

# CHAPTER 9

## Think & Discuss (p. 531)

- $\frac{13,000}{1300} = 10$ ;  $\frac{13,000}{800} = 16.25$ ;  $\frac{13,000}{350} \approx 37.1$
- Headfirst; this position has the highest ratio of volume to cross-sectional surface area.

## Skill Review (p. 532)

- $y = \frac{5}{2}x$     2.  $y = \frac{1}{10}x$     3.  $y = -\frac{1}{4}x$     4.  $y = -4x$
- $5(3x - 1) = 15x - 5$
- $(x - 1)(x + 4)^2 = (x - 1)(x^2 + 8x + 16)$   
 $= x^3 + 7x^2 + 8x - 16$
- $-x(x^2 - 5) = -x^3 + 5x$
- $x(x - 1)(x + 8) = x(x^2 + 7x - 8) = x^3 + 7x^2 - 8x$
- $x^2 - 6x + 9 = (x - 3)^2$
- $4x^3 - 4 = 4(x^3 - 1) = 4(x - 1)(x^2 + x + 1)$
- $8x^3 - 162x = 2x(4x^2 - 81) = 2x(2x - 9)(2x + 9)$
- $6x^2 + 7x - 5 = (2x - 1)(3x + 5)$
- $y = x^2 + 2x$                       14.  $y = x^2 + 2x - 15$   
 $0 = x(x + 2)$                        $0 = (x + 5)(x - 3)$   
 $x = 0, x = -2$                        $x = -5, x = 3$
- $y = x^3 - 2x^2 - 7x - 4$   
 $0 = (x + 1)(x^2 - 3x - 4)$   
 $0 = (x + 1)(x - 4)(x + 1)$   
 $x = -1, x = 4$

## Lesson 9.1

### Developing Concepts Activity 9.1 (p. 533)

- No; as the distance increases, the apparent height decreases.
- The product of distance and apparent height is approximately constant.
- Equations may vary but should have the form  $dh = c$  where  $d$  is the distance between partners,  $h$  is the height of the person standing against the wall, and  $c$  the constant from Ex. 2.
- Answers may vary but should be consistent with the equation from Ex. 3.

## 9.1 Guided Practice (p. 537)

- jointly
- Each product  $xy$  will be approximately equal to the same number.
- It will be constant.
- inverse variation    5. direct variation    6. neither
- inverse variation    8. direct variation
- inverse variation    10. inverse variation    11. neither
- yes    13. yes    14. no    15. yes    16. no    17. yes
- yes    19. yes
- $F = \frac{(250 \times 6)}{l} = \frac{1500}{l}$   
 $F = \frac{1500}{24} = 62.5 \text{ lb}$

## 9.1 Practice and Applications (pp. 537–539)

- inverse variation    22. inverse variation
- neither    24. direct variation    25. inverse variation
- direct variation    27. direct variation    28. neither
- $(5x - 2) = k$                       30.  $(4 \times 8) = k$   
 $y = \frac{-10}{x}$                                    $y = \frac{32}{x}$   
 $y = \frac{-10}{2} = -5$                        $y = \frac{32}{2} = 16$
- $(7 \times 1) = k$                       32.  $\left(\frac{1}{2} \times 10\right) = k$   
 $y = \frac{7}{x}$                                    $y = \frac{5}{x}$   
 $y = \frac{7}{2} = 3.5$                        $y = \frac{5}{2} = 2.5$
- $\left(-\frac{2}{3} \times 6\right) = k$                       34.  $\left(\frac{3}{4} \times \frac{3}{8}\right) = k$   
 $y = \frac{-4}{x}$                                    $y = \frac{9}{32x}$   
 $y = \frac{-4}{2} = -2$                        $y = \frac{9}{32 \times 2} = \frac{9}{64}$
- inverse variation    36. direct variation    37. neither
- inverse variation

## Chapter 9 *continued*

$$39. k = \frac{6}{3 \times 8} = \frac{1}{4}$$

$$z = \frac{1}{4}xy$$

$$z = \frac{-4 \times 7}{4} = -7$$

$$41. k = \frac{5}{1 \times \frac{1}{3}} = 15$$

$$z = 15xy$$

$$z = 15(-4 \times 7) = -420$$

$$43. k = \frac{8}{\frac{5}{6} \times \frac{3}{10}} = 32$$

$$z = 32xy$$

$$z = 32 \times -4 \times 7$$

$$z = -896$$

$$40. k = \frac{2}{-12 \times 4} = \frac{-1}{24}$$

$$z = \frac{-1}{24}xy$$

$$z = \frac{-4 \times 7}{-24} = \frac{7}{6}$$

$$42. k = \frac{\frac{2}{5}}{-6 \times 3} = \frac{-1}{45}$$

$$z = \frac{-1}{45}xy$$

$$z = \frac{-4 \times 7}{-45} = \frac{28}{45}$$

$$44. k = \frac{\frac{3}{2}}{\frac{3}{8} \times \frac{16}{17}} = \frac{17}{4}$$

$$z = \frac{17}{4}xy$$

$$z = \frac{17 \times -4 \times 7}{4} = -119$$

$$45. x = \frac{kz}{y} \quad 46. y = kz\sqrt{x} \quad 47. w = \frac{kzy}{x} \quad 48. \text{no}$$

$$49. \text{yes; } l = \frac{45\pi}{8A}$$

$$50. A = \pi r^2 = \pi \left(\frac{3}{8}\right)^2 = \frac{9\pi}{64}$$

$$l = \frac{45\pi}{8\left(\frac{9\pi}{64}\right)} = \frac{360\pi}{9\pi} = 40 \text{ in.}$$

$$52. D = \frac{33,640,000\sqrt{10,000}}{(5800)^2}$$

$$D = 100$$

$$54. I = \frac{k}{d^2}$$

$$k = 10 \times 1^2 = 10 \text{ watts/m}^2$$

$$I = \frac{10}{(15)^2} = \frac{10}{225} = 0.044 \text{ watts/m}^2$$

$$55. k = \frac{2116.8}{(1.8 \times 120)} = \frac{49}{5}$$

$$W = \frac{49}{5}mh$$

$$W = \frac{49}{5}(100 \times 1.5) = 1470 \text{ joules}$$

$$56. h = kAd$$

$$57. k = \frac{5.7}{1 \times 1} = 5.7$$

$$h = 5.7 \times 2.5 \times 20$$

$$h = 285 \text{ watts}$$

$$58. k = \frac{36}{4 \times 18} = \frac{1}{2}$$

$$A = \frac{1}{2}h(b_1 + b_2)$$

$$59. P = \frac{kWD^2}{L}$$

a. It stays the same.

b. It is multiplied by a factor of 8.

c. It is multiplied by a factor of 4.

d. *Sample answer:* Double only the depth or make the beam 4 times as wide.

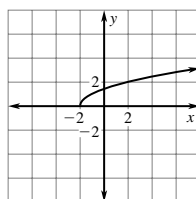
$$60. x = \frac{k_1}{y} \quad y = \frac{k_2}{z}$$

$$x = \frac{k_1}{k_2}z = kz$$

$x$  varies directly with  $z$ .

### 9.1 Mixed Review (p. 539)

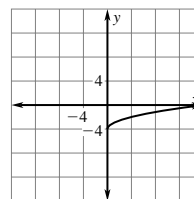
$$61. y = \sqrt{x+2}$$



Domain:  $x \geq -2$

Range:  $y \geq 0$

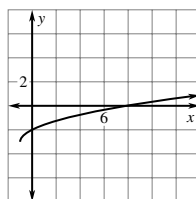
$$62. y = \sqrt{x} - 4$$



Domain:  $x \geq 0$

Range:  $y \geq -4$

$$63. y = \sqrt{x+1} - 3$$



Domain:  $x \geq -1$

Range:  $y \geq -3$

$$65. \sqrt[4]{2x} + 2 = 6$$

$$\sqrt[4]{2x} = 4$$

$$2x = 256$$

$$x = 128$$

$$67. \sqrt[3]{x+12} = 5$$

$$x + 12 = 125$$

$$x = 113$$

$$69. \sqrt{3x+1} = \sqrt{x+15}$$

$$3x + 1 = x + 15$$

$$2x = 14$$

$$x = 7$$

$$64. \sqrt{x} = 22$$

$$x = 484$$

$$66. x^{1/3} - 7 = 0$$

$$x^{1/3} = 7$$

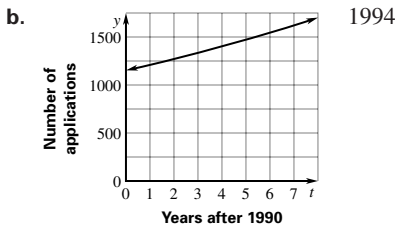
$$x = 343$$

$$68. (x-2)^{3/2} = -8$$

no solution

# Chapter 9 *continued*

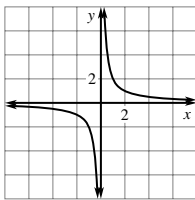
70. a.  $A = 1152(1.05)^t$



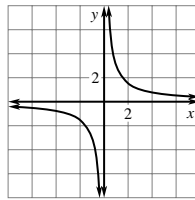
## Lesson 9.2

### Activity (p. 540)

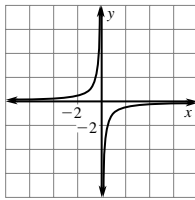
1. a.  $y = \frac{2}{x}$



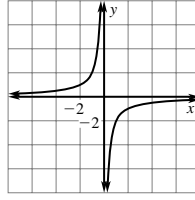
b.  $y = \frac{3}{x}$



c.  $y = \frac{-1}{x}$



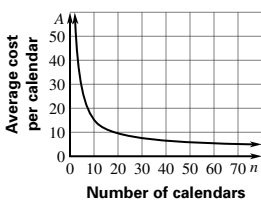
d.  $y = \frac{-2}{x}$



- If  $a > 0$ , the branches of the hyperbola are in the first and third quadrants. If  $a < 0$ , then the branches are in the second and fourth quadrants.
- As  $|a|$  gets larger, the branches move further away from the origin.

### 9.2 Guided Practice (p. 543)

- hyperbola
- The vertical asymptote should be  $x = -3$ .
- Both are all real nonzero numbers.
- $x = 3, y = 4$    5.  $x = -4, y = 2$    6.  $x = -3, y = 1$
- $x = 2, y = \frac{1}{2}$    8.  $x = -8, y = -10$
- $x = 6, y = -5$
- $A = \frac{125 + 3.25n}{n}$
- $x = 0, y = 2$

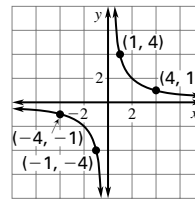


about 70 calendars

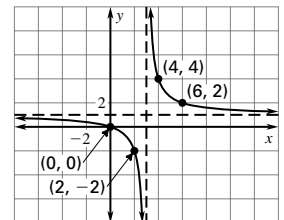
domain: all real numbers except 0; range: all real numbers except 2

### 9.2 Practice and Applications (pp. 543–545)

- $y = 2; x = 3$ ; domain: all real numbers except 3; range: all real numbers except 2
- $y = -2; x = -3$ ; domain: all real numbers except  $-3$ ; range: all real numbers except  $-2$
- $y = 1; x = 3$ ; domain: all real numbers except 3; range: all real numbers except 1
- $y = \frac{2}{3}; x = -\frac{1}{3}$ ; domain: all real numbers except  $-\frac{1}{3}$ ; range: all real numbers except  $\frac{2}{3}$
- $y = \frac{3}{4}; x = -\frac{5}{4}$ ; domain: all real numbers except  $-\frac{5}{4}$ ; range: all real numbers except  $\frac{3}{4}$
- $y = -17; x = -43$ ; domain: all real numbers except  $-43$ ; range: all real numbers except  $-17$
- $y = \frac{17}{8}; x = -\frac{1}{4}$ ; domain: all real numbers except  $-\frac{1}{4}$ ; range: all real numbers except  $\frac{17}{8}$
- $y = 19; x = 6$ ; domain: all real numbers except 6; range: all real numbers except 19
- B   21. C   22. C
- $y = \frac{4}{x}$
- $y = \frac{3}{x-3} + 1$



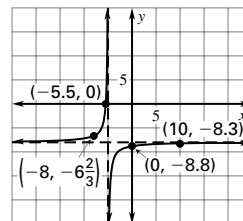
domain: all real numbers except 0; range: all real numbers except 0



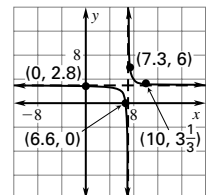
domain: all real numbers except 3; range: all real numbers except 1

25.  $y = \frac{-4}{x+5} - 8$

26.  $y = \frac{1}{x-7} + 3$



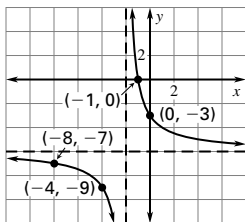
domain: all real numbers except  $-5$ ; range: all real numbers except  $-8$



domain: all real numbers except 7; range: all real numbers except 3

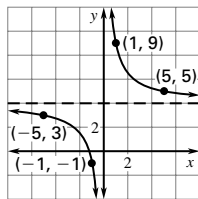
# Chapter 9 *continued*

27.  $y = \frac{6}{x+2} - 6$



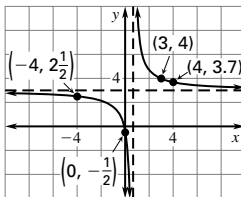
domain: all real numbers except  $-2$ ; range: all real numbers except  $-6$

28.  $y = \frac{5}{x} + 4$



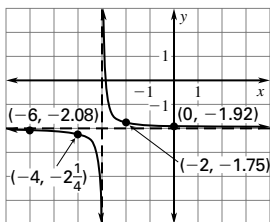
domain: all real numbers except  $0$ ; range: all real numbers except  $4$

35.  $y = \frac{9x+1}{3x-2}$



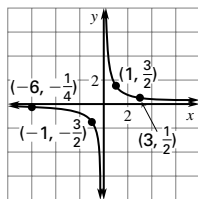
domain: all real numbers except  $\frac{2}{3}$ ; range: all real numbers except  $3$

29.  $y = \frac{1}{4x+12} - 2$



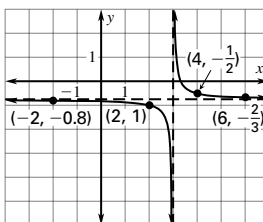
domain: all real numbers except  $-3$ ; range: all real numbers except  $-2$

30.  $y = \frac{3}{2x}$



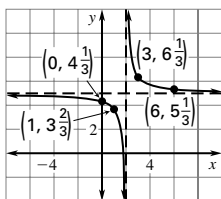
domain: all real numbers except  $0$ ; range: all real numbers except  $0$

36.  $y = \frac{-3x+10}{4x-12}$



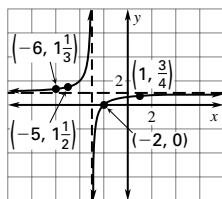
domain: all real numbers except  $3$ ; range: all real numbers except  $-\frac{3}{4}$

31.  $y = \frac{4}{3x-6} + 5$



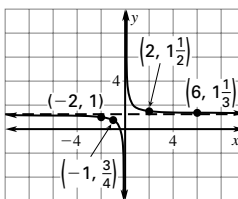
domain: all real numbers except  $2$ ; range: all real numbers except  $5$

