Chapter 9 Rational Expressions and Equations
Lesson 9-1 Multiplying and Dividing Rational Expressions
Pages 476–478

1. Sample answer: $\frac{4}{6}$, $\frac{4(x+2)}{6(x+2)}$

2. To multiply rational numbers or rational expressions, you multiply the numerators and multiply the denominators. To divide rational numbers or rational expressions, you multiply by the reciprocal of the divisor. In either case, you can reduce your answer by dividing the numerator and the denominator of the results by any common factors.

3. Never; solving the equation using cross products leads to $15 = 10$, which is never true.

4. $\frac{9m}{4n^4}$

5. $\frac{1}{a-b}$

6. $\frac{3y^2}{y+4}$

7. $\frac{3c}{20b}$

8. $\frac{5}{12x}$

9. $\frac{6}{5}$

10. $\frac{p+5}{p+1}$

11. cd^2x

12. $\frac{2y(y-2)}{3(y+2)}$

13. D

14. $\frac{5c}{2b}$

15. $-\frac{n^2}{7m}$

16. $-3x^4y$

17. $\frac{s}{3}$

18. $\frac{5}{t+1}$

19. $\frac{1}{2}$

20. $\frac{y+2}{3y-1}$

21. $\frac{a+1}{2a+1}$

22. $\frac{3x^2}{2y}$

23. $-\frac{4bc}{27a}$

24. $-f$

25. $-2p^2$

26. $\frac{xz}{8y}$

27. $\frac{b^3}{x^2y^2}$

28. 3

29. $\frac{4}{3}$

30. $\frac{2}{3}$

31. 1

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

33. $\frac{w - 3}{w - 4}$

34. $\frac{3(r + 4)}{r + 3}$

35. $\frac{2(a + 5)}{(a - 2)(a + 2)}$

36. $-\frac{3n}{m}$

37. $-2p$

38. $\frac{m + n}{m^2 + n^2}$

39. $\frac{2x + y}{2x - y}$

40. $y + 1$

41. $\frac{4}{3}$

42. $d = -2, -1$ or 2

43. $a = -b$ or b

44. $\frac{6827}{13{,}129}$

45. $\frac{6827 + m}{13{,}129 + a}$

46. $2x + 1$ units

47. $(2x^2 + x - 15)m^2$

48. $\frac{1}{a - 2}$

49. A rational expression can be used to express the fraction of a nut mixture that is peanuts. Answers should include the following.
   - The rational expression $\frac{8 + x}{13 + x}$ is in simplest form because the numerator and the denominator have no common factors.

50. C

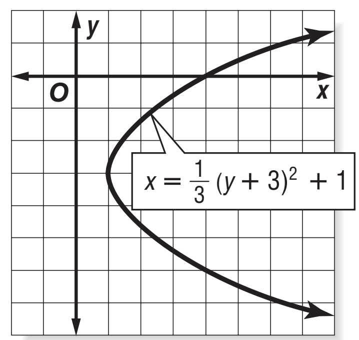
- Sample answer: $\frac{8 + x}{13 + x + y}$ could be used to represent the fraction that is peanuts if x pounds of peanuts and y pounds of cashews were added to the original mixture.

51. A

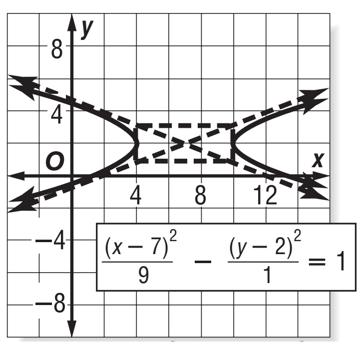
52. $(-1, \pm 4), (5, \pm 2)$

53. $(\pm\sqrt{17}, \ \pm 2\sqrt{2})$

54. $x = \frac{1}{3}(y + 3)^2 + 1$; parabola



55. $\frac{(x - 7)^2}{9} \frac{(y - 2)^2}{1} = 1$; hyperbola



56. even; 2

57. odd; 3

58. even; 0

59. $-1, 4$

60. $-\frac{1}{6}, \frac{1}{3}$

61. 0, 5

62. 4.99×10^2 s or about 8 min 19 s

63. $\varnothing$

64. $\frac{3}{2}, \frac{19}{16}$

65. $-1\frac{1}{9}$

66. $-1\frac{11}{24}$

67. $1\frac{4}{15}$

68. $-\frac{11}{16}$

69. $-\frac{11}{18}$

70. $\frac{1}{6}$

Lesson 9-2 Adding and Subtracting Rational Epressions Pages 481–484

1. Catalina; you need a common denominator, not a common numerator, to subtract two rational expressions.

2. Sample answer: $d^2 - d$, $d + 1$

3a. Always; since a, b, and c are factors of abc, abc is always a common denominator of $\frac{1}{a} + \frac{1}{b} + \frac{1}{c}$.

3b. Sometimes; if a, b, and c have no common factors, then abc is the LCD of $\frac{1}{a} + \frac{1}{b} + \frac{1}{c}$.

3c. Sometimes; if a and b have no common factors and c is a factor of ab, then ab is the LCD of $\frac{1}{a} + \frac{1}{b} + \frac{1}{c}$.

3d. Sometimes; if a and c are factors of b, then b is the LCD of $\frac{1}{a} + \frac{1}{b} + \frac{1}{c}$.

3e. Always; since $\frac{1}{a} + \frac{1}{b} + \frac{1}{c} = \frac{bc}{abc} + \frac{ac}{abc} + \frac{ab}{abc}$, the sum is always $\frac{bc + ac + ab}{abc}$.

