Solutions Key

Rational and Radical Functions

ARE YOU READY? PAGE 565

1. D

2. A

3. B

4. F

5. C

6. $\frac{x^{11}y^5}{x^4y^7}$

$x^{11-4}y^{5-7}$

x^7y^{-2}

$\frac{x^7}{y^2}$

7. $\left(\frac{3x^2y}{z}\right)^4$

$\frac{(3x^2y)^4}{z^4}$

$\frac{81x^8y^4}{z^4}$

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

$x^{3(-2)}$

x^{-6}

$\frac{1}{x^6}$

9. $(3x^3y)(6xy^5)$

$(3 \cdot 6)(x^3y \cdot xy^5)$

$18x^4y^6$

10. $(2x^{-4})^3$

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

$8x^{-12}$

$\frac{8}{x^{12}}$

11. $12x^0$

$12(1)$

12

12. $5x^2 + 6x + 6$

13. $-7x + 12$

14. $4x^2 - 3x$

15. $3a^2 = 3 \cdot a \cdot a$

$12a = 2 \cdot 2 \cdot 3 \cdot a$

The GCF of $3a^2$ and $12a$ is $3a$.

16. $c^2d = c \cdot c \cdot d$

$cd^2 = c \cdot d \cdot d$

The GCF of c^2d and cd^2 is cd.

17. $16x^4 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot x \cdot x \cdot x \cdot x$

$40x^3 = 2 \cdot 2 \cdot 2 \cdot 5 \cdot x \cdot x \cdot x$

The GCF of $16x^4$ and $40x^3$ is $8x^3$.

18. $(x - 5)(x + 1)$

19. $(x - 4)(x + 6)$

20. $(x + 4)(x + 8)$

21. $(x + 3)(x + 6)$

22. $(x - 3)^2$

23. $(x - 10)(x + 2)$

24. $5x^2 = 45$

$x^2 = 9$

$x = \pm\sqrt{9} = \pm 3$

25. $4x^2 - 7 = 93$

$4x^2 = 100$

$x^2 = 25$

$x = \pm\sqrt{25} = \pm 5$

26. $2(x - 2)^2 = 32$

$(x - 2)^2 = 16$

$x - 2 = \pm\sqrt{16}$

$x = 2 \pm 4$

$x = 6$ or -2

8-1 VARIATION FUNCTIONS, PAGES 569–576

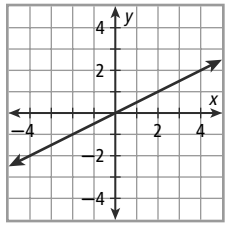
CHECK IT OUT!

1. $y = kx$

$6.5 = 13x$

$0.5 = k$

$y = 0.5x$



2. $\frac{P_1}{s_1} = \frac{P_2}{s_2}$

$\frac{18}{1.5} = \frac{75}{s}$

$18s = 75(1.5)$

$s = 6.25$

The side length s is 6.25 in.

3. $L = kr\ell$

$63\pi = k(3.5)(18)$

$\pi = k$

$L = \pi r\ell$

$8\pi = \pi r(5)$

$1.6 = r$

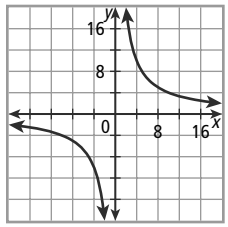
The radius r is 1.6 m.

4. $y = \frac{k}{x}$

$4 = \frac{k}{10}$

$k = 40$

$y = \frac{40}{x}$



5. $t = \frac{k}{v} = \frac{1250}{15} = \frac{250}{3}$

It would take them $83\frac{1}{3}$ hours to build a house.

6a. inverse **b.** direct

7. $V = \frac{kT}{P} = \frac{0.05(400)}{1} = 20$

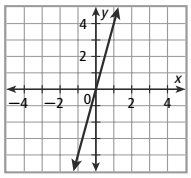
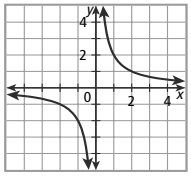
The volume is 20 L.

THINK AND DISCUSS

1. Possible answer: A direct variation equation is in the form $y = mx + b$, with $m = k$ and $b = 0$.

2. Possible answer: The length varies inversely as the width, with a constant of variation of 400.

3.

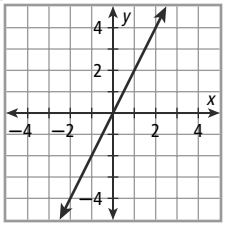
Type of Variation	Equation	Graph	Example
Direct	$y = kx$		$d = rt$
Joint	$y = kxz$		$I = Prt$
Inverse	$y = \frac{k}{x}$		$I = \frac{V}{R}$

EXERCISES

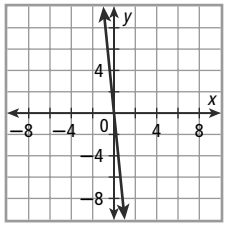
GUIDED PRACTICE

1. indirect variation

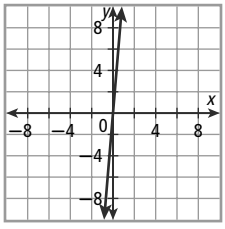
2. $y = 2x$



3. $y = -9x$



4. $y = 12x$



5. $\frac{\lambda_1}{v_1} = \frac{\lambda_2}{v_2}$

$\frac{60}{15} = \frac{\lambda}{3}$

$3(60) = 15\lambda$

$12 = \lambda$

The wavelength λ is 12 ft.

6. $\frac{d_1}{t_1} = \frac{d_2}{t_2}$

$\frac{116.25}{15} = \frac{178.25}{t}$

$116.25t = 178.25(15)$

$t = 23$

The time t is 23 h.

7. $V = k\ell w$

$224 = k(8)(4)$

$7 = k$

$V = k\ell w$

$210 = 7\ell(5)$

$6 = \ell$

The length ℓ is 6 ft.

8. $C = mtk$

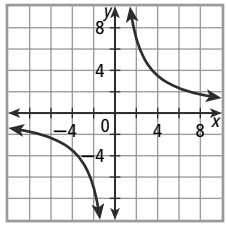
$12 = m(50)(6)$

$0.04 = m$

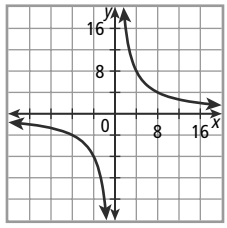
$C = mtk = 0.04(30)(8) = 9.6 \approx 10$

The total cost C is about 10 cents.

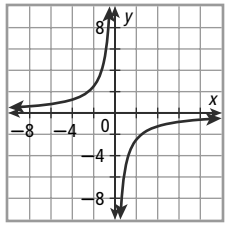
9. $y = \frac{14}{x}$



10. $y = \frac{32}{x}$



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



12. $t = \frac{d}{r}$

$4.75 = \frac{d}{60}$

$285 = d$

$t = \frac{d}{r} = \frac{285}{50} = 5.7$

It would take the driver 5.7 h.

13. neither

14. inverse

15. direct

16. $P = \frac{kd}{t}$

$147 = \frac{k(500)}{50}$

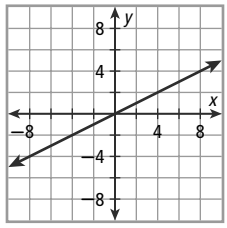
$14.7 = k$

$P = \frac{kd}{t} = \frac{14.7(700)}{30} = 343$

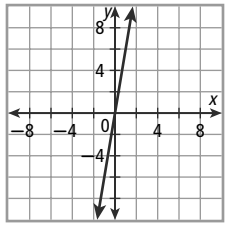
The power P is 343 kilowatts.

PRACTICE AND PROBLEM SOLVING

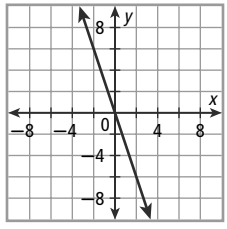
17. $y = \frac{1}{2}x$



18. $y = 6x$



19. $y = -3x$



20. $\frac{d_1}{m_1} = \frac{d_2}{m_2}$

$\frac{100}{55} = \frac{d}{70}$

$100(70) = 55d$

$127 \approx d$

The dosage d is 127 mg.

21. $\frac{C_1}{w_1} = \frac{C_2}{w_2}$

$\frac{25}{3.2} = \frac{C}{12.35}$

$25(12.35) = 3.2C$

$88 \approx C$

There are 88 Cal in the melon.

22. $N = kap$

$980 = k(700)(70)$

$0.02 = k$

$N = kap = 0.02(1000)(75) = 1500$

The number of bags N is 1500.

23. $Q = kmT$

$20930 = k(1)(5)$

$4186 = k$

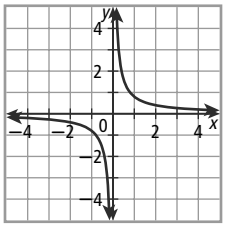
$Q = kmT$

$8372 = 4186m(10)$

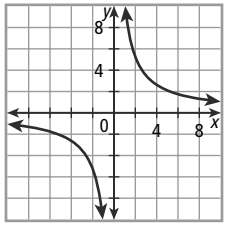
$0.2 = m$

The mass m is 0.2 kg.

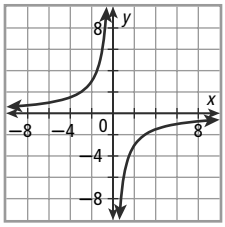
24. $y = \frac{4}{5x}$



25. $y = \frac{10.5}{x}$



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



27. $d = \frac{k}{w}$

$3 = \frac{k}{20}$

$60 = k$

$d = \frac{k}{w} = \frac{60}{12} = 5$

It would take 5 days.

28. inverse

29. neither

30. direct

31. $V = \frac{kT}{P}$

$20 = \frac{k(320)}{1}$

$0.0625 = k$

$V = \frac{kT}{P}$

$15 = \frac{0.0625(330)}{P}$

$P = 1.375$

The pressure P is 1.375 atm.

32. always

33. sometimes

34. never

35. always

36. never

37a. $s = \frac{k}{t}$

$200 = \frac{k}{31.5}$

$6300 = k$

$s = \frac{6300}{t}$

b. $s = \frac{6300}{t}$

$210 = \frac{6300}{t}$

$30 = t$

It takes 30 s to complete one lap.

38. Answers will vary.

Possible answer: $I(d) = \frac{1150}{d^2}$, where I is intensity in milliwatts per square centimeter and d is distance from the light source in centimeters

39a. $I = kPt$

$12.5 = k(2500)\left(\frac{3}{12}\right)$

$0.02 = k$

$I = 0.02Pt$

b. True Federal Bank

c. $I = kPt = 0.02(3000)\left(\frac{6}{12}\right) = 30$

The interest earned in six months is $30.

40. 12; −16; 0.04

41. $x = 5$; $z = 2$; $y = 4.4$

42. approximately 9 min

43. Possible answer: 2 points are needed to determine a line. Since direct variations always include (0, 0), only 1 other point is needed to write the equation.

44. Possible answer: If the ratios of the coordinates in each ordered pair are the same, the variation is direct. If the products of the coordinates in each ordered pair are the same, the variation is inverse.

TEST PREP

45. D

46. H

47. D

48. $c = \frac{k}{n}$

$250 = \frac{k}{24}$

$6000 = k$

$c = \frac{k}{n}$

$200 = \frac{6000}{n}$

$n = 30$

The number of students n is 30.

CHALLENGE AND EXTEND

49. $y = kxz^2$

$189 = k(7)\left(9^2\right)$

$\frac{1}{3} = k$

$y = kxz^2 = \frac{1}{3}(2)\left(6^2\right) = 24$

50a. $r = kp$

$19 = k(12{,}281{,}054)$

$k \approx 0.00000155$

$r \approx 0.00000155p$

b. FL: $r \approx 0.00000155(15{,}982{,}378) \approx 25$
IL: $r \approx 0.00000155(12{,}419{,}293) \approx 19$
MI: $r \approx 0.00000155(9{,}938{,}444) \approx 15$

c. $r = kp$
$32 \approx 0.00000155p$
$p \approx 21{,}000{,}000$
The population p is about 21,000,000

51. $y = \dfrac{7\pi z^2}{x} = \dfrac{7\pi\left(2^2\right)}{12} \approx 7$

SPIRAL REVIEW

52. $\dfrac{h_1}{t_1} = \dfrac{h_2}{t_2}$

$\dfrac{6\frac{8}{12}}{9\frac{4}{12}} = \dfrac{985}{t}$

$6\frac{8}{12}t = 985\left(9\frac{4}{12}\right)$

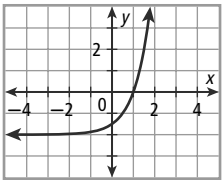
$t = 1379$

The length of the Eiffel Tower's shadow is 1379 ft.

53. $y = \frac{5}{4}x + \frac{1}{4}$ **54.** $y = -\frac{1}{2}x + 8$

55.

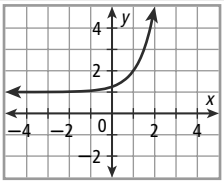
x	-2	-1	0	1	2
$g(x)$	$-\frac{63}{32}$	$-\frac{15}{8}$	$-\frac{3}{2}$	0	6



asymptote: $y = -2$; vertically compressed by a factor of $\frac{1}{2}$ and translated 2 units down

56.

x	-2	-1	0	1	2
$h(x)$	$\frac{65}{64}$	$\frac{17}{16}$	$\frac{5}{4}$	2	5



asymptote: $y = 1$; translated 1 unit right and 1 unit up

8-2 MULTIPLYING AND DIVIDING RATIONAL EXPRESSIONS, PAGES 577–582

CHECK IT OUT!