32.  $y = \frac{x+2}{x+3}$



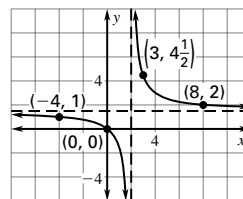
domain: all real numbers except  $-3$ ; range: all real numbers except  $1$

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



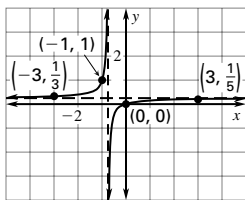
domain: all real numbers except  $0$ ; range: all real numbers except  $\frac{5}{4}$

38.  $y = \frac{3x}{2x-4}$



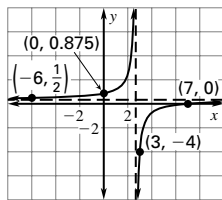
domain: all real numbers except  $2$ ; range: all real numbers except  $\frac{3}{2}$

33.  $y = \frac{x}{4x+3}$



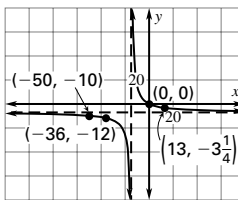
domain: all real numbers except  $-\frac{3}{4}$ ; range: all real numbers except  $\frac{1}{4}$

34.  $y = \frac{x-7}{3x-8}$



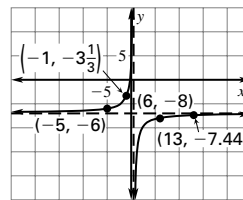
domain: all real numbers except  $\frac{8}{3}$ ; range: all real numbers except  $\frac{1}{3}$

39.  $y = \frac{7x}{-x-15}$



domain: all real numbers except  $-15$ ; range: all real numbers except  $-7$

40.  $y = \frac{-14x-4}{2x-1}$

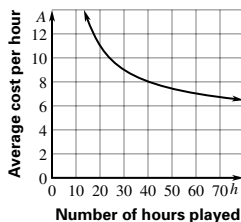


domain: all real numbers except  $\frac{1}{2}$ ; range: all real numbers except  $-7$

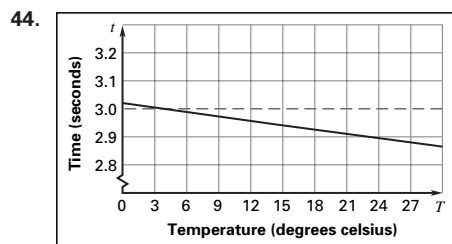
## Chapter 9 *continued*

41. Sample answer:  $y = \frac{1}{x+4} + 3$

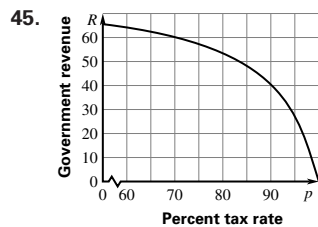
42.  $A = \frac{120 + 5h}{h}$       43. 30



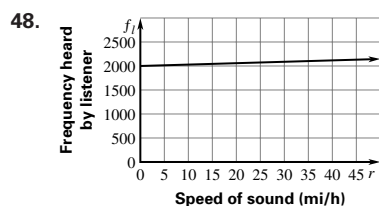
$A = 5$ ; the average cost per hour will approach \$5.



about  $3.89^{\circ}\text{C}$



46. 70%    47.  $f_l = \frac{740 \times 2000}{740 - r} = \frac{1,480,000}{740 - r}$



As  $r$  increases, the frequency increases.

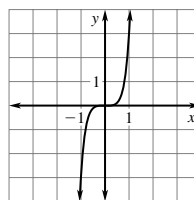
49. It is symmetric in the line  $y = x$  and in the line  $y = -x$ . Because it is symmetric in the line  $y = x$ , the function and its inverse are the same.

50. A    51. E

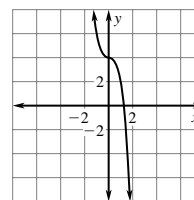
52.  $f(x) = \frac{3}{x-5} + 10$   
 $= \frac{3}{x-5} + \frac{10(x-5)}{(x-5)}$   
 $= \frac{3 + 10x - 50}{x-5}$   
 $= \frac{10x - 47}{x-5}$

### 9.2 Mixed Review (p. 545)

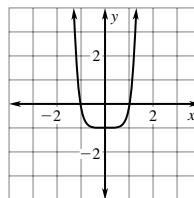
53.  $f(x) = 3x^5$



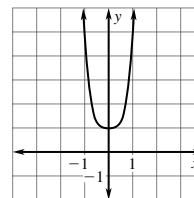
54.  $f(x) = 4 - 2x^3$



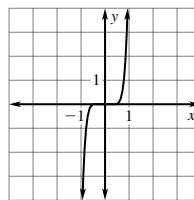
55.  $f(x) = x^6 - 1$



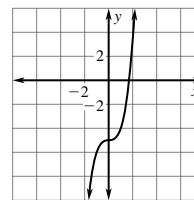
56.  $f(x) = 4x^4 + 1$



57.  $f(x) = 6x^7$



58.  $f(x) = x^3 - 5$



59.  $8x^3 - 125 = (2x - 5)(4x^2 + 10x + 25)$

60.  $3x^3 + 81 = 3(x^3 + 27) = 3(x + 3)(x^2 - 3x + 9)$

61.  $x^3 + 3x^2 + 3x + 9 = x^2(x + 3) + 3(x + 3)$   
 $= (x + 3)(x^2 + 3)$

62.  $5x^3 + 10x^2 + x + 2 = 5x^2(x + 2) + (x + 2)$   
 $= (x + 2)(5x^2 + 1)$

63.  $81x^4 - 1 = (9x^2 - 1)(9x^2 + 1)$   
 $= (3x - 1)(3x + 1)(9x^2 + 1)$

64.  $4x^4 - 4x^2 - 120 = 4(x^4 - x^2 - 30)$   
 $= 4(x^2 - 6)(x^2 + 5)$

65.  $\frac{e^x}{5e} = \frac{1}{5}e^{x-1}$

## Chapter 9 *continued*

66.  $7e^{-5}e^8 = 7e^3$     67.  $e^xe^{4x+1} = e^{5x+1}$     68.  $\frac{6e^x}{e^{6x}} = \frac{6}{e^{5x}}$

69.  $e^4e^{2x}e^{-3x} = e^{-x+4}$     70.  $e^3e^{-5} = e^{-2} = \frac{1}{e^2}$

### Technology Activity 9.2 (p. 546)

1.  $-10 \leq x \leq 10$                       2.  $-10 \leq x \leq 10$

$-7 \leq y \leq 13$                                $-1 \leq y \leq 19$

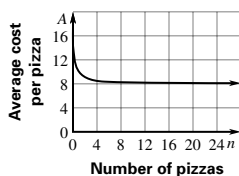
3.  $-4 \leq x \leq 16$                         4.  $-10 \leq x \leq 10$

$-5 \leq y \leq 15$                                $-4 \leq y \leq 16$

5.  $-9 \leq x \leq 11$                         6.  $-5 \leq x \leq 15$

$-9 \leq y \leq 11$                                $-15 \leq y \leq 5$

7.  $A = \frac{2 + 8n}{n}$



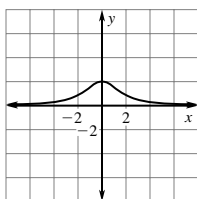
The average cost approaches \$8.

### Lesson 9.3

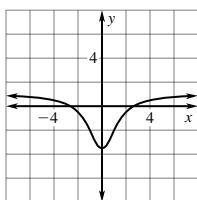
#### 9.3 Guided Practice (p. 550)

- greater than
- The  $x$ -intercepts are the real zeros of  $p(x)$ . The graph has a vertical asymptote of each real zero of  $q(x)$ .
- The graph approaches the horizontal asymptote of  $y = 4$ .

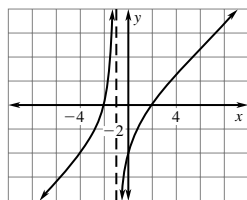
4.  $y = \frac{6}{x^2 + 3}$



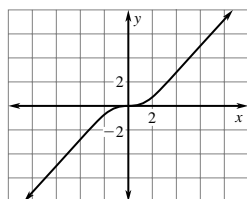
6.  $y = \frac{x^2 - 7}{x^2 + 2}$



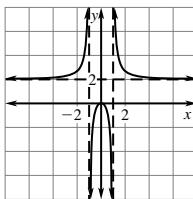
5.  $y = \frac{x^2 - 4}{x + 1}$



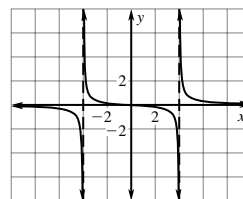
7.  $y = \frac{x^3}{x^2 + 7}$



8.  $y = \frac{2x^2}{x^2 - 1}$



9.  $y = \frac{x}{x^2 - 16}$



10.  $342 = \pi r^2 h$

$$\frac{342}{\pi r^2} = h$$

$$S = 2\pi r^2 + 2\pi r \left( \frac{342}{\pi r^2} \right)$$

$$S = 2\pi r^2 + \frac{684}{r}$$

$$r \approx 3.79 \text{ cm}$$

$$h \approx \frac{342}{3.79^2 \pi} = 7.6 \text{ cm}$$

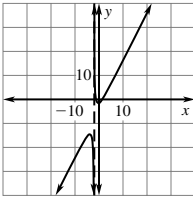
The actual can is taller and more narrow than the can with minimum surface area.

#### 9.3 Practice and Applications (pp. 550–552)

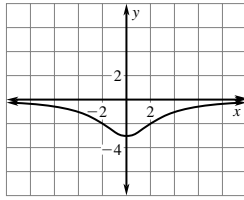
- $x$ -intercept: 0  
vertical asymptotes:  $x = \pm 3$
- $x$ -intercepts: none  
vertical asymptote:  $x = 1$
- $x$ -intercepts:  $-\frac{1}{2}, 5$   
vertical asymptotes:  $x = \pm 4$
- $x$ -intercept:  $-\frac{3}{2}$   
vertical asymptote:  $x = 0$
- $x$ -intercepts:  $-5, 1$   
vertical asymptote:  $x = 6$
- $x$ -intercepts:  $1, \frac{10}{3}$   
vertical asymptotes: none
- $x$ -intercept:  $-4$   
vertical asymptotes:  $x = \pm \sqrt{3}$
- $x$ -intercepts:  $0, -\frac{1}{2}$   
vertical asymptotes: none
- $x$ -intercept: 3  
vertical asymptote:  $x = 0$
- A    21. C    22. B    23. B    24. A    25. C

# Chapter 9 continued

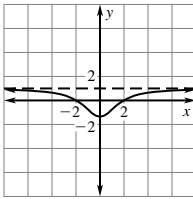
26.  $y = \frac{2x^2 - 3}{x + 2}$



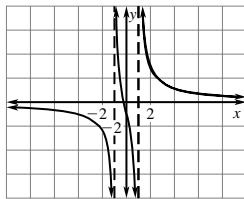
27.  $y = \frac{-24}{x^2 + 8}$



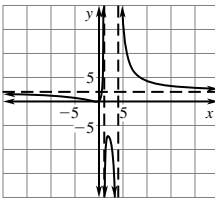
28.  $y = \frac{x^2 - 4}{x^2 + 3}$



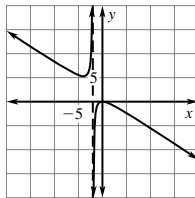
29.  $y = \frac{4x + 1}{x^2 - 1}$



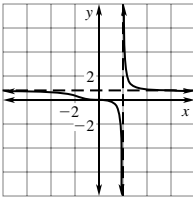
30.  $y = \frac{2x^2 + 3x + 1}{x^2 - 5x + 4}$



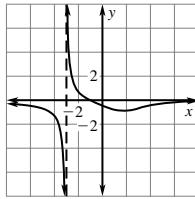
31.  $y = \frac{-2x^2}{3x + 6}$



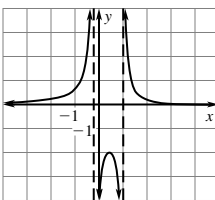
32.  $y = \frac{3x^3 + 1}{4x^3 - 32}$



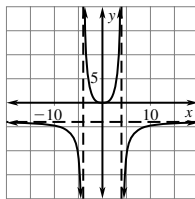
33.  $y = \frac{x^2 - 11x - 12}{x^3 + 27}$



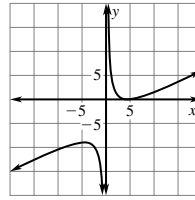
34.  $y = \frac{4 - x}{5x^2 - 4x - 1}$



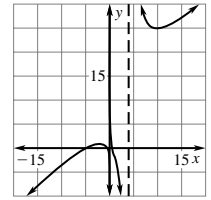
35.  $y = \frac{-4x^2}{x^2 - 16}$



36.  $y = \frac{x^2 - 9x + 20}{2x}$



37.  $y = \frac{x^3 + 5x^2 - 1}{x^2 - 4x}$



38.  $A = 200$

$l \times w = 200$

$l = \frac{200}{w}$

$P = l + 2w$

$P = \frac{200}{w} + 2w$

$P = \frac{200 + 2w^2}{w}$

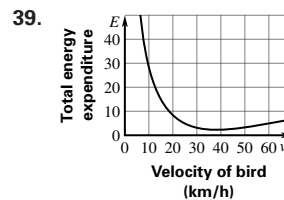
$\min w = 10 \quad P = 40$

$l = \frac{200}{10} = 20$

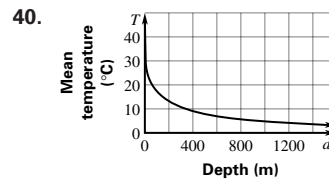
$20 \times w = 200$

$w = 10$

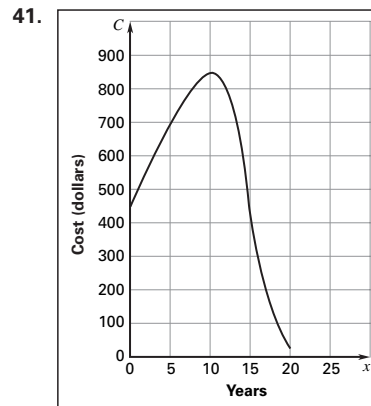
$20 \text{ ft} \times 10 \text{ ft}$



about 39 km/h



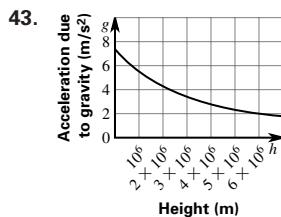
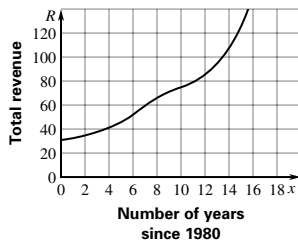
about 1240 m



No, this model predicts an average daily cost close to zero after 2005 and this is not realistic.

## Chapter 9 *continued*

42. 1990

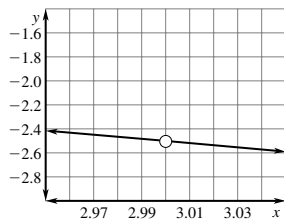
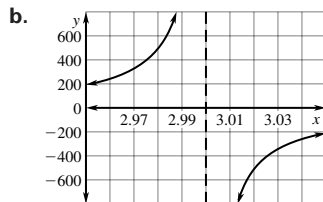


44. about 3.08 m/sec<sup>2</sup> 45.  $g'$  decreases as  $h$  increases.

46. Sample answer:  $y = \frac{x}{x^2 - 9x + 14}$  47. B 48. D

49. a.