4. $12x^2y^2$

5. $80ab^3c$

6. $x(x - 2)(x + 2)$

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

8. $\frac{42a^2 + 5b^2}{90ab^2}$

9. $\frac{37}{42m}$

10. $\frac{5d + 16}{(d + 2)^2}$

11. $\frac{3a - 10}{(a - 5)(a + 4)}$

12. $\frac{8}{5}$

13. $\frac{13x^2 + 4x - 9}{2x(x - 1)(x + 1)}$ units

14. $70s^2t^2$

15. $180x^2yz$

16. $420a^3b^3c^3$

17. $36p^3q^4$

18. $4(w - 3)$

19. $x^2(x - y)(x + y)$

20. $(2t + 3)(t - 1)(t + 1)$

21. $(n - 4)(n - 3)(n + 2)$

22. $\frac{6 + 8b}{ab}$

23. $\frac{31}{12v}$

24. $\frac{5 + 7r}{r}$

25. $\frac{2x + 15y}{3y}$

26. $\frac{9x^2 - 2y^3}{12x^2y}$

27. $\frac{25b - 7a^3}{5a^2b^2}$

28. $-\frac{3}{20q}$

29. $\frac{110w - 423}{90w}$

30. $\frac{13}{y - 8}$

31. $\frac{a + 3}{a - 4}$

32. $\frac{5m - 4}{3(m + 2)(m - 2)}$

33. $\frac{y(y - 9)}{(y + 3)(y - 3)}$

34. $\frac{7x + 38}{2(x - 7)(x + 4)}$

35. $\frac{-8d + 20}{(d - 4)(d + 4)(d - 2)}$

36. $\frac{-4h + 15}{(h - 4)(h - 5)^2}$

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

38. 0

39. $\frac{2y^2 + y - 4}{(y - 1)(y - 2)}$

40. $\frac{1}{b + 1}$

41. -1

42. $\frac{2s - 1}{2s + 1}$

43. $\frac{a + 7}{a + 2}$

44. $\frac{3x - 4}{2x(x - 2)}$

45. 12 ohms

46. $\frac{24}{x}$ h

47. $\frac{24}{x-4}$ h

48. $\frac{48(x-2)}{x(x-4)}$ h

49. $\frac{2md}{(d-L)^2(d+L)^2}$ or $\frac{2md}{(d^2-L^2)^2}$

50. Sample answer: $\frac{1}{x+1}, \frac{1}{x-2}$

51. Subtraction of rational expressions can be used to determine the distance between the lens and the film if the focal length of the lens and the distance between the lens and the object are known. Answers should include the following.

- To subtract rational expressions, first find a common denominator. Then, write each fraction as an equivalent fraction with the common denominator. Subtract the numerators and place the difference over the common denominator. If possible, reduce the answer.
- $\frac{1}{q} = \frac{1}{10} - \frac{1}{60}$ could be used to determine the distance between the lens and the film if the focal length of the lens is 10 cm and the distance between the lens and the object is 60 cm.

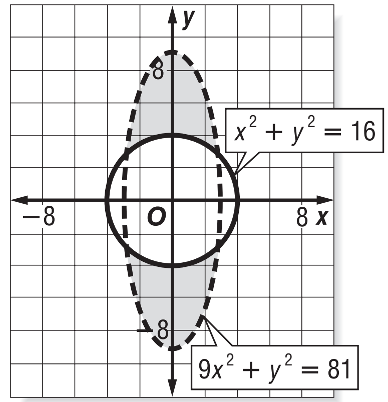
52. B

53. C

54. $\frac{4}{15xyz^2}$

55. $\dfrac{a(a+2)}{a+1}$

56.



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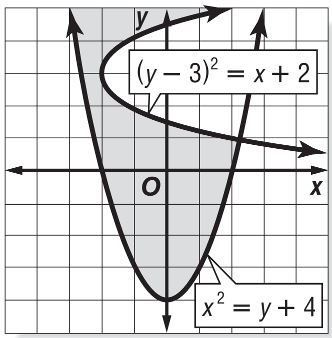
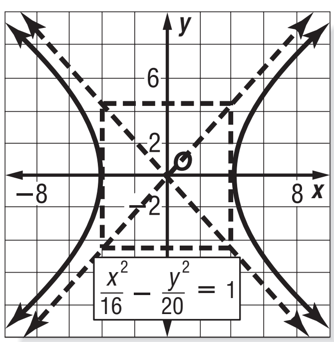


58. 2.5 ft

59.



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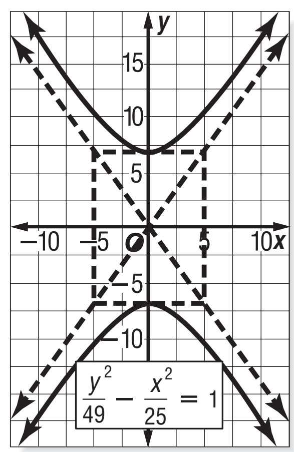

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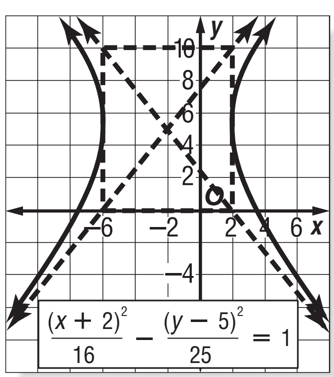


Chapter 9
Practice Quiz 1
Page 484

1. $\frac{t+2}{t-3}$

2. $\frac{c}{6b^2}$

3. $-\frac{y^2}{32}$

4. $\frac{7}{2}$

5. $(w+4)(3w+4)$

6. $x-1$

7. $\frac{4a+1}{a+b}$

8. $\frac{6ax+20by}{15a^2b^3}$

9. $\frac{n-29}{(n+6)(n-1)}$

10. $\frac{1}{4}$

Lesson 9-3 Graphing Rational Functions
Pages 488–490

1. Sample answer:

$f(x) = \frac{1}{(x+5)(x-2)}$

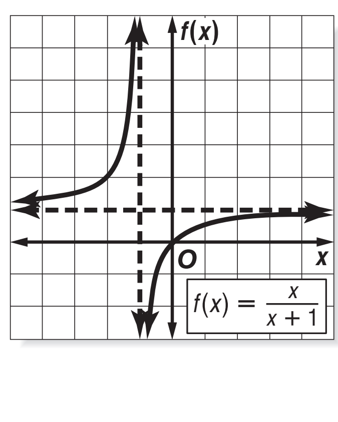
2. Each of the graphs is a straight line passing through $(-5, 0)$ and $(0, 5)$. However, the graph of $f(x) = \frac{(x-1)(x+5)}{x-1}$ has a hole at $(1, 6)$, and the graph of $g(x) = x + 5$ does not have a hole.