1a. $\dfrac{16x^{11}}{8x^2}$

$\dfrac{16}{8}x^{11-2}$

$2x^9;\ x \neq 0$

b. $\dfrac{3x+4}{3x^2+x-4}$

$\dfrac{3x+4}{(3x+4)(x-1)}$

$\dfrac{1}{x-1};\ x \neq -\dfrac{4}{3}$ and $x \neq 1$

c. $\dfrac{6x^2+7x+2}{6x^2-5x-6}$

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

$\dfrac{2x+1}{2x-3};\ x \neq -\dfrac{2}{3}$ and $x \neq \dfrac{3}{2}$

2a. $\dfrac{10-2x}{x-5}$

$\dfrac{-2(x-5)}{x-5}$

$-2;\ x \neq 5$

b. $\dfrac{-x^2+3x}{2x^2-7x+3}$

$\dfrac{-x(x-3)}{(2x-1)(x-3)}$

$\dfrac{-x}{2x-1};\ x \neq 3$ and $x \neq \dfrac{1}{2}$

3a. $\dfrac{x}{15} \cdot \dfrac{x^7}{2x} \cdot \dfrac{20}{x^4}$

$\dfrac{x^7}{20} \cdot \dfrac{20}{x^4}$

$\dfrac{2x^3}{3}$

b. $\dfrac{10x-40}{x^2-6x+6} \cdot \dfrac{x+3}{5x+15}$

$\dfrac{10(x-4)}{(x-4)(x-2)} \cdot \dfrac{x+3}{5(x+3)}$

$\dfrac{10}{x-2} \cdot \dfrac{1}{5}$

$\dfrac{2}{x-2}$

4a. $\dfrac{x^2}{4} \div \dfrac{x^4y}{12y^2}$

$\dfrac{x^2}{4} \cdot \dfrac{12y^2}{x^4y}$

$\dfrac{3y}{x^2}$

b. $\dfrac{2x^2-7x-4}{x^2-9} \div \dfrac{4x^2-1}{8x^2-28x+12}$

$\dfrac{(x-4)(2x+1)}{(x+3)(x-3)} \cdot \dfrac{4(x-3)(2x-1)}{(2x+1)(2x-1)}$

$\dfrac{(x-4)(2x+1)}{(x+3)(x-3)} \cdot \dfrac{4(x-3)}{2x+1}$

$\dfrac{4(x-4)}{x+3}$

5a. $\dfrac{x^2+x-12}{x+4} = -7$

$\dfrac{(x+4)(x-3)}{x+4} = -7$

$x - 3 = -7$

$x = -4$

since $x \neq -4$, no solution

b. $\dfrac{4x^2-9}{(2x+3)} = 5$

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

$2x - 3 = 5$

$2x = 8$

$x = 4$

THINK AND DISCUSS

1. Possible answer: Set the denominator of the unsimplified expression equal to 0, and solve.
2. Possible answer: Solving a rational equation may produce extraneous solutions.

3.

	Fractions	Rational Expressions
Simplifying	$\frac{4}{16}=\frac{\cancel{4}^{1}}{\cancel{16}_{4}}=\frac{1}{4}$	$\frac{3x^2y^3}{12xy^6}=\frac{\cancel{3}^{1}\cancel{x}^{x}\cancel{y^2}}{\cancel{12}_{4}\cancel{xy^6}_{y^3}}=\frac{x}{4y^3}$
Multiplying	$\frac{15}{7}\cdot\frac{3}{25}=\frac{\cancel{15}^{3}}{7}\cdot\frac{3}{\cancel{25}_{5}}=\frac{9}{35}$	$\frac{5x^3}{4y^5}\cdot\frac{3y^8}{20x}=\frac{\cancel{5x^3}^{x^2}}{\cancel{4y^5}}\cdot\frac{\cancel{3y^8}^{y^3}}{\cancel{20x}_{4}}=\frac{3x^2y^3}{16}$
Dividing	$\frac{2}{3}\div\frac{8}{9}=\frac{\cancel{2}^{1}}{\cancel{3}_{1}}\cdot\frac{\cancel{9}^{3}}{\cancel{8}_{4}}=\frac{3}{4}$	$\frac{2x}{3y^5}\div\frac{4x}{15y}=\frac{\cancel{2x}}{\cancel{3y^5}_{y^4}}\cdot\frac{\cancel{15y}^{5}}{\cancel{4x}_{2}}=\frac{5}{2y^4}$

EXERCISES

GUIDED PRACTICE

1. Possible answer: A rational expression is the quotient of 2 polynomials.

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

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

$\frac{2x^6}{x-3}$; $x \neq 3$

3. $\frac{6x^2+13x-5}{6x^2-23x+7}$

$\frac{(2x+5)(3x-1)}{(2x-7)(3x-1)}$

$\frac{2x+5}{2x-7}$; $x \neq \frac{1}{3}$ and $x \neq \frac{7}{2}$

4. $\frac{x+4}{3x^2+11x-4}$

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

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

$x \neq -4$ and $x \neq \frac{1}{3}$

5. $\frac{-x-4}{x^2-x-20}$

$\frac{-(x+4)}{(x-5)(x+4)}$

$\frac{-1}{x-5}$;

$x \neq 5$ and $x \neq -4$

6. $\frac{6x^2+7x-3}{-3x^2+x}$

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

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

$x \neq 0$ and $x \neq \frac{1}{3}$

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

$\frac{6x(x^2+1)}{x^2+1}$

$6x$; defined for all real values of x

8. $\frac{x-2}{2x-3}\cdot\frac{4x-6}{x^2-4}$

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

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

9. $\frac{x-2}{x-3}\cdot\frac{2x-6}{x+5}$

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

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

10. $\frac{x^2-16}{x^2-4x+4}\cdot\frac{x-2}{x^2+6x+8}$

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

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

11. $\frac{x^5y^4}{3xy}\div\frac{1}{x^3y}$

$\frac{x^5y^4}{3xy}\cdot x^3y$

$\frac{x^7y^4}{3}$

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

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

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

13. $\frac{x^2-25}{2x^2+5x-12}\div\frac{x^2-3x-10}{x^2+9x+20}$

$\frac{(x+5)(x-5)}{(x+4)(2x-3)}\cdot\frac{(x+4)(x+5)}{(x-5)(x+2)}$

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

14. $\frac{x^2+2x+1}{x^2-3x-18}\div\frac{x^2-1}{x^2-7x+6}$

$\frac{(x+1)^2}{(x-6)(x+3)}\cdot\frac{(x-6)(x-1)}{(x+1)(x-1)}$

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

15. $\frac{16x^2-9}{4x+3}=-6$

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

$4x-3=-6$

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

since $x \neq -\frac{3}{4}$, no solution

16. $\frac{2x^2+7x-15}{2x-3}=10$

$\frac{(x+5)(2x-3)}{2x-3}=10$

$x+5=10$

$x=5$

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

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

$x+2=1$

$x=-1$

PRACTICE AND PROBLEM SOLVING

18. $\frac{4x-8}{x^2-2x}$

$\frac{4(x-2)}{x(x-2)}$

$\frac{4}{x}$; $x \neq 0$ and $x \neq 2$

19. $\frac{8x-4}{2x^2+9x-5}$

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

$\frac{4}{x+5}$; $x \neq -5$ and $x \neq \frac{1}{2}$

20. $\frac{x^2-36}{x^2-12x+36}$

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

$\frac{x+6}{x-6}$; $x \neq 6$

21. $\frac{3x+18}{24-2x-x^2}$

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

$\frac{-3}{x-4}$; $x \neq -6$ and $x \neq 4$

22. $\frac{-2x^2-9x}{4x^2-81}$

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

$\frac{-x}{2x-9}$; $x \neq -\frac{9}{2}$ and $x \neq \frac{9}{2}$

23. $\frac{4x+20}{-5-x}$

$\frac{4(x+5)}{-(x+5)}$

-4; $x \neq -5$

24. $\frac{x^2y}{4xy}\cdot\frac{x}{6}\cdot\frac{3y^5}{x^4}$

$\frac{x^2}{24}\cdot\frac{3y^5}{x^4}$

$\frac{y^5}{8x^2}$

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

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

26. $\frac{x^2-2x-8}{9x^2-16} \cdot \frac{3x^2+10x+8}{x^2-16}$

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

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

27. $\frac{4x^2-20x+25}{x^2-4x} \cdot \frac{3x-12}{2x-5}$

$\frac{(2x-5)^2}{x(x-4)} \cdot \frac{3(x-4)}{2x-5}$

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

28. $\frac{4x^2+15x+9}{8x^2+10x+3} \div \frac{x^2+4x}{2x+1}$

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

$\frac{x+3}{x(x+4)}$

29. $\frac{x^2-4x-5}{x^2-3x+2} \div \frac{x^2-3x-10}{x^2-4}$

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

$\frac{x+1}{x-1}$

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

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

$3(x+2)$

$3x+6$

31. $\frac{x^2-2x-3}{x^2-x-2} \div \frac{x^2+2x-15}{x^2+x-6}$

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

$\frac{x+3}{x+5}$

32. $\frac{3x^2+10x+8}{-x-2} = -2$

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

$-(3x+4) = -2$

$3x+4 = 2$

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

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

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

$x+3 = 5$

$x = 2$

34. $\frac{x^2+3x-28}{(x+7)(x-4)} = -11$

$\frac{(x+7)(x-4)}{(x+7)(x-4)} = -11$

$1 = -11$

no solution

35. $\frac{\pi r^2}{\pi(5r)^2}$;

$\frac{\pi r^2}{\pi(5r)^2} = \frac{\pi r^2}{\pi(25r^2)} = \frac{1}{25}$

36. $\frac{2x}{3} \cdot \frac{x^3}{6x-8}$

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

$\frac{x^4}{3(3x-4)}$

37. $\frac{4x^2-3x}{4x^2-1} \cdot \frac{2x+1}{x}$

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

$\frac{4x-3}{2x-1}$

38. $\frac{1}{25x^2-49} \div \frac{x}{10x-14}$

$\frac{1}{(5x+7)(5x-7)} \cdot \frac{2(5x-7)}{x}$

$\frac{2}{x(5x+7)}$

39. $2xy \cdot \frac{2x^2}{y} \cdot \frac{y^2}{2x}$

$4x^3 \cdot \frac{y^2}{2x}$

$2x^2y^2$

40. $\frac{14x^4}{xy} \cdot \frac{x^3}{6y^3} \div \frac{5x^2}{12y^5}$

$\frac{7x^6}{3y^4} \cdot \frac{12y^5}{5x^2}$

$\frac{28x^4y}{5}$

41. $(y+4) \div \frac{4x+4+xy+y}{3}$

$(y+4) \cdot \frac{3}{4(x+1)+y(x+1)}$

$(y+4) \cdot \frac{3}{(4+y)(x+1)}$

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

42. $(x+1) \div \frac{x-5}{x-2} \cdot (x-5)$

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

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

x^2-x-2

43a. square prism: $\frac{s^2h}{s^2} = \frac{h}{1}$;

cylinder: $\frac{\pi r^2 h}{\pi r^2} = \frac{h}{1}$

b. square prism: $\frac{2s^2+4sh}{s^2h} = \frac{s(2s+4h)}{s(sh)} = \frac{2s+4h}{sh}$;

cylinder: $\frac{2\pi r^2+2\pi rh}{\pi r^2 h} = \frac{\pi r(2r+2h)}{\pi r(rh)} = \frac{2r+2h}{rh}$

c. $\frac{2(2r)+2(2h)}{(2r)(2h)} \div \frac{2r+4h}{rh} = \frac{4r+8h}{4rh} \cdot \frac{2r+4h}{rh}$

$= \frac{2r+4h}{2rh} \cdot \frac{rh}{2r+4h}$

$= \frac{1}{2}$

The ratio would be reduced by a factor of $\frac{1}{2}$.

44a. $v = \frac{d}{t} = \frac{v_0 t + \frac{1}{2}at^2}{t} = v_0 + \frac{1}{2}at$

b. $v = v_0 + \frac{1}{2}at = 264 + \frac{1}{2}(10)(3) = 279$

The driver's average speed was 279 ft/s.

45. Student A; the student didn't leave a 1 in the numerator.

46. No; it is true for all real numbers except $x = 2$. At this value, the rational expression is undefined.

TEST PREP

47. D;

$x^2+x-2 = 0$

$(x-1)(x+2) = 0$

$x-1 = 0$ or $x+2 = 0$

$x = 1$ or -2

48. F;

$\frac{x^2+7x+10}{x^2-6x} \div \frac{x^3-4x}{x^2-8x+12}$

$\frac{(x+2)(x+5)}{x(x-6)} \cdot \frac{(x-2)(x-6)}{x(x+2)(x-2)}$

$\frac{x+5}{x^2}$

49. A;

$\frac{x^2+13x+36}{x+9}$

$\frac{(x+4)(x+9)}{x+9}$

$x+4$

CHALLENGE AND EXTEND

50. $\frac{8x^3 - 1}{x + 2} \cdot \frac{x^2 - 4}{2x^2 - 5x + 2}$

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

$4x^2 + 2x + 1$

51. $\frac{2x^2 - 50}{x^3 + 125} \cdot \frac{x^3 - 125}{x^2 - 10x + 25}$

$\frac{2(x + 5)(x - 5)}{(x + 5)(x^2 - 5x + 25)} \cdot \frac{(x - 5)(x^2 + 5x + 25)}{(x - 5)^2}$

$\frac{2(x^2 + 5x + 25)}{x^2 - 5x + 25}$

52. $\frac{x^2 - 16}{x - 3} \div \left(\frac{x^2 - 9}{x + 4}\right)^{-1}$

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

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

$(x - 4)(x + 3)$

53. $\frac{x^5 - 4x^3 - x^2 + 4}{x^3 - 2x^2 + x - 2} \div \frac{3x^3 + 3x^2 + 3x}{x^2 - 1} \cdot \frac{6x}{x^2 - 2x + 1}$

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

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

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

$\cdot \frac{6x}{(x - 1)^2}$

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

SPIRAL REVIEW

54. $6x^2(x^4 - 2)$

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

$6x^6 - 12x^2$

55. $(x + 5)(3x^2 - 7x - 1)$

$3x^3 - 7x^2 - x + 15x^2 - 35x - 5$

$3x^3 + 8x^2 - 36x - 5$

56. $8x^2y^3(xy^2 - 4x + 7y)$

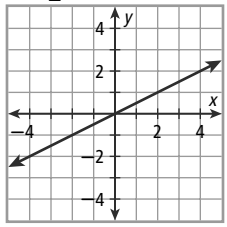
$8x^3y^5 - 32x^3y^3 + 56x^2y^4$

57. $y \approx 56{,}800(1.39)^x$;

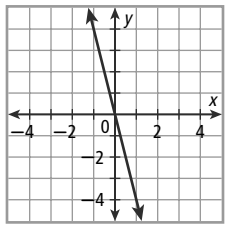
$y \approx 56{,}800(1.39)^8 \approx 800{,}000$

The number of births is about 800,000.

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



59. $y = -4x$



8-3 ADDING AND SUBTRACTING RATIONAL EXPRESSIONS, PAGES 583–590

CHECK IT OUT!

1a. $\frac{6x + 5}{x^2 - 3} + \frac{3x - 1}{x^2 - 3}$

$\frac{6x + 5 + 3x - 1}{x^2 - 3}$

$\frac{9x + 4}{x^2 - 3}$; $x \neq \pm\sqrt{3}$

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

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

$\frac{x^2 + 3x - 3}{3x - 1}$; $x \neq \frac{1}{3}$

2a. $4x^3y^7 = 2^2 \cdot x^3 \cdot y^7$

$3x^5y^4 = 3 \cdot x^5 \cdot y^4$

The LCM is $12x^5y^7$.

b. $x^2 - 4 = (x + 2)(x - 2)$

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

The LCM is $(x + 2)(x - 2)(x + 3)$.