$x$	$f(x)$	$g(x)$
2.95	190.76	-2.42
2.96	240.71	-2.43
2.97	323.99	-2.45
2.98	490.60	-2.47
2.99	990.55	-2.48
3	na	na
3.01	-1009.55	-2.52
3.02	-509.61	-2.54
3.03	-342.99	-2.55
3.04	-259.71	-2.57
3.05	-209.77	-2.59



c.  $f(x)$  has vertical asymptote at  $x = 3$ . The values of  $g(x)$  gets close to  $-2.5$ .

d. The graph has a hole at  $x = k$ .

### 9.3 Mixed Review (p. 553)

50.  $\frac{x^{-3}y}{xy^4} = \frac{1}{x^4y^3}$  51.  $\frac{x^6y^5}{xy} = x^5y^4$  52.  $\frac{3x^3y^3}{6x^{-1}y} = \frac{x^4y^2}{2}$

53.  $\frac{12x^5y^{-2}}{3x^{-2}y^5} = \frac{4x^7}{y^7}$  54.  $\left(\frac{x^2y^2}{x^3y}\right)^2 = \left(\frac{y}{x}\right)^2 = \frac{y^2}{x^2}$

55.  $\left(\frac{5x^3}{25xy^2}\right)^3 = \left(\frac{x^2}{5y^2}\right)^3 = \frac{x^6}{125y^6}$

56.  $z = -\frac{xy}{9}$  57.  $z = -\frac{3xy}{40}$   
 $z = \frac{-(-3)(2)}{9} = \frac{2}{3}$   $z = \frac{-3(-3)(2)}{40} = \frac{9}{20}$

58.  $z = -\frac{xy}{12}$  59.  $z = 8xy$   
 $z = \frac{-(-3)(2)}{12} = \frac{1}{2}$   $z = (-3)(2)8 = -48$

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

$g(f(x)) = g\left(\frac{1}{2}x - 3\right) = 2\left(\frac{1}{2}x - 3\right) + 6$   
 $= x - 6 + 6 = x$

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

$g(f(x)) = g(-3x + 2) = -\frac{1}{3}(-3x + 2) + \frac{2}{3}$   
 $= x - \frac{2}{3} + \frac{2}{3} = x$

62.  $f(g(x)) = f\left[\left(\frac{x-2}{5}\right)^{1/3}\right] = 5\left[\left(\frac{x-2}{5}\right)^{1/3}\right]^3 + 2$   
 $= 5\left(\frac{x-2}{5}\right) + 2 = x - 2 + 2 = x$

$g(f(x)) = g(5x^3 + 2) = \left(\frac{5x^3 + 2 - 2}{5}\right)^{1/3}$   
 $= \left(\frac{5x^3}{5}\right)^{1/3} = [x^3]^{1/3} = x$

63.  $f(g(x)) = f\left(\frac{\sqrt[4]{x}}{2}\right) = 16\left(\frac{\sqrt[4]{x}}{2}\right)^4 = \frac{16x}{16} = x$

$g(f(x)) = g(16x^4) = \frac{\sqrt[4]{16x^4}}{2} = \frac{2x}{2} = x$



# Chapter 9 continued

## Quiz 1 (p. 553)

1.  $y = -\frac{12}{x}$

$$y = \frac{-12}{-3} = 4$$

3.  $y = \frac{6}{x}$

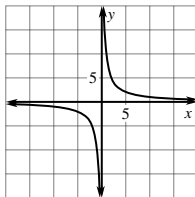
$$y = \frac{6}{-3} = -2$$

5.  $x = 4yz$

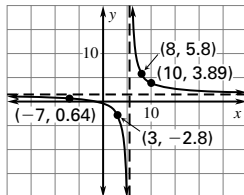
$$4 = 4y$$

$$y = 1$$

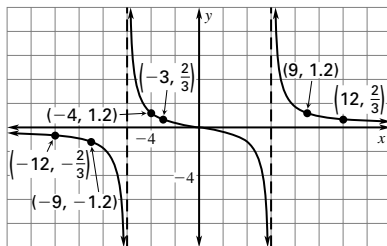
7.  $y = \frac{10}{x}$



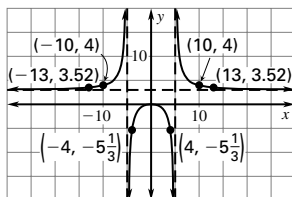
9.  $y = \frac{3x + 5}{2x - 11}$



10.  $y = \frac{6x}{x^2 - 36}$



11.  $y = \frac{3x^2}{x^2 - 25}$



2.  $y = \frac{66}{x}$

$$y = \frac{66}{-3} = -22$$

4.  $x = -\frac{yz}{6}$

$$4 = -\frac{y}{6}$$

$$y = -24$$

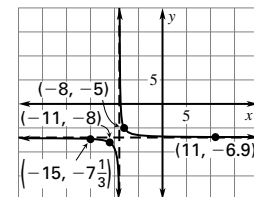
6.  $x = -\frac{5yz}{4}$

$$4 = -\frac{5y}{4}$$

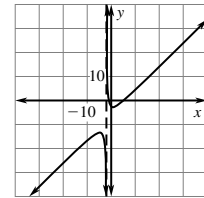
$$16 = -5y$$

$$y = -\frac{16}{5}$$

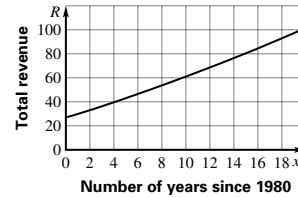
8.  $y = \frac{2}{x + 9} - 7$



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



13.



1992

## Lesson 9.4

### 9.4 Guided Practice (p. 558)

1. A rational expression is in simplified form if its numerator and denominator have no common factors.

2. The  $5x$ 's cannot be canceled in the second line.

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

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

5.  $\frac{x^2 + 10x - 4}{x^2 + 10x}$ ; in simplified form

6.  $\frac{6x^2 - 4x - 3}{3x^2 + x}$ ; in simplified form

7.  $\frac{x^2 - 9}{2x + 1}$ ; in simplified form

8.  $\frac{2x^3 - 32x}{x^2 + 8x + 16} = \frac{2x(x^2 - 16)}{(x + 4)(x + 4)}$   
 $= \frac{2x(x - 4)(x + 4)}{(x + 4)(x + 4)} = \frac{2x(x - 4)}{x + 4}$

9.  $\frac{16x^3}{5y^9} \cdot \frac{x^5y^8}{80x^3y} = \frac{16x^8y^8}{400x^3y^{10}} = \frac{x^5}{25y^2}$

10.  $\frac{7x^4y^3}{5xy} \cdot \frac{2x^7}{21y^5} = \frac{14x^{11}y^3}{105xy^6} = \frac{2x^{10}}{15y^3}$

11.  $\frac{x^2 + x - 6}{2x^2} \cdot \frac{2x + 8}{x^2 + 7x + 12}$   
 $= \frac{(x + 3)(x - 2) \cdot 2(x + 4)}{2x^2(x + 3)(x + 4)} = \frac{x - 2}{x^2}$

12.  $\frac{144}{4xy} \div \frac{54y^3}{3x^3y} = \frac{144 \cdot 3x^3y}{4xy \cdot 54y^3} = \frac{432x^3y}{216xy^4} = \frac{2x^2}{y^3}$

13.  $\frac{16xy}{3x^5y^5} \div \frac{8x^2}{9xy^7} = \frac{16xy \cdot 9xy^7}{3x^5y^5 \cdot 8x^2} = \frac{144x^2y^8}{24x^7y^5} = \frac{6y^3}{x^5}$

## Chapter 9 *continued*

14.  $\frac{5x^2 + 10x}{x^2 - x - 6} \div \frac{15x^3 + 45x^2}{x^2 - 9}$   
 $= \frac{5x(x+2) \cdot (x-3)(x+3)}{(x+2)(x-3) \cdot 15x^2(x+3)}$   
 $= \frac{1}{3x}$
15.  $\frac{\text{Volume}}{\text{Surface Area}} = \frac{104x^3}{70x^2} = 1.5x$   
 $14x = 65$   
 $x = 4.6$   
 $1.5(4.6) = 6.9$  with  
 $\frac{\text{Volume}}{\text{Surface Area}} = \frac{104x^3}{52x^2} = 2x$   
 $14x = 65$   
 $x = 4.6$   
 $2(4.6) = 9.2$  without
16.  $\frac{3x^3}{12x^2 + 9x} = \frac{3x^3}{3x(4x+3)} = \frac{x^2}{4x+3}$
17.  $\frac{x^2 - x - 6}{x^2 + 8x + 16}$ ; in simplified form
18.  $\frac{x^2 - 3x + 2}{x^2 + 5x - 6} = \frac{(x-2)(x-1)}{(x-1)(x+6)} = \frac{x-2}{x+6}$
19.  $\frac{x^2 + 2x - 4}{x^2 + x - 6}$ ; in simplified form
20.  $\frac{x^2 - 2x - 3}{x^2 - 7x + 12} = \frac{(x-3)(x+1)}{(x-3)(x-4)} = \frac{x+1}{x-4}$
21.  $\frac{3x^2 - 3x - 6}{x^2 - 4} = \frac{3(x^2 - x - 2)}{(x-2)(x+2)} = \frac{3(x-2)(x+1)}{(x-2)(x+2)}$   
 $= \frac{3(x+1)}{x+2}$
22.  $\frac{x-2}{x^3 - 8} = \frac{x-2}{(x-2)(x^2 + 2x + 4)} = \frac{1}{x^2 + 2x + 4}$
23.  $\frac{x^3 - 27}{x^3 + 3x^2 + 9x} = \frac{(x-3)(x^2 + 3x + 9)}{x(x^2 + 3x + 9)} = \frac{x-3}{x}$
24.  $\frac{x^2 + 6x + 9}{x^2 - 9} = \frac{(x+3)(x+3)}{(x+3)(x-3)} = \frac{x+3}{x-3}$
25.  $\frac{15x^2 - 8x - 18}{-20x^2 + 14x + 12}$  in simplified form
26.  $\frac{x^3 - 2x^2 + x - 2}{3x^2 - 3x - 8}$ ; in simplified form
27.  $\frac{x^3 + 3x^2 - 2x - 6}{x^3 + 27} = \frac{(x^2 - 2)(x + 3)}{(x + 3)(x^2 - 3x + 9)}$   
 $= \frac{x^2 - 2}{x^2 - 3x + 9}$
28.  $\frac{4xy^3}{x^2y} \cdot \frac{y}{8x} = \frac{4xy^4}{8x^3y} = \frac{y^3}{2x^2}$
29.  $\frac{80x^4}{y^3} \cdot \frac{xy}{5x^2} = \frac{80x^5y}{5x^2y^3} = \frac{16x^3}{y^2}$
30.  $\frac{2x^2 - 10}{x+1} \cdot \frac{x+2}{3x^2 - 15} = \frac{2(x^2 - 5)(x+2)}{(x+1)3(x^2 - 5)} = \frac{2(x+2)}{3(x+1)}$
31.  $\frac{x-3}{2x-8} \cdot \frac{6x^2 - 96}{x^2 - 9} = \frac{(x-3)6(x-4)(x+4)}{2(x-4)(x-3)(x+3)}$   
 $= \frac{3(x+4)}{x+3}$
32.  $\frac{x^2 - x - 6}{4x^3} \cdot \frac{x+1}{x^2 + 5x + 6} = \frac{(x-3)(x+2)(x+1)}{4x^3(x+2)(x+3)}$   
 $= \frac{(x-3)(x+1)}{4x^3(x+3)}$
33.  $\frac{2x^2 - 2}{x^2 - 6x - 7} \cdot (x^2 - 10x + 21)$   
 $= \frac{2(x-1)(x+1)(x-3)(x-7)}{(x-7)(x+1)} = 2(x-1)(x-3)$
34.  $\frac{x^3 + 5x^2 - x - 5}{x^2 - 25} \cdot (x+1) = \frac{(x^2 - 1)(x+5)(x+1)}{(x+5)(x-5)}$   
 $= \frac{(x-1)(x+1)^2}{(x-5)}$
35.  $\frac{x-3}{-x^3 + 3x^2} \cdot (x^2 + 2x + 1) = \frac{(x-3)(x+1)(x+1)}{-x^2(x-3)}$   
 $= \frac{(x+1)^2}{-x^2}$
36.  $\frac{32x^3y}{y^9} \div \frac{8x^4}{y^6} = \frac{32x^3y \cdot y^6}{y^9 \cdot 8x^4} = \frac{32x^3y^7}{8x^4y^9} = \frac{4}{xy^2}$
37.  $\frac{2xyz}{x^2z^2} \div \frac{6y^3}{3xz} = \frac{2xyz \cdot 3xz}{x^2z^2 \cdot 6y^3} = \frac{6x^2yz^2}{6x^2y^3z^2} = \frac{1}{y^2}$
38.  $\frac{3x^2 + x - 2}{x^2 + 3x + 2} \div \frac{2x}{x+2} = \frac{(3x-2)(x+1)(x+2)}{(x+2)(x+1)2x}$   
 $= \frac{3x-2}{2x}$
39.  $\frac{x^2 - 14x + 48}{x^2 - 6x} \div (3x - 24) = \frac{(x-8)(x-6)}{x(x-6) \cdot 3(x-8)}$   
 $= \frac{1}{3x}$
40.  $\frac{2x^2 - 12x}{x^2 - 7x + 6} \div \frac{2x}{3x-3} = \frac{2x(x-6) \cdot 3(x-1)}{(x-6)(x-1)2x} = 3$
41.  $\frac{x^2 + 8x + 16}{x+2} \div \frac{x^2 + 6x + 8}{x^2 - 4}$   
 $= \frac{(x+4)(x+4)(x-2)(x+2)}{(x+2)(x+2)(x+4)} = \frac{(x+4)(x-2)}{x+2}$
42.  $\frac{x^2 + 6x - 7}{3x^2} \div \frac{x+7}{6x} = \frac{(x+7)(x-1)6x}{3x^2(x+7)} = \frac{2(x-1)}{x}$
43.  $(x^2 + 6x - 27) \div \frac{3x^2 + 27x}{x+5} = \frac{(x+9)(x-3)(x+5)}{3x(x+9)}$   
 $= \frac{(x-3)(x+5)}{3x}$

## Chapter 9 continued

$$44. (x-5) \div \frac{x^2 - 11x + 30}{x^2 + 7x + 12} \cdot (x-6)$$

$$= (x-5) \cdot \frac{(x+3)(x+4)}{(x-5)(x-6)} \cdot (x-6)$$

$$= (x+3)(x+4)$$

$$45. \frac{x^2 - x - 12}{8x^2} \div \frac{x^3 + 3x^2}{8x^3 - 2x^2} \div \frac{4x-1}{x+2}$$

