w)}$

13. 17

14. 36

15. -3

16. 2

17. 47

18. 15

19. $17/2$

20. 28

21. 6

22. $25/2$

23. 15

24. 82

Chapter 16

Exponential Equations

Solve each. Round to 3 decimal places when necessary.

1. $3e^{x-2} = 7$
2. $5^x + 4 > 1$
3. $2^{3x+4} = 32^{x-7}$
4. $5e^{7x} + 10 = 42$
5. $7^{4x+1} \geq 343$
6. $1000e^{0.04x} = 2000$
7. $3(4.1)^{x-2} = 8$
8. $2^{x+1} = 5^{7x-5}$
9. $8(17)^{-5x} = 22$
10. $-3(11)^{x-10} = -58$
11. $12^{-10x} + 8 = 80$
12. $-5(10)^{7x} + 9 = -46$
13. $8(8)^{10x} - 1 = 55.2$
14. $3(3)^{-5x} - 8 = 74$
15. $6(16)^{4x-9} = 19$
16. $-7(11)^{5x-7} = -3$
17. $3^{9-6x} - 7 = 26$
18. $3^{1-2x} = 7$
19. $\frac{2}{3} \left(\frac{1}{2}\right)^{-x+4} = 8$
20. $-7(10)^{5x+4} = -15$

16.1 Applications

1. Plutonium has a half-life of 24,360 years. If 15 grams are initially present, how long until 9.5 grams remain?
2. Cadmium-109 has a half-life of about 1.267 years. If 50 mg are initially present, how many years will it take for 16 mg to remain?
3. The half-life of bismuth-207 is about 32.9 years. If 90 mg are initially present, how many years will it take for 75 mg to remain?

16.2 Answer Key

1. $x \approx 2.847$
2. $(-\infty, \infty)$
3. $x = 19.5$
4. $x \approx 0.265$
5. $[\frac{1}{2}, \infty)$
6. $x \approx 17.329$
7. $x \approx 2.695$
8. $x \approx 0.827$
9. $x \approx -0.071$
10. $x \approx 11.235$
11. $x \approx -0.172$
12. $x \approx 0.149$
13. $x \approx 0.094$
14. $x \approx -0.602$
15. $x \approx 2.354$
16. $x \approx 1.323$
17. $x \approx 0.970$
18. $x \approx -0.3856$
19. $x \approx 7.5850$
20. $x \approx -0.7338$

Applications

1. Approximately 17,952 years
2. Approximately 2.0828 years
3. Approximately 8.6538 years

Chapter 17

Logarithmic Equations and Inequalities

Solve each. Round to 3 decimal places when necessary.

1. $\log_5(x) + x \log_5(x) > 0$
2. $\ln(8 - x^2) = \ln(2 - x)$
3. $\log_{25}\left(\frac{3x+1}{2x-2}\right) = \frac{1}{2}$
4. $\log_3(2x + 1) - \log_3(x - 5) = \log_3(x + 1)$
5. $\log_4(x + 1) + \log_4(x - 5) > 2$
6. $\log(x + 1) - \log(x - 5) = \log(x - 3)$
7. $x \log_3(x + 2) - \log_3(x + 2) = 0$
8. $\log_{1/2}(x + 1) > -3$
9. $\log_{12}(4x + 4) = \log_{12}(5x + 1)$
10. $\log_{15}(-4x + 2) = \log_{15}(6 - 2x)$
11. $\log_{11}(-5 - 3x^2) = \log_{11}(-2x^2 + 6x)$
12. $\log_{16}(x^2 + 4) = \log_{16}(2x + 3)$
13. $\log_7(8x - 1) = \log_7(x^2 + 14)$
14. $-7 \log_5(x + 5) = -7$
15. $7 \log_8(-x) = 28$
16. $-10 \log_3(x - 5) = -20$

17.1 Answer Key

1. $(1, \infty)$
2. $x = -2$
3. $x \approx 1.571$
4. $x \approx 6.873$
5. $(2, \infty)$
6. $x = 7$
7. $x = \pm 1$
8. $(-1, 7)$
9. $x = 3$
10. $x = -2$
11. No Solution
12. $x = 1$
13. $x = 3, 5$
14. $x = 0$
15. $x = -4096$
16. $x = 14$

Chapter 18

Sequences

Write the first 4 terms of each sequence.

1. $a_n = 2(-3)^n$

2. $b_n = \frac{n!}{2^n}$

3. $c_{n+1} = 5c_n + 1$; $c_1 = 2$

4. $d_n = \frac{1}{2}d_{n-1} + n$; $d_1 = 3$

Find the indicated term of each sequence. For term values above 10 billion or below 0.00001, write the first 4 digits after the decimal point when the answer is given in scientific notation. **Do not round.**

5. $a_n = \{343, 667, 991, 1315, \dots\}$; Find the 582nd term.

6. $b_n = \{300, 240, 192, 153.6, \dots\}$; Find the 711th term.

7. $c_n = \{1, \frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \dots\}$; Find the 8,675,309th term.

Given each sequence, find the first 4 digits **after the decimal point** in the **scientific notation** version of each term.

8. $a_n = 17, 33, 49, 65, \dots$; $a_{21,972}$

9. $b_n = 25, 36, 49, 64, 81, \dots$ $b_{413,401}$

10. $c_n = \frac{1}{3}, \frac{1}{6}, \frac{1}{12}, \frac{1}{24}, \dots$ c_{152}

Find the exact value of the indicated term for each sequence.

11. $a_n = \{-0.7, -2.8, -4.9, -7, \dots\}$; find a_{941}

12. $b_n = \{\frac{1}{3}, \frac{4}{5}, \frac{9}{7}, \frac{16}{9}, \dots\}$; find b_{137}

18.1 Answer Key

1. $-6, 18, -54, 162$
2. $\frac{1}{2}, \frac{1}{2}, \frac{3}{4}, \frac{3}{2}$
3. $2, 11, 56, 281$
4. $3, \frac{7}{2}, \frac{19}{4}, \frac{51}{8}$
5. $188,587$
6. 6882
7. 7634
8. $5155 (3.51553 \times 10^5)$
9. $7090 (1.7090369403 \times 10^{11})$
10. $1677 (1.1677487203 \times 10^{-46})$
11. -1974.7
12. $\frac{18769}{275}$

Chapter 19

Series

Find the sum of each, if possible.