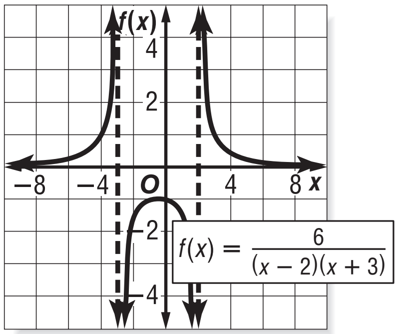
3. $x = 2$ and $y = 0$ are asymptotes of the graph. The y-intercept is 0.5 and there is no x-intercept because $y = 0$ is an asymptote.

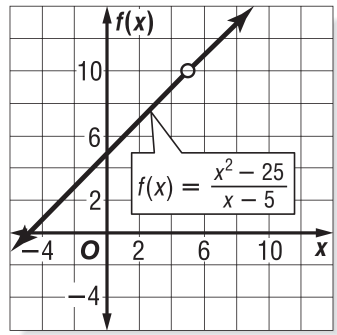
4. asymptote: $x = 2$

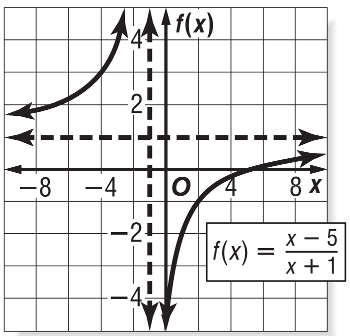
5. asymptote: $x = -5$; hole: $x = 1$

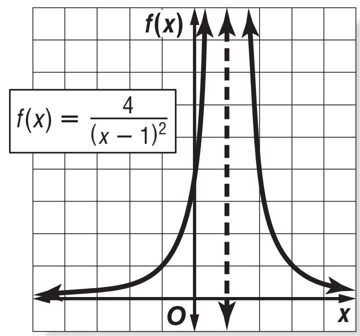
6.

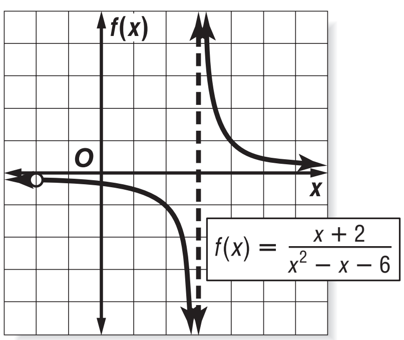


7. 

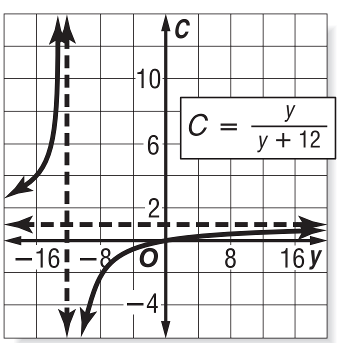
8. 

9. 

10. 

11. 

12. 100 mg

13. 

14. $y = -12$, $C = 1$; 0; 0

15. $y > 0$ and $0 < C < 1$

16. asymptotes: $x = 2$, hole: $x = 3$

17. asymptotes: $x = -4$, $x = 2$

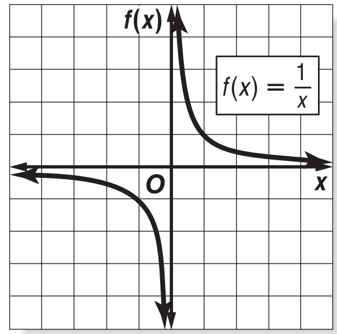
18. asymptotes: $x = -4$, hole: $x = -3$

19. asymptotes: $x = -1$, hole: $x = 5$

20. hole: $x = 4$

21. hole: $x = 1$

22.



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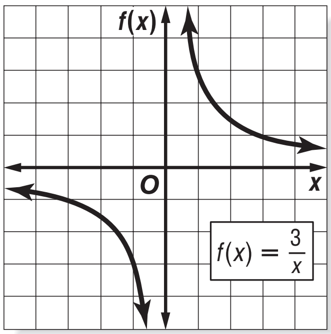

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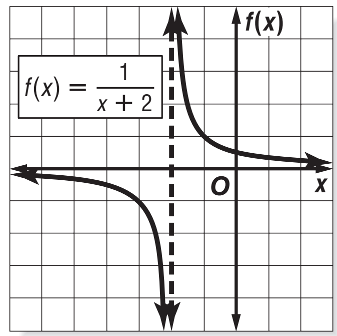

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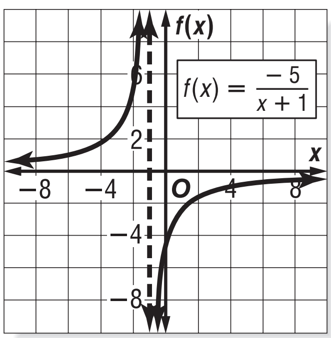

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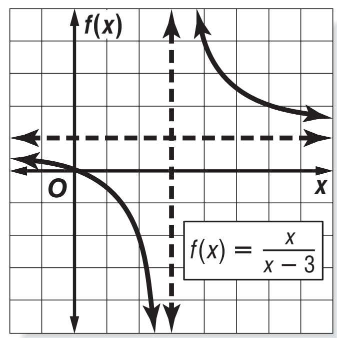