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

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

$$46. \frac{x^2 + 11x}{x-2} \div (3x^2 + 6x) \cdot \frac{x^2 - 4}{x+11}$$

$$= \frac{x(x+11)}{(x-2)} \cdot \frac{1}{3x(x+2)} \cdot \frac{(x-2)(x+2)}{(x+11)} = \frac{1}{3}$$

$$47. \frac{2x^2 + x - 15}{2x^2 - 11x - 21} \cdot (6x+9) \div \frac{2x-5}{3x-21}$$

$$= \frac{(2x-5)(x+3)}{(2x+3)(x-7)} \cdot 3(2x+3) \cdot \frac{3(x-7)}{(2x-5)} = 9(x+3)$$

$$48. (x^3 + 8) \cdot \frac{x-2}{x^2 - 2x + 4} \div \frac{x^2 - 4}{x-6}$$

$$= (x+2)(x^2 - 2x + 4) \cdot \frac{(x-2)}{(x^2 - 2x + 4)} \cdot \frac{(x-6)}{(x-2)(x+2)}$$

$$= x - 6$$

$$49. \frac{x^2 + 12x + 20}{4x^2 - 9} \cdot \frac{6x^3 - 9x^2}{x^3 + 10x^2} \cdot (2x+3)$$

$$= \frac{(x+2)(x+10)}{(2x+3)(2x-3)} \cdot \frac{3x^2(2x-3)}{x^2(x+10)} \cdot (2x+3)$$

$$= 3(x+2)$$

$$50. \frac{\text{heat generated}}{\text{heat released}} = \frac{k_1 H^3 V^2}{k_2 H^2} = \frac{k_1 H V^2}{k_2}$$

$$51. H = \frac{k_2}{k_1 V^2}; \text{ shorter runner has an advantage.}$$

$$52. A = L \div F = \frac{43.3t + 999}{0.0482t + 1} \div \frac{0.101t^2 + 2.20}{0.0500t^2 + 1}$$

$$= \frac{(43.3t + 999)(0.0500t^2 + 1)}{(0.0482t + 1)(0.101t^2 + 2.20)}$$

$$53. \text{ when } t = 6, \frac{(43.3(6) + 999)(0.0500(6)^2 + 1)}{(0.0482(6) + 1)(0.101(6)^2 + 2.20)}$$

$$= \frac{3524.64}{7.5237712} \approx 468.5 \text{ acres}$$

$$54. V = W \cdot P$$

$$= \frac{(-0.0112t^5 + 0.193t^4 - 1.17t^3 + 2.82t^2 - 1.76t + 10.4)(53.4t^2 - 243t + 385)}{(0.00146t^3 + 0.122t^2 - 0.586t + 1)}$$

$$55. \text{ when } t = 4, P \approx 381.22 \quad W \approx 11.54$$

$$W \cdot P = \$4.4 \text{ billion}$$

$$56. \frac{\text{Vol. of rectangular prism}}{\text{Vol. of cylinder}} = \frac{(4x)(4x)(7x+1)}{\pi(2x)^2(7x+1)}$$

$$= \frac{16x^2(7x+1)}{4x^2\pi(7x+1)} = \frac{4}{\pi}$$

$$57. \text{ a. } \frac{2\pi r^2 + 2\pi r h}{\pi r^2 h} = \frac{2\pi r(r+h)}{\pi r^2 h} = \frac{2(r+h)}{r h}$$

$$\text{ b. when } h = 2r, \frac{2(r+2r)}{r \cdot 2r} = \frac{2(3r)}{2r^2} = \frac{3}{r}$$

$$\text{ c. } r = 2\frac{5}{8}, h = 3\frac{7}{8}$$

$$2\left(2\frac{5}{8} + 3\frac{7}{8}\right) = 2\left(\frac{52}{8}\right) = \left(\frac{52}{4}\right)\left(\frac{64}{651}\right) = \frac{832}{651} \approx 1.278$$

$$\left(2\frac{5}{8}\right)\left(3\frac{7}{8}\right) = \left(\frac{651}{64}\right) = \left(\frac{52}{4}\right)\left(\frac{64}{651}\right) = \frac{832}{651} \approx 1.278$$

$$r = 5\frac{1}{8}, h = 6\frac{1}{2}$$

$$2\left(5\frac{1}{8} + 6\frac{1}{2}\right) = 2\left(\frac{93}{8}\right) = \left(\frac{93}{4}\right)\left(\frac{16}{533}\right) = \frac{372}{533} \approx 0.698$$

$$\left(5\frac{1}{8}\right)\left(6\frac{1}{2}\right) = \left(\frac{533}{16}\right) = \left(\frac{93}{4}\right)\left(\frac{16}{533}\right) = \frac{372}{533} \approx 0.698$$

$$r = 6\frac{3}{16}, h = 7$$

$$2\left(6\frac{3}{16} + 7\right) = 2\left(\frac{211}{16}\right) = \left(\frac{211}{8}\right)\left(\frac{16}{693}\right) = \frac{422}{693} = 0.609$$

$$\left(6\frac{3}{16}\right)(7) = \left(\frac{693}{16}\right) = \left(\frac{211}{8}\right)\left(\frac{16}{693}\right) = \frac{422}{693} = 0.609$$

d. 3 pound can, 2 pound can, soup can; reducing the surface area to volume ratio makes the can more efficient.

58. Sample answer:

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

$$\frac{x(x-1)}{x+2} = \frac{x^2}{g(x)}, \quad g(x) = \frac{x^2(x+2)}{x(x-1)} = \frac{x(x+2)}{(x-1)}$$

## Chapter 9 *continued*

59. *Sample answer:*

$$f(x) \cdot g(x) = x - 1$$

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

$$f(x)$$

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

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

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

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

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

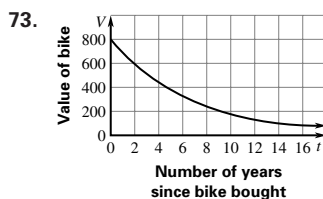
$$g(x) = \frac{(x-1)x^2}{(x+1)(x-1)} = \frac{x^2}{x+1}$$

### 9.4 Mixed Review (p. 560)

60.  $96 = 2^5 \cdot 3$   
 $160 = 2^5 \cdot 5$   
 GCF (96, 160) = 32  
 LCD (96, 160) = 480
61.  $120 = 3 \cdot 5 \cdot 2^3$   
 $165 = 3 \cdot 5 \cdot 11$   
 GCF (120, 165) = 15  
 LCD (120, 165) = 1320
62.  $48 = 2^4 \cdot 3$   
 $108 = 2^2 \cdot 3^3$   
 GCF (48, 108) = 12  
 LCD (48, 108) = 432
63.  $72 = 2^3 \cdot 3^2$   
 $84 = 2^2 \cdot 3 \cdot 7$   
 GCF (72, 84) = 12  
 LCD (72, 84) = 504
64.  $238 = 2 \cdot 7 \cdot 17$   
 $51 = 3 \cdot 17$   
 GCF (238, 51) = 17  
 LCD (238, 51) = 714
65.  $480 = 2^5 \cdot 3 \cdot 5$   
 $600 = 5^2 \cdot 3 \cdot 2^3$   
 GCF (480, 600) = 120  
 LCD (480, 600) = 2400
66.  $x(x^2 + 7x - 1) = x^3 + 7x^2 - x$
67.  $(x + 7)(x - 1) = x^2 + 7x - x - 7 = x^2 + 6x - 7$
68.  $(x + 10)(x - 3) = x^2 - 3x + 10x - 30$   
 $= x^2 + 7x - 30$
69.  $(x + 3)(x^2 + 3x + 2) = x^3 + 3x^2 + 2x + 3x^2 + 9x + 6$   
 $= x^3 + 6x^2 + 11x + 6$
70.  $(2x - 2)(x^3 - 4x^2) = 2x^4 - 8x^3 - 2x^2 + 8x^2$   
 $= 2x^4 - 10x^3 + 8x^2$
71.  $x(x^2 - 4)(5 - 6x^3) = (x^3 - 4x)(5 - 6x^3)$   
 $= 5x^3 - 6x^6 - 20x + 24x^4$   
 $= -6x^6 + 24x^4 + 5x^3 - 20x$

72.  $V = 800(0.86)^t$

when  $t = 4$ ,  $V = 800(0.86)^4 \approx \$438$



about 6.5 years

### Technology Activity 9.4 (p. 561)

- $\frac{x^2 - 3x}{x^2 + x - 12} = \frac{x(x-3)}{(x+4)(x-3)} = \frac{x}{x+4}$
- $\frac{2x^2 - 10x}{x^2 - 4x - 5} = \frac{2x(x-5)}{(x-5)(x+1)} = \frac{2x}{x+1}$
- $\frac{x^2 + x - 6}{x^2 + 4x + 3} = \frac{(x+3)(x-2)}{(x+3)(x+1)} = \frac{x-2}{x+1}$
- $\frac{x-1}{2x^2} \cdot \frac{x+2}{x-1} = \frac{x+2}{2x^2}$
- $\frac{2x^2 - 10x}{3x + 3} \div \frac{x-5}{x+1} = \frac{2x(x-5)}{3(x+1)} \cdot \frac{(x+1)}{(x-5)} = \frac{2x}{3}$
- $\frac{x^2 - x - 12}{x^2 + 6x + 6} \cdot \frac{x^2 + 3x + 2}{x^2 + 5x + 6}$   
 $= \frac{(x-4)(x+3)(x+2)(x+1)}{(x^2 + 6x + 6)(x+2)(x+3)} = \frac{(x-4)(x+1)}{x^2 + 6x + 6}$

## Lesson 9.5

### 9.5 Guided Practice (p. 565)

- Sample answers:*  $\frac{4 + \frac{1}{x}}{2 - \frac{3}{2x+5}}; \frac{\frac{5}{x+1} + 3}{x^2 + 5x + 6}$
- You need common denominators to add (or subtract) rational expressions or numerical fractions.
- Write the numerator and denominator as a single fraction. Then divide by multiplying the numerator by the reciprocal of the denominator.
  - Multiply the numerator and denominator by the least common denominator of every fraction in the numerator and denominator.
- $(x + 1)^3$  is a common denominator, but not the lowest. The LCD is  $(x + 1)^2$ .
- $\frac{2x}{x+5} + \frac{7}{x+5} = \frac{2x+7}{x+5}$
- $\frac{7}{5x} + \frac{8}{3x} = \frac{21}{15x} + \frac{40}{15x} = \frac{61}{15x}$

## Chapter 9 continued

$$7. \frac{x}{x-4} - \frac{6}{x+3} = \frac{x(x+3)}{(x-4)(x+3)} - \frac{6(x-4)}{(x-4)(x+3)}$$

$$= \frac{x^2 + 3x - 6x + 24}{(x-4)(x+3)}$$

$$= \frac{x^2 - 3x + 24}{(x-4)(x+3)}$$

$$8. \frac{\frac{x}{5} + 4}{8 + \frac{1}{x}} = \frac{\frac{x+20}{5}}{\frac{8x+1}{x}} = \frac{x+20}{5} \cdot \frac{x}{8x+1} = \frac{x(x+20)}{5(8x+1)}$$

$$9. \frac{\frac{x+2}{5} - 5}{8 + \frac{4}{x}} = \frac{\frac{x+2-25}{5}}{\frac{8x+4}{x}} = \frac{x-23}{5} \cdot \frac{x}{8x+4}$$

$$= \frac{x(x-23)}{20(2x+1)}$$

$$10. \frac{\frac{2x+2}{6} - \frac{1}{x-2}}{\frac{15}{2x}} = \frac{\frac{2(x+1)}{12-x}}{2x} = \frac{15}{2(x+1)} \cdot \frac{2x}{(12-x)}$$

$$= \frac{15x}{(x+1)(12-x)}$$

$$11. m = \frac{Pi}{1 - \left(\frac{1}{1+i}\right)^{12t}} = \frac{Pi}{1 - \frac{1}{(1+i)^{12t}}}$$

$$= \frac{Pi(1+i)^{12t}}{\frac{(1+i)^{12t} - 1}{(1+i)^{12t}} \cdot (1+i)^{12t}}$$

$$= \frac{Pi(1+i)^{12t}}{(1+i)^{12t} - 1}$$

### 9.5 Practice and Applications (pp. 565–567)

$$12. \frac{7}{6x} + \frac{11}{6x} = \frac{18}{6x} = \frac{3}{x} \quad 13. \frac{23}{10x^2} - \frac{x}{10x^2} = \frac{23-x}{10x^2}$$

$$14. \frac{4x}{x+1} - \frac{3}{x+1} = \frac{4x-3}{x+1}$$

$$15. \frac{5x^2}{x+8} + \frac{5x}{x+8} = \frac{5x^2+5x}{x+8} = \frac{5x(x+1)}{x+8}$$

$$16. \frac{6x^2}{x-2} - \frac{12x}{x-2} = \frac{6x^2-12x}{x-2} = \frac{6x(x-2)}{(x-2)} = 6x$$

$$17. \frac{x}{x^2-5x} - \frac{5}{x^2-5x} = \frac{x-5}{x^2-5x} = \frac{(x-5)}{x(x-5)} = \frac{1}{x}$$

$$18. \text{LCD} \left( \frac{14}{4(x+1)}, \frac{7}{4x} \right) = 4x(x+1)$$

$$19. \text{LCD} \left( \frac{4}{21x^2}, \frac{x}{3x^2-15x} \right) = 21x^2(x-5)$$

$$20. \text{LCD} \left( \frac{5x+2}{4x^2-1}, \frac{3}{x}, \frac{9x}{2x+1} \right) = x(2x+1)(2x-1)$$

$$21. \text{LCD} \left( \frac{1}{x(x-6)}, \frac{12}{x^2-3x-18} \right) = x(x+3)(x-6)$$

$$22. \text{LCD} \left( \frac{3x+1}{x(x-7)}, \frac{3}{x^2-6x-7} \right) = x(x+1)(x-7)$$

$$23. \text{LCD} \left( \frac{1}{x^2-3x-28}, \frac{x}{x^2+6x+8} \right)$$

$$= (x-7)(x+2)(x+4)$$

24. Sometimes; the LCD will be the product of the denominators if the denominators have no common factors.

25. Always; each denominator must be a factor of the LCD, so the LCD must have degree greater than or equal to each of the separate denominators.