3a. $\frac{3x}{2x - 2} + \frac{3x - 2}{3x - 3}$

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

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

$\frac{9x + 2(3x - 2)}{6(x - 1)}$

$\frac{9x + 6x - 4}{6(x - 1)}$

$\frac{15x - 4}{6(x - 1)}$; $x \neq 1$

b. $\frac{x}{x + 3} + \frac{2x + 6}{x^2 + 6x + 9}$

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

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

$\frac{x + 2}{x + 3}$; $x \neq -3$

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

$\frac{3x - 2}{2x + 5}\left(\frac{5x - 2}{5x - 2}\right) - \frac{2}{5x - 2}\left(\frac{2x + 5}{2x + 5}\right)$

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

$\frac{15x^2 - 16x + 4 - 4x - 10}{(2x + 5)(5x - 2)}$

$\frac{15x^2 - 20x - 6}{(2x + 5)(5x - 2)}$; $x \neq -\frac{5}{2}$ and $x \neq \frac{2}{5}$

4b. $\frac{2x^2+64}{x^2-64}-\frac{x-4}{x+8}$

$\frac{2x^2+64}{x^2-64}-\frac{x-4}{x+8}\left(\frac{x-8}{x-8}\right)$

$\frac{2x^2+64-(x-4)(x-8)}{x^2-64}$

$\frac{2x^2+64-x^2+12x-32}{x^2-64}$

$\frac{x^2+12x+32}{x^2-64}$

$\frac{(x+8)(x+4)}{(x+8)(x-8)}$

$\frac{x+4}{x+8}; x \neq -8$

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

$\frac{x+1}{x^2-1} \div \frac{x}{x-1}$

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

$\frac{1}{x}$

b. $\frac{\frac{20}{x-1}}{\frac{6}{3x-3}}$

$\frac{20}{x-1} \div \frac{6}{3x-3}$

$\frac{20}{x-1} \cdot \frac{3(x-1)}{6}$

10

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

$\frac{\left(\frac{1}{x}\right)2x(x-2)+\left(\frac{1}{2x}\right)2x(x-2)}{\left(\frac{x+4}{x-2}\right)2x(x-2)}$

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

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

6. $\frac{2d}{\frac{d}{40}+\frac{d}{45}}$

$\frac{2d(360)}{\frac{d}{40}(360)+\frac{d}{45}(360)}$

$\frac{720d}{9d+8d}$

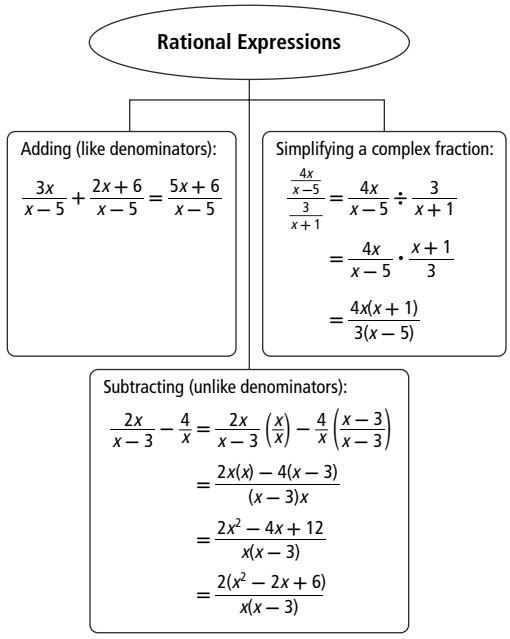
$\frac{720d}{17d} \approx 42.4$

The average speed is 42.4 mi/h.

THINK AND DISCUSS

1. Possible answer: Factor each denominator. Find the product of the different factors. If the same factor is in both denominators, use the highest power of that factor.

2. Possible answer:



EXERCISES

GUIDED PRACTICE

1. Possible answer: A complex fraction has 1 or more fractions in its numerator, its denominator, or both.

2. Possible answer:

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

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

$\frac{5x+1}{4x-1}; x \neq \frac{1}{4}$

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

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

$\frac{-2x-7}{4x+5}; x \neq -\frac{5}{4}$

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

$\frac{4x-3-(4x+3)}{2x-5}$

$\frac{-6}{2x-5}; x \neq \frac{5}{2}$

5. $4x^2y^3 = 2^2 \cdot x^2 \cdot y^3$

$16x^4y = 2^4 \cdot x^4 \cdot y$

The LCM is $16x^4y^3$.

6. $x^2-25=(x+5)(x-5)$

$x^2+10x+25=(x+5)^2$

The LCM is $(x+5)^2(x-5)$.

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

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

$\frac{(3x-2)(2x-1)+(2x-3)(x+6)}{(x+6)(2x-1)}$

$\frac{6x^2-7x+2+2x^2+9x-18}{(x+6)(2x-1)}$

$\frac{8x^2+2x-16}{(x+6)(2x-1)}$

$\frac{2(x^2+x-8)}{(x+6)(2x-1)}; x \neq -6$ and $x \neq \frac{1}{2}$

8. $\frac{4x-5}{12x+4}+\frac{3x-1}{3x+1}$

$\frac{4x-5}{4(3x+1)}+\frac{3x-1}{3x+1}\left(\frac{4}{4}\right)$

$\frac{4x-5+4(3x-1)}{4(3x+1)}$

$\frac{4x-5+12x-4}{4(3x+1)}$

$\frac{16x-9}{4(3x+1)}$; $x\neq -\frac{1}{3}$

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

$\frac{3x-4}{x^2-9}+\frac{2x-1}{x+3}\left(\frac{x-3}{x-3}\right)$

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

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

$\frac{2x^2-4x-1}{(x+3)(x-3)}$; $x\neq \pm 3$

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

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

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

$\frac{9x^2-12x-5-4x^2+20x-25}{(2x-5)(3x+1)}$

$\frac{5x^2+8x-30}{(2x-5)(3x+1)}$; $x\neq -\frac{1}{3}$ and $x\neq \frac{5}{2}$

11. $\frac{2x+8}{x^2-16}-\frac{3}{x-4}$

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

$\frac{2x+8-3(x+4)}{(x-4)(x+4)}$

$\frac{2x+8-3x-12}{(x-4)(x+4)}$

$\frac{-(x+4)}{(x-4)(x+4)}$

$\frac{-1}{x-4}$; $x\neq \pm 4$

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

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

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

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

$\frac{-x^2-x+1}{(x+3)(x+1)}$; $x\neq -3$ and $x\neq -1$

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

$\frac{2x-3}{x-2}\div\frac{4x-3}{x^2-4}$

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

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

14. $\frac{\frac{3x-7}{4x+5}}{\frac{6x-1}{5x-6}}$

$\frac{3x-7}{4x+5}\div\frac{6x-1}{5x-6}$

$\frac{3x-7}{4x+5}\cdot\frac{5x-6}{6x-1}$

$\frac{(3x-7)(5x-6)}{(4x+5)(6x-1)}$

15. $\frac{\frac{2}{x}+\frac{1}{x}}{\frac{2x}{x+2}}$

$\frac{\left(\frac{2}{x}\right)x(x+2)+\left(\frac{1}{x}\right)x(x+2)}{\left(\frac{2x}{x+2}\right)x(x+2)}$

$\frac{2(x+2)+(x+2)}{2x^2}$

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

16. $\frac{2d}{\frac{d}{6.20}+\frac{d}{7.75}}$

$\frac{2d(31)}{\frac{d}{6.20}(31)+\frac{d}{7.75}(31)}$

$\frac{62d}{5d+4d}$

$\frac{62d}{9d}\approx 6.9$

The average speed is about 6.9 ft/s.

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

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

$\frac{4x-6}{4x-7}$

$\frac{2(2x-3)}{4x-7}$; $x\neq \frac{7}{4}$

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

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

$\frac{-2x}{3x+4}$; $x\neq -\frac{4}{3}$

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

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

$\frac{x^2-2x+2}{2x+7}$; $x\neq -\frac{7}{2}$

20. $12x^2y^3=2^2\cdot 3\cdot x^2\cdot y^3$

$14x^3y^2=2\cdot 7\cdot x^3\cdot y^2$

The LCM is $84x^3y^3$.

21. $16x^2-25=(4x+5)(4x-5)$

$4x^2-x-5=(4x-5)(x+1)$

The LCM is $(4x-5)(4x+5)(x+1)$.

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

$\frac{3x-2}{x+2}\left(\frac{4x-1}{4x-1}\right)+\frac{2x}{4x-1}\left(\frac{x+2}{x+2}\right)$

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

$\frac{12x^2-11x+2+2x^2+4x}{(x+2)(4x-1)}$

$\frac{14x^2-7x+2}{(x+2)(4x-1)}$; $x\neq -2$ and $x\neq \frac{1}{4}$

23. $\frac{2x-7}{x-2}+\frac{8x}{3x-6}$

$\frac{2x-7}{x-2}\left(\frac{3}{3}\right)+\frac{8x}{3x-6}$

$\frac{3(2x-7)+8x}{3(x-2)}$

$\frac{6x-21+8x}{3(x-2)}$

$\frac{14x-21}{3(x-2)}$

$\frac{7(2x-3)}{3(x-2)}$; $x\neq 2$

24. $\frac{5x}{4x^2}+\frac{7}{x+1}$

$\frac{5}{4x}+\frac{7}{x+1}$

$\frac{5}{4x}\left(\frac{x+1}{x+1}\right)+\frac{7}{x+1}\left(\frac{4x}{4x}\right)$

$\frac{5(x+1)+28x}{4x(x+1)}$

$\frac{33x+5}{4x(x+1)}$;

$x\neq -1$ and $x\neq 0$

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

$\frac{4x-3}{(x+3)(x-3)}-\frac{2x-3}{x-3}\left(\frac{x+3}{x+3}\right)$

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

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

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

$\frac{-(2x+3)(x-2)}{(x-3)(x+3)}$; $x \neq \pm 3$

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

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

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

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

$\frac{-2x^2-11x-3}{(2x-3)(2x+3)}$; $x \neq \pm\frac{3}{2}$

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

$\frac{1}{x-4}\left(\frac{x-2}{x-2}\right)-\frac{2}{(x-4)(x-2)}$

$\frac{x-2-2}{(x-4)(x-2)}$

$\frac{x-4}{(x-4)(x-2)}$

$\frac{1}{x-2}$; $x \neq 2$ and $x \neq 4$

28. $\dfrac{\frac{2x-5}{x^2-9}}{\frac{3x-1}{x+3}}$

$\frac{2x-5}{x^2-9} \div \frac{3x-1}{x+3}$

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

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

29. $\dfrac{\frac{3x-2}{x^2-4}}{\frac{5x+1}{x^2+x-6}}$

$\frac{3x-2}{x^2-4} \div \frac{5x+1}{x^2+x-6}$

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

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

30. $\dfrac{\frac{x}{x+1}}{x+\frac{x}{3}}$

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

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

$\frac{3}{4(x+1)}$

31. $\dfrac{100}{\frac{50}{1.5}+\frac{50}{0.4}}$

$\frac{100(6)}{\frac{50}{1.5}(6)+\frac{50}{0.4}(6)}$

$\frac{600}{200+750}$

$\frac{600}{950} \approx 0.6$

The average rate is 0.6°C/min.

32a. $\frac{3d}{185}+\frac{5d}{200}$

b. $\dfrac{8d}{\frac{3d}{185}+\frac{5d}{200}}$

$\frac{8d(7400)}{\frac{3d}{185}(7400)+\frac{5d}{200}(7400)}$

$\frac{59200d}{120d+185d}$

$\frac{59200d}{305d} \approx 194$

The average speed is 194 mi/h.

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

$\frac{2}{x+4}\left(\frac{x-3}{x-3}\right)+\frac{x}{x-3}\left(\frac{x+4}{x+4}\right)$

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

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

$\frac{x^2+6x-6}{(x+4)(x-3)}$; $x \neq -4$ and $x \neq 3$

34. $\frac{2x}{x^2-36}+\frac{x+4}{x+6}$

$\frac{2x}{(x+6)(x-6)}+\frac{x+4}{x+6}\left(\frac{x-6}{x-6}\right)$

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

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

$\frac{x^2-24}{(x+6)(x-6)}$; $x \neq \pm 6$

35. $\frac{2}{x^2-x-20}+\frac{3}{x^2+7x+12}$

$\frac{2}{(x-5)(x+4)}\left(\frac{x+3}{x+3}\right)+\frac{3}{(x+3)(x+4)}\left(\frac{x-5}{x-5}\right)$

$\frac{2(x+3)+3(x-5)}{(x-5)(x+4)(x+3)}$

$\frac{2x+6+3x-15}{(x-5)(x+4)(x+3)}$

$\frac{5x-9}{(x-5)(x+4)(x+3)}$; $x \neq -4$, $x \neq -3$ and $x \neq 5$

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

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

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

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

$x \neq 0$ and $x \neq 5$

37. $\frac{2x}{x-1}-\frac{9}{x-2}$

$\frac{2x}{x-1}\left(\frac{x-2}{x-2}\right)-\frac{9}{x-2}\left(\frac{x-1}{x-1}\right)$

$\frac{2x(x-2)-9(x-1)}{(x-1)(x-2)}$

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

$\frac{2x^2-13x+9}{(x-2)(x-1)}$;

$x \neq 1$ and $x \neq 2$

38. $\frac{2x+3}{3x+4}-\frac{x}{9x+12}$

$\frac{2x+3}{3x+4}\left(\frac{3}{3}\right)-\frac{x}{3(3x+4)}$

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

$\frac{6x+9-x}{3(3x+4)}$

$\frac{5x+9}{3(3x+4)}$; $x \neq -\frac{4}{3}$

39. $\frac{4x^2}{3x+4}-\frac{2}{2x-3}$

$\frac{4x^2}{3x+4}\left(\frac{2x-3}{2x-3}\right)-\frac{2}{2x-3}\left(\frac{3x+4}{3x+4}\right)$

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

$\frac{8x^3-12x^2-6x-8}{(3x+4)(2x-3)}$

$\frac{2(4x^3-6x^2-3x-4)}{(3x+4)(2x-3)}$; $x \neq -\frac{4}{3}$ and $x \neq \frac{3}{2}$

40. $\frac{6}{x^2+4x-32}-\frac{x-5}{x-4}$

$\frac{6}{(x-4)(x+8)}-\frac{x-5}{x-4}\left(\frac{x+8}{x+8}\right)$

$\frac{6-(x-5)(x+8)}{(x-4)(x+8)}$

$\frac{6-x^2-3x+40}{(x-4)(x+8)}$

$\frac{-x^2-3x+46}{(x-4)(x+8)}$; $x \neq -8$ and $x \neq 4$

41. $\frac{x+7}{x^2+13x+42}-\frac{10x}{x^2+8x+7}$

$\frac{x+7}{(x+7)(x+6)}\left(\frac{x+1}{x+1}\right)-\frac{10x}{(x+1)(x+7)}\left(\frac{x+6}{x+6}\right)$

$\frac{(x+7)(x+1)-10x(x+6)}{(x+1)(x+7)(x+6)}$

$\frac{x^2+8x+7-10x^2-60x}{(x+1)(x+7)(x+6)}$

$\frac{-9x^2-52x+7}{(x+1)(x+7)(x+6)}$; $x \neq -7$, $x \neq -6$ and $x \neq -1$

42a. $\frac{1600}{s}-\frac{1600}{s+12}$

$\frac{1600}{s}\left(\frac{s+12}{s+12}\right)-\frac{1600}{s+12}\left(\frac{s}{s}\right)$

$\frac{1600(s+12)-1600s}{s(s+12)}$

$\frac{19{,}200}{s(s+12)}$

b. $\frac{19{,}200}{s(s+12)}=\frac{19{,}200}{48(48+12)} \approx 6.7$

Each senior has to clean about 6.7 m more.

c. The number of meters that a student can clean in one minute is $\frac{15 \text{ m}}{10 \text{ min}} = 1.5$ m/min

$\frac{\frac{1600}{48}}{1.5}-\frac{\frac{1600}{60}}{1.5}=\frac{\frac{1600}{48}-\frac{1600}{60}}{1.5}=\frac{6.7}{1.5} \approx 4.4$

The junior class will finish about 4.4 min sooner.