1. $\sum_{i=1}^{\infty} \left(\frac{1}{5}\right)^i$

2. $\sum_{i=0}^{\infty} 3 \left(-\frac{2}{3}\right)^i$

3. $\sum_{k=1}^{\infty} -2 \left(\frac{1}{3}\right)^k$

4. $\sum_{j=0}^{\infty} -\frac{1}{2} \left(\frac{3}{2}\right)^j$

5. $\sum_{i=0}^{\infty} 1.2(0.8)^i$

6. $\sum_{i=1}^{\infty} 1.2(0.8)^i$

7. $\sum_{i=0}^{\infty} 0.8(1.2)^i$

8. $\sum_{k=1}^{\infty} \frac{2}{3^k}$

Find the sum of each of the following. Round to 4 decimal places when necessary.

9. $9 + 13 + 17 + 21 + \cdots + 1565$

10. $-3 + 6 - 12 + 24 - 48 + \cdots + 50,331,648$

11. $1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \cdots + \frac{1}{981}$

12. $2 + 4 + 6 + 8 + 10 + \cdots + 38,214$

13. $3 + 7 + 11 + 15 + \cdots + 11,491$

14. $\frac{4}{5} + \frac{5}{6} + \frac{6}{7} + \cdots + \frac{742}{743}$

19.1 Answer Key

1. $\frac{1}{4}$
2. $\frac{9}{5}$
3. -1
4. Diverges
5. 6
6. 4.8
7. Diverges
8. 2
9. 306,930
10. $-33,554,433$
11. 7.4663
12. 365,096,556
13. 16,511,131
14. 733.8947

Chapter 20

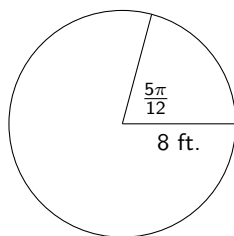
Angles and Radian Measure

Sketch each of the following. Then find a coterminal between 0 and 360° (or 0 and 2π radians) for each.

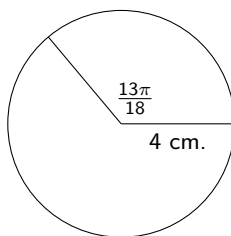
1. $-\frac{3\pi}{4}$
2. 900°
3. $\frac{27\pi}{10}$
4. -125°

Find the arc length and sector area formed by the central angle of each. Exact answers only.

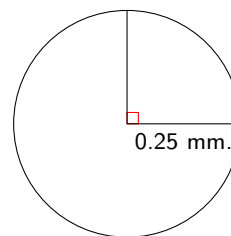
5.



6.



7.

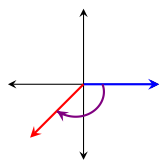


A belt runs on a pulley with radius 4 inches at 250 revolutions per minute.

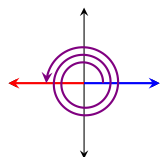
8. Find the angular velocity in rad/sec. Round your answer to 2 decimal places.
9. Find the linear velocity in ft/sec. Round your answer to 2 decimal places.

20.1 Answer Key

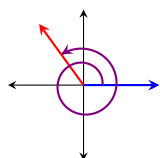
1. $\frac{5\pi}{4}$



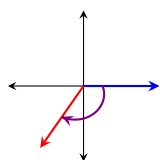
2. 180°



3. $\frac{7\pi}{10}$



4. 235°



5. $s = \frac{10\pi}{3}$ ft.; $A = \frac{40\pi}{3}$ sq.ft.

6. $s = \frac{26\pi}{9}$ cm.; $A = \frac{52\pi}{9}$ sq.cm.

7. $s = \frac{\pi}{8}$ mm.; $A = \frac{\pi}{64}$ sq.mm.

8. 26.18 rad/sec

9. 8.73 ft/sec

Chapter 21

Trig Functions of Any Angle

Find the exact value of each of the six trig functions of θ if P is a point on the terminal side of θ .

- | | | |
|---------------|----------------|-----------------------|
| 1. $P(-2, 3)$ | 2. $P(0, -4)$ | 3. $P(-2\sqrt{3}, 2)$ |
| 4. $P(-3, 5)$ | 5. $P(-2, 1)$ | 6. $P(-4, -7)$ |
| 7. $P(-7, 4)$ | 8. $P(-9, -9)$ | 9. $P(4, -8)$ |

Find the exact values of the 6 trig functions of the following angles.

- | | | | | |
|---------------------------------|--------------------------------|----------------------|-----------------------|------------------------|
| 10. $\theta = \frac{-17\pi}{4}$ | 11. $\theta = \frac{21\pi}{2}$ | 12. $\theta = 24\pi$ | 13. $-\frac{5\pi}{3}$ | 14. $\frac{23\pi}{6}$ |
| 15. $-\frac{\pi}{2}$ | 16. $\frac{10\pi}{3}$ | 17. $-\frac{\pi}{3}$ | 18. $\frac{11\pi}{4}$ | 19. $-\frac{13\pi}{2}$ |