$$26. \frac{6}{4x^2} + \frac{2}{5x} = \frac{30}{20x^2} + \frac{8x}{20x^2} = \frac{30+8x}{20x^2} = \frac{15+4x}{10x^2}$$

$$27. -\frac{4}{7x} - \frac{5}{3x} = -\frac{12}{21x} - \frac{35}{21x} = \frac{-47}{21x}$$

$$28. \frac{7}{6(x-2)} - \frac{x+3}{6x} = \frac{7x}{6x(x-2)} - \frac{(x+3)(x-2)}{6x(x-2)}$$

$$= \frac{7x - x^2 - x + 6}{6x(x-2)}$$

$$= \frac{-(x^2 - 6x - 6)}{6x(x-2)}$$

$$29. \frac{6x+1}{x^2-9} + \frac{4}{x-3} = \frac{6x+1}{(x-3)(x+3)} + \frac{4(x+3)}{(x-3)(x+3)}$$

$$= \frac{6x+1+4x+12}{(x-3)(x+3)}$$

$$= \frac{10x+13}{(x-3)(x+3)}$$

$$30. \frac{10}{x^2-5x-14} + \frac{2}{x-7}$$

$$= \frac{10}{(x-7)(x+2)} + \frac{2(x+2)}{(x-7)(x+2)}$$

$$= \frac{10+2x+4}{(x-7)(x+2)}$$

$$= \frac{2x+14}{(x-7)(x+2)}$$

$$= \frac{2(x+7)}{(x-7)(x+2)}$$

$$31. \frac{5x-1}{x^2+2x-8} - \frac{6}{x+4}$$

$$= \frac{5x-1}{(x+4)(x-2)} - \frac{6(x-2)}{(x+4)(x-2)}$$

$$= \frac{5x-1-6x+12}{(x+4)(x-2)}$$

$$= \frac{-x+11}{(x+4)(x-2)}$$

## Chapter 9 *continued*

$$\begin{aligned}
 32. \quad \frac{4x^2}{3x+5} - \frac{10}{x+8} &= \frac{4x^2(x+8)}{(3x+5)(x+8)} - \frac{10(3x+5)}{(3x+5)(x+8)} \\
 &= \frac{4x^3 + 32x^2 - 30x - 50}{(3x+5)(x+8)} \\
 &= \frac{2(2x^3 + 16x^2 - 15x - 25)}{(3x+5)(x+8)}
 \end{aligned}$$

$$\begin{aligned}
 33. \quad \frac{2-5x}{x-10} + \frac{1}{3x+2} \\
 &= \frac{(2-5x)(3x+2)}{(x-10)(3x+2)} + \frac{(x-10)}{(x-10)(3x+2)} \\
 &= \frac{-15x^2 - 10x + 6x + 4 + x - 10}{(x-10)(3x+2)} \\
 &= \frac{-15x^2 - 3x - 6}{(x-10)(3x+2)} \\
 &= \frac{-3(5x^2 + x + 2)}{(x-10)(3x+2)}
 \end{aligned}$$

$$\begin{aligned}
 34. \quad \frac{x^2+x-3}{x^2-12x+32} + \frac{3x}{x-8} \\
 &= \frac{x^2+x-3}{(x-4)(x-8)} + \frac{3x(x-4)}{(x-4)(x-8)} \\
 &= \frac{x^2+x-3+3x^2-12x}{(x-4)(x-8)} \\
 &= \frac{4x^2-11x-3}{(x-4)(x-8)} \\
 &= \frac{(4x+1)(x-3)}{(x-4)(x-8)}
 \end{aligned}$$

$$\begin{aligned}
 35. \quad \frac{2x+1}{x^2+8x+16} - \frac{3}{x^2-16} \\
 &= \frac{(2x+1)(x-4)}{(x+4)^2(x-4)} - \frac{3(x+4)}{(x+4)^2(x-4)} \\
 &= \frac{2x^2-7x-4-3x-12}{(x+4)^2(x-4)} \\
 &= \frac{2x^2-10x-16}{(x+4)^2(x-4)} \\
 &= \frac{2(x^2-5x-8)}{(x+4)^2(x-4)}
 \end{aligned}$$

$$\begin{aligned}
 36. \quad \frac{4x}{x+1} + \frac{5}{2x-3} - \frac{4}{x} \\
 &= \frac{4x(2x-3)x + 5(x+1)x - 4(x+1)(2x-3)}{x(x+1)(2x-3)} \\
 &= \frac{8x^3 - 15x^2 + 9x + 12}{x(x+1)(2x+3)} \\
 &= \frac{8x^3 - 12x^2 + 5x^2 + 5x - 8x^2 + 4x + 12}{x(x+1)(2x+3)}
 \end{aligned}$$

$$\begin{aligned}
 37. \quad \frac{10x}{3(x-1)(x+1)} + \frac{4}{x-1} + \frac{5}{6x} \\
 &= \frac{(10x)(2x) + 4(6x)(x+1) + 5(x-1)(x+1)}{6x(x-1)(x+1)} \\
 &= \frac{20x^2 + 24x^2 + 24x + 5x^2 - 5}{6x(x-1)(x+1)} \\
 &= \frac{49x^2 + 24x - 5}{6x(x-1)(x+1)}
 \end{aligned}$$

$$\begin{aligned}
 38. \quad \frac{\frac{x}{2} - 5}{6 + \frac{3}{x}} = \frac{\frac{x-10}{2}}{\frac{6x+3}{x}} = \frac{x-10}{2} \cdot \frac{x}{6x+3} = \frac{x(x-10)}{6(2x+1)}
 \end{aligned}$$

$$\begin{aligned}
 39. \quad \frac{\frac{20}{x+1}}{\frac{1}{4} - \frac{7}{x+1}} = \frac{\frac{20}{x+1}}{\frac{x+1-28}{4(x+1)}} = \frac{20}{x+1} \cdot \frac{4(x+1)}{x-27} = \frac{80}{x-27}
 \end{aligned}$$

$$\begin{aligned}
 40. \quad \frac{\frac{1}{2x^2-2}}{\frac{2}{x+1} + \frac{x}{x^2-2x-3}} &= \frac{\frac{1}{2(x^2-2)}}{\frac{2(x-3)+x}{(x+1)(x-3)}} \\
 &= \frac{1}{2(x+1)(x-1)} \cdot \frac{(x+1)(x-3)}{3(x-2)} \\
 &= \frac{(x-3)}{6(x-1)(x-2)}
 \end{aligned}$$

$$\begin{aligned}
 41. \quad \frac{\frac{1}{x} - \frac{x}{\frac{1}{x}+1}}{\frac{3}{x}} &= \frac{\frac{1}{x} - \frac{x}{\frac{1+x}{x}}}{\frac{3}{x}} \\
 &= \frac{\frac{1}{x} - \left(\frac{x}{1} \cdot \frac{x}{1+x}\right)}{\frac{3}{x}} \\
 &= \frac{x+1-x^3}{x(1+x)} \cdot \frac{x}{3} \\
 &= \frac{-x^3+x+1}{3(x+1)}
 \end{aligned}$$

$$\begin{aligned}
 42. \quad \frac{\frac{1-x}{x^4}}{\frac{1}{x^2} - \frac{2}{x^2(x+1)}} &= \left(\frac{1-x}{x^4}\right) \div \left[\frac{x+1-2}{x^2(x+1)}\right] \\
 &= \frac{1-x}{x^4} \cdot \frac{-x^2(x+1)}{(-x+1)} = -\frac{x+1}{x^2}
 \end{aligned}$$

$$\begin{aligned}
 43. \quad \frac{\frac{1}{4x+3} - \frac{5}{3(4x+3)}}{\frac{x}{4x+3}} &= \left(\frac{3-5}{3(4x+3)}\right) \div \frac{3x}{3(4x+3)} \\
 &= \frac{-2}{3(4x+3)} \cdot \frac{3(4x+3)}{3x} = -\frac{2}{3x}
 \end{aligned}$$

## Chapter 9 continued

$$44. \frac{\frac{4}{x^2-9} + \frac{2}{x-3}}{\frac{1}{x+3} + \frac{1}{x-3}} = \left[ \frac{4 + 2(x+3)}{(x+3)(x-3)} \right] \div \left[ \frac{x-3+x+3}{(x+3)(x-3)} \right]$$

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

$$= \frac{x+5}{x}$$

$$45. \frac{\frac{1}{x^3+64}}{\frac{5}{x^2-16} - \frac{2}{3x^2+12x}} = \frac{1}{(x+4)(x^2-4x+16)} \div \frac{5}{(x+4)(x-4)} - \frac{2}{3x(x+4)}$$

$$= \frac{1}{(x+4)(x^2-4x+16)} \div \frac{5(3x) - 2(x-4)}{3x(x+4)(x-4)}$$

$$= \frac{1}{(x+4)(x^2-4x+16)} \cdot \frac{3x(x+4)(x-4)}{13x+8}$$

$$= \frac{3x(x-4)}{(13x+8)(x^2-4x+16)}$$

$$46. \frac{\frac{3}{2x^2+6x+18} + \frac{x}{x^3-27}}{\frac{5x}{3x-9} - \frac{3}{x-3}}$$

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

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

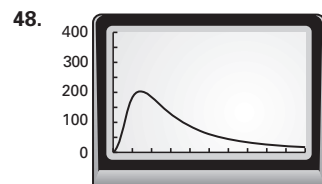
$$= \frac{5x-9}{2(x-3)(x^2+3x+9)} \cdot \frac{3(x-3)}{5x-9}$$

$$= \frac{3}{2(x^2+3x+9)}$$

$$47. M = G - F$$

$$= \frac{7560t^2 + 978,000}{0.00418t^2 + 1} - \frac{-19,600t + 493,000}{-0.0580t + 1}$$

$$\approx \frac{357t^3 + 5500t^2 - 37,100t + 485,000}{(0.00418t^2 + 1)(-0.0580t + 1)}$$

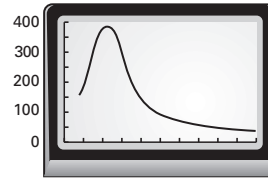


$$49. A = \frac{391(t-1)^2 + 0.112}{0.218(t-1)^4 + 0.991(t-1)^2 + 1} \text{ for } t \geq 1$$

50.

$$A = \frac{391t^2 + 0.112}{0.218t^4 + 0.991t^2 + 1} + \frac{391(t-1)^2 + 0.112}{0.218(t-1)^4 + 0.991(t-1)^2 + 1}$$

for  $t \geq 1$



51. about 1.2 hr after the second dose

$$52. \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = 1 \div \frac{R_2R_3 + R_1R_3 + R_1R_2}{R_1R_2R_3}$$

$$= \frac{R_1R_2R_3}{R_1R_2 + R_2R_3 + R_1R_3}$$

$$53. \frac{(6)(12)(24)}{(6)(12) + (12)(24) + (6)(24)} = \frac{1728}{72 + 288 + 144}$$

$$= \frac{1728}{504} = \frac{24}{7}$$

54. a.

$$\frac{5783 + 1134(1)}{1 + 0.025(1)} - \frac{5783}{1} = \left( \frac{6917}{1.025} - \frac{5783}{1} \right) \frac{1}{5783}$$

$$= \frac{6917 - (1.025)(5783)}{1.025(5783)} \approx 16.7\%$$

b.  $C = \frac{98,942.5}{(0.025t + 1.025)(5783 + 1134t)}$

c. The percent change is getting smaller.

$$55. 2 + \frac{1}{1 + \frac{1}{2}} = 2 + \frac{1}{\frac{3}{2}} = 2 + \frac{2}{3} = \frac{8}{3}$$

$$2 + \frac{1}{1 + \frac{1}{2 + \frac{2}{3}}} = 2 + \frac{1}{1 + \frac{3}{8}} = 2 + \frac{8}{11} = \frac{30}{11}$$

$$2 + \frac{1}{1 + \frac{1}{2 + \frac{2}{3 + \frac{3}{4}}}} = 2 + \frac{1}{1 + \frac{1}{2 + \frac{8}{15}}} = 2 + \frac{1}{1 + \frac{15}{38}}$$

$$= 2 + \frac{38}{53} = \frac{144}{53};$$

—CONTINUED—

## Chapter 9 *continued*

55. —CONTINUED—

$$\begin{aligned}
 2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{3 + \frac{1}{4 + \frac{1}{5}}}}} &= 2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{3 + \frac{5}{8}}}} \\
 &= 2 + \frac{1}{1 + \frac{1}{2 + \frac{16}{29}}} \\
 &= 2 + \frac{1}{1 + \frac{29}{74}} \\
 &= 2 + \frac{74}{103} = \frac{280}{103}; \\
 2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{3 + \frac{1}{4 + \frac{1}{5 + \frac{1}{6}}}}}} &= 2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{3 + \frac{105}{164}}}} \\
 &= 2 + \frac{1}{1 + \frac{1}{2 + \frac{597}{1522}}} \\
 &= 2 + \frac{1522}{2119} = \frac{5760}{2119};
 \end{aligned}$$

56.  $e \approx 2.718$

### 9.5 Mixed Review (p. 567)

57. $\frac{1}{2}x - 7 = 5$ $\frac{1}{2}x = 12$ $x = 24$	58. $6 - \frac{1}{10}x = -1$ $\frac{1}{10}x = 7$ $x = 70$
59. $\frac{3}{4}x + \frac{1}{2} = x - \frac{5}{6}$ $-\frac{1}{4}x = -\frac{4}{3}$ $x = \frac{16}{3}$	60. $\frac{3}{8}x + 4 = -8$ $\frac{3}{8}x = -12$ $x = -32$
61. $-\frac{1}{12}x - 3 = \frac{5}{2}$ $-\frac{1}{12}x = \frac{11}{2}$ $x = -66$	62. $2 = -\frac{4}{3}x + 10$ $\frac{4}{3}x = 8$ $x = 6$

63.  $-5x - \frac{3}{4}x = \frac{51}{2}$   
 $-\frac{23x}{4} = \frac{51}{2}$   
 $x = -\frac{102}{23}$

64.  $2x + \frac{7}{8}x = -23$   
 $\frac{23}{8}x = -23$   
 $x = -8$

65.  $x = 12 + \frac{5}{6}x$   
 $\frac{1}{6}x = 12$   
 $x = 72$

67.  $5x^2 - 8 = 4(x^2 + 3)$   
 $5x^2 - 8 = 4x^2 + 12$   
 $x^2 = 20$   
 $x = \pm 2\sqrt{5}$

66.  $x^2 - 5x - 24 = 0$   
 $(x - 8)(x + 3) = 0$   
 $x = 8, x = -3$

68.  $6x^2 + 13x - 5 = 0$   
 $(2x + 5)(3x - 1) = 0$   
 $x = -\frac{5}{2}, x = \frac{1}{3}$

69.  $3(x - 5)^2 = 27$   
 $(x - 5)^2 = 9$   
 $x - 5 = \pm 3$   
 $x = 8, x = 2$

70.  $2(x + 7)^2 - 1 = 49$   
 $2(x + 7)^2 = 50$   
 $(x + 7)^2 = 25$   
 $x + 7 = \pm 5$   
 $x = -12, x = -2$

71.  $2x(x + 6) = 7 - x$   
 $2x^2 + 12x = 7 - x$   
 $2x^2 + 13x - 7 = 0$   
 $(2x - 1)(x + 7) = 0$   
 $x = \frac{1}{2}, x = -7$

## Lesson 9.6

### 9.6 Guided Practice (p. 571)

- Sample answer:  $\frac{3}{x + 1} = \frac{5x}{x + 8}$
- 3 is extraneous; it makes both fractions undefined.
- Multiply each term on both sides of the equation by the LCD of the terms. Simplify and solve the resulting polynomial equation.
  - cross multiplying to solve a simple rational equation for which each side of the equation is a single rational expression

Multiplying by the LCD can always be used because cross multiplying can only be used if each side of the equation is a single rational expression.