43. $\frac{\frac{4}{x+2}}{\frac{x+2}{6}}$

$\frac{4}{x+2} \div \frac{x+2}{6}$

$\frac{4}{x+2} \cdot \frac{6}{x+2}$

$\frac{24}{(x+2)^2}$

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

$\frac{2}{3x-4} \div (5x+3)$

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

$\frac{2}{(3x-4)(5x+3)}$

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

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

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

$\frac{7(x-3)}{6x(x-1)}$

46a. $\frac{2}{\frac{1}{a}+\frac{1}{b}}$

$\frac{2(ab)}{\frac{1}{a}(ab)+\frac{1}{b}(ab)}$

$\frac{2ab}{b+a}$

b.

Rooms with a Width of 30 ft		
Length-to-Width Ratio	Length (ft)	Height (ft)
2 : 1	60	40
3 : 2	45	36
4 : 3	40	34.3
5 : 3	50	37.5
$\sqrt{2}$: 1	42.4	35.1

c. Both the width and the height will double.

47. Possible answer: $\frac{x}{x+2}+\frac{-3}{x+2}$ or $\frac{x^2-6x+8}{x^2-4}+\frac{1}{x+2}$

48. Possible answer: Using the LCD reduces the need to simplify the sum of the rational expressions.

TEST PREP

49. D;

$\frac{3}{3x} + \frac{5}{9x}$

$\frac{3}{3x}\left(\frac{3}{3}\right) + \frac{5}{9x}$

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

$\frac{14}{9x}$

50. H;

$\frac{5}{x+2} - \frac{8}{x+4}$

$\frac{5}{x+2}\left(\frac{x+4}{x+4}\right) - \frac{8}{x+4}\left(\frac{x+2}{x+2}\right)$

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

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

51. A;

$\frac{\frac{8}{7x}}{\frac{-4}{x+1}}$

$\frac{8}{7x} \cdot \frac{x+1}{-4}$

$\frac{-2(x+1)}{7x}$

52. H;

$\frac{3d}{\frac{d}{35.5} + \frac{d}{31.1} + \frac{d}{25.6}}$

$\frac{3d(28263.68)}{\frac{d}{35.5}(28263.68) + \frac{d}{31.1}(28263.68) + \frac{d}{25.6}(28263.68)}$

$\frac{84791.04d}{796.16d + 908.8d + 1104.05d}$

$\frac{84791.04d}{2809.01d} \approx 30.2$

CHALLENGE AND EXTEND

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

$\frac{x-1}{x+2}\left(\frac{x-2}{x-2}\right) + \frac{4}{(x+2)(x-2)} - \frac{6x}{x-2}\left(\frac{x+2}{x+2}\right)$

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

$\frac{x^2 - 3x + 2 + 4 - 6x^2 - 12x}{(x-2)(x+2)}$

$\frac{-5x^2 - 15x + 6}{(x+2)(x-2)}$

54. $\frac{x^{-1} + y^{-1}}{x^{-1} - y^{-1}}$

$\frac{x^{-1}(xy) + y^{-1}(xy)}{x^{-1}(xy) - y^{-1}(xy)}$

$\frac{y + x}{y - x}$

55. $(x+2)^{-2} - (x^2-4)^{-1}$

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

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

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

56. $(x-y)^{-1} - (x+y)^{-1}$

$\frac{1}{x-y}\left(\frac{x+y}{x+y}\right) - \frac{1}{x+y}\left(\frac{x-y}{x-y}\right)$

$\frac{(x+y) - (x-y)}{(x-y)(x+y)}$

$\frac{2y}{(x-y)(x+y)}$

57. $\frac{5}{x+5} + \frac{x+4}{x^2-x}$

$\frac{5}{x+5}\left(\frac{x(x-1)}{x(x-1)}\right) + \frac{x+4}{x(x-1)}\left(\frac{x+5}{x+5}\right)$

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

$\frac{5x^2 - 5x + x^2 + 9x + 20}{x(x^2 + 4x - 5)}$

$\frac{6x^2 + 4x + 20}{x^3 + 4x^2 - 5x}$

so, ■ $= 6x^2 + 4x + 20$

SPIRAL REVIEW

58. $\frac{-x^2}{y^2 - x^2}$

$\frac{-(-2)^2}{(3)^2 - (-2)^2}$

$\frac{-4}{9 - 4}$

$-\frac{4}{5}$

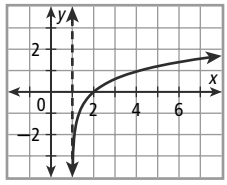
59. $\frac{m^2 - nm}{n^2 + 10}$

$\frac{(-4)^2 - (-4)(0)}{(0)^2 + 10}$

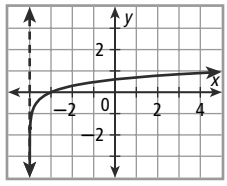
$\frac{16 - 0}{0 + 10}$

$\frac{8}{5}$

60. The asymptote is $x = 1$. The transformation is a vertical stretch by a factor of 2 and a translation 1 unit right.



61. The asymptote is $x = -4$. The transformation is a translation 4 units left.



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

$\frac{x(2x + 5x^2)}{x}$

$5x^2 + 2x;\ x \neq 0$

63. $\frac{x^2 - 2x - 48}{x^2 + 10x + 24}$

$\frac{(x-8)(x+6)}{(x+4)(x+6)}$

$\frac{x-8}{x+4};\ x \neq -6$ and $x \neq -4$

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

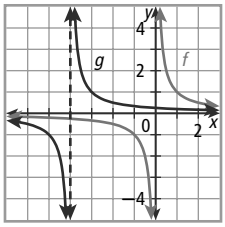
$\frac{x-2}{(x-1)(x-2)}$

$\frac{1}{x-1};\ x \neq 1$ and $x \neq 2$

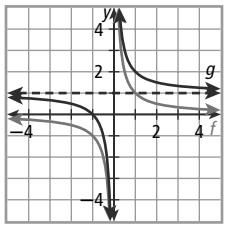
8-4 RATIONAL FUNCTIONS, PAGES 592–599

CHECK IT OUT!

1a. g is f translated 4 units left.

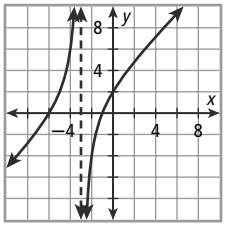


b. g is f translated 1 unit up.

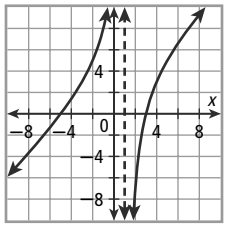


2. asymptotes: $x = 3$, $y = -5$;
D: $\{x \mid x \neq 3\}$;
R: $\{y \mid y \neq -5\}$

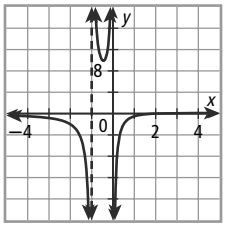
3. zeros: -6, -1;
asymptote: $x = -3$



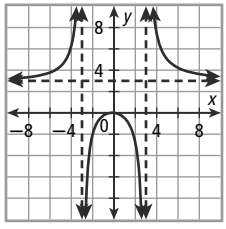
4a. zeros: -5, 3;
asymptote: $x = 1$



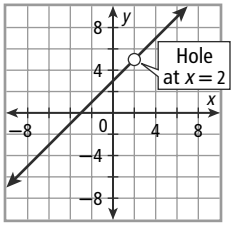
b. zero: 2;
asymptotes: $x = -1$, $x = 0$, $y = 0$



c. zeros: $-\frac{1}{3}$, 0;
asymptotes: $x = -3$, $x = 3$, $y = 3$



5. hole at $x = 2$



THINK AND DISCUSS

1. Possible answer: The x-value of the vertical asymptotes are excluded from the domain.

2. Both types of functions may have more than one zero. Rational functions may have one or more asymptotes, but polynomial functions do not. The domain of polynomial functions is all real numbers, but the domain of many rational functions do not include all real numbers.

3.

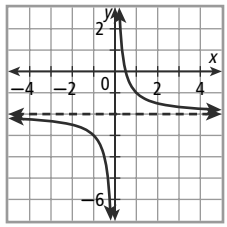
Zeros: at each real value of x for which $p(x) = 0$	Vertical asymptotes: at each real value of x for which $q(x) = 0$
$f(x) = \frac{p(x)}{q(x)}$	
Horizontal asymptotes: none if degree of $p >$ degree of q; the line $y = 0$ if degree of $p <$ degree of q; the line $y = \frac{\text{leading coefficient of } p}{\text{leading coefficient of } q}$ if degree of $p =$ degree of q	Holes: at any point where $x = b$ if $x - b$ is a factor of both p and q and the line $x = b$ is not a vertical asymptote

EXERCISES

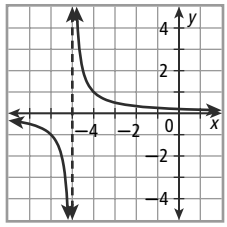
GUIDED PRACTICE

1. discontinuous

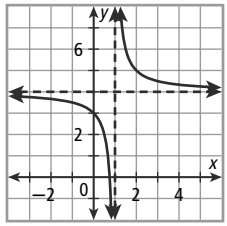
2. g is f translated 2 units down.



3. g is f translated 5 units left.



4. g is f translated 1 unit right and 4 units up.

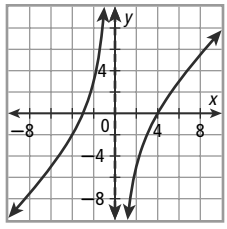


5. asymptotes: $x = 0$, $y = -1$;
D: $\{x \mid x \neq 0\}$;
R: $\{y \mid y \neq -1\}$

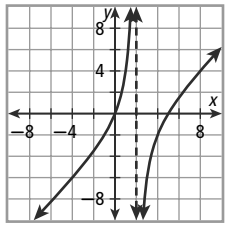
6. asymptotes: $x = -4$, $y = 3$;
D: $\{x \mid x \neq -4\}$;
R: $\{y \mid y \neq 3\}$

7. asymptotes: $x = 2$, $y = -8$;
D: $\{x \mid x \neq 2\}$;
R: $\{y \mid y \neq -8\}$

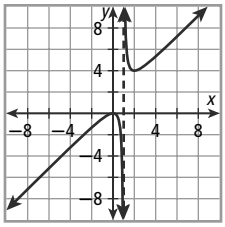
8. zeros: -3, 4
vertical asymptote: $x = 0$



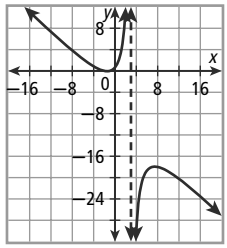
9. zeros: 0, 5
vertical asymptote: $x = 2$



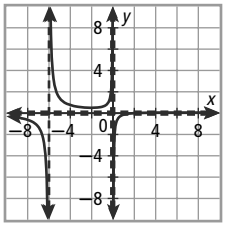
10. zero: 0;
vertical asymptote: $x = 1$



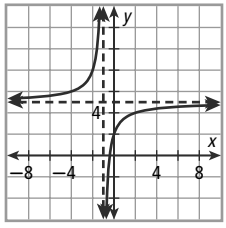
11. zeros: -2, -1;
asymptote: $x = 3$



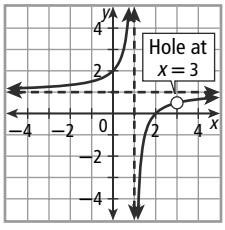
12. zero: 2;
asymptotes: $x = -6$, $x = 0$, $y = 0$



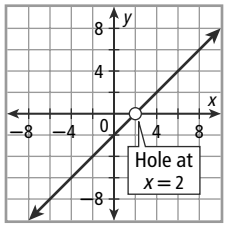
13. zero: $-\frac{2}{5}$;
asymptotes: $x = -1$, $y = 5$



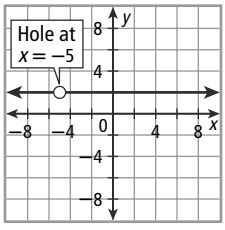
14. hole at $x = 3$



15. hole at $x = 2$

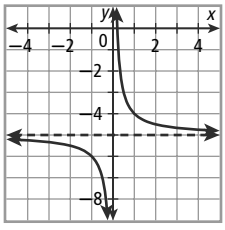


16. hole at $x = -5$

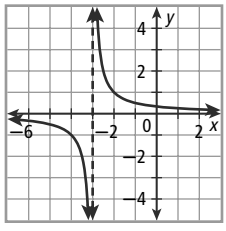


PRACTICE AND PROBLEM SOLVING

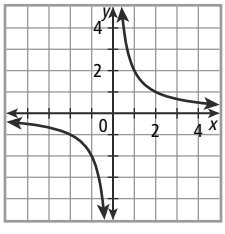
17. g is f translated 5 units down.



18. g is f translated 3 units left.