21.1 Answer Key

1. $\sin \theta = \frac{3\sqrt{13}}{13}$, $\cos \theta = \frac{-2\sqrt{13}}{13}$, $\tan \theta = -\frac{3}{2}$, $\csc \theta = \frac{\sqrt{13}}{3}$, $\sec \theta = -\frac{\sqrt{13}}{2}$, $\cot \theta = -\frac{2}{3}$
2. $\sin \theta = -1$, $\cos \theta = 0$, $\tan \theta = \text{undef.}$, $\csc \theta = -1$, $\sec \theta = \text{undef.}$, $\cot \theta = 0$
3. $\sin \theta = \frac{1}{2}$, $\cos \theta = -\frac{\sqrt{3}}{2}$, $\tan \theta = -\frac{\sqrt{3}}{3}$, $\csc \theta = 2$, $\sec \theta = -\frac{2\sqrt{3}}{3}$, $\cot \theta = -\sqrt{3}$
4. $\sin \theta = \frac{5\sqrt{34}}{34}$, $\cos \theta = -\frac{3\sqrt{34}}{34}$, $\tan \theta = -\frac{5}{3}$, $\csc \theta = \frac{\sqrt{34}}{5}$, $\sec \theta = -\frac{\sqrt{34}}{3}$, $\cot \theta = -\frac{3}{5}$
5. $\sin \theta = \frac{\sqrt{5}}{5}$, $\cos \theta = -\frac{2\sqrt{5}}{5}$, $\tan \theta = -\frac{1}{2}$, $\csc \theta = \sqrt{5}$, $\sec \theta = -\frac{\sqrt{5}}{2}$, $\cot \theta = -2$
6. $\sin \theta = -\frac{7\sqrt{65}}{65}$, $\cos \theta = -\frac{4\sqrt{65}}{65}$, $\tan \theta = \frac{7}{4}$, $\csc \theta = -\frac{\sqrt{65}}{7}$, $\sec \theta = -\frac{\sqrt{65}}{4}$, $\cot \theta = \frac{4}{7}$
7. $\sin(\theta) = \frac{4\sqrt{65}}{65}$ $\cos(\theta) = -\frac{7\sqrt{65}}{65}$ $\tan(\theta) = -\frac{4}{7}$ $\csc(\theta) = \frac{\sqrt{65}}{4}$ $\sec(\theta) = -\frac{\sqrt{65}}{7}$ $\cot(\theta) = -\frac{7}{4}$
8. $\sin(\theta) = -\frac{\sqrt{2}}{2}$ $\cos(\theta) = -\frac{\sqrt{2}}{2}$ $\tan(\theta) = 1$ $\csc(\theta) = -\sqrt{2}$ $\sec(\theta) = -\sqrt{2}$ $\cot(\theta) = 1$
9. $\sin(\theta) = -\frac{2\sqrt{5}}{5}$ $\cos(\theta) = \frac{\sqrt{5}}{5}$ $\tan(\theta) = -2$ $\csc(\theta) = -\frac{\sqrt{5}}{2}$ $\sec(\theta) = \sqrt{5}$ $\cot(\theta) = -\frac{1}{2}$
10. $\sin \theta = -\frac{\sqrt{2}}{2}$, $\cos \theta = \frac{\sqrt{2}}{2}$, $\tan \theta = -1$, $\csc \theta = -\sqrt{2}$, $\sec \theta = \sqrt{2}$, $\cot \theta = -1$
11. $\sin \theta = 1$, $\cos \theta = 0$, $\tan \theta = \text{undefined}$, $\csc \theta = 1$, $\sec \theta = \text{undefined}$, $\cot \theta = 0$
12. $\sin \theta = 0$, $\cos \theta = 1$, $\tan \theta = 0$, $\csc \theta = \text{undefined}$, $\sec \theta = 1$, $\cot \theta = \text{undefined}$
13. $\sin\left(-\frac{5\pi}{3}\right) = \frac{\sqrt{3}}{2}$, $\cos\left(-\frac{5\pi}{3}\right) = \frac{1}{2}$, $\tan\left(-\frac{5\pi}{3}\right) = \sqrt{3}$, $\csc\left(-\frac{5\pi}{3}\right) = \frac{2\sqrt{3}}{3}$, $\sec\left(-\frac{5\pi}{3}\right) = 2$, $\cot\left(-\frac{5\pi}{3}\right) = \frac{\sqrt{3}}{3}$
14. $\sin\left(\frac{23\pi}{6}\right) = -\frac{1}{2}$, $\cos\left(\frac{23\pi}{6}\right) = \frac{\sqrt{3}}{2}$, $\tan\left(\frac{23\pi}{6}\right) = -\frac{\sqrt{3}}{3}$, $\csc\left(\frac{23\pi}{6}\right) = -2$, $\sec\left(\frac{23\pi}{6}\right) = \frac{2\sqrt{3}}{3}$, $\cot\left(\frac{23\pi}{6}\right) = -\sqrt{3}$
15. $\sin\left(-\frac{\pi}{2}\right) = -1$, $\cos\left(-\frac{\pi}{2}\right) = 0$, $\tan\left(-\frac{\pi}{2}\right) = \text{undefined}$, $\csc\left(-\frac{\pi}{2}\right) = -1$, $\sec\left(-\frac{\pi}{2}\right) = \text{undefined}$, $\cot\left(-\frac{\pi}{2}\right) = 0$
16. $\sin\left(\frac{10\pi}{3}\right) = -\frac{\sqrt{3}}{2}$, $\cos\left(\frac{10\pi}{3}\right) = -\frac{1}{2}$, $\tan\left(\frac{10\pi}{3}\right) = \sqrt{3}$, $\csc\left(\frac{10\pi}{3}\right) = -\frac{2\sqrt{3}}{3}$, $\sec\left(\frac{10\pi}{3}\right) = -2$, $\cot\left(\frac{10\pi}{3}\right) = \frac{\sqrt{3}}{3}$
17. $\sin\left(-\frac{\pi}{3}\right) = -\frac{\sqrt{3}}{2}$, $\cos\left(-\frac{\pi}{3}\right) = \frac{1}{2}$, $\tan\left(-\frac{\pi}{3}\right) = -\sqrt{3}$, $\csc\left(-\frac{\pi}{3}\right) = -\frac{2\sqrt{3}}{3}$, $\sec\left(-\frac{\pi}{3}\right) = 2$, $\cot\left(-\frac{\pi}{3}\right) = -\frac{\sqrt{3}}{3}$
18. $\sin\left(\frac{11\pi}{4}\right) = \frac{\sqrt{2}}{2}$, $\cos\left(\frac{11\pi}{4}\right) = -\frac{\sqrt{2}}{2}$, $\tan\left(\frac{11\pi}{4}\right) = -1$, $\csc\left(\frac{11\pi}{4}\right) = \sqrt{2}$, $\sec\left(\frac{11\pi}{4}\right) = -\sqrt{2}$, $\cot\left(\frac{11\pi}{4}\right) = -1$
19. $\sin\left(-\frac{13\pi}{2}\right) = -1$, $\cos\left(-\frac{13\pi}{2}\right) = 0$, $\tan\left(-\frac{13\pi}{2}\right) = \text{undefined}$, $\csc\left(-\frac{13\pi}{2}\right) = -1$, $\sec\left(-\frac{13\pi}{2}\right) = \text{undefined}$, $\cot\left(-\frac{13\pi}{2}\right) = 0$

Chapter 22

Graphs of Sine and Cosine Functions

Determine the exact values of the amplitude, period, phase shift, vertical shift, domain, and range of each. *Be specific.*

1. $f(x) = -2 \sin \left(3x - \frac{\pi}{4} \right) + 1$

2. $g(x) = \frac{1}{3} \cos \left(\frac{1}{2}x + 2 \right)$

3. $f(x) = 2 \sin \left(x - \frac{\pi}{3} \right) + 7$

4. $f(x) = -4 \cos \left(\frac{2}{3}x - \frac{2\pi}{3} \right)$

5. $h(x) = \sin \left(\frac{3}{4}x + \frac{\pi}{12} \right) - 8$

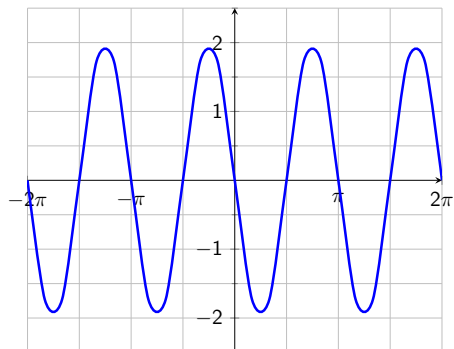
6. $f(x) = 3 \sin \left(2x + \frac{\pi}{2} \right) - \sqrt{3}$