- $\frac{1}{x} = \frac{2}{x^2}$ ; the graph does not intersect at the extraneous solutions.

$$\begin{aligned}
 x^2 &= 2x \\
 x &= 2
 \end{aligned}$$



## Chapter 9 *continued*

$$5. \frac{7}{x} + \frac{3}{4} = \frac{5}{x}$$

$$\frac{2}{x} = -\frac{3}{4}$$

$$8 = -3x$$

$$x = -\frac{8}{3}$$

$$7. 3x + \frac{x}{3} = 5$$

$$\frac{10x}{3} = 5$$

$$10x = 15$$

$$x = \frac{3}{2}$$

$$9. \frac{5}{x-3} = \frac{2x}{x^2-9}$$

$$\frac{5(x+3) - 2x}{x^2-9} = 0$$

$$\frac{5x+15-2x}{(x-3)(x+3)} = 0$$

$$\frac{3(x+5)}{(x-3)(x+3)} = 0$$

$$x = -5$$

$$10. \frac{5x}{x-1} + 5 = \frac{15}{x-1}$$

$$\frac{5x + 5(x-1) - 15}{x-1} = 0$$

$$\frac{5x + 5x - 5 - 15}{x-1} = 0$$

$$\frac{10x - 20}{x-1} = 0$$

$$x = 2$$

$$11. \frac{2x}{x+3} = \frac{3x}{x-3}$$

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

$$-15x = x^2$$

$$x = -15, 0$$

$$13. \frac{2x}{2x+4} = \frac{3x}{x+2}$$

$$\frac{x}{x+2} - \frac{3x}{x+2} = 0$$

$$\frac{-2x}{x+2} = 0$$

$$x = 0$$

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

$$x^2 - 3x + 2 = 6x - 12$$

$$x^2 - 9x + 14 = 0$$

$$(x-7)(x-2) = 0$$

$$x = 7, x = 2$$

$$8. \frac{x}{x-3} = 2 - \frac{2}{x-3}$$

$$\frac{x+2}{x-3} = 2$$

$$x+2 = 2x-6$$

$$x = 8$$

12. no solution

$$14. 0.8 = \frac{12+x}{20+x}$$

$$16 + 0.8x = 12 + x$$

$$4 = 0.2x$$

$$20 = x$$

### 9.6 Practice and Applications (pp. 571–573)

$$15. \frac{2(-1) - 3}{-1 + 3} = \frac{3(-1)}{-1 + 4}$$

$$\frac{-5}{2} \neq -1$$

no

$$17. \frac{4(2) - 3}{2 - 4} + 1 = \frac{2}{2 - 3}$$

$$\frac{5}{-2} + 1 \neq -2$$

no

$$19. \frac{6}{6-3} = \frac{6}{6-3}$$

$$\frac{6}{3} = \frac{6}{3}$$

yes

$$21. \frac{3}{2} + \frac{1}{x} = 2$$

$$\frac{3x+2}{2x} = 2$$

$$3x+2 = 4x$$

$$x = 2$$

$$16. \frac{-1}{2(-1)+1} = \frac{5}{4-(-1)}$$

$$1 = 1$$

yes

$$18. \frac{3(6)}{6-6} = 5 + \frac{18}{6-6}$$

$$\frac{18}{0} = 5 + \frac{18}{0}$$

no

$$20. \frac{2}{2(2+2)} + \frac{3}{2} = \frac{4}{2-2}$$

$$\frac{2}{8} + \frac{3}{2} = \frac{4}{0}$$

no

$$22. \frac{3}{x} + x = 4$$

$$\frac{3+x^2}{x} = 4$$

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

$$(x-3)(x-1) = 0$$

$$x = 3, x = 1$$

$$23. \frac{3}{2x} - \frac{9}{2} = 6x$$

$$\frac{3-9x}{2x} = 6x$$

$$3-9x = 12x^2$$

$$12x^2 + 9x - 3 = 0$$

$$3(4x^2 + 3x - 1) = 0$$

$$3(4x-1)(x+1) = 0$$

$$x = \frac{1}{4}, x = -1$$

$$24. \frac{8}{x+2} + \frac{8}{2} = 5$$

$$\frac{8}{x+2} = 1$$

$$8 = x + 2$$

$$x = 6$$

$$25. \frac{3x}{x+1} + \frac{6}{2x} = \frac{7}{x}$$

$$\frac{3x}{x+1} = \frac{4}{x}$$

$$4x+4 = 3x^2$$

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

$$(3x+2)(x-2) = 0$$

$$x = -\frac{2}{3}, x = 2$$

## Chapter 9 *continued*

$$26. \quad \frac{2}{3x} + \frac{2}{3} = \frac{8}{x+6}$$

$$\frac{2+2x}{3x} = \frac{8}{x+6}$$

$$24x = 2x^2 + 14x + 12$$

$$2(x^2 - 5x + 6) = 0$$

$$(x-3)(x-2) = 0$$

$$x = 3, x = 2$$

$$27. \quad \frac{6x}{x+4} + 4 = \frac{2x+2}{x-1}$$

$$\frac{6x+4x+16}{x+4} = \frac{2(x+1)}{x-1}$$

$$\frac{10x+16}{x+4} = \frac{2(x+1)}{x-1}$$

$$\frac{5x+8}{x+4} = \frac{x+1}{x-1}$$

$$5x^2 + 3x - 8 = x^2 + 5x + 4$$

$$4x^2 - 2x - 12 = 0$$

$$2(2x^2 - x - 6) = 0$$

$$(2x+3)(x-2) = 0$$

$$x = -\frac{3}{2}, x = 2$$

$$28. \quad \frac{x-3}{x-4} + 4 = \frac{3x}{x}$$

$$\frac{x-3}{x-4} = -1$$

$$x-3 = -x+4$$

$$2x = 7$$

$$x = \frac{7}{2}$$

$$29. \quad \frac{7x+1}{2x+5} + 1 = \frac{10x-3}{3x}$$

$$\frac{9x+6}{2x+5} = \frac{10x-3}{3x}$$

$$27x^2 + 18x = 20x^2 + 44x - 15$$

$$7x^2 - 26x + 15 = 0$$

$$(7x-5)(x-3) = 0$$

$$x = \frac{5}{7}, x = 3$$

$$30. \quad \frac{10}{x(x-2)} + \frac{4}{x} = \frac{5}{x-2}$$

$$\frac{10+4x-8}{x(x-2)} = \frac{5x}{x(x-2)}$$

$$2 = x$$

no solution

$$31. \quad \frac{4(x-1)}{x-1} = \frac{2(x-1)}{x+1}$$

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

$$4x^2 - 4 = 2x^2 - 4x + 2$$

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

$$2(x^2 + 2x - 3) = 0$$

$$(x+3)(x-1) = 0$$

$$x = -3$$

$$32. \quad \frac{2(x+7)}{x+4} - 2 = \frac{2x+20}{2x+8}$$

$$\frac{2x+14-2x-8}{x+4} = \frac{x+10}{x+4}$$

$$\frac{6}{x+4} = \frac{x+10}{x+4}$$

$$6 = x + 10$$

$$x = -4$$

no solution

$$33. \quad \frac{3}{4x} = \frac{5}{x+2}$$

$$3(x+2) = 20x$$

$$3x+6 = 20x$$

$$6 = 17x$$

$$x = \frac{6}{17}$$

$$34. \quad \frac{-3}{x+1} = \frac{4}{x-1}$$

$$-3x+3 = 4x+4$$

$$-7x = 1$$

$$x = -\frac{1}{7}$$

$$35. \quad \frac{x}{x^2-8} = \frac{2}{x}$$

$$x^2 = 2x^2 - 16$$

$$0 = x^2 - 16$$

$$0 = (x+4)(x-4)$$

$$x = 4, x = -4$$

$$36. \quad \frac{x}{2x+7} = \frac{x-5}{x-1}$$

$$x^2 - x = 2x^2 - 3x - 35$$

$$x^2 - 2x - 35 = 0$$

$$(x-7)(x+5) = 0$$

$$x = 7, x = -5$$

$$37. \quad \frac{-2}{x-1} = \frac{x-8}{x+1}$$

$$-2x-2 = x^2-9x+8$$

$$x^2-7x+10 = 0$$

$$(x-2)(x-5) = 0$$

$$x = 2, x = 5$$

## Chapter 9 *continued*

$$38. \frac{2(x-2)}{x^2-10x+16} = \frac{2}{x+2}$$

$$x^2 - 4 = x^2 - 10x + 16$$

$$10x = 20$$

$$x = 2$$

$$39. \frac{8(x-1)}{x^2-4} = \frac{4}{x-2}$$

$$2(x-1)(x-2) = x^2 - 4$$

$$2x^2 - 6x + 4 = x^2 - 4$$

$$x^2 - 6x + 8 = 0$$

$$(x-2)(x-4) = 0$$

$$x = 4$$

$$40. \frac{x^2-3}{x+2} = \frac{x-3}{2}$$

$$2x^2 - 6 = x^2 - x - 6$$

$$x^2 + x = 0$$

$$x(x+1) = 0$$

$$x = 0, x = -1$$

$$41. \frac{-1}{x-3} = \frac{x-4}{x^2-27}$$

$$-x^2 + 27 = x^2 - 7x + 12$$

$$2x^2 - 7x - 15 = 0$$

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

$$x = -\frac{3}{2}, x = 5$$

$$42. \frac{x-2}{x+3} = \frac{3}{x}$$

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

$$x^2 - 5x - 6 = 0$$

$$(x-6)(x+1) = 0$$

$$x = 6, x = -1$$

$$43. \frac{3}{x+2} = \frac{6}{x-1}$$

$$x-1 = 2x+4$$

$$-5 = x$$

$$44. \frac{3x}{x+1} = \frac{12}{x^2-1} + 2$$

$$\frac{-3x(x-1) + 12 + 2(x^2-1)}{x^2-1} = 0$$

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

$$-x^2 + 3x + 10 = 0$$

$$x^2 - 3x - 10 = 0$$

$$(x+2)(x-5) = 0$$

$$x = -2, x = 5$$

$$45. \frac{3x+6}{x^2-4} = \frac{x+1}{x-2}$$

$$3x+6 = (x+1)(x+2)$$

$$3x+6 = x^2+3x+2$$

$$x^2 = 4$$

$$x = \pm 2$$

no solution

$$46. \frac{x-4}{x} = \frac{6}{x^2-3x}$$

$$(x-4)(x-3) = 6$$

$$x^2 - 7x + 6 = 0$$

$$(x-6)(x-1) = 0$$

$$x = 6, x = 1$$

$$47. \frac{2x}{4-x} = \frac{x^2}{x-4}$$

$$-2x = x^2$$

$$-2 = x$$

$$x = 0$$

$$48. \frac{2x}{x-3} = \frac{3x}{x^2-9} + 2$$

$$2x(x+3) = 3x + 2(x^2-9)$$

$$2x^2 + 6x = 3x + 2x^2 - 18$$

$$3x = -18$$

$$x = -6$$

$$49. \frac{x}{2x-6} = \frac{2}{x-4}$$

$$x(x-4) = 2(2x-6)$$

$$x^2 - 4x = 4x - 12$$

$$x^2 - 8x + 12 = 0$$

$$(x-6)(x-2) = 0$$

$$x = 6, x = 2$$

$$50. \frac{2}{x+1} + \frac{x}{x-1} = \frac{2}{x^2-1}$$

$$2(x-1) + x(x+1) = 2$$

$$2x - 2 + x^2 + x = 2$$

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

$$(x+4)(x-1) = 0$$

$$x = -4$$

51. Always true; when you solve by crossmultiplying, you get  $x = 1$  or  $x = a$  and  $x = a$  makes both fractions undefined.

52. Sometimes true; when  $a = x$  the equation has no solution.

53. Always true; when you multiply each side of the equation by  $x^2 - a^2$  you get  $x = a$ , making the fraction undefined.

## Chapter 9 *continued*

54.  $\frac{4763}{7989} = \frac{326 + x}{575 + x}$   
 $2,738,725 + 4763x = 2,604,414 + 7989x$   
 $134,311 = 3226x$   
 $42 \approx x$

55.  $8 = \frac{200 + 5.7x}{x}$   
 $8x = 200 + 5.7x$   
 $2.3x = 200$   
 $x \approx 87$  cards

56.  $0.88 = \frac{5}{12 + x} + \frac{5}{12 - x}$   
 $0.88(144 - x^2) = 60 - 5x + 60 + 5x$   
 $126.72 - 0.88x^2 = 120$   
 $0.88x^2 = 6.72$   
 $x^2 = 7.64$   
 $x = 2.76$  mi/h

57.  $15 = \frac{26.6d}{d + 0.0017}$   
 $15d + 0.0255 = 26.6d$   
 $0.255 = 11.6d$   
 $0.0022$  flies per  $\text{cm}^3 \approx d$   
 $2,198$  flies per  $\text{m}^3 = d$

58.  $\$412.50 = \frac{9000 \times 1.10}{F}$   
 $412.50 F = 9900$   
 $F = 24$  mi/gallon

59.  $C = \frac{9000 \times 1.10}{25}$   
 $C = 396$   
 $\$412.50 - \$396 = \$16.50$

60. A 61. C

62.  $12 = \frac{0.5(16) + x(10)}{0.5 + x}$   
 $6 + 12x = 8 + 10x$   
 $2x = 2$   
 $x = 1$  liter

### 9.6 Mixed Review (p. 573)

63.  $y = x + 3$  parallel = 1 perpendicular =  $-1$   
 64.  $y = 3x - 4$  parallel = 3 perpendicular =  $-\frac{1}{3}$

65.  $y = -\frac{2}{3}x + 15$  parallel =  $-\frac{2}{3}$  perpendicular =  $\frac{3}{2}$   
 66.  $y + 3 = 3x + 2$  parallel = 3 perpendicular =  $-\frac{1}{3}$

67.  $2y - x = 7$  parallel =  $\frac{1}{2}$  perpendicular =  $-2$   
 68.  $4x - 3y = 17$  parallel =  $\frac{4}{3}$  perpendicular =  $-\frac{3}{4}$

69.  $\sqrt{48} = 4\sqrt{3}$  70.  $\sqrt{18} = 3\sqrt{2}$  71.  $\sqrt{108} = 6\sqrt{3}$

72.  $\sqrt{432} = 12\sqrt{3}$  73.  $\sqrt{6} \cdot \sqrt{45} = 3\sqrt{30}$

74.  $\sqrt{\frac{16}{72}} = \frac{4}{6\sqrt{2}} = \frac{\sqrt{2}}{3}$  75.  $\sqrt{75} \cdot \sqrt{3} = \sqrt{225} = 15$

76.  $\sqrt{\frac{8}{49}} = \frac{2\sqrt{2}}{7}$  77. pH =  $-\log[1.6 \times 10^{-7}] \approx 6.796$

### Quiz 2 (p. 574)

1.  $\frac{3x^3y}{2xy^2} \cdot \frac{10x^4y^2}{9x} = \frac{30x^7y^3}{18x^2y^2} = \frac{5x^5y}{3}$

2.  $\frac{x^2 - 3x - 40}{5x} \div (x + 5) = \frac{(x - 8)(x + 5)}{5x} \cdot \frac{1}{x + 5}$   
 $= \frac{x - 8}{5x}$

3.  $\frac{18x}{x^2 - 5x - 36} + \frac{2x}{x + 4}$   
 $= \frac{18x}{(x + 4)(x - 9)} + \frac{2x(x - 9)}{(x + 4)(x - 9)}$   
 $= \frac{18x + 2x^2 - 18x}{(x + 4)(x - 9)}$   
 $= \frac{2x^2}{(x + 4)(x - 9)}$

4.  $\frac{8x^2}{25x^2 - 36} - \frac{1}{10x + 12}$   
 $= \frac{16x^2}{2(5x - 6)(5x + 6)} - \frac{5x - 6}{2(5x - 6)(5x + 6)}$   
 $= \frac{16x^2 - 5x + 6}{2(5x - 6)(5x + 6)}$

5.  $\frac{\frac{8}{x} + 11}{\frac{1}{6x} - 1} = \left(\frac{8 + 11x}{x}\right) \div \left(\frac{1 - 6x}{6x}\right)$   
 $= \frac{8 + 11x}{x} \cdot \frac{6x}{1 - 6x} = \frac{6(8 + 11x)}{1 - 6x}$

## Chapter 9 continued

$$6. \frac{36 - \frac{1}{x^2}}{\frac{1}{6x^2} - 6} = \left( \frac{36x^2 - 1}{x^2} \right) \div \left( \frac{1 - 36x^2}{6x^2} \right)$$

$$= \frac{36x^2 - 1}{x^2} \cdot \frac{-6x^2}{36x^2 - 1} = -6$$

$$7. \frac{\frac{2}{x^2 - 1} - \frac{1}{x + 1}}{\frac{1}{12x^2 - 3}} = \left( \frac{2 - x + 1}{x^2 - 1} \right) \div \left( \frac{1}{12x^2 - 3} \right)$$

$$= \frac{3 - x}{x^2 - 1} \cdot \frac{12x^2 - 3}{1}$$

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

$$8. \frac{\frac{1}{x - 5} - \frac{x}{x^2 - 25}}{\frac{5}{2x}} = \left( \frac{x + 5 - x}{x^2 - 25} \right) \div \frac{5}{2x}$$