19. g is f vertically stretched by a factor of 2

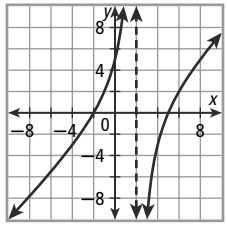


20. asymptotes: $x = -6$, $y = 0$;
D: $\{x \mid x \neq -6\}$;
R: $\{y \mid y \neq 0\}$

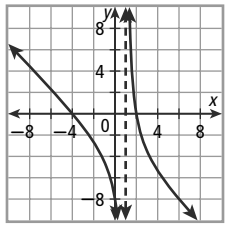
21. asymptotes: $x = 0$, $y = 5$;
D: $\{x \mid x \neq 0\}$;
R: $\{y \mid y \neq 5\}$

22. asymptotes: $x = 4$, $y = -1$;
D: $\{x \mid x \neq 4\}$;
R: $\{y \mid y \neq -1\}$

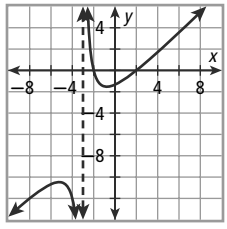
23. zeros: -2, 5;
vertical asymptote:
$x = 2$



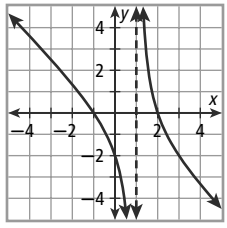
24. zeros: -4, 2;
vertical asymptote:
$x = 1$



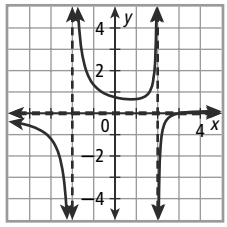
25. zeros: -2, 2;
vertical asymptote:
$x = -3$



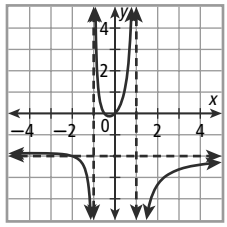
26. zeros: -1, 2;
vertical asymptote:
$x = 1$



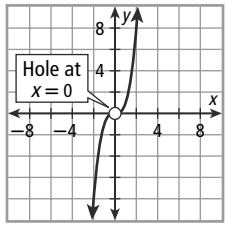
27. zero: 3;
asymptotes: $x = -2$, $x = 2$, $y = 0$



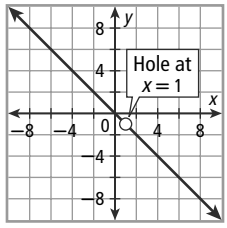
28. zeros: $-\frac{1}{2}$, 0;
asymptotes: $x = -1$, $x = 1$, $y = -2$



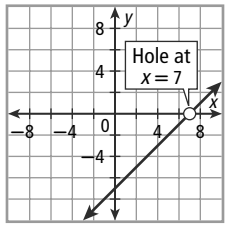
29. hole at $x = 0$



30. hole at $x = 1$

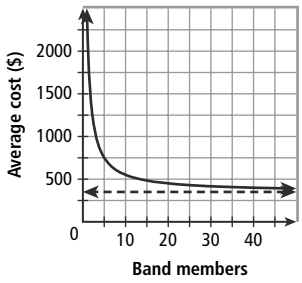


31. hole at $x = 7$



32a. $f(x) = \frac{2000}{x} + 350$

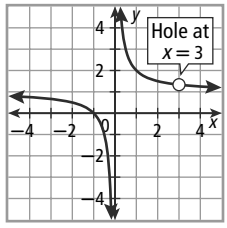
b.



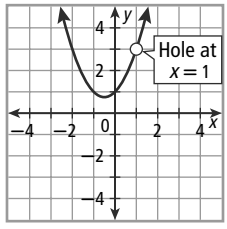
c. $f(40) = \frac{2000}{40} + 350 = 400$

The average cost per person is $400.

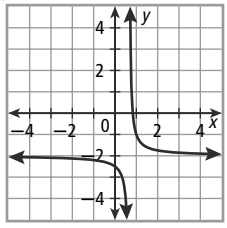
33. zero: -1;
asymptotes: $x = 0$, $y = 1$;
hole at $x = 3$



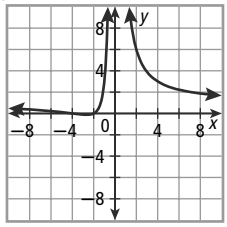
34. hole at $x = 1$



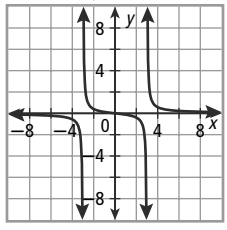
35. zero: $\frac{5}{6}$;
asymptotes: $x = \frac{2}{3}$, $y = -2$



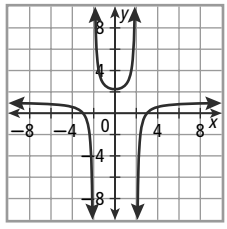
36. zeros: -4, -2;
asymptotes: $x = 0$, $y = 1$



37. zero: 0;
asymptotes: $x = 3$, $x = -3$, $y = 0$



38. zeros: ± 3;
asymptotes: $x = 2$, $x = -2$, $y = 1$

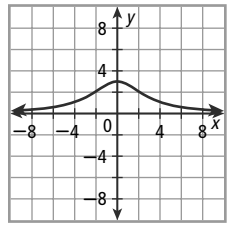


39. Possible answer: $f(x) = \frac{(x+1)(x-3)}{x}$

40. Possible answer: $f(x) = \frac{(x-2)}{x(x+2)}$

41. Possible answer: $f(x) = \frac{(x-2)(x+3)}{(x+3)(x+1)}$

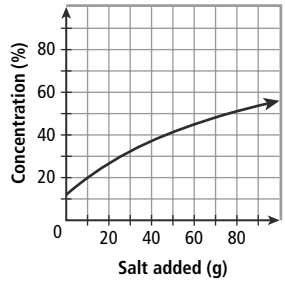
42a.



b. D: $\mathbb{R}$;
R: $\{y \mid 0 < y \leq 3\}$

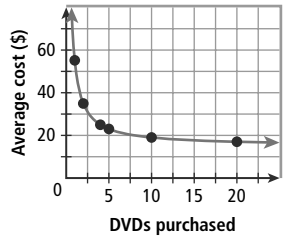
c. $y = 0$

43a.



b. The chemist must add about 17 g salt.

44a.



b. $f(x) = \frac{40}{x} + k$

$55 = \frac{40}{1} + k$

$55 = 40 + k$

$k = 15$

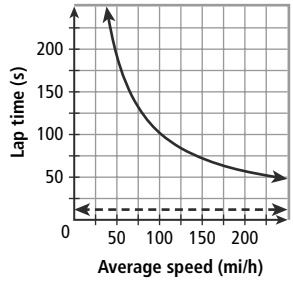
c. $xf(x) = 15\left(\frac{40}{15} + 15\right) = 40 + 225 = 265$

The total cost is $265.

45. Possible answer: The graph has only 1 vertical asymptote, at $x = -1$. There is a hole at $x = 1$ because $x - 1$ is a factor of both the numerator and denominator.

46. Possible answer: Yes; a rational function with a denominator that is never equal to zero will have no vertical asymptotes (for example: $f(x) = \frac{x-3}{x^2+1}$).

47a.



b. $t = 12$; the number of seconds the driver spent at the pit stop

c. $t(200) = \dfrac{12(200) + 9000}{200} = 57$

It takes 57 s in total.

48. The equation is false for $x = -3$ because the denominator of the left side of the equation is equal to 0 when $x = -3$. Division by 0 is undefined.

49. Possible answer: The domain of a rational function is all real numbers except the x-values of vertical asymptotes and holes.

TEST PREP

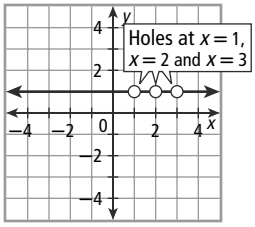
50. A

51. F

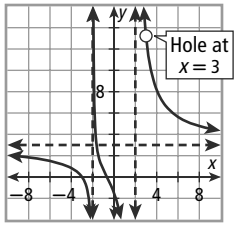
52. D

CHALLENGE AND EXTEND

53. holes at $x = 1$, $x = 2$, $x = 3$;



54. zeros: $-3, -\frac{2}{3}$; asymptotes: $x = -2$, $x = 2$, $y = 3$; hole at $x = 3$



55a. Possible answer: 2

b. Possible answer: 1

c. Possible answer: 0

56. Possible answer: $f(x) = \dfrac{x^2 + 1}{x^2 + 2}$

57. Possible answer: $f(x) = \dfrac{x(x^2 - 1)}{(x^2 - 1)(x^2 - 9)}$

SPIRAL REVIEW

58. $\dfrac{2{,}865{,}358 - 817{,}073}{817{,}073} \times 100\% \approx 250\%$

The percent increase in the number of females participating is about 250%.

59. $\log_3(5x - 2) = \log_3(2x + 8)$

$5x - 2 = 2x + 8$

$3x = 10$

$x = \dfrac{10}{3}$

60. $\log_2 x^2 = 4$

$x^2 = 2^4$

$x = \pm\sqrt{2^4}$

$x = \pm 4$

61. $\log_x \dfrac{1}{27} = 3$

$x^3 = \dfrac{1}{27}$

$x = \sqrt[3]{\dfrac{1}{27}}$

$x = \dfrac{1}{3}$

62. $\log_4 48 - \log_4 4x = 4$

$\log_4\left(\dfrac{48}{4x}\right) = 4$

$\log_4\left(\dfrac{12}{x}\right) = 4$

$\dfrac{12}{x} = 4^4$

$x = \dfrac{12}{4^4}$

$x = \dfrac{3}{64}$

63. $\dfrac{5x - 7}{2x + 1} + \dfrac{3x - 6}{2x + 1}$

$\dfrac{5x - 7 + 3x - 6}{2x + 1}$

$\dfrac{8x - 13}{2x + 1}; x \neq -\dfrac{1}{2}$

64. $\dfrac{x - 1}{x + 2} - \dfrac{x + 1}{x - 3}$

$\dfrac{x - 1}{x + 2}\left(\dfrac{x - 3}{x - 3}\right) - \dfrac{x + 1}{x - 3}\left(\dfrac{x + 2}{x + 2}\right)$

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

$\dfrac{x^2 - 4x + 3 - (x^2 + 3x + 2)}{(x + 2)(x - 3)}$

$\dfrac{-7x + 1}{(x + 2)(x - 3)}$;

$x \neq -2$ and $x \neq 3$

8-5 SOLVING RATIONAL EQUATIONS AND INEQUALITIES, PAGES 600–607

CHECK IT OUT!

1a. $\dfrac{10}{3} = \dfrac{4}{x + 2}$

$\dfrac{10}{3}(x) = \dfrac{4}{x}(x) + 2(x)$

$\dfrac{10}{3}x = 4 + 2x$

$\dfrac{4}{3}x = 4$

$x = 3$

b. $\dfrac{6}{x} + \dfrac{5}{4} = -\dfrac{7}{4}$

$\dfrac{6}{x} = -3$

$\dfrac{6}{x}(x) = -3(x)$

$6 = -3x$

$x = -2$

c. $x = \dfrac{6}{x} - 1$

$x(x) = \dfrac{6}{x}(x) - 1(x)$

$x^2 = 6 - x$

$x^2 + x - 6 = 0$

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

$x - 2 = 0$ or $x + 3 = 0$

$x = 2$ or $x = -3$

2a. $\dfrac{16}{x^2 - 16} = \dfrac{2}{x - 4}$

$\dfrac{16}{x^2 - 16}(x^2 - 16) = \dfrac{2}{x - 4}(x^2 - 16)$

$16 = 2(x + 4)$

$8 = x + 4$

$x = 4$

The solution $x = 4$ is extraneous.

Therefore there is no solution.

b. $\dfrac{1}{x - 1} = \dfrac{x}{x - 1} + \dfrac{x}{6}$

$\left(\dfrac{1}{x - 1}\right)6(x - 1) = \left(\dfrac{x}{x - 1}\right)6(x - 1) + \left(\dfrac{x}{6}\right)6(x - 1)$

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

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

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

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

$x - 1 = 0$ or $x + 6 = 0$

$x = 1$ or $x = -6$

The solution $x = 1$ is extraneous.

The only solution is $x = -6$.

3. $5 = \frac{2}{2-c} + \frac{2}{2+c}$

$5(4-c^2) = \frac{2}{2-c}(4-c^2) + \frac{2}{2+c}(4-c^2)$

$5(4-c^2) = 2(2+c) + 2(2-c)$

$20 - 5c^2 = 8$

$-5c^2 = -12$

$c \approx \pm 1.5$

The average speed of the current is 1.5 mi/h.

4. $\frac{1}{20}(11) + \frac{1}{h}(11) = 1$

$\frac{1}{20}(11)(20h) + \frac{1}{h}(11)(20h) = 1(20h)$

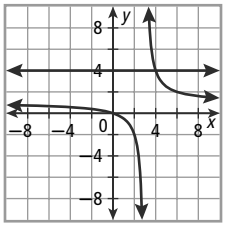
$11h + 220 = 20h$

$220 = 9h$

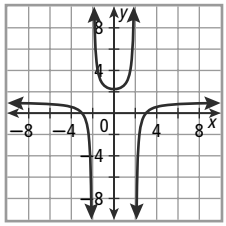
$24 \approx h$

It will take Remy about 24 min to mulch the garden when working alone.

5a. $3 < x \leq 4$



b. $x = -5$



6a. $\frac{6}{x-2} \geq -4$

LCD is positive.

$\frac{6}{x-2}(x-2) \geq -4(x-2)$

$6 \geq -4x + 8$

$4x \geq 2$

$x \geq \frac{1}{2}$;

$x - 2 > 0$

$x > 2$

Solution in this case is $x > 2$.

LCD is negative.

$\frac{6}{x-2}(x-2) \leq -4(x-2)$

$6 \leq -4x + 8$

$4x \leq 2$

$x \leq \frac{1}{2}$;

$x - 2 < 0$

$x < 2$

Solution in this case is $x \leq \frac{1}{2}$.

The solution to the inequality is $x \leq \frac{1}{2}$ or $x > 2$.

b. $\frac{9}{x+3} < 6$

LCD is positive.

$\frac{9}{x+3}(x+3) < 6(x+3)$

$9 < 6x + 18$

$-9 < 6x$

$x > -\frac{3}{2}$;

$x + 3 > 0$

$x > -3$

The solution in this case is $x > -\frac{3}{2}$.

LCD is negative.

$\frac{9}{x+3}(x+3) > 6(x+3)$

$9 > 6x + 18$

$-9 > 6x$

$x < -\frac{3}{2}$;

$x + 3 < 0$

$x < -3$

The solution in this case is $x < -3$.

The solution to the inequality is $x < -3$ or $x > -\frac{3}{2}$.

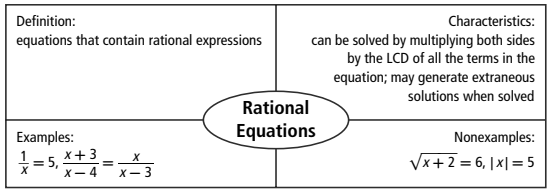
THINK AND DISCUSS

1. Possible answer: The LCD is a multiple of each denominator. Therefore, each denominator is a factor of the LCD.

2. Possible answer: When you multiply both sides of an equation by a variable expression, you may produce an equation with solutions that make denominators of the original equation equal to 0.

3. Possible answer: (1) Graph each side of the inequality. (2) Multiply both sides by x and consider two cases, x is positive or x is negative.

4. Possible answer:



EXERCISES

GUIDED PRACTICE

1. Possible answer: An equation is a statement that 2 expressions are equal. A rational expression is a quotient of 2 polynomials. A rational equation contains at least 1 rational expression.