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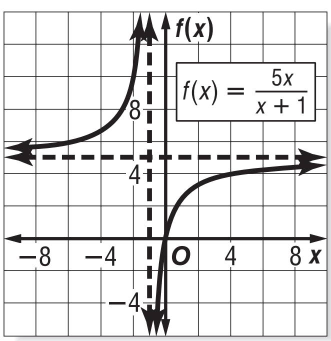

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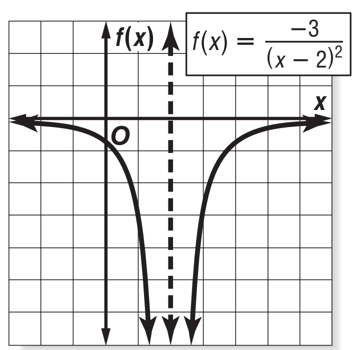

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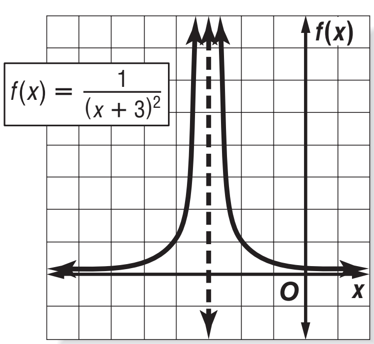

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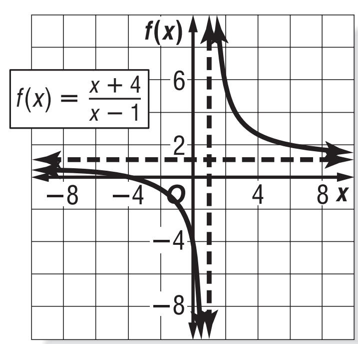

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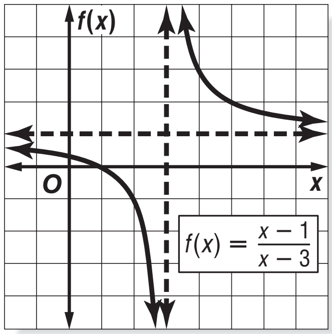

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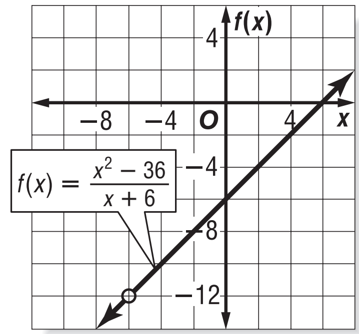

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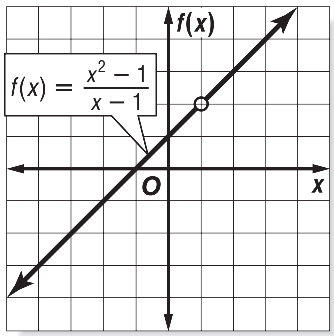

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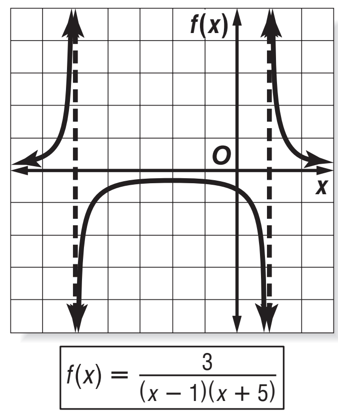

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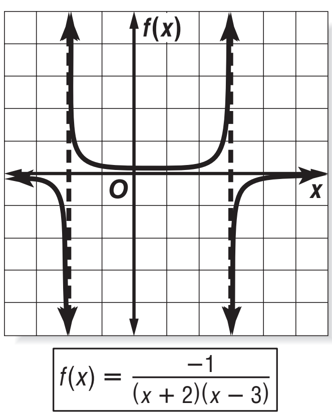

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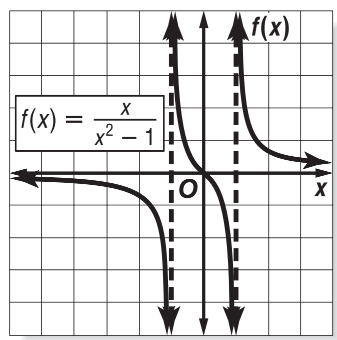

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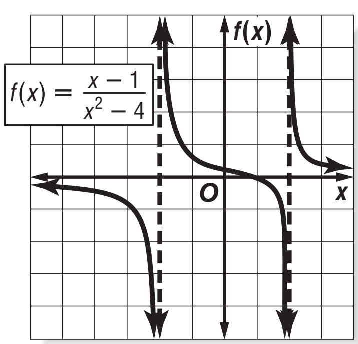

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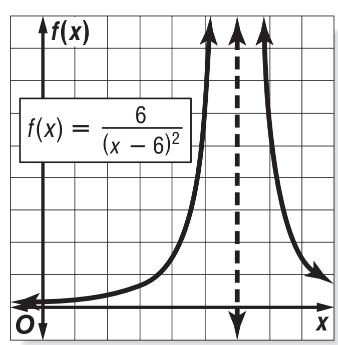

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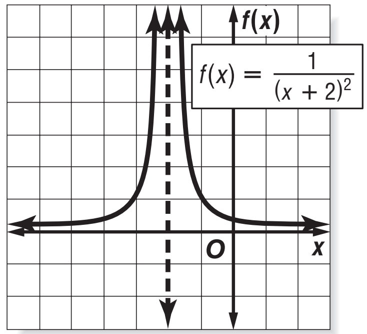

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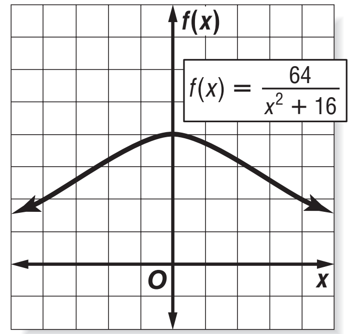
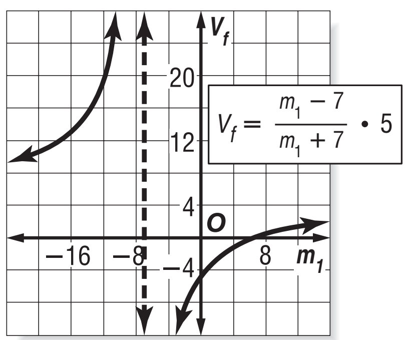


41. The graph is bell-shaped with a horizontal asymptote at $f(x) = 0$.

42. Since $\frac{-64}{x^2 + 16} = -\left(\frac{64}{x^2 + 16}\right)$, the graph of $f(x) = \frac{-64}{x^2 + 16}$ would be a reflection of the graph of $f(x) = \frac{64}{x^2 + 16}$ over the x-axis.