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

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

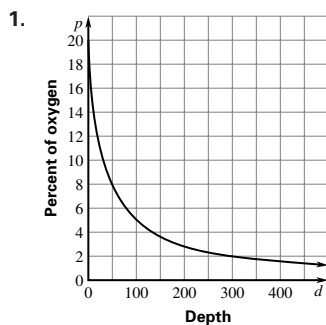
$$9. 4.50 = \frac{10 + 4x}{x}$$

$$4.50x = 10 + 4x$$

$$0.50x = 10$$

$$x = 20 \text{ dozen}$$

### Math and History (p. 574)



2. 99 ft    3. 0%

### Chapter 9 Review (pp. 576–578)

1.  $y = \frac{5}{x}$       2.  $y = \frac{10}{x}$       3.  $y = \frac{2}{x}$

$y = \frac{5}{2}$        $y = 5$        $y = 1$

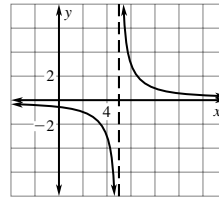
4.  $y = -\frac{4}{x}$       5.  $z = \frac{1}{3}xy$       6.  $z = -\frac{1}{8}xy$

$y = -2$        $z = -10$        $z = \frac{15}{4}$

7.  $z = 3xy$

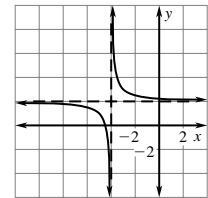
$z = -90$

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



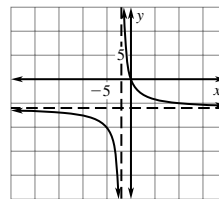
domain: all real numbers except 5; range: all real numbers except 0

9.  $y = \frac{1}{x + 4} + 2$



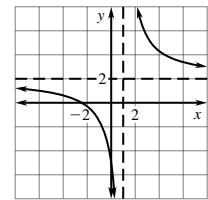
domain: all real numbers except -4; range: all real numbers except 2

10.  $y = \frac{-6x}{x + 2}$



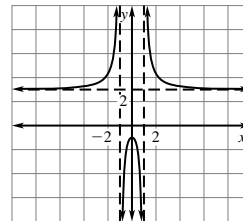
domain: all real numbers except -2; range: all real numbers except -6

11.  $y = \frac{2x + 5}{x - 1}$

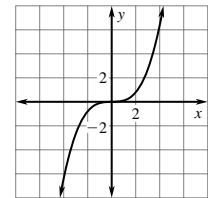


domain: all real numbers except 1; range: all real numbers except 2

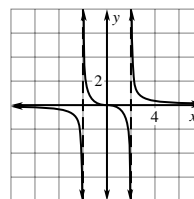
12.  $y = \frac{3x^2 + 1}{x^2 - 1}$



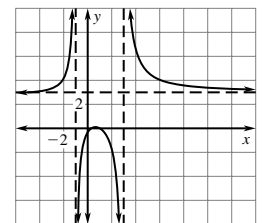
13.  $y = \frac{x^3}{10}$



14.  $y = \frac{x}{x^2 - 4}$



15.  $y = \frac{3x^2 - 4x + 1}{x^2 - 2x - 3}$



16.  $\frac{x^2 - 3x}{4x^2 - 8x} \cdot (4x^2 - 16) = \frac{x(x - 3)}{4x(x - 2)} \cdot 4(x^2 - 4)$

$$= \frac{x(x - 3)}{4x(x - 2)} \cdot 4(x - 2)(x + 2)$$

$$= (x - 3)(x + 2)$$

## Chapter 9 continued

$$17. 5x \div \frac{1}{x-6} \cdot \frac{x^2-9}{x} = 5x \cdot \frac{x-6}{1} \cdot \frac{(x-3)(x+3)}{x}$$

$$= 5(x-6)(x-3)(x+3)$$

$$18. \frac{x^2-2x-3}{x+1} \div \frac{x^2+x-12}{x^2} - 1$$

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

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

$$= \frac{x^2-x-4}{x+4}$$

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

$$20. \frac{x+5}{x-5} - \frac{3}{x+5} = \frac{x^2+10x+25-3x+15}{(x-5)(x+5)}$$

$$= \frac{x^2+7x+40}{(x-5)(x+5)}$$

$$21. \frac{x-2}{5x(x-1)} + \frac{1}{x-1} - \frac{3x+2}{x^2+4x-5}$$

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

$$= \frac{x^2+3x-10+5x^2+25x-15x^2-10x}{5x(x-1)(x+5)}$$

$$= \frac{-9x^2+18x-10}{5x(x-1)(x+5)}$$

$$22. \frac{x+3}{1+\frac{x}{3}} = \left(\frac{x+3}{6}\right) \div \left(1+\frac{x}{3}\right) = \left(\frac{x+3}{6}\right) \cdot \left(\frac{3}{x+3}\right) = \frac{1}{2}$$

$$23. \frac{\frac{x}{2}-4}{9+\frac{2}{x}} = \left(\frac{x-8}{2}\right) \div \left(\frac{9x+2}{x}\right) = \left(\frac{x-8}{2}\right) \cdot \left(\frac{x}{9x+2}\right)$$

$$= \frac{x(x-8)}{2(9x+2)}$$

$$24. \frac{\frac{1}{x+1} + \frac{1}{x-1}}{\frac{x}{x+1}} = \left[\frac{x-1+x+1}{(x+1)(x-1)}\right] \div \left(\frac{x}{x+1}\right)$$

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

$$25. \frac{\frac{4}{5-x}}{\frac{2}{5-x} + \frac{1}{3x-15}} = \left(\frac{4}{5-x}\right) \div \left(\frac{-6+1}{-3(5-x)}\right)$$

$$= \left(\frac{4}{5-x}\right) \cdot \left(\frac{-3(5-x)}{-5}\right) = \frac{12}{5}$$

$$26. \frac{x}{x-1} = \frac{2x+10}{x+11}$$

$$x^2+11x = 2x^2+8x-10$$

$$x^2-3x-10 = 0$$

$$(x+2)(x-5) = 0$$

$$x = -2, x = 5$$

$$27. \frac{x+3}{x} - 1 = \frac{1}{x-1}$$

$$\frac{3}{x} = \frac{1}{x-1}$$

$$3x-3 = x$$

$$2x = 3$$

$$x = \frac{3}{2}$$

$$29. \frac{3x+2}{x+1} = 2 - \frac{2x+3}{x+1}$$

$$\frac{5x+5}{x+1} = 2$$

$$5x+5 = 2x+2$$

$$3x = -3$$

$$x = -1$$

no solution

$$31. 1 + \frac{3}{x-3} = \frac{4}{x^2-9}$$

$$\frac{x-3+3}{x-3} = \frac{4}{x^2-9}$$

$$\frac{x}{x-3} = \frac{4}{x^2-9}$$

$$\frac{x(x+3)-4}{x^2-9} = 0$$

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

$$(x+4)(x-1) = 0$$

$$x = -4, x = 1$$

### Chapter 9 Test (p. 579)

$$1. y = -\frac{36}{x}$$

$$y = -\frac{36}{3} = -12$$

$$3. y = \frac{8}{x}$$

$$y = \frac{8}{3}$$

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

$$y = \frac{5}{2 \cdot 3} = \frac{5}{6}$$

$$4. y = -\frac{6}{x}$$

$$y = -\frac{6}{3} = -2$$

## Chapter 9 continued

$$5. z = \frac{1}{10}xy$$

$$z = \frac{1}{10}(-2)(4)$$

$$z = \frac{-4}{5}$$

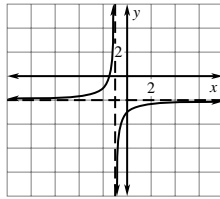
$$7. z = 10xy$$

$$z = 10(-2)(4) = -80$$

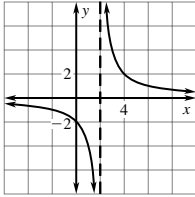
$$6. z = -3xy$$

$$z = -3(-2)(4) = 24$$

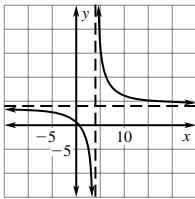
$$8. y = \frac{-1}{x+1} - 2$$



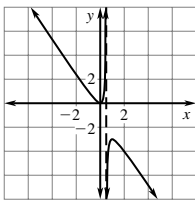
$$9. y = \frac{4}{x-2}$$



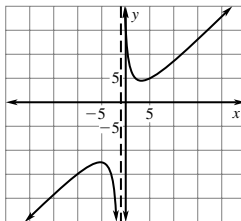
$$11. y = \frac{4x-3}{x-4}$$



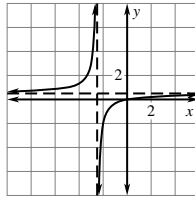
$$13. y = \frac{-3x^2}{2x-1}$$



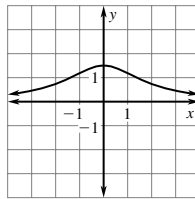
$$15. y = \frac{x^2 - 2x + 15}{x+1}$$



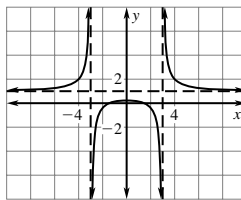
$$10. y = \frac{x}{2x+5}$$



$$12. y = \frac{6}{x^2+4}$$



$$14. y = \frac{x^2-2}{x^2-9}$$



$$16. \frac{x^2-4}{x+3} \cdot \frac{x^2+4x+3}{2x-4} = \frac{(x-2)(x+2)(x+1)(x+3)}{2(x+3)(x-2)} = \frac{(x+1)(x+2)}{2}$$

$$17. \frac{4x-8}{x^2-3x+2} \div \frac{3x-6}{x-1} = \frac{4(x-2)}{(x-1)(x-2)} \cdot \frac{x-1}{3(x-2)} = \frac{4}{3(x-2)}$$

$$18. \frac{x+4}{x^2-25} \cdot (x^2+3x-10) = \frac{(x+4)(x+5)(x-2)}{(x+5)(x-5)} = \frac{(x+4)(x-2)}{x-5}$$

$$19. \frac{5}{6x} + \frac{7}{18x} = \frac{15+7}{18x} = \frac{22}{18x} = \frac{11}{9x}$$

$$20. \frac{x-1}{x-2} - \frac{x-4}{x+1} = \frac{(x-1)(x+1) - (x-4)(x-2)}{(x+1)(x-2)} = \frac{x^2-1-x^2+6x-8}{(x+1)(x-2)} = \frac{6x-9}{(x+1)(x-2)} = \frac{3(2x-3)}{(x+1)(x-2)}$$

$$21. \frac{3x}{x^2-10x+21} + \frac{5}{x-3} = \frac{3x+5(x-7)}{(x-3)(x-7)} = \frac{3x+5x-35}{(x-3)(x-7)} = \frac{8x-35}{(x-3)(x-7)}$$

$$22. \frac{1+\frac{3}{x}}{2-\frac{5}{x^2}} = \left(1+\frac{3}{x}\right) \div \left(2-\frac{5}{x^2}\right) = \left(\frac{x+3}{x}\right) \div \left(\frac{2x^2-5}{x^2}\right) = \left(\frac{x+3}{x}\right) \left(\frac{x^2}{2x^2-5}\right) = \frac{x(x+3)}{2x^2-5}$$

$$23. \frac{\frac{4+x}{10}}{\frac{x^2-16}{8}} = \left(\frac{4+x}{10}\right) \div \left[\frac{(x-4)(x+4)}{8}\right] = \left(\frac{4+x}{10}\right) \left[\frac{8}{(x-4)(x+4)}\right] = \frac{4}{5(x-4)}$$

$$24. \frac{\frac{2}{x-1}+5}{\frac{x}{3}} = \left[\frac{2+5(x-1)}{x-1}\right] \div \frac{x}{3} = \left(\frac{5x-3}{x-1}\right) \left(\frac{3}{x}\right) = \frac{3(5x-3)}{x(x-1)}$$

## Chapter 9 continued

$$25. \frac{36}{\frac{1}{x} + \frac{7}{2x}} = 36 \div \left(\frac{2+7}{2x}\right) = 36 \cdot \frac{2x}{9} = 8x$$

$$26. \frac{9}{x} + \frac{11}{5} = \frac{31}{x}$$

$$\frac{11}{5} = \frac{22}{x}$$

$$11x = 110$$

$$x = 10$$

$$27. \frac{-15}{x} = \frac{x+16}{4}$$

$$-60 = x^2 + 16x$$

$$x^2 + 16x + 60 = 0$$

$$(x+6)(x+10) = 0$$

$$x = -6, x = -10$$

$$28. \frac{8}{x+3} = \frac{5}{x-3}$$

$$8x - 24 = 5x + 15$$

$$3x = 39$$

$$x = 13$$

$$29. \frac{4x}{x+3} = \frac{37}{x^2-9} - 3$$

$$4x(x-3) = 37 - 3(x^2-9)$$

$$4x^2 - 12x = 37 - 3x^2 + 27$$

$$7x^2 - 12x - 64 = 0$$

$$(7x+16)(x-4) = 0$$

$$x = -\frac{16}{7}, x = 4$$

$$30. d = \frac{840}{112} = 7.5 \text{ ft}$$

$$31. \frac{\text{Vol. of cube}}{\text{Vol. of sphere}} = \frac{(2r)^3}{\left(\frac{4}{3}\pi r^3\right)} = 8r^3 \cdot \frac{3}{4\pi r^3} = \frac{6}{\pi}$$

$$32. 1.79 = \frac{500 + 1.25x}{x}$$

$$1.79x = 500 + 1.25x$$

$$0.54x = 500$$

$$x \approx 926 \text{ lb}$$

### Chapter 9 Standardized Test (pp. 580–581)

1. A 2. C 3. B 4. A

$$5. \frac{-10}{x-9} = \frac{x}{2}$$

6. A

$$-20 = x^2 - 9x$$

$$x^2 - 9x + 20 = 0$$

$$(x-4)(x-5) = 0$$

$$x = 4, x = 5$$

E

$$7. \frac{8x-3}{x^2+2x-35} - \frac{7}{x^2-25}$$

$$= \frac{8x-3}{(x+7)(x-5)} - \frac{7}{(x-5)(x+5)}$$

$$= \frac{8x^2+37x-15-7x-49}{(x+7)(x-5)(x+5)}$$

$$= \frac{8x^2+30x-64}{(x+7)(x-5)(x+5)}$$

$$= \frac{2(4x^2+15x-32)}{(x+7)(x-5)(x+5)}$$

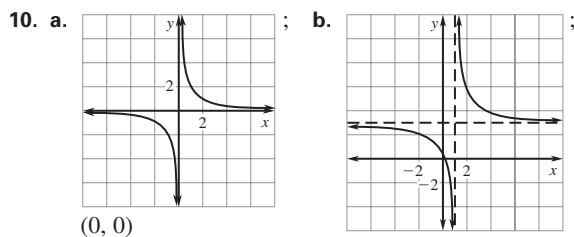
D

$$8. \frac{\frac{10}{x+1}}{\frac{1}{2} + \frac{3}{x+1}} = \left(\frac{10}{x+1}\right) \div \left[\frac{x+1+6}{2(x+1)}\right]$$

$$= \frac{10}{x+1} \cdot \frac{2(x+1)}{x+7} = \frac{20}{x+7}$$

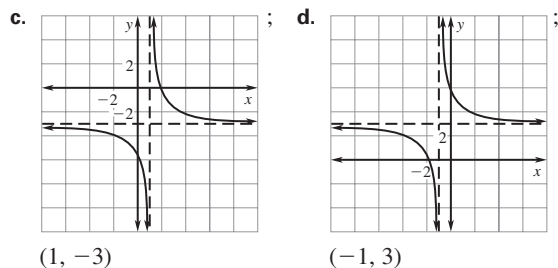
B

9. B



(0, 0)

(1, 3)



(1, -3)

(-1, 3)

e. (-1, -3) f. The asymptotes will intersect at (h, k).

$$11. a. h = 6r, V = 6\pi r^3$$

$$b. \frac{\text{Vol. of balls}}{\text{Vol. of can}} = \frac{3\left(\frac{4}{3}\pi r^3\right)}{6\pi r^3} = \frac{4}{6} = \frac{2}{3}$$

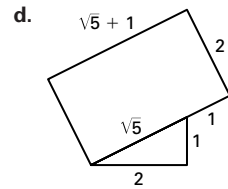
c. *Sample answer:* A cylinder is a fairly efficient way to package tennis balls. Only  $\frac{1}{3}$  of the space inside the cylinder is wasted.