2. $\frac{1}{8} + \frac{2}{t} = \frac{17}{8t}$

$\frac{1}{8}(8t) + \frac{2}{t}(8t) = \frac{17}{8t}(8t)$

$t + 16 = 17$

$t = 1$

3. $7 = \frac{1}{w} - 4$

$7(w) = \frac{1}{w}(w) - 4(w)$

$7w = 1 - 4w$

$11w = 1$

$w = \frac{1}{11}$

4. $\frac{1}{r-5} = \frac{7}{2r}$

$\left(\frac{1}{r-5}\right)2r(r-5) = \left(\frac{7}{2r}\right)2r(r-5)$

$2r = 7(r-5)$

$2r = 7r - 35$

$r = 7$

5. $\frac{1}{x} = \frac{x}{6} - \frac{5}{6}$

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

$6 = x^2 - 5x$

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

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

$x - 6 = 0$ or $x + 1 = 0$

$x = 6$ or $x = -1$

6. $m + \frac{12}{m} = 7$

$m(m) + \frac{12}{m}(m) = 7(m)$

$m^2 + 12 = 7m$

$m^2 - 7m + 12 = 0$

$(m-3)(m-4) = 0$

$m - 3 = 0$ or $m - 4 = 0$

$m = 3$ or $m = 4$

7. $k + \frac{1}{k} = 2$

$k(k) + \frac{1}{k}(k) = 2(k)$

$k^2 + 1 = 2k$

$k^2 - 2k + 1 = 0$

$(k-1)^2 = 0$

$k - 1 = 0$

$k = 1$

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

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

$-6x + x(x+2) = 12$

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

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

$x = 6$ or $x = -2$

The solution $x = -2$ is extraneous.

The only solution is $x = 6$.

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

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

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

$x^2 - 7x = 0$

$x(x-7) = 0$

$x = 0$ or $x = 7$

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

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

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

$x(x+1) = 0$

$x = 0$ or $x = -1$

Both solutions are extraneous.

Therefore there is no solution.

11. $16.5 = \frac{60}{8-c} + \frac{60}{8+c}$

$16.5(64 - c^2) = \frac{60}{8-c}(64 - c^2) + \frac{60}{8+c}(64 - c^2)$

$16.5(64 - c^2) = 60(8+c) + 60(8-c)$

$1056 - 16.5c^2 = 960$

$-16.5c^2 = -96$

$c \approx \pm 2.4$

The average speed of the current is 2.4 mi/h.

This is close to 2 mi/h, so the barge would take about $\frac{60 \text{ mi}}{8 - 2 \text{ mi/h}}$, or 10 h, to travel upstream and about $\frac{60 \text{ mi}}{8 + 2 \text{ mi/h}}$, or 6 h, to travel downstream.

The trip should take about 16 h, which is close to the given time, so the answer is reasonable.

12. $\frac{1}{50}(30) + \frac{1}{m}(30) = 1$

$\frac{1}{50}(30)(50m) + \frac{1}{m}(30)(50m) = 1(50m)$

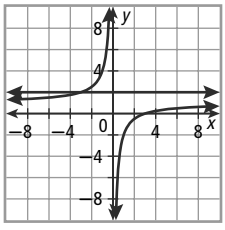
$30m + 1500 = 50m$

$1500 = 20m$

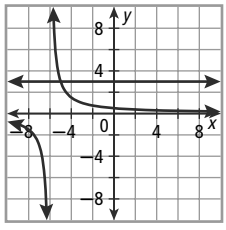
$75 = m$

The job will take 75 min if the large copier is broken.

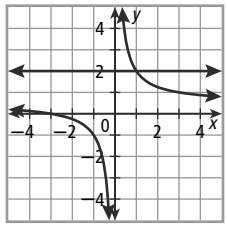
13. $-5 < x < 0$



14. $x = -5$



15. $x < 0$ or $x > 1$



16. $\frac{4}{x+1} < 4$

LCD is positive.	LCD is negative.
$\frac{4}{x+1}(x+1) < 4(x+1)$	$\frac{4}{x+1}(x+1) > 4(x+1)$
$4 < 4x + 4$	$4 > 4x + 4$
$0 < 4x$	$0 > 4x$
$x > 0$;	$x < 0$;
$x + 1 > 0$	$x + 1 < 0$
$x > -1$	$x < -1$
The solution in this case is $x > 0$.	The solution in this case is $x < -1$.

The solution to the inequality is $x < -1$ or $x > 0$.

17. $\frac{12}{x-4} \leq 3$

LCD is positive.	LCD is negative.
$\frac{12}{x-4}(x-4) \leq 3(x-4)$	$\frac{12}{x-4}(x-4) \geq 3(x-4)$
$12 \leq 3x - 12$	$12 \geq 3x - 12$
$24 \leq 3x$	$24 \geq 3x$
$x \geq 8$;	$x \leq 8$;
$x - 4 > 0$	$x - 4 < 0$
$x > 4$	$x < 4$
The solution in this case is $x \geq 8$.	The solution in this case is $x < 4$.

The solution to the inequality is $x < 4$ or $x \geq 8$.

18. $\frac{10}{x+8} > 2$

LCD is positive.	LCD is negative.
$\frac{10}{x+8}(x+8) > 2(x+8)$	$\frac{10}{x+8}(x+8) < 2(x+8)$
$10 > 2x + 16$	$10 < 2x + 16$
$-6 > 2x$	$-6 < 2x$
$x < -3$;	$x > -3$;
$x + 8 > 0$	$x + 8 < 0$
$x > -8$	$x < -8$
The solution in this case is $-8 < x < -3$.	No solution in this case.

The solution to the inequality is $-8 < x < -3$.

PRACTICE AND PROBLEM SOLVING

19. $4 + \frac{1}{x} = \frac{10}{2x}$

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

$8x + 2 = 10$

$8x = 8$

$x = 1$

20. $\frac{5}{4} = \frac{n-3}{n-4}$

$5(n-4) = 4(n-3)$

$5n - 20 = 4n - 12$

$n = 8$

21. $\frac{1}{a-7} = 3$

$1 = 3(a-7)$

$\frac{1}{3} = a - 7$

$\frac{22}{3} = a$

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

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

$4 - 3x = x^2$

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

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

$x = 1$ or $x = -4$

23. $\frac{14}{z} = 9 - z$

$\frac{14}{z}(z) = 9(z) - z(z)$

$14 = 9z - z^2$

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

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

$z = 2$ or $z = 7$

24. $x + \frac{4}{x} = 4$

$x(x) + \frac{4}{x}(x) = 4(x)$

$x^2 + 4 = 4x$

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

$(x-2)^2 = 0$

$x - 2 = 0$

$x = 2$

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

$\left(\frac{4x}{x-3}\right)2(x-3) + \left(\frac{x}{2}\right)2(x-3) = \left(\frac{12}{x-3}\right)2(x-3)$

$8x + x(x-3) = 24$

$x^2 + 5x - 24 = 0$

$(x-3)(x+8) = 0$

$x = 3$ or $x = -8$

The solution $x = 3$ is extraneous.

The only solution is $x = -8$.

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

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

$3x = 2x - 1$

$x = -1$

The solution $x = -1$ is extraneous.

Therefore there is no solution.

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

$\left(\frac{2}{x(x-1)}\right)x(x-1) = 1\big(x(x-1)\big) + \left(\frac{2}{x-1}\right)x(x-1)$

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

$x^2 + x - 2 = 0$

$(x-1)(x+2) = 0$

$x = 1$ or $x = -2$

The solution $x = 1$ is extraneous.

The only solution is $x = -2$.

28. $22(550 - v) = 17(550 + v)$

$12100 - 22v = 9350 + 17v$

$2750 = 39v$

$71 \approx v$

The average speed of the wind is about 71 mi/h. This is close to 70 mi/h. The plane travels about $22(550 - 70)$, or 10,560, mi on the flight to Bombay and about $22(550 + 70)$, or 10,540, mi on the flight to Los Angeles. Because the distances are approximately equal, the answer is reasonable.

29. $\frac{1}{2}(1.5) + \frac{1}{h}(1.5) = 1$

$\frac{1}{2}(1.5)(2h) + \frac{1}{h}(1.5)(2h) = 1(2h)$

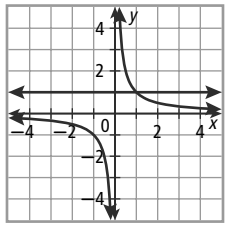
$1.5h + 3 = 2h$

$3 = 0.5h$

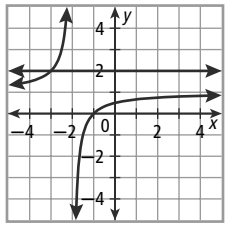
$6 = h$

It would take the apprentice 6 h.

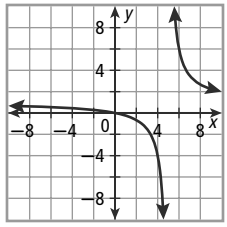
30. $0 < x < 1$



31. $x = -3$



32. $0 \le x < 5$



33. $\frac{1}{3x} < 2$

LCD is positive.

$\frac{1}{3x}(3x) < 2(3x)$

$1 < 6x$

$x > \frac{1}{6}$;

$3x > 0$

$x > 0$

The solution in this case is $x > \frac{1}{6}$.

LCD is negative.

$\frac{1}{3x}(3x) > 2(3x)$

$1 > 6x$

$x < \frac{1}{6}$;

$3x < 0$

$x < 0$

The solution in this case is $x < 0$.

The solution to the inequality is $x < 0$ or $x > \frac{1}{6}$.

34. $\frac{9}{x-4} \ge -6$

LCD is positive.

$\frac{9}{x-4}(x-4) \ge -6(x-4)$

$9 \ge -6x + 24$

$6x \ge 15$

$x \ge 2.5$;

$x - 4 > 0$

$x > 4$

The solution in this case is $x > 4$.

LCD is negative.

$\frac{9}{x-4}(x-4) \le -6(x-4)$

$9 \le -6x + 24$

$6x \le 15$

$x \le 2.5$;

$x - 4 < 0$

$x < 4$

The solution in this case is $x \le 2.5$.

The solution to the inequality is $x \le 2.5$ or $x > 4$.

35. $\frac{9}{x+10} > 3$

LCD is positive.

$\frac{9}{x+10}(x+10) > 3(x+10)$

$9 > 3x + 30$

$-21 > 3x$

$x < -7;$

$x + 10 > 0$

$x > -10$

The solution in this case is $-10 < x < -7$.

LCD is negative.

$\frac{9}{x+10}(x+10) < 3(x+10)$

$9 < 3x + 30$

$-21 < 3x$

$x > -7;$

$x + 10 < 0$

$x < -10$

No solution in this case.

The solution to the inequality is $-10 < x < -7$.

36a. $P \le 2w + 2\left(\frac{17{,}000}{w}\right)$ or equivalent inequality

b. No; substituting 400 for P in the inequality results in nonreal values of w.

37a. 2003

b. Possible answer: $\frac{188+h}{643+h} = \frac{191}{614}$; 18 hits

c. $\frac{156+h}{482+h} = \frac{0.5}{1}$

$156 + h = 241 + 0.5h$

$0.5h = 85$

$h = 170$

170 hits; He had 326 more at bats than hits, and this will stay constant with each hit. He would need to reach a total of 326 hits from 156 hits, so the answer is reasonable.

38. $\frac{15n}{n-3} = \frac{5}{n-3} - 8$

$\frac{15n}{n-3}(n-3) = \frac{5}{n-3}(n-3) - 8(n-3)$

$15n = 5 - 8(n-3)$

$15n = 5 - 8n + 24$

$23n = 29$

$n = \frac{29}{23}$

39. $\frac{z}{z+1} = \frac{z}{z-4}$

$z(z-4) = z(z+1)$

$z^2 - 4z = z^2 + z$

$-4z = z$

$z = 0$

40. $\frac{4}{x} + 6 = \frac{1}{x^2}$

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

$4x + 6x^2 = 1$

$6x^2 + 4x - 1 = 0$

$x = \frac{-4 \pm \sqrt{4^2 - 4(6)(-1)}}{2(6)} = \frac{-2 \pm \sqrt{10}}{6}$

41. $\frac{8}{x} - \frac{3}{x} = \frac{6}{x-1}$

$\left(\frac{8}{x}\right)x(x-1) - \left(\frac{3}{x}\right)x(x-1) = \left(\frac{6}{x-1}\right)x(x-1)$

$8(x-1) - 3(x-1) = 6x$

$5x - 5 = 6x$

$x = -5$

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

$2(x+4) = 3x$

$2x + 8 = 3x$

$x = 8$

43. $\frac{1}{a-1} + \frac{4}{a+1} = \frac{7}{a^2-1}$

$\frac{1}{a-1}(a^2-1) + \frac{4}{a+1}(a^2-1) = \frac{7}{a^2-1}(a^2-1)$

$(a+1) + 4(a-1) = 7$

$5a - 3 = 7$

$5a = 10$

$a = 2$

44. $\frac{6}{r} \ge \frac{5}{2}$

LCD is positive.

$\frac{6}{r}(r) \ge \frac{5}{2}(r)$

$6 \ge 2.5r$

$r \le 2.4;$

The solution in this case is $0 < r \le 2.4$.

LCD is negative.

$\frac{6}{r}(r) \le \frac{5}{2}(r)$

$6 \le 2.5r$

$r \ge 2.4;$

No solution in this case.

The solution to the inequality is $0 < r \le 2.4$.

45. $\frac{8}{x+1} > 4$

LCD is positive.

$\frac{8}{x+1}(x+1) > 4(x+1)$

$8 > 4x + 4$

$4 > 4x$

$x < 1;$

$x + 1 > 0$

$x > -1$

The solution in this case is $-1 < x < 1$.

LCD is negative.

$\frac{8}{x+1}(x+1) < 4(x+1)$

$8 < 4x + 4$

$4 < 4x$

$x > 1;$

$x + 1 < 0$

$x < -1$

No solution in this case.

The solution to the inequality is $-1 < x < 1$.

46. $x \ge \frac{4}{x}$

LCD is positive.

$x(x) \ge \frac{4}{x}(x)$

$x^2 \ge 4$

$x \le -2$ or $x \ge 2;$

The solution in this case is $x \ge 2$.

LCD is negative.

$x(x) \le \frac{4}{x}(x)$

$x^2 \le 4$

$-2 \le x \le 2;$

The solution in this case is $-2 \le x < 0$.

The solution to the inequality is $-2 \le x < 0$ or $x \ge 2$.

47. ± 0.45

48. ± 1.27

49. 0, 2

50. $\frac{1}{x} + \frac{7}{2} = 2$

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

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

51a. 2001 winner: $\frac{500}{s}$;

2002 winner: $\frac{500}{s+25}$

b. Possible answer: $\frac{500}{s+25}+\frac{32}{60}=\frac{500}{s}$;

$$15\left(\frac{500s(s+25)}{s+25}+\frac{8s(s+25)}{15}\right)=15\left(\frac{500s(s+25)}{s}\right)$$

$$7500s+8s(s+25)=7500(s+25)$$

$$8s^2+200s-187500=0$$

$$s=\frac{-200\pm\sqrt{200^2-4(8)(-187500)}}{2(8)}$$

$s\approx 141$ or -166

The average speed of the 2001 winner is 141 mi/h.