43.



44. $m_1 = -7; 7; -5$

45. about -0.83 m/s

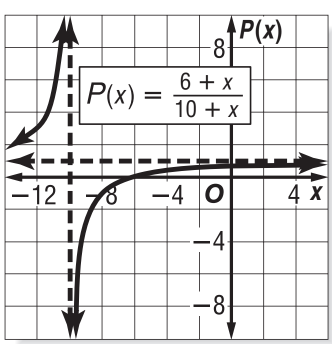
46. Sample answers:

$f(x) = \frac{x + 2}{(x + 2)(x - 3)}$,

$f(x) = \frac{2(x + 2)}{(x + 2)(x - 3)}$,

$f(x) = \frac{5(x + 2)}{(x + 2)(x - 3)}$

47.

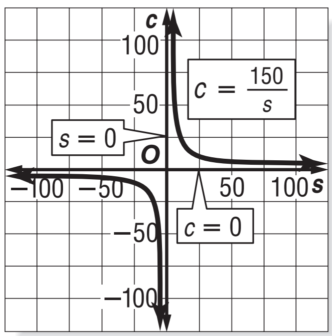


48. the part in the first quadrant

49. It represents her original free-throw percentage of 60%.

50. $y = 1$; This represents 100%, which she cannot achieve because she has already missed 4 free throws.

51. A rational function can be used to determine how much each person owes if the cost of the gift is known and the number of people sharing the cost is *s*. Answers should include the following.

- 

- Only the portion in the first quadrant is significant in the real world because there cannot be a negative number of people nor a negative amount of money owed for the gift.

52. A

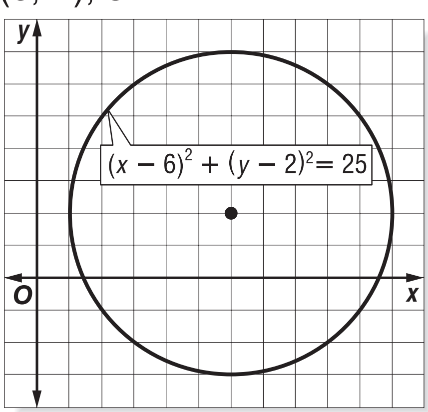
53. B

54. $\frac{3m + 4}{m + n}$

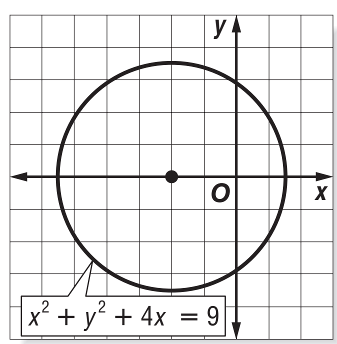
55. $\frac{3x - 16}{(x + 3)(x - 2)}$

56. $\frac{5(w - 2)}{(w + 3)^2}$

57. (6, 2); 5



58. $(-2, 0)$; $\sqrt{13}$



59. \$65,892

60. $-4 \pm 2i$

61. $-12, 10$

62. $\frac{-7 \pm 3\sqrt{13}}{2}$

63. 4.5

64. 1.4

65. 20

66. 12

Lesson 9-4 Direct, Joint, and Inverse Variation Pages 495–498

1a. inverse
1b. direct

2. Both are examples of direct variation. For $y = 5x$, y increases as x increases. For $y = -5x$, y decreases as x increases.

3. Sample answers: wages and hours worked, total cost and number of pounds of apples; distances traveled and amount of gas remaining in the tank, distance of an object and the size it appears

4. inverse; 20

5. direct; -0.5

6. joint; $\frac{1}{2}$

7. 24

8. -45

9. -8

10. $P = 0.43d$

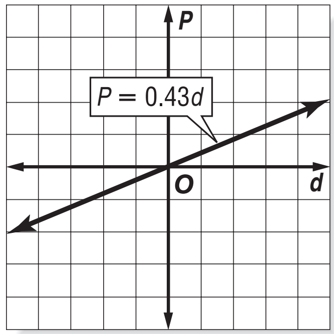
11. 25.8 psi

12. about 150 ft

13.

Depth(ft)	Pressure(psi)
0	0
1	0.43
2	0.86
3	1.29
4	1.72

14. direct; 1.5



15. joint; 5

16. inverse; −18

17. direct; 3

18. inverse; 12

19. direct; −7

20. joint; $\frac{1}{3}$

21. inverse; 2.5

22. $V = \frac{k}{p}$

23. $V = kt$

24. directly; 2π

25. 118.5 km

26. 60

27. 20

28. 216

29. 64

30. 25

31. 4

32. 1.25

33. 9.6

34. −12.6

35. 0.83

36. $2\frac{1}{4}$

37. $\frac{1}{6}$

38. 30 mph

39. 100.8 cm^3

40. See students' work.

41. $m = 20sd$

42. joint

43. 1860 lb

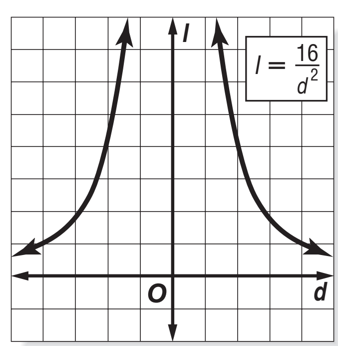
44. $\ell = 15md$

45. joint

46. See students' work.

47. $I = \frac{k}{d^2}$

48.