7. $f(x) = -4 \cos \left(4x - \frac{\pi}{3} \right) + \pi$

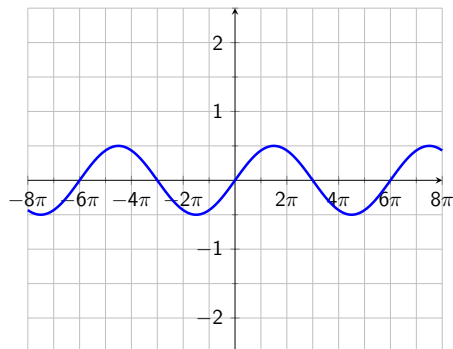
8. $g(x) = \frac{4}{9} \cos \left(\frac{3}{10}x + \frac{3\pi}{2} \right) - 1$

Write the equation of each of the following in the form $y = a \sin(bx)$.

9.



10.



22.1 Answer Key

1. Amp = 2, Per = $\frac{2\pi}{3}$, P.S. = $\frac{\pi}{12} \rightarrow$, V.S. = 1 \uparrow , Dom: $(-\infty, \infty)$, Range: $[-1, 3]$
2. Amp = $\frac{1}{3}$, Per = 4π , P.S. = $4 \leftarrow$, V.S. = None, Dom: $(-\infty, \infty)$, Range: $[-\frac{1}{3}, \frac{1}{3}]$
3. Amp = 2, Period = 2π , P.S. = $\frac{\pi}{3}$ right, V.S. = 7 up, Dom: $(-\infty, \infty)$, Range: $[5, 9]$
4. Amp = 4, Period = 3π , P.S. = π right, V.S. = 0 (or none), Dom: $(-\infty, \infty)$, Range: $[-4, 4]$
5. Amp = 1, Per = $\frac{8\pi}{3}$, P.S. = $\frac{\pi}{9}$ left, V.S. = 8 down, Dom: $(-\infty, \infty)$, Range: $[-8, 8]$
6. Amp = 3, Period = π , P.S. = $\frac{\pi}{4}$ left, V.S. = $\sqrt{3}$ down, Dom: $(-\infty, \infty)$, Range: $[-3 - \sqrt{3}, 3 - \sqrt{3}]$
7. Amp = 4, Period = $\frac{\pi}{2}$, P.S. = $\frac{\pi}{12}$ right, V.S. = π up, Dom: $(-\infty, \infty)$, Range: $[-4 + \pi, 4 + \pi]$
8. Amp = $\frac{4}{9}$, Period = $\frac{20\pi}{3}$, P.S. = 5π left, V.S. = 1 down, Dom: $(-\infty, \infty)$, Range: $[-\frac{13}{9}, -\frac{5}{9}]$
9. $y = -2\sin(2x)$
10. $y = \frac{1}{2}\sin(\frac{1}{3}x)$

Chapter 23

Graphs of Other Trig Functions

Determine the exact values of the amplitude, period, phase shift, vertical shift, domain, and range of each. *Be specific.*