52. depending on the values of a, b, and c, either 2, 1, or 0

53. Multiply each term by the LCD, $5x$.

Divide out common factors, to get $3x^2=15-30x$.

Simplify, to get $x^2+10x-5=0$.

Use the quadratic formula to solve for x

$x=-5\pm\sqrt{30}$.

TEST PREP

54. A;

$$\frac{1}{x}+\frac{3}{x+3}=\frac{6}{x}$$

$$\left(\frac{1}{x}\right)x(x+3)+\left(\frac{3}{x+3}\right)x(x+3)=\left(\frac{6}{x}\right)x(x+3)$$

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

$$4x+3=6x+18$$

$$-15=2x$$

$$-\frac{15}{2}=x$$

55. G;

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

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

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

$$x^2+x=0$$

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

$$x=0 \text{ or } x+1=0$$

$$x=0 \text{ or } x=-1$$

The solution $x=0$ is extraneous.

The only solution is $x=-1$.

56. B

57a. Possible answer: $\frac{1}{15}(7)+\frac{1}{h}(7)=1$

b. $\frac{1}{15}(7)(15h)+\frac{1}{h}(7)(15h)=1(15h)$

$$7h+105=15h$$

$$105=8h$$

$$13\approx h$$

It would take about 13 h to fill the tank.

CHALLENGE AND EXTEND

58. $\frac{4x}{x^2+x-6}=\frac{7x}{x^2-5x-24}$

$$\frac{4x(x-2)(x+3)(x-8)}{(x-2)(x+3)}=\frac{7x(x-2)(x+3)(x-8)}{(x-8)(x+3)}$$

$$4x(x-8)=7x(x-2)$$

$$3x^2+18x=0$$

$$3x(x+6)=0$$

$$x=0 \text{ or } x+6=0$$

$$x=0 \text{ or } x=-6$$

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

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

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

$$\frac{1-x^{-1}}{1+3x^{-1}}\left(\frac{x}{x}\right)=\frac{x-1}{x+3}$$

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

all real numbers except -3, 0, and 3.

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

LCD is positive.

$$\frac{3x(x+2)(x+4)}{x+2}-\frac{2(x+2)(x+4)}{x+4}\geq 7(x+2)(x+4)$$

$$3x(x+4)-2(x+2)\geq 7(x+2)(x+4)$$

$$4x^2+32x+60\leq 0$$

$$4(x+3)(x+5)\leq 0$$

$$x+3\leq 0 \text{ and } x+5\geq 0$$

$$-5\geq x\leq -3;$$

$$(x+2)(x+4)>0$$

$$x+2>0 \text{ and } x+4>0$$

$$x>-2 \text{ or } x<-4$$

The solution in this case is $-5\leq x<-4$.

LCD is negative.

$$\frac{3x(x+2)(x+4)}{x+2}-\frac{2(x+2)(x+4)}{x+4}\leq 7(x+2)(x+4)$$

$$3x(x+4)-2(x+2)\leq 7(x+2)(x+4)$$

$$4x^2+32x+60\geq 0$$

$$4(x+3)(x+5)\geq 0$$

$$x+3\geq 0 \text{ and } x+5\geq 0$$

$$x\geq -3 \text{ or } x\leq -5$$

$$(x+2)(x+4)<0$$

$$x+2<0 \text{ and } x+4>0$$

$$-4<x<-2$$

The solution in this case is $-3\leq x<-2$.

The solution to the inequality is $-5\leq x<-4$ or $-3\leq x<-2$.

61. $\frac{6}{x-3} > \frac{x}{4} + 5$

LCD is positive.

$$\left(\frac{6}{x-3}\right)4(x-3) > \left(\frac{x}{4}\right)4(x-3) + (5)4(x-3)$$
$$24 > x(x-3) + 20(x-3)$$
$$x^2 + 17x - 84 < 0$$
$$(x-4)(x+21) < 0$$

$x - 4 < 0$ and $x + 21 > 0$

$$-21 < x < 4;$$

$x - 3 > 0$

$x > 3$

The solution in this case is $3 < x < 4$.

LCD is negative.

$$\left(\frac{6}{x-3}\right)4(x-3) < \left(\frac{x}{4}\right)4(x-3) + (5)4(x-3)$$
$$24 < x(x-3) + 20(x-3)$$
$$x^2 + 17x - 84 > 0$$
$$(x-4)(x+21) > 0$$

$x - 4 > 0$ and $x + 21 > 0$

$$x > 4 \text{ or } x < -21;$$

$x - 3 < 0$

$x < 3$

The solution in this case is $x < -21$.

The solution to the inequality is $x < -21$ or $3 < x < 4$.

62. Let h be the number of hours needed for Marcus to paint the barn individually, then $2h$ will be the number of hours needed for Will.

$$\frac{1}{h}(6) + \frac{1}{2h}(6) = \frac{1}{3}$$
$$\frac{1}{h}(6)(2h) + \frac{1}{2h}(6)(2h) = \frac{1}{3}(2h)$$
$$12 + 6 = \frac{2}{3}h$$
$$h = 27$$
$$\left(1 - \frac{1}{3}\right) \div \frac{1}{27} = \frac{2}{3} \div \frac{1}{27} = 18$$

It will take Marcus 18 additional hours to complete.

SPIRAL REVIEW

63. $4(4 + x) - \frac{1}{2}(4)(x)$

$16 + 4x - 2x$

$2x + 16$

64. $\frac{-3\sqrt{3}}{\sqrt{8}}$

$\frac{-3\sqrt{3}}{\sqrt{8}}\left(\frac{\sqrt{2}}{\sqrt{2}}\right)$

$\frac{-3\sqrt{6}}{\sqrt{16}}$

$\frac{-3\sqrt{6}}{4}$

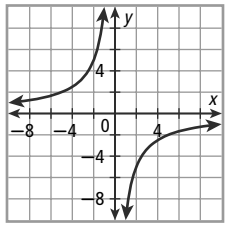
65. $\frac{5}{4\sqrt{7}}$

$\frac{5}{4\sqrt{7}}\left(\frac{\sqrt{7}}{\sqrt{7}}\right)$

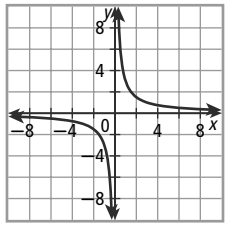
$\frac{5\sqrt{7}}{4(7)}$

$\frac{5\sqrt{7}}{28}$

66. $y = \frac{-10}{x}$



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



READY TO GO ON? PAGE 609

1. $\frac{m_1}{V_1} = \frac{m_2}{V_2}$

$\frac{8.7}{1000} = \frac{m}{4500}$

$1000m = 8.7(4500)$

$m = 39.15$

The mass of the statue is 39.15 kg.

2. $t = \frac{k}{n}$

$6 = \frac{k}{6}$

$k = 36$

$t = \frac{k}{n} = \frac{36}{10} = 3.6$

It will take 10 workers 3.6 h to clean the rides.

3. $\frac{5x^3}{10x^2 + 5x}$

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

$\frac{x^2}{2x+1}$;

$x \neq -\frac{1}{2}$ and $x \neq 0$

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

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

$\frac{x-3}{x+4}$;

$x \neq -4$ and $x \neq -1$

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

$\frac{-(x-6)}{(x-6)(x+3)}$

$\frac{-1}{x+3}$; $x \neq -3$ and $x \neq 6$

6. $\frac{x+3}{x+2} \cdot \frac{2x-4}{x^2-9}$

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

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

7. $\frac{9x^6y}{27x^2y^5} \div \frac{x}{6y^2}$

$\frac{x^4}{3y^4} \cdot \frac{6y^2}{x}$

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

8. $\frac{2x^3 - 18x}{x^2 - 2x - 8} \div \frac{x^2 + x - 12}{x^2 - 16}$

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

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

$\frac{2x(x+3)}{x+2}$

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

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

$\frac{2x-3}{x-2}; x \neq 2$

10. $\frac{x^2-x}{x^2-25} + \frac{3}{x+5}$

$\frac{x^2-x}{x^2-25} + \frac{3}{x+5}\left(\frac{x-5}{x-5}\right)$

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

$\frac{x^2+2x-15}{(x+5)(x-5)}$

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

$\frac{x-3}{x-5}; x \neq -5$ and $x \neq 5$

11. $\frac{x}{x-3} - \frac{1}{x+3}$

$\frac{x}{x-3}\left(\frac{x+3}{x+3}\right) - \frac{1}{x+3}\left(\frac{x-3}{x-3}\right)$

$\frac{x(x+3)-(x-3)}{(x-3)(x+3)}$

$\frac{x^2+2x+3}{(x-3)(x+3)}; x \neq -3$ and $x \neq 3$

12. $\frac{2d}{\frac{d}{550}+\frac{d}{430}}$

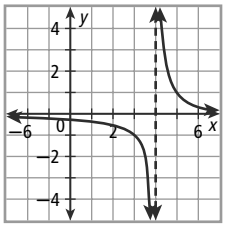
$\frac{2d(23650)}{\frac{d}{550}(23650)+\frac{d}{430}(23650)}$

$\frac{47300d}{43d+55d}$

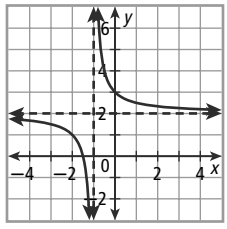
$\frac{47300d}{98d} \approx 483$

The average speed for the entire trip is 483 mi/h.

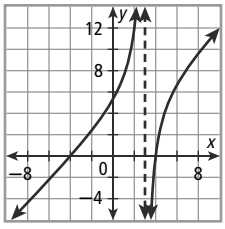
13. g is f translated 4 units right.



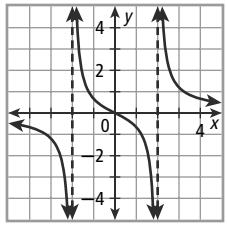
14. g is f translated 1 unit left and 2 units up.



15. zeros: 4, −4; vertical asymptote: $x = 3$



16. zero: 0; vertical asymptotes: $x = -2$, $x = 2$, horizontal asymptote: $y = 0$



17. $y - \frac{10}{y} = 3$

$y(y) - \frac{10}{y}(y) = 3(y)$

$y^2 - 10 = 3y$

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

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

$y - 5 = 0$ or $y + 2 = 0$

$y = 5$ or $y = -2$

18. $\frac{x}{x-8} = \frac{24-2x}{x-8}$

$\frac{x}{x-8}(x-8) = \frac{24-2x}{x-8}(x-8)$

$x = 24 - 2x$

$x = 8$

The solution $x = 8$ is extraneous. Therefore there is no solution.

19. $\frac{-3x}{3} - \frac{x+15}{x+9} = 1$

$\frac{-3x}{3}(x+9) - \frac{x+15}{x+9}(x+9) = 1(x+9)$

$-x(x+9) - (x+15) = x+9$

$-x^2 - 11x - 24 = 0$

$-(x+3)(x+8) = 0$

$x + 3 = 0$ or $x + 8 = 0$

$x = -3$ or $x = -8$

20. $\frac{1}{4}(3) + \frac{1}{h}(3) = 1$

$\frac{1}{4}(3)(4h) + \frac{1}{h}(3)(4h) = 1(4h)$

$3h + 12 = 4h$

$h = 12$

It would take the small oven 12 hours to bake the bread.

8-6 RADICAL EXPRESSIONS AND RATIONAL EXPONENTS, PAGES 610–617

CHECK IT OUT!

1a. no real roots **b.** ± 1

c. 5

2a. $\sqrt[4]{16x^4}$

$\sqrt[4]{2^4 \cdot x^4}$

$\sqrt[4]{2^4} \cdot \sqrt[4]{x^4}$

$2 \cdot x^2$

$2x^2$

b. $\sqrt[4]{\frac{x^8}{3}}$

$\frac{\sqrt[4]{x^4 \cdot x^4}}{\sqrt[4]{3}}$

$\frac{\sqrt[4]{x^4} \cdot \sqrt[4]{x^4}}{\sqrt[4]{3}}$

$\frac{x^2}{\sqrt[4]{3}}$

$\frac{x^2}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}}$

$\frac{x^2\sqrt[4]{3^3}}{\sqrt[4]{3^4}}$

$\frac{x^2\sqrt[4]{27}}{3}$

c. $\sqrt[3]{x^7} \cdot \sqrt[3]{x^2}$

$\sqrt[3]{x^7 \cdot x^2}$

$\sqrt[3]{x^9}$

$\sqrt[3]{x^3 \cdot x^3 \cdot x^3}$

$\sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3}$

x^3

3a. $64^{\frac{1}{3}}$

$\left(\sqrt[3]{64}\right)^1$

$(4)^1$

4

b. $4^{\frac{5}{2}}$

$\left(\sqrt{4}\right)^5$

$(2)^5$

32

c. $625^{\frac{3}{4}}$

$\left(\sqrt[4]{625}\right)^3$

$(5)^3$

125

4a. $81^{\frac{3}{4}}$

b. $\sqrt[3]{10^9}$

$10^{\frac{9}{3}}$

$10^3 = 1000$

c. $\sqrt[4]{5^2}$

$5^{\frac{2}{4}}$

$5^{\frac{1}{2}}$

5a. $36^{\frac{3}{8}} \cdot 36^{\frac{1}{8}}$

$36^{\frac{3}{8} + \frac{1}{8}}$

$36^{\frac{1}{2}}$

$\sqrt{36}$

6

b. $(-8)^{-\frac{1}{3}}$

$\frac{1}{(-8)^{\frac{1}{3}}}$

$\frac{1}{\sqrt[3]{-8}}$

$\frac{1}{-2}$

$-\frac{1}{2}$

c. $\frac{5^{\frac{9}{4}}}{5^{\frac{1}{4}}}$

$5^{\frac{9}{4} - \frac{1}{4}}$

5^2

25

6. $64\left(2^{-\frac{n}{12}}\right) = 64\left(2^{-\frac{12}{12}}\right)$

$= 64\left(2^{-1}\right)$

$= 64\left(\frac{1}{2}\right)$

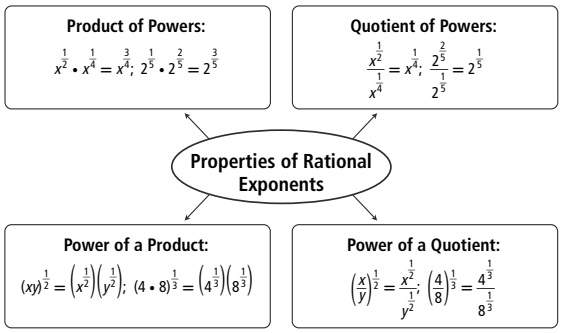
$= 32$

The fret should be placed 32 cm from the bridge.