49. The sound will be heard $\frac{1}{4}$ as intensely.

50. 0.02; $C = \frac{0.02P_1P_2}{d^2}$

51. about 127,572 calls

52. about 601 mi

53. no; $d \neq 0$

54. Sample answer: If the average student spends $2.50 for lunch in the school cafeteria, write an equation to represent the amount *s* students will spend for lunch in *d* days. How much will 30 students spend in a week? $a = 2.50sd$; $375

55. A direct variation can be used to determine the total cost when the cost per unit is known. Answers should include the following.

- Since the total cost *T* is the cost per unit *u* times the number of units *n* or $C = un$, the relationship is a direct variation. In this equation *u* is the constant of variation.
- Sample answer: The school store sells pencils for 20¢ each. John wants to buy 5 pencils. What is the total cost of the pencils? ($1.00)

56. D

57. C

58. asymptote: $x = 1$; hole $x = -1$

59. asymptotes: $x = -4$, $x = 3$

60. hole: $x = -3$

61. $\frac{x}{y - x}$

62. $\frac{t^2 - 2t - 2}{(t + 2)(t - 2)}$

63. $\frac{m(m + 1)}{m + 5}$

64. 9.3×10^7

65. 0.4; 1.2

66. 3; 7

67. $-\frac{3}{5}$; 3

68. C

69. A

70. S

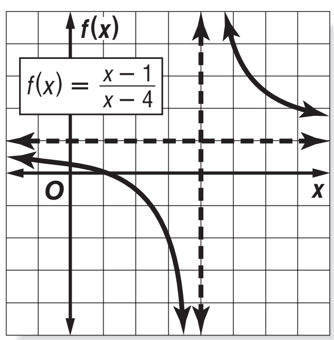
71. P

73. C

72. A

Chapter 9
Practice Quiz 2
Page 498

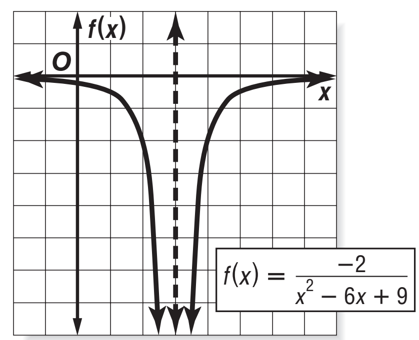
1.



3. 49

5. 112

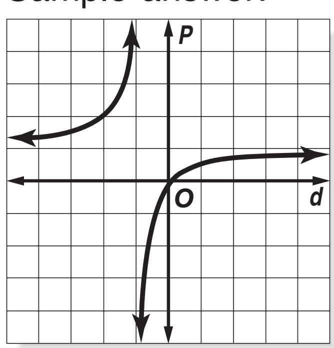
2.



4. 4.4

Lesson 9-5 Classes of Functions
Pages 501–504

1. Sample answer:



This graph is a rational function. It has an asymptote at $x = -1$.

3. The equation is a greatest integer function. The graph looks like a series of steps.

5. inverse variation or rational

2. constant ($y = 1$), direct variation ($y = 2x$), identity ($y = x$)