1. $h(x) = \tan\left(\frac{3}{4}x + \frac{\pi}{12}\right) - 8$

2. $f(x) = 3 \tan\left(2x + \frac{\pi}{2}\right) - \sqrt{3}$

3. $f(x) = -4 \cot\left(4x - \frac{\pi}{3}\right) + \pi$

4. $g(x) = \frac{4}{9} \cot\left(\frac{3}{10}x + \frac{3\pi}{2}\right) - 1$

5. $h(x) = \sec\left(\frac{3}{4}x + \frac{\pi}{12}\right) - 8$

6. $f(x) = 3 \sec\left(2x + \frac{\pi}{2}\right) - \sqrt{3}$

7. $f(x) = -4 \csc\left(4x - \frac{\pi}{3}\right) + \pi$

8. $g(x) = \frac{4}{9} \csc\left(\frac{3}{10}x + \frac{3\pi}{2}\right) - 1$

9. $f(x) = \frac{1}{10} \cot\left(3x + \frac{3\pi}{4}\right) + 5$

10. $g(x) = 6 \csc\left(2x - \frac{\pi}{6}\right) + 5$

11. $h(x) = 4 \csc\left(8x - \frac{\pi}{6}\right) - 1$

12. $k(x) = \tan\left(\frac{1}{7}x + \frac{\pi}{4}\right) - 5$

13. $f(x) = 7 \tan\left(8x + \frac{\pi}{6}\right)$

14. $g(x) = 6 \tan\left(7x - \frac{\pi}{4}\right) - 4$

15. $h(x) = 4 \tan(5x) - 5$

16. $k(x) = \cot\left(\frac{1}{3}x - \frac{2\pi}{3}\right) - 5$

17. $f(x) = 10 \cot\left(\frac{1}{8}x - \frac{\pi}{2}\right)$

18. $g(x) = 10 \cot\left(5x - \frac{\pi}{4}\right) + 5$

19. $f(x) = -3 \tan\left(\frac{x}{5} - \frac{2\pi}{3}\right) + 1$

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

21. $h(x) = -\frac{1}{10} \sec\left(\pi x - \frac{\pi}{2}\right)$

23.1 Answer Key

1. Amp = n/a , Per = $\frac{4\pi}{3}$, P.S. = $\frac{\pi}{9}$ left, V.S. = 8 down, Dom: $x \neq \frac{5\pi}{9} + \frac{4\pi}{3}k$, Range: $(-\infty, \infty)$
2. Amp = n/a , Period = $\frac{\pi}{2}$, P.S. = $\frac{\pi}{4}$ left, V.S. = $\sqrt{3}$ down, Dom: $x \neq \frac{\pi}{2}k$, Range: $(-\infty, \infty)$
3. Amp = n/a , Period = $\frac{\pi}{4}$, P.S. = $\frac{\pi}{12}$ right, V.S. = π up, Dom: $x \neq \frac{\pi}{12} + \frac{\pi}{4}k$, Range: $(-\infty, \infty)$
4. Amp = n/a , Period = $\frac{10\pi}{3}$, P.S. = 5π left, V.S. = 1 down, Dom: $x \neq -5\pi + \frac{10\pi}{3}k$, Range: $(-\infty, \infty)$
5. Amp = n/a , Per = $\frac{8\pi}{3}$, P.S. = $\frac{\pi}{9}$ left, V.S. = 8 down, Dom: $x \neq \frac{5\pi}{9} + \frac{4\pi}{3}k$, Range: $(-\infty, -9] \cup [-7, \infty)$
6. Amp = n/a , Period = π , P.S. = $\frac{\pi}{4}$ left, V.S. = $\sqrt{3}$ down, Dom: $x \neq \frac{\pi}{2}k$, Range: $(-\infty, -3 - \sqrt{3}] \cup [3 - \sqrt{3}, \infty)$
7. Amp = n/a , Period = $\frac{\pi}{2}$, P.S. = $\frac{\pi}{12}$ right, V.S. = π up, Dom: $x \neq \frac{\pi}{8} + \frac{\pi}{4}k$, Range: $(-\infty, -4 + \pi] \cup [4 + \pi, \infty)$
8. Amp = n/a , Period = $\frac{20\pi}{3}$, P.S. = 5π left, V.S. = 1 down, Dom: $x \neq -5\pi + \frac{10\pi}{3}k$, Range: $(-\infty, -\frac{13}{9}] \cup [-\frac{5}{9}, \infty)$
9. Amp = n/a , Period = $\frac{\pi}{3}$, P.S. = $\frac{\pi}{4}$ left, V.S. = 5 up, Dom: $x \neq -\frac{\pi}{4} + \frac{\pi}{3}k$, Range: $(-\infty, \infty)$
10. Amp = n/a , Period = π , P.S. = $\frac{\pi}{12}$ right, V.S. = 5 up, Dom: $x \neq \frac{\pi}{12} + \frac{\pi}{2}k$, Range: $(-\infty, -1] \cup [11, \infty)$
11. Amp = n/a , Period = $\frac{\pi}{4}$, P.S. = $\frac{\pi}{48}$ right, V.S. = 1 down, Dom: $x \neq \frac{\pi}{48} + \frac{\pi}{8}k$, Range: $(-\infty, -5] \cup [3, \infty)$
12. Amp = n/a , Period = 7π , P.S. = $\frac{7\pi}{4}$ left, V.S. = 5 down, Dom: $x \neq \frac{7\pi}{4} + 7\pi k$, Range: $(-\infty, \infty)$
13. Amp = n/a , Period = $\frac{\pi}{8}$, P.S. = $\frac{\pi}{48}$ left, V.S. = 0 (or none), Dom: $x \neq \frac{\pi}{24} + \frac{\pi}{8}k$, Range: $(-\infty, \infty)$
14. Amp = n/a , Period = $\frac{\pi}{7}$, P.S. = $\frac{\pi}{28}$ right, V.S. = 4 down, Dom: $x \neq \frac{\pi}{28} + \frac{\pi}{7}k$, Range: $(-\infty, \infty)$
15. Amp = n/a , Period = $\frac{\pi}{5}$, P.S. = 0 (or none), V.S. = 5 down, Dom: $x \neq \frac{\pi}{10} + \frac{\pi}{5}k$, Range: $(-\infty, \infty)$
16. Amp = n/a , Period = 3π , P.S. = 2π right, V.S. = 5 down, Dom: $x \neq 2\pi + 3\pi k$, Range: $(-\infty, \infty)$
17. Amp = n/a , Period = 8π , P.S. = 4π right, V.S. = 0 (or none), Dom: $x \neq 4\pi + 8\pi k$, Range: $(-\infty, \infty)$
18. Amp = n/a , Period = $\frac{\pi}{5}$, P.S. = $\frac{\pi}{20}$ right, V.S. = 5 up, Dom: $x \neq \frac{\pi}{20} + \frac{\pi}{5}k$, Range: $(-\infty, \infty)$
19. Amp = n/a , Per = 5π , P.S. = $\frac{10\pi}{3}$ right, V.S. = Up 1, Dom: $x \neq \frac{35\pi}{6} + 5\pi k$, Range: $(-\infty, \infty)$
20. Amp = n/a , Per = π , P.S. = $\frac{\pi}{2}$ left, V.S. = Down 9, Dom: $x \neq -\frac{\pi}{2} + \frac{\pi}{2}k$, Range: $(-\infty, -\frac{37}{4}] \cup [-\frac{35}{4}, \infty)$
21. Amp = n/a , Per = 2, P.S. = $\frac{1}{2}$ right, V.S. = 0, Dom: $x \neq 1 + k$, Range: $(-\infty, -\frac{1}{10}] \cup [\frac{1}{10}, \infty)$

Chapter 24

Inverse Trig Functions

State the exact, simplified value of each or write as an expression of x .