## Chapter 9 continued

12. a.  $\frac{\frac{l}{w} + 1}{\frac{l}{w}}$   
 c.  $\frac{1 + \sqrt{5}}{2} \approx 1.62$

b.  $g = \frac{g+1}{g}$   
 $g^2 - g - 1 = 0$



### Cumulative Practice Chs. 1–9 (pp. 582–583)

1.  $6x - 2y = 7$   
 $2y = 6x - 7$   
 $y = \frac{6x - 7}{2}$

2.  $-\frac{3}{4}x - y = 9$   
 $y = -\frac{3}{4}x - 9$

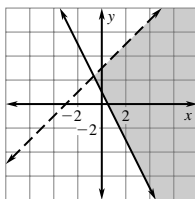
3.  $\frac{1}{3}x + \frac{2}{5}y = 10$   
 $\frac{2}{5}y = 10 - \frac{1}{3}x$   
 $y = 25 - \frac{5}{6}x$

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

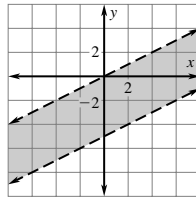
5.  $m_1 = \frac{1-1}{2+6} = 0$   
 $m_2 = \frac{-3+3}{0+2} = 0$   
 parallel

6.  $m_1 = \frac{1+1}{-1-5} = \frac{2}{-6} = -\frac{1}{3}$   
 $m_2 = \frac{5-2}{2-3} = \frac{3}{-1} = -3$   
 neither

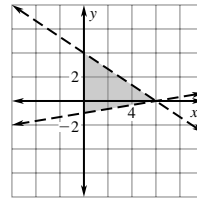
7.  $y < x + 3$   
 $y \geq -2x + 1$



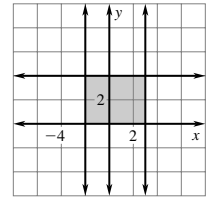
8.  $y < \frac{1}{2}x$   
 $y + 5 > \frac{1}{2}x$



9.  $x \geq 0$   
 $2x + 3y < 12$   
 $x - 6y < 6$



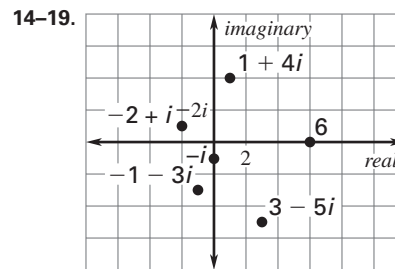
10.  $x \geq -2$   
 $x \leq 3$   
 $y \geq 0$   
 $y \leq 4$



11.  $\begin{bmatrix} 10 & 3 \\ -6 & -1 \end{bmatrix} - \begin{bmatrix} -2 & 5 \\ 6 & -3 \end{bmatrix} = \begin{bmatrix} 12 & -2 \\ -12 & 2 \end{bmatrix}$

12.  $3 \begin{bmatrix} 1 & 0 & 6 \\ -3 & 5 & -2 \\ 2 & 8 & -1 \end{bmatrix} = \begin{bmatrix} 3 & 0 & 18 \\ -9 & 15 & -6 \\ 6 & 24 & -3 \end{bmatrix}$

13.  $\begin{bmatrix} 1 & -1 & -2 \\ 4 & 3 & -5 \end{bmatrix} \begin{bmatrix} 0 & 4 \\ 4 & 8 \\ -1 & 2 \end{bmatrix} = \begin{bmatrix} -2 & -8 \\ 17 & 30 \end{bmatrix}$



14.  $\sqrt{1^2 + (4i)^2} = \sqrt{17}$     15.  $\sqrt{(-2)^2 + (i)^2} = \sqrt{5}$

16.  $\sqrt{(-i)^2} = 1$     17.  $\sqrt{6^2} = 6$

18.  $\sqrt{(-1)^2 + (-3i)^2} = \sqrt{10}$

19.  $\sqrt{(3)^2 + (-5i)^2} = \sqrt{34}$

20.  $f(x) = x^3 + 2x^2 - 11x - 12$   
 $0 = (x + 1)(x^2 + x - 12)$   
 $0 = (x + 1)(x + 4)(x - 3)$   
 $x = -1, x = -4, x = 3$

21.  $f(x) = x^3 - 5x^2 + 5x - 25$   
 $0 = x^2(x - 5) + 5(x - 5)$   
 $0 = (x^2 + 5)(x - 5)$   
 $x = 5, x = \sqrt{5}i, x = -\sqrt{5}i$

22.  $f(x) = x^4 - 81$   
 $0 = (x^2 - 9)(x^2 + 9)$   
 $0 = (x - 3)(x + 3)(x^2 + 9)$   
 $x = 3, x = -3, x = -3i, x = 3i$

23.  $\frac{3x^5}{5y} \cdot \frac{xy}{2x^2} = \frac{3x^4}{10}$     24.  $(-6x^{-2}y)^{-2} = \frac{x^4}{36y^2}$

## Chapter 9 *continued*

25.  $\sqrt[4]{16a^4b^5c} = 2ab\sqrt[4]{bc}$

26.  $(9x^6)^{3/2} = (\sqrt{9x^6})^3 = (3x^3)^3 = 27x^9$

27.  $\left(\frac{1}{2}e^{-2}\right)^3 = \frac{1}{8e^6}$     28.  $\frac{100e^{6x}}{24e^{4x}} = \frac{25e^{2x}}{6}$     29.  $\sqrt[5]{64} = 2$

30.  $-(100^{3/2}) = -1000$     31.  $125^{-1/3} = \frac{1}{5}$

32.  $\log_2 \frac{1}{32} = -5$     33.  $\log_7 \sqrt{7} = \frac{1}{2}$     34.  $\log 0.1 = -1$

35.  $f - g = 2x - 7 - x^2 + 20 = -x^2 + 2x + 13$   
domain: all real numbers

36.  $f \cdot g = (3x^{1/4})(-x^{5/4}) = -3x^{3/2}$   
domain:  $x \geq 0$

37.  $f(g(x)) = f(-2x^2 - 5) = -2x^2 - 5 - 10 = -2x^2 - 15$   
domain: all real numbers

38.  $g(f(x)) = g(x + 6) = (x + 6)^2 - 7(x + 6) + 3$   
 $= x^2 + 12x + 36 - 7x - 42 + 3$   
 $= x^2 + 5x - 3$   
domain: all real numbers

39.  $y = \frac{1}{2}x - 6$     40.  $y = x^2 + 1$   
 $x = \frac{1}{2}y - 6$      $x = y^2 + 1$   
 $x + 6 = \frac{1}{2}y$      $x - 1 = y^2$   
 $2x + 12 = y$      $\pm\sqrt{x-1} = y$

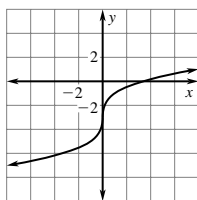
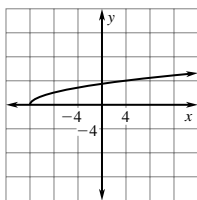
41.  $y = \log_5 x$     42.  $y = \ln 3x$   
 $x = \log_5 y$      $x = \ln 3y$   
 $y = 5^x$      $e^x = e^{\ln 3y}$   
 $e^x = 3y$   
 $\frac{e^x}{3} = y$

43.  $\log 3 + 2 \log x + 3 \log_3 y = \log 3 + \log x^2 + \log y^3$   
 $= \log(3x^2y^3)$

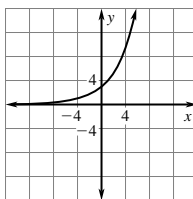
44.  $\log_7 4 + \log_7 y - 2 \log_7 3 = \log_7 (4y) - \log_7 9 = \log_7 \left(\frac{4y}{9}\right)$

45.  $2(\ln x + \ln y) = 2 \ln x + 2 \ln y = \ln x^2 + \ln y^2 = \ln(x^2y^2)$

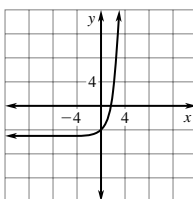
46.  $y = \sqrt{x + 12}$     47.  $y = 2x^{1/3} - 3$



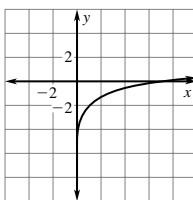
48.  $y = 3\left(\frac{4}{3}\right)^x$



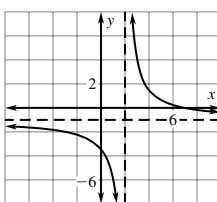
50.  $y = e^x - 5$



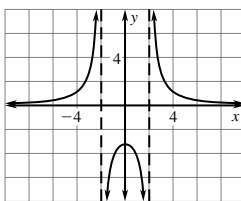
52.  $y = \ln x - 2$



54.  $y = \frac{5}{x-2} - 1$

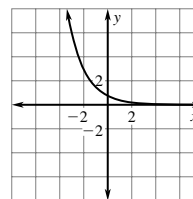


56.  $y = \frac{13}{x^2 - 4}$

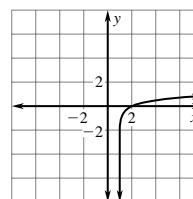


58.  $2\sqrt{x+5} = 18$   
 $\sqrt{x+5} = 9$   
 $x+5 = 81$   
 $x = 76$

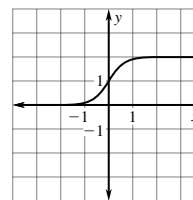
49.  $y = 3\left(\frac{1}{2}\right)^{x+2}$



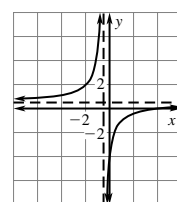
51.  $y = \log(x - 1)$



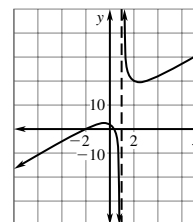
53.  $y = \frac{2}{1 + e^{-3x}}$



55.  $y = \frac{x-4}{2x+1}$



57.  $y = \frac{3x^2 + 5x - 2}{x - 1}$



59.  $\frac{1}{8}(x-6)^{3/2} = 1$   
 $(x-6)^{3/2} = 8$   
 $x-6 = 4$   
 $x = 10$

## Chapter 9 *continued*

60.  $2^{5x} = 8^{x+6}$   
 $2^{5x} = 2^{3(x+6)}$   
 $5x = 3x + 18$   
 $2x = 18$   
 $x = 9$

61.  $4 \log_3(-2x) = 10$   
 $\log_3(-2x)^4 = 10$   
 $\log_3 16x^4 = 10$   
 $16x^4 = 59,049$   
 $x^4 = \frac{59,049}{16}$   
 $x = \pm \frac{9\sqrt{3}}{2}$

62.  $2 \ln x + 5 = 7$   
 $2 \ln x = 2$   
 $\ln x = 1$   
 $x = e$

63.  $\frac{5}{1 + 2e^{-x}} = 4$   
 $5 = 4 + 8e^{-x}$   
 $1 = 8e^{-x}$   
 $\frac{1}{8} = e^{-x}$   
 $\ln \frac{1}{8} = -x$   
 $-\ln \frac{1}{8} = x$

64.  $\frac{5}{2x-3} = \frac{2x}{x+4}$   
 $5x + 20 = 4x^2 - 6x$   
 $4x^2 - 11x - 20 = 0$   
 $(4x + 5)(x - 4) = 0$   
 $x = -\frac{5}{4}, x = 4$

65.  $\frac{1}{x-2} - \frac{4}{x^2-4} = 5$   
 $(x+2) - 4 = 5(x^2-4)$   
 $x+2-4 = 5x^2-20$   
 $5x^2-x-18 = 0$   
 $(5x+9)(x-2) = 0$   
 $x = -\frac{9}{5}$

66.  $y = 0.894(2.236)^x$     67.  $y = \frac{5}{32}(2)^x$     68.  $y = 2(\sqrt{2})^x$

69.  $y = 0.759(1.737)^x$     70.  $y = x^2$     71.  $y = 1.651x^{0.861}$

72.  $y = 0.0204x^{2.807}$     73.  $y = 1.704x^{0.231}$

74.  $\frac{3x^2y}{x-2} \cdot \frac{x^2+x-6}{3x-6} \div (x^2-4)$   
 $= \left( \frac{3x^2y}{x-2} \right) \left[ \frac{(x+3)(x-2)}{3(x-2)} \right] \left[ \frac{1}{(x+2)(x-2)} \right]$   
 $= \frac{x^2y(x+3)}{(x+2)(x-2)^2}$

75.  $\frac{6x}{3x+1} + \frac{9}{2x} - \frac{x+1}{x-1}$   
 $= \frac{(6x)(2x)(x-1) + 9(3x+1)(x-1)(x+1)(2x)(3x+1)}{2x(3x+1)(x-1)}$   
 $= \frac{12x^3 - 12x^2 + 27x^2 - 18x - 9 - 6x^3 - 8x^2 - 2x}{2x(3x+1)(x-1)}$   
 $= \frac{6x^3 + 7x^2 - 20x - 9}{2x(3x+1)(x-1)}$

76.  $|C_m - 21| \leq \frac{1}{4}; |C_e - 28\frac{1}{8}| \leq \frac{3}{8}$

77.  $h = -16t^2 + 200$   
 $0 = -16t^2 + 200$   
 $16t^2 = 200$   
 $t^2 = \frac{25}{2}$   
 $t \approx 3.5$

about 3.5 sec

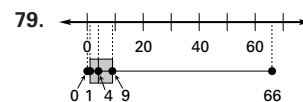
78. mean =  $\frac{208}{23} = 9.04$

median = 4

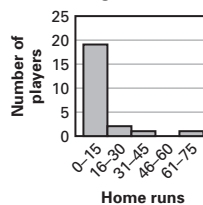
mode = 0

range = 66

$\sigma = 14.48$



80. **Chicago Cubs**



Intervals	Freq.
0-9	18
10-19	2
20-29	1
30-39	1
40-49	0
50-59	0
60-69	1

81.  $f = \frac{kq_1q_2}{r^2}$

82.  $f = \frac{8,987,760,000(2)(3)}{4} = 13,481,640,000$  newtons