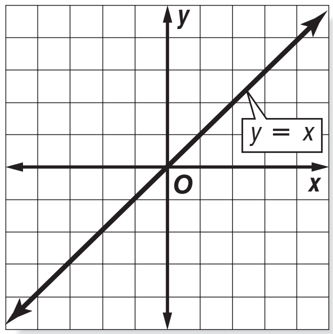
4. greatest integer

6. constant

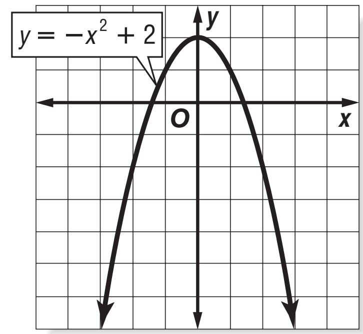
7. c

8. b

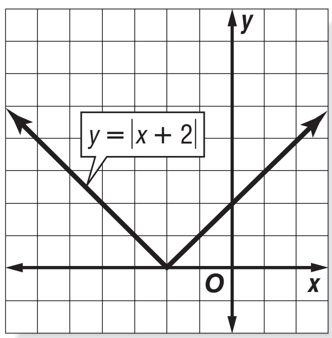
9. identity or direct variation



10. quadratic



11. absolute value



12. $A = \pi r^2$; quadratic; the graph is a parabola

13. absolute value

14. square root

15. rational

16. direct variation

17. quadratic

18. constant

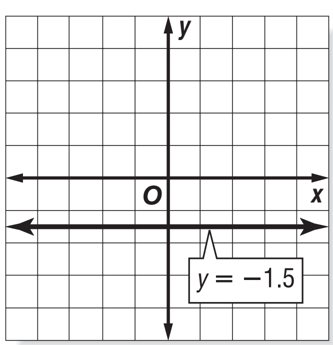
19. b

20. e

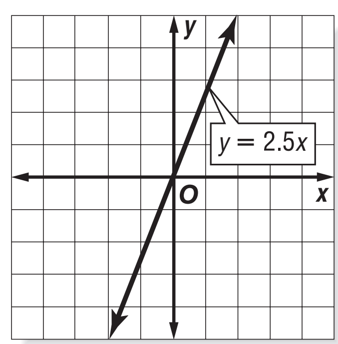
21. g

22. a

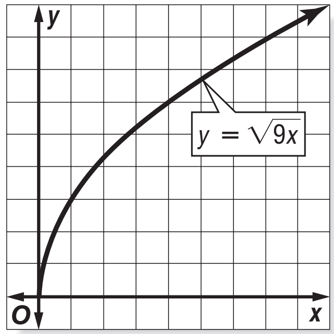
23. constant



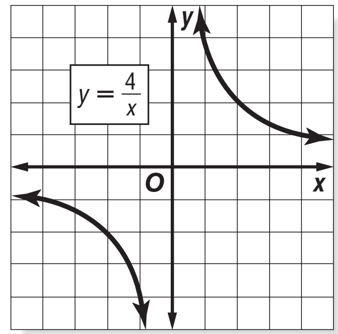
24. direct variation



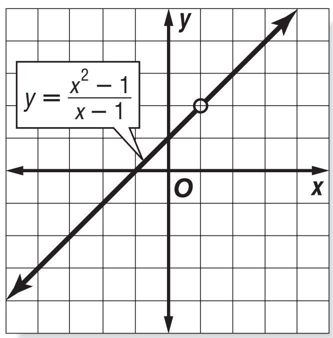
25. square root



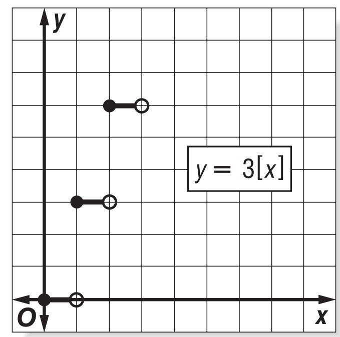
26. inverse variation or rational



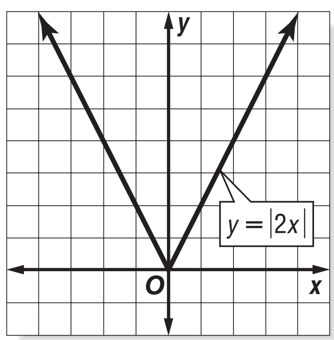
27. rational



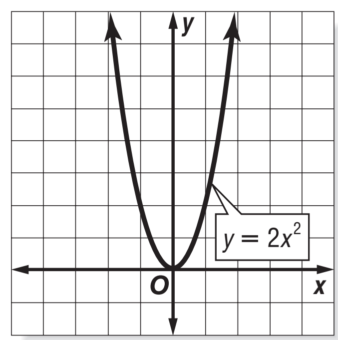
28. greatest integer



29. absolute value



30. quadratic



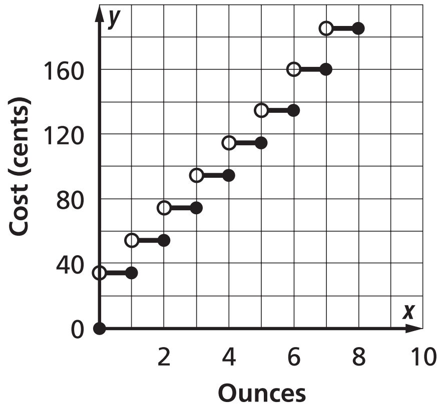
31. $C = 4.5m$

32. direct variation

33. a line slanting to the right and passing through the origin

34. similar to a parabola

35.

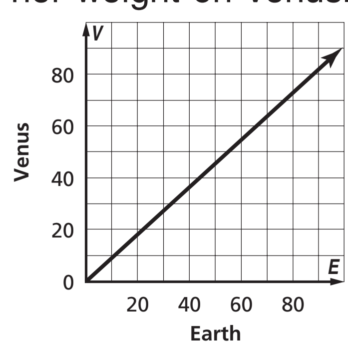


37a. absolute value
37b. quadratic
37c. greatest integer
37d. square root

36. The graph is similar to the graph of the greatest integer function because both graphs look like a series of steps. In the graph of the postage rates, the solid dots are on the right and the circles are on the left. However, in the greatest integer function, the circles are on the right and the solid dots are on the left.

38. A graph of the function that relates a person's weight on Earth with his or her weight on a different planet can be used to determine a person's weight on the other planet by finding the point on the graph that corresponds with the weight on Earth and determining the value on the other planet's axis. Answers should include the following.

- The graph comparing weight on Earth and Mars represents a direct variation function because it is a straight line passing through the origin and is neither horizontal nor vertical.
- The equation $V = 0.9E$ compares a person's weight on Earth with his or her weight on Venus.

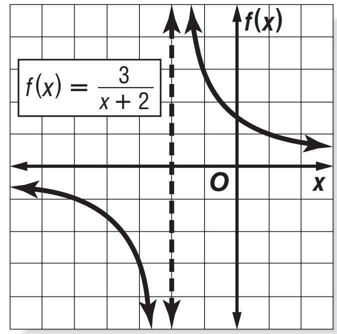


39. C

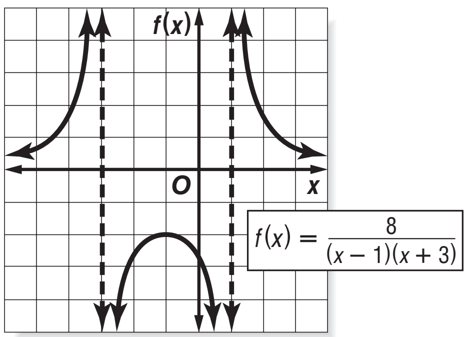
40. D

41. 22

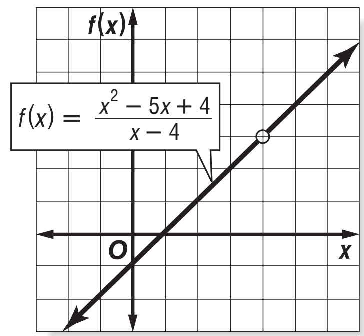
42.



43.

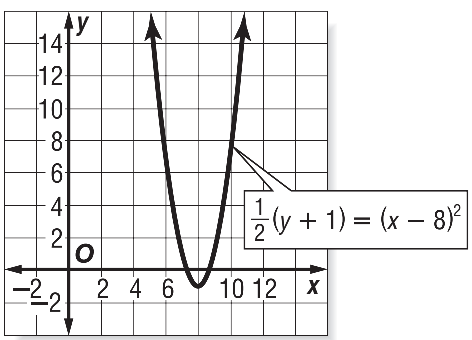


44.