1. $\cot^{-1}(-1)$

2. $\sin^{-1}\left(-\frac{\sqrt{3}}{2}\right)$

3. $\tan^{-1}(0)$

4. $\sec^{-1}\left(\frac{2\sqrt{3}}{3}\right)$

5. $\cos^{-1}\left(\frac{1}{2}\right)$

6. $\sec^{-1}(-2)$

7. $\tan^{-1}(-\sqrt{3})$

8. $\sec\left(\sin^{-1}\left(\frac{2}{5}\right)\right)$

9. $\cot\left(\sec^{-1}(x)\right)$

10. $\sin\left(\cos^{-1}\left(\frac{3x}{4}\right)\right)$

11. $\cot\left(\csc^{-1}\left(-\frac{7}{2}\right)\right)$

12. $\sec\left(\arcsin\left(\frac{9}{13}\right)\right)$

13. $\cos\left(\tan^{-1}(7x)\right)$

14. $\sin\left(\sec^{-1}\left(\frac{8}{x}\right)\right)$

15. $\csc\left(\arctan\left(-\frac{3}{2}\right)\right)$

16. $\cos\left(\sin^{-1}\left(\frac{7}{8}\right)\right)$

17. $\tan\left(\cos^{-1}\left(\frac{3}{x}\right)\right)$

18. $\csc\left(\sec^{-1}(\sqrt{2})\right)$

19. $\tan\left(\sec^{-1}\left(\frac{\sqrt{17}}{4}\right)\right)$

20. $\sin\left(\tan^{-1}\left(\frac{4x}{5}\right)\right)$

21. $\cos\left(\tan^{-1}\left(\frac{\sqrt{3}}{5}\right)\right)$

22. $\sin\left(\cos^{-1}\left(\frac{9}{10}\right)\right)$

23. $\tan\left(\cot^{-1}(8)\right)$

24. $\csc\left(\cot^{-1}\left(\frac{\sqrt{2}}{x}\right)\right)$

25. $\sin\left(\tan^{-1}(12x)\right)$

26. $\cos\left(\sec^{-1}\left(\frac{x}{9}\right)\right)$

24.1 Answer Key

1. $\frac{3\pi}{4}$
2. $-\frac{\pi}{3}$
3. 0
4. $\frac{\pi}{6}$
5. $\frac{\pi}{3}$
6. $\frac{2\pi}{3}$
7. $-\frac{\pi}{3}$
8. $\frac{5\sqrt{21}}{21}$
9. $\frac{1}{\sqrt{x^2-1}} = \frac{\sqrt{x^2-1}}{x^2-1}$
10. $\frac{\sqrt{16-9x^2}}{4}$
11. $-\frac{3\sqrt{5}}{2}$
12. $\frac{13\sqrt{22}}{44}$
13. $\frac{\sqrt{49x^2+1}}{49x^2+1}$
14. $\frac{\sqrt{64-x^2}}{x}$
15. $-\frac{\sqrt{13}}{3}$
16. $\frac{\sqrt{15}}{8}$
17. $\frac{\sqrt{x^2-9}}{3}$
18. $\sqrt{2}$
19. $\sqrt{17}$
20. $\frac{4x}{\sqrt{16x^2+25}}$
21. $\frac{5\sqrt{7}}{14}$
22. $\frac{\sqrt{19}}{10}$
23. $\frac{1}{8}$
24. $\frac{\sqrt{x^2+2}}{x}$
25. $\frac{12x}{\sqrt{144x^2+1}} = \frac{12x\sqrt{144x^2+1}}{144x^2+1}$
26. $\frac{9}{x}$

Chapter 25

Trig Equations and Inequalities

Solve each in the interval $[0, 2\pi)$. Write your answers to inequalities using interval notation.

1. $\tan(6x) = 1$
2. $\cot(2x) = -\frac{\sqrt{3}}{3}$
3. $\sin^2(x) = \frac{3}{4}$
4. $\sin(2x) = \cos(x)$
5. $\sin(2x) \geq \sin(x)$
6. $\cos(2x) < 0$
7. $2 \sin\left(x - \frac{\pi}{3}\right) = -1$
8. $3 \tan\left(-2x + \frac{\pi}{2}\right) = \sqrt{3}$
9. $\sin^2(x) < \frac{1}{2}$
10. $\tan^2(x) = 3 \sec(x) - 3$
11. $2 \csc(x) - 3 \csc^2(x) = -2 \csc^2(x) + 1$
12. $-2 \cot(x) - \csc^2(x) = 0$
13. $\tan(x) = -\tan(x) \cos(x)$
14. $3 \cos(x) = 2 \cos^2(x) + 1$
15. $\csc(x) - \cot^2(x) + 1 = 0$
16. $-\sin(x) + \sin(2x) = 2 \sin(2x)$
17. $3 \cos(x) = \sin(2x) + 2 \cos(x)$
18. $-2 \sin\left(3x - \frac{2\pi}{3}\right) = 1$
19. $\tan\left(\frac{1}{2}x + \pi\right) = \frac{\sqrt{3}}{3}$
20. $2 \cos\left(-\frac{2}{3}x + \frac{\pi}{4}\right) = \sqrt{2}$
21. $2 \sec^2(x) - 2 = 3 \sec(x)$
22. $3 \cos^2(x) - 2 \cos(x) = 5$
23. $\cos(2x) = \sin(x)$
24. $\sin(2x) = \sqrt{3} \sin(x)$

25.1 Answer Key

1. $\frac{\pi}{24}, \frac{5\pi}{24}, \frac{3\pi}{8}, \frac{13\pi}{24}, \frac{17\pi}{24}, \frac{7\pi}{8}, \frac{25\pi}{24}, \frac{29\pi}{24}, \frac{11\pi}{8}, \frac{37\pi}{24}, \frac{41\pi}{24}, \frac{15\pi}{8}$
2. $\frac{\pi}{3}, \frac{5\pi}{6}, \frac{4\pi}{3}, \frac{11\pi}{6}$
3. $\frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}$
4. $\frac{\pi}{2}, \frac{5\pi}{6}, \frac{3\pi}{2}$
5. $[0, \frac{\pi}{3}] \cup [\pi, \frac{5\pi}{3}]$
6. $(\frac{\pi}{4}, \frac{3\pi}{4}) \cup (\frac{5\pi}{4}, \frac{7\pi}{4})$
7. $x = \frac{\pi}{6}, \frac{3\pi}{2}$
8. $x = \frac{\pi}{6}, \frac{2\pi}{3}, \frac{7\pi}{6}, \frac{5\pi}{3}$
9. $[0, \frac{\pi}{4}) \cup (\frac{3\pi}{4}, \frac{5\pi}{4}) \cup (\frac{7\pi}{4}, 2\pi)$
10. $x = 0, \frac{\pi}{3}, \frac{5\pi}{3}$
11. $x = \frac{\pi}{2}$
12. $x = \frac{3\pi}{4}, \frac{7\pi}{4}$
13. $x = 0, \pi$
14. $x = 0, \frac{\pi}{3}, \frac{5\pi}{3}$
15. $x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{3\pi}{2}$
16. $x = 0, \frac{2\pi}{3}, \pi, \frac{4\pi}{3}$
17. $x = \frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{3\pi}{2}$
18. $x = \frac{\pi}{6}, \frac{11\pi}{18}, \frac{5\pi}{6}, \frac{23\pi}{18}, \frac{3\pi}{2}, \frac{35\pi}{18}$
19. $x = \frac{\pi}{3}$
20. $x = 0, \frac{3\pi}{4}$
21. $x = \frac{\pi}{3}, \frac{5\pi}{3}$
22. $x = \pi$
23. $x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{3\pi}{2}$
24. $x = 0, \frac{\pi}{6}, \pi, \frac{11\pi}{6}$

Chapter 26

Law of Sines and Cosines; Area of Triangles

Solve each triangle and find its area.

1. $m\angle B = 37.8^\circ$, $a = 15$, $c = 21.1$
2. $m\angle A = 41.9^\circ$, $m\angle C = 59.2^\circ$, $a = 10.2$
3. $a = 14$, $b = 19.6$, $c = 13.1$
4. $c = 29$, $b = 23$, $m\angle A = 55^\circ$
5. $c = 8$, $b = 12$, $m\angle A = 90^\circ$
6. $m\angle B = 67.2^\circ$, $a = 15.6$, $c = 18.9$
7. $b = 20$, $a = 30$, $c = 12$
8. $a = 14$, $b = 6$, $c = 12$
9. $a = 7$, $b = 14$, $c = 12$

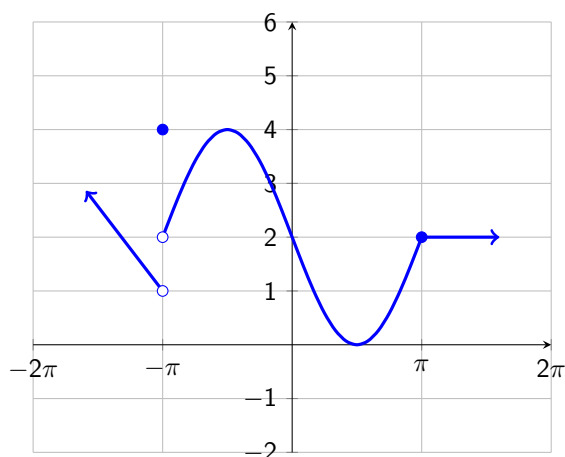
26.1 Answer Key

1. $b \approx 13.0$, $m\angle A \approx 44.8^\circ$, $m\angle C \approx 97.4^\circ$, Area ≈ 97.0 units²
2. $m\angle B = 78.9^\circ$, $b \approx 15.0$, $c \approx 13.1$, Area ≈ 65.7 units²
3. $m\angle A \approx 45.5^\circ$, $m\angle B \approx 92.6^\circ$, $m\angle C \approx 41.9^\circ$, Area ≈ 91.6 units²
4. $m\angle B \approx 50.1^\circ$, $m\angle C \approx 74.9^\circ$, $a \approx 24.6$, Area ≈ 273.19 units²
5. $m\angle B \approx 56.3^\circ$, $m\angle C \approx 33.7^\circ$, $a \approx 14.4$, Area = 48 units²
6. $m\angle A \approx 48.2^\circ$, $m\angle C \approx 64.6^\circ$, $b \approx 19.3$, Area ≈ 135.9 units²
7. $m\angle A \approx 137.8^\circ$, $m\angle B \approx 26.6^\circ$, $m\angle C \approx 15.6^\circ$, Area ≈ 80.5 units²
8. $m\angle A \approx 96.4^\circ$, $m\angle B \approx 25.2^\circ$, $m\angle C \approx 58.4^\circ$, Area ≈ 35.8 units²
9. $m\angle A \approx 30^\circ$, $m\angle B \approx 91^\circ$, $m\angle C \approx 59^\circ$, Area ≈ 42.0 units²

Chapter 27

Numerical and Graphical Limits

Solve using the graph of $f(x)$ below.



1. $\lim_{x \rightarrow -\pi^-} f(x)$

2. $\lim_{x \rightarrow -\pi^+} f(x)$

3. $\lim_{x \rightarrow -\pi} f(x)$

4. $f(-\pi)$

5. $\lim_{x \rightarrow \pi^-} f(x)$

6. $\lim_{x \rightarrow \pi^+} f(x)$

7. $\lim_{x \rightarrow \pi} f(x)$

8. $f(\pi)$

Find each limit.

9. $\lim_{x \rightarrow 0} \frac{e^x - 1}{x}$

10. $\lim_{x \rightarrow 1^+} \log(x - 1)$

11. $\lim_{x \rightarrow 2} \left(\frac{3e^{1/(x-2)}}{e^{1/(x-2)} + 1} - 1 \right)$

12. $\lim_{x \rightarrow 0} f(x), f(x) = \begin{cases} -x^2 - 4x - 5, & x \leq 0 \\ x - 5, & x > 0 \end{cases}$

13. $\lim_{x \rightarrow 4} g(x), g(x) = \begin{cases} x + 4, & x < -4 \\ \frac{x}{2} + 3, & x \geq -4 \end{cases}$

14. $\lim_{x \rightarrow 0} h(x), h(x) = \begin{cases} -x - 4, & x < 0 \\ -2x - 5, & x \geq 0 \end{cases}$

27.1 Answer Key

1. 1
2. 2
3. Does not exist
4. 4
5. 2
6. 2
7. 2
8. 2
9. $e \approx 2.71828$
10. Does not exist
11. Does not exist
12. -5
13. 1
14. Does not exist

Chapter 28

Limits and Algebra

Find each limit algebraically.

1. $\lim_{x \rightarrow -4} \left(\frac{x+4}{x^2+6x+8} \right)$

3. $\lim_{x \rightarrow 3} \left(\frac{x-3}{x^2-8x+15} \right)$

5. $\lim_{x \rightarrow -1} \left(-\frac{x^2+5x+4}{x+1} \right)$

7. $\lim_{x \rightarrow 2} \left(\frac{x^2-2x}{x-2} \right)$

9. $\lim_{x \rightarrow 0} \left(\frac{x}{\frac{1}{x-1}+1} \right)$

11. $\lim_{x \rightarrow 3} \left(\frac{x}{\frac{1}{x-3}+\frac{1}{3}} \right)$

13. $\lim_{x \rightarrow 1} \left(\frac{x}{\frac{1}{x-1}+1} \right)$

15. $\lim_{x \rightarrow 1} \left(\frac{\sqrt{x}-1}{x-1} \right)$

17. $\lim_{x \rightarrow 25} \left(\frac{x-25}{\sqrt{x}-5} \right)$

19. $\lim_{x \rightarrow 9} \left(\frac{x-9}{\sqrt{x}-3} \right)$

2. $\lim_{x \rightarrow -3} \left(-\frac{x^2+2x-3}{x+3} \right)$

4. $\lim_{x \rightarrow -2} \left(\frac{x^2-2x-8}{x+2} \right)$

6. $\lim_{x \rightarrow -4} \left(\frac{x^2+7x+12}{x+4} \right)$

8. $\lim_{x \rightarrow -1} \left(-\frac{x^2-3x-4}{x+1} \right)$

10. $\lim_{x \rightarrow 0} \left(\frac{x}{\frac{1}{x+2}-\frac{1}{2}} \right)$

12. $\lim_{x \rightarrow 2} \left(\frac{x}{\frac{1}{x-2}+\frac{1}{2}} \right)$

14. $\lim_{x \rightarrow -1} \left(\frac{x}{\frac{1}{x+1}-1} \right)$

16. $\lim_{x \rightarrow 2} \left(\frac{\sqrt{x+7}-3}{x-2} \right)$

18. $\lim_{x \rightarrow 1} \left(\frac{x-1}{\sqrt{x+8}-3} \right)$

20. $\lim_{x \rightarrow 2} \left(\frac{\sqrt{x+14}-4}{x-1} \right)$

28.1 Answer Key

1. $-\frac{1}{2}$
2. 4
3. $-\frac{1}{2}$
4. -6
5. -3
6. -1
7. 2
8. 5
9. -1
10. -4
11. 0
12. 0
13. 0
14. 0
15. $\frac{1}{2}$
16. $\frac{1}{6}$
17. 10
18. 6
19. 6
20. $\frac{1}{8}$

Chapter 29

Derivatives

Use the definition of the derivative to find the derivative of each function with respect to x .