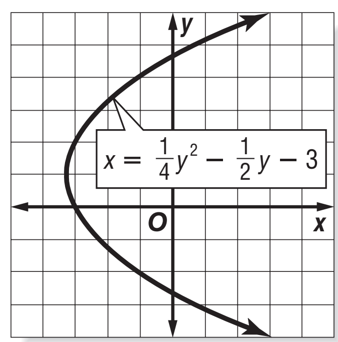
45. $(8, -1)$; $\left(8, -\frac{7}{8}\right)$; $x = 8$;

$y = -1\frac{1}{8}$; up; $\frac{1}{2}$ unit

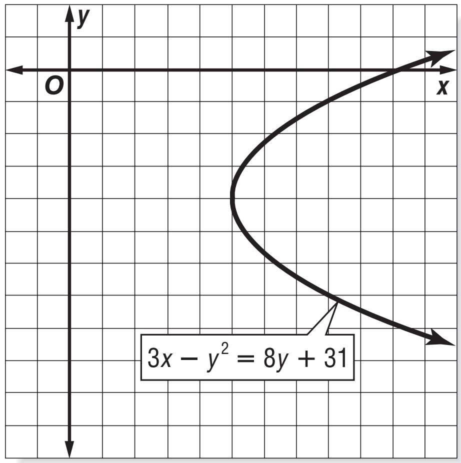


46. $\left(-3\frac{1}{4}, 1\right)$; $\left(-2\frac{1}{4}, 1\right)$;

$y = 1$; $x = -4\frac{1}{4}$; right; 4 units



47. $(5, -4)$; $\left(5\frac{3}{4}, -4\right)$; $y = -4$; $x = 4\frac{1}{4}$; right; 3 units



48. $\begin{bmatrix} -25 & 23 & -54 \\ 66 & -26 & 57 \end{bmatrix}$

49. impossible

50. $(7, -5)$

51. $\left(\frac{1}{3}, 2\right)$

52. $(2, -2)$

53. 1

54. 12

55. $-\frac{17}{6}$

56. $60a^3b^2c^2$

57. $45x^3y^3$

58. $15(d - 2)$

59. $3(x - y)(x + y)$

60. $(a - 3)(a + 1)(a + 2)$

61. $(t - 5)(t + 6)(2t + 1)$

Lesson 9-6 Solving Rational Equations and Inequalities Pages 509–511

1. Sample answer: $\frac{1}{5} + \frac{2}{a + 2} = 1$

2. $2(x + 4)$; -4

3. Jeff; when Dustin multiplied by $3a$, he forgot to multiply the 2 by $3a$.

4. 3

5. 2, 6

6. $\frac{2}{3}$

7. $-6, -2$

8. $-2 < c < 2$

9. $v < 0$ or $v > 1\frac{1}{6}$

10. $2\frac{2}{9}$ h

11. 2

12. $-\frac{4}{3}$

13. $-6, 1$

14. $-3, 2$

15. $-1 < a < 0$

16. $-1 < m < 1$

17. 11

18. 3

19. $t < 0$ or $t > 3$

20. $0 < b < 1$

21. $0 < y < 2$

22. $p < 0$ or $p > 2\frac{1}{2}$

23. 14

24. $\frac{3}{2}$

25. $\varnothing$

26. $\varnothing$

27. 7

28. $\frac{7}{3}$

29. $\frac{-3 \pm 3\sqrt{2}}{2}$

30. $\frac{1 \pm \sqrt{145}}{4}$

31. 32

32. 2 or 4

33. band, 80 members; chorale, 50 members

34. 4.8 cm/g

35. 24 cm

36. 15 km/h

37. 5 mL

38. 5

39. 6.15

40. $\frac{b}{bc + 1}$

41. If something has a general fee and cost per unit, rational equations can be used to determine how many units a person must buy in order for the actual unit price to be a given number. Answers should include the following.
   - To solve $\frac{500 + 5x}{x} = 6$, multiply each side of the equation by x to eliminate the rational expression.

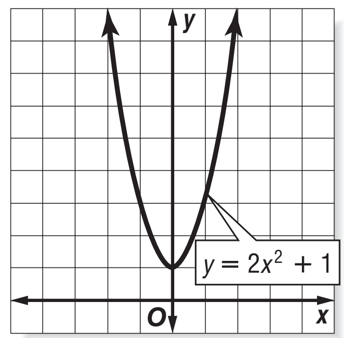
42. B

Then subtract $5x$ from each side. Therefore, $500 = x$. A person would need to make 500 minutes of long distance calls to make the actual unit price 6¢.

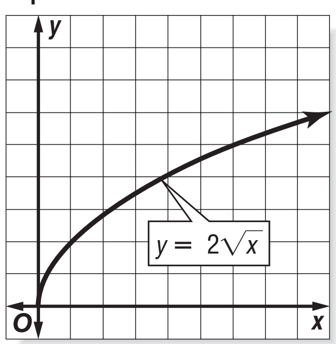
- Since the cost is 5¢ per minute plus \$5.00 per month, the actual cost per minute could never be 5¢ or less.

43. C

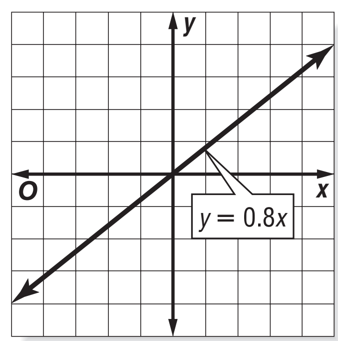
44. quadratic



45. square root



46. direct variation



47. 36

48. 33.75

49. $2\sqrt{130}$

50. $2\sqrt{5}$

51. $\sqrt{137}$

52. $\{x \mid x < -11 \text{ or } x > 3\}$

53. $\{x \mid 0 \le x \le 4\}$

54. $\left\{b \,\middle|\, -1\frac{1}{2} < b < 2\right\}$