1. $f(x) = x^2 + 2x + 4$
2. $f(x) = -5x + 5$
3. $f(x) = 2x^2 - 5x - 2$
4. $f(x) = 5x + 2$
5. $f(x) = x^3 - x^2$
6. $f(x) = 5x^2 + 5$
7. $f(x) = 2x + 3$
8. $f(x) = x^2 - 2$
9. $f(x) = -5x^3 + 4$
10. $f(x) = -4x^2 + x - 5$
11. $f(x) = 2x^2 - 3x + 5$
12. $f(x) = 5x^2 - 7x + 4$
13. $g(x) = \frac{9}{x}$
14. $h(x) = 8\sqrt{x}$

29.1 Answer Key

1. $2x + 2$
2. -5
3. $4x - 5$
4. 5
5. $3x^2 - 2x$
6. $10x$
7. 2
8. $2x$
9. $-15x^2$
10. $-8x + 1$
11. $4x - 3$
12. $10x - 7$
13. $-\frac{9}{x^2}$
14. $\frac{4}{\sqrt{x}}$

Chapter 30

Derivative Shortcuts

Using the shortcut rules, find the derivative of each.

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

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

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

30.1 Answer Key

1. $6x + 6$

2. $-x^{-1/2} - 35x^{-8}$

3. $\frac{(2x-6)(x^3+4x^2)-(3x^2+8x)(x^2-6x+1)}{(x^3+4x^2)^2}$

Appendix A

Factoring

Factor each of the following completely.

1. $x^2 + 2x - 15$

2. $x^2 - 8x + 12$

3. $x^2 + 15x + 56$

4. $5x^2 + 19x - 4$

5. $4x^2 - 5x - 6$

6. $9x^2 - 400$

7. $5x^2 - 7x - 6$

8. $9x^2 - 54x + 45$

9. $3x^3 + 12x^2 + 9x$

10. $9y^2 - 16$

11. $4x^2 - 28x + 49$

12. $14x^2 + 11xy - 15y^2$

13. $6x^2 - 48x - 120$

14. $9x^4 - 54x^3 + 45x^2$

15. $16y^2 - 40y + 25$

16. $30x^2 + xy - y^2$

17. $8w^2 + 33w + 4$

18. $3p^2 + 22p - 16$

19. $18x^2 - 27x + 4$

20. $14a^2 + 15a - 9$

21. $4x^2 - 4x - 24$

22. $18t^2 - 9t - 5$

23. $6a^2 + 23a + 21$

24. $25x^2 - 1$

A.1 Answer Key

- | | | | |
|------------------------|--------------------------|------------------------|--------------------------|
| 1. $(x + 5)(x - 3)$ | 2. $(x - 6)(x - 2)$ | 3. $(x + 7)(x + 8)$ | 4. $(5x - 1)(x + 4)$ |
| 5. $(4x + 3)(x - 2)$ | 6. $(3x + 20)(3x - 20)$ | 7. $(5x + 3)(x - 2)$ | 8. $9(x - 5)(x - 1)$ |
| 9. $3x(x + 3)(x + 1)$ | 10. $(3y + 4)(3y - 4)$ | 11. $(2x - 7)^2$ | 12. $(7x - 5y)(2x + 3y)$ |
| 13. $6(x - 10)(x + 2)$ | 14. $9x^2(x - 1)(x - 5)$ | 15. $(4y - 5)^2$ | 16. $(6x - y)(5x + y)$ |
| 17. $(8w + 1)(w + 4)$ | 18. $(3p - 2)(p + 8)$ | 19. $(6x - 1)(3x - 4)$ | 20. $(7a - 3)(2a + 3)$ |
| 21. $4(x - 3)(x + 2)$ | 22. $(6t - 5)(3t + 1)$ | 23. $(2a + 3)(3a + 7)$ | 24. $(5x + 1)(5x - 1)$ |

Appendix B

Complex Fractions

Simplify each as much as possible.

$$1. \frac{5 + \frac{3}{x}}{x - \frac{1}{2}}$$

$$2. \frac{\frac{1}{x} + \frac{2}{x^2}}{x + \frac{8}{x^2}}$$

$$3. \frac{3}{2 - \frac{x}{x-1}}$$

$$4. \frac{1 + \frac{3}{x}}{\frac{2}{x} + 7}$$

$$5. \frac{\frac{4}{x} - \frac{x}{x-2}}{\frac{1}{x} + \frac{3}{x-2}}$$

$$6. \frac{\frac{3}{x+1} - 4}{\frac{2}{x+1}}$$

$$7. \frac{\frac{5}{x} + \frac{3}{x-2}}{\frac{7}{x^2 - 2x}}$$

$$8. \frac{\frac{1}{x} - \frac{1}{7}}{x - 7}$$

$$9. \frac{\frac{1}{x} + \frac{1}{x+1}}{5}$$

$$10. \frac{\frac{5-5x}{x} - 1}{x-1}$$

$$11. \frac{\frac{1}{2+x} - \frac{1}{2}}{x}$$

$$12. \frac{\frac{3}{x-4} + \frac{2x}{x+1}}{4x}$$

$$13. \frac{\frac{1}{x-a} + \frac{1}{a}}{x}$$

$$14. \frac{\frac{1}{x-1} - \frac{1}{x-3}}{\frac{2}{x-1} + \frac{3}{x+1}}$$

$$15. \frac{\frac{2}{x^2-4} + \frac{1}{x-2}}{\frac{4}{x+2}}$$

B.1 Answer Key

1. $\frac{2(5x+3)}{x(2x-1)}$

2. $\frac{1}{x^2-2x+4}$

3. $\frac{3(x-1)}{x-2}$

4. $\frac{x+3}{2+7x}$

5. $\frac{-1(x^2-4x+8)}{2(2x-1)}$

6. $\frac{-4x-1}{2}$

7. $\frac{8x-10}{7}$

8. $-\frac{1}{7x}$

9. $\frac{2x+1}{5x(x+1)}$

10. $\frac{-5x-5}{x}$

11. $\frac{-1}{2x+4}$

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

13. $\frac{1}{a(x-a)}$

14. $\frac{-2x-2}{5x^2-16x+3}$

15. $\frac{x+4}{4x-8}$