THINK AND DISCUSS

1. Possible answer: When a and n are natural numbers, the expression $\sqrt[n]{a^n}$ can be written with a rational exponent: $a^{\frac{n}{n}}$. The exponent simplifies to 1, so the expression becomes a^1, or a.

2. Possible answer:



EXERCISES

GUIDED PRACTICE

1. 3

2. 3

3. ± 5

4. 0

5. $\sqrt[3]{8x^3}$

$\sqrt[3]{2^3 \cdot x^3}$

$\sqrt[3]{2^3} \cdot \sqrt[3]{x^3}$

$2 \cdot x$

$2x$

6. $\sqrt[4]{\frac{32}{x^4}}$

$\frac{\sqrt[4]{2^5}}{\sqrt[4]{x^4}}$

$\frac{\sqrt[4]{2^4 \cdot 2}}{\sqrt[4]{x^4}}$

$\frac{\sqrt[4]{2^4} \cdot \sqrt[4]{2}}{\sqrt[4]{x^4}}$

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

7. $\sqrt[3]{\frac{125x^6}{6}}$

$\frac{\sqrt[3]{125x^6}}{\sqrt[3]{6}}$

$\frac{\sqrt[3]{5^3 \cdot x^3 \cdot x^3}}{\sqrt[3]{6}}$

$\frac{\sqrt[3]{5^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3}}{\sqrt[3]{6}}$

$\frac{5x^2}{\sqrt[3]{6}}$

$\frac{5x^2}{\sqrt[3]{6}} \cdot \frac{\sqrt[3]{6}}{\sqrt[3]{6}} \cdot \frac{\sqrt[3]{6}}{\sqrt[3]{6}}$

$\frac{5x^2\sqrt[3]{6^2}}{\sqrt[3]{6^3}}$

$\frac{5x^2\sqrt[3]{36}}{6}$

8. $\sqrt{50x^3}$

$\sqrt{2x \cdot 5^2 \cdot x^2}$

$\sqrt{2x} \cdot \sqrt{5^2} \cdot \sqrt{x^2}$

$\sqrt{2x} \cdot 5 \cdot x$

$5x\sqrt{2x}$

9. $\sqrt[4]{x^8} \cdot \sqrt[3]{x^4}$

$\sqrt[4]{x^4 \cdot x^4} \cdot \sqrt[3]{x^3 \cdot x}$

$\sqrt[4]{x^4} \cdot \sqrt[4]{x^4} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x}$

$x \cdot x \cdot x \cdot \sqrt[3]{x}$

$x^3\sqrt[3]{x}$

10. $\sqrt[3]{\frac{x^5}{4}}$

$\frac{\sqrt[3]{x^3 \cdot x^2}}{\sqrt[3]{4}}$

$\frac{\sqrt[3]{x^3} \cdot \sqrt[3]{x^2}}{\sqrt[3]{4}}$

$\frac{x\sqrt[3]{x^2}}{\sqrt[3]{4}}$

$\frac{x\sqrt[3]{x^2}}{\sqrt[3]{4}} \cdot \frac{\sqrt[3]{2}}{\sqrt[3]{2}}$

$\frac{x\sqrt[3]{2x^2}}{\sqrt[3]{2^3}}$

$\frac{x\sqrt[3]{2x^2}}{2}$

11. $\frac{\sqrt{40x^4}}{\sqrt[3]{-x^3}}$

$\frac{\sqrt{10 \cdot 2^2 \cdot x^2 \cdot x^2}}{\sqrt[3]{(-x)^3}}$

$\frac{\sqrt{10} \cdot \sqrt{2^2} \cdot \sqrt{x^2} \cdot \sqrt{x^2}}{-x}$

$\frac{\sqrt{10} \cdot 2 \cdot x \cdot x}{-x}$

$-2x\sqrt{10}$

12. $\sqrt[4]{\frac{x^{12}y^4}{3}}$

$\frac{\sqrt[4]{x^4 \cdot x^4 \cdot x^4 \cdot y^4}}{\sqrt[4]{3}}$

$\frac{\sqrt[4]{x^4} \cdot \sqrt[4]{x^4} \cdot \sqrt[4]{x^4} \cdot \sqrt[4]{y^4}}{\sqrt[4]{3}}$

$\frac{x^3y}{\sqrt[4]{3}}$

$\frac{x^3y}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}} \cdot \frac{\sqrt[4]{3}}{\sqrt[4]{3}}$

$\frac{x^3y\sqrt[4]{3^3}}{\sqrt[4]{3^4}}$

$\frac{x^3y\sqrt[4]{27}}{3}$

13. $36^{\frac{3}{2}}$

$\left(\sqrt{36}\right)^3$

$(6)^3$

216

14. $32^{\frac{3}{5}}$

$\left(\sqrt[5]{32}\right)^3$

$(2)^3$

8

15. $(-27)^{\frac{1}{3}}$

$\sqrt[3]{-27}$

-3

16. $8^{\frac{2}{3}}$

$\left(\sqrt[3]{8}\right)^2$

$(2)^2$

4

17. $\sqrt[5]{9^{10}}$

$9^{\frac{10}{5}}$

$9^2 = 81$

18. $8^{\frac{3}{2}}$

19. $5^{\frac{3}{6}} = 5^{\frac{1}{2}}$

20. $27^{\frac{2}{3}}$

21. $13^{\frac{1}{2}} \cdot 13^{\frac{3}{2}}$

$13^{\frac{1}{2}+\frac{3}{2}}$

13^2

169

22. $\frac{9^{\frac{4}{3}}}{9^{\frac{2}{3}}}$

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

$9^{\frac{2}{3}}$

$\sqrt[3]{9^2}$

$\sqrt[3]{81}$ or $3\sqrt[3]{3}$

23. $\left(64^{\frac{1}{2}}\right)^{\frac{1}{3}}$

$64^{\frac{1}{2} \cdot \frac{1}{3}}$

$64^{\frac{1}{6}}$

2

24. $\left(\frac{8}{27}\right)^{\frac{1}{3}}$

$\frac{\sqrt[3]{8}}{\sqrt[3]{27}}$

$\frac{2}{3}$

25. $25^{-\frac{1}{2}}$

$\frac{1}{25^{\frac{1}{2}}}$

$\frac{1}{5}$

26. $7^{\frac{1}{4}} \cdot 7^{-\frac{3}{4}}$

$7^{\frac{1}{4}-\frac{3}{4}}$

$7^{-\frac{1}{2}}$

$\frac{1}{7^{\frac{1}{2}}}$

$\frac{\sqrt{7}}{7}$

27. $(-125)^{-\frac{1}{3}}$

$\frac{1}{(-125)^{\frac{1}{3}}}$

$\frac{1}{-5}$

$-\frac{1}{5}$

28. $\left(6^{\frac{1}{2}}\right)^6$

$6^{\frac{1}{2} \cdot 6}$

6^3

216

29. $\sqrt[3]{50} \approx 3.68$

$3.68 \text{ ft} = 3.68 \times 12 \text{ in} \approx 44 \text{ in.}$

The side length of the cube is about 44 in.

PRACTICE AND PROBLEM SOLVING

30. -4

31. 2

32. no real roots

33. $\sqrt[3]{9x} \cdot \sqrt[3]{3x^2}$

$\sqrt[3]{9x \cdot 3x^2}$

$\sqrt[3]{3^3 \cdot x^3}$

$\sqrt[3]{3^3} \cdot \sqrt[3]{x^3}$

$3 \cdot x$

$3x$

34. $\sqrt[4]{324x^8}$

$\sqrt[4]{3^4 \cdot 4 \cdot x^4 \cdot x^4}$

$\sqrt[4]{3^4} \cdot \sqrt[4]{4} \cdot \sqrt[4]{x^4} \cdot \sqrt[4]{x^4}$

$3 \cdot \sqrt[4]{4} \cdot x \cdot x$

$3x^2\sqrt[4]{4}$

35. $\sqrt[3]{\frac{x^6}{250}}$

$\frac{\sqrt[3]{x^3 \cdot x^3}}{\sqrt[3]{250}}$

$\frac{\sqrt[3]{x^3} \cdot \sqrt[3]{x^3}}{\sqrt[3]{250}}$

$\frac{x^2}{\sqrt[3]{250}}$

$\frac{x^2}{\sqrt[3]{250}} \cdot \frac{\sqrt[3]{4}}{\sqrt[3]{4}}$

$\frac{x^2\sqrt[3]{4}}{\sqrt[3]{1000}}$

$\frac{x^2\sqrt[3]{4}}{10}$

36. $\sqrt{\frac{x^5}{45}}$

$\frac{\sqrt{x^2 \cdot x^2 \cdot x}}{\sqrt{45}}$

$\frac{\sqrt{x^2} \cdot \sqrt{x^2} \cdot \sqrt{x}}{\sqrt{45}}$

$\frac{x^2\sqrt{x}}{\sqrt{45}}$

$\frac{x^2\sqrt{x}}{\sqrt{45}} \cdot \frac{\sqrt{5}}{\sqrt{5}}$

$\frac{x^2\sqrt{5x}}{\sqrt{225}}$

$\frac{x^2\sqrt{5x}}{15}$

37. $\sqrt[3]{56x^9}$

$\sqrt[3]{2^3 \cdot 7 \cdot x^3 \cdot x^3 \cdot x^3}$

$\sqrt[3]{2^3} \cdot \sqrt[3]{7} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3}$

$2 \cdot \sqrt[3]{7} \cdot x \cdot x \cdot x$

$2x^3\sqrt[3]{7}$

38. $\frac{\sqrt[4]{x^{10}}}{\sqrt[4]{x^4}}$

$\sqrt[4]{\frac{x^{10}}{x^4}}$

$\sqrt[4]{x^6}$

$\sqrt[4]{x^4 \cdot x^2}$

$\sqrt[4]{x^4} \cdot \sqrt[4]{x^2}$

$x\sqrt{x}$

39. $\sqrt[5]{x^7} \cdot \sqrt[5]{x^6}$

$\sqrt[5]{x^7 \cdot x^6}$

$\sqrt[5]{x^5 \cdot x^5 \cdot x^3}$

$\sqrt[5]{x^5} \cdot \sqrt[5]{x^5} \cdot \sqrt[5]{x^3}$

$x \cdot x \cdot \sqrt[5]{x^3}$

$x^2\sqrt[5]{x^3}$

40. $\sqrt[3]{-54x^9y^3}$

$\sqrt[3]{(-3)^3 \cdot 2 \cdot x^3 \cdot x^3 \cdot x^3 \cdot y^3}$

$\sqrt[3]{(-3)^3} \cdot \sqrt[3]{2} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{y^3}$

$(-3) \cdot \sqrt[3]{2} \cdot x \cdot x \cdot x \cdot y$

$-3x^3y\sqrt[3]{2}$

41. $64^{\frac{1}{2}}$

$\sqrt{64}$

8

42. $216^{\frac{2}{3}}$

$\left(\sqrt[3]{216}\right)^2$

$(6)^2$

36

43. $(-1000)^{\frac{4}{3}}$

$\left(\sqrt[3]{-1000}\right)^4$

$(-10)^4$

$10{,}000$

44. $6^{\frac{3}{2}}$

$\sqrt{6^3}$

$\sqrt{6^2} \cdot \sqrt{6}$

$6\sqrt{6}$

45. $\sqrt[3]{14^3}$

$14^{\frac{3}{3}}$

14^1

14

46. $(-8)^{\frac{4}{5}}$

47. $\left(\sqrt[4]{144}\right)^2$

$144^{\frac{2}{4}}$

$144^{\frac{1}{2}} = 12$

48. $48^{\frac{3}{2}}$

49. $(8 \cdot 64)^{\frac{2}{3}}$

$8^{\frac{2}{3}} \cdot 64^{\frac{2}{3}}$

$\left(\sqrt[3]{8}\right)^2 \cdot \left(\sqrt[3]{64}\right)^2$

$(2)^2 \cdot (4)^2$

$4 \cdot 16$

64

50. $144^{-\frac{1}{2}}$

$\frac{1}{144^{\frac{1}{2}}}$

$\frac{1}{\sqrt{144}}$

$\frac{1}{12}$

51. $\left(\frac{2^3}{27}\right)^{\frac{1}{3}}$

$\frac{\left(2^3\right)^{\frac{1}{3}}}{27^{\frac{1}{3}}}$

$\frac{2^1}{\sqrt[3]{27}}$

$\frac{2}{3}$

52. $2^{\frac{1}{2}} \cdot 2^{\frac{1}{4}}$

$2^{\frac{1}{2}+\frac{1}{4}}$

$2^{\frac{3}{4}}$

$\left(2^3\right)^{\frac{1}{4}}$

$8^{\frac{1}{4}}$ or $\sqrt[4]{8}$

53. $\left(\frac{49}{81}\right)^{-\frac{1}{2}}$

$\frac{1}{\left(\frac{49}{81}\right)^{\frac{1}{2}}}$

$\frac{1}{\frac{\sqrt{49}}{\sqrt{81}}}$

$\frac{1}{\frac{7}{9}}$

$\frac{9}{7}$

54. $\frac{12^{\frac{1}{4}}}{12^{\frac{3}{4}}}$

$12^{\frac{1}{4}-\frac{3}{4}}$

$12^{-\frac{1}{2}}$

$\frac{1}{12^{\frac{1}{2}}}$ or $\frac{\sqrt{3}}{6}$

55. $\left(5^{\frac{1}{3}}\right)^{\frac{1}{3}}$

$5^{\frac{1}{3} \cdot \frac{1}{3}}$

$5^{\frac{1}{9}}$ or $\sqrt[9]{5}$

56. $\left(\frac{27}{27^{\frac{1}{3}}}\right)^{\frac{1}{2}}$

$\left(\frac{27}{3}\right)^{\frac{1}{2}}$

$9^{\frac{1}{2}}$

3

57. $a(6) = 1000\left(2^{\frac{6}{24}}\right) \approx 1189$

The amount will be about \$1189 after 6 years.

58a. $P = 73.3\sqrt[4]{55^3} \approx 1480$

A cheetah has a metabolism rate of 1480 Cal/day.

b. House cat: $P = 73.3\sqrt[4]{4.5^3} \approx 227$

Lion: $P = 73.3\sqrt[4]{170^3} \approx 3451$

$3451 - 227 = 3224$

A lion needs to consume about 3224 more Calories each day than a house cat.

59a. $100\left(\frac{1}{2}\right)^{\frac{t}{h}} = 100\left(\frac{1}{2}\right)^{\frac{20}{8}} \approx 18\%$

About 18% of the sample will remain.

b. Iodine-131: $20 \times 100\left(\frac{1}{2}\right)^{\frac{30}{8}} \approx 1.5$

Iodine-125: $20 \times 100\left(\frac{1}{2}\right)^{\frac{30}{59}} \approx 14.1$

$14.1 - 1.5 = 12.6$

About 12.6 g more iodine-125 than iodine-131 will remain after 30 days.

60. $W = 35.74 + 0.6215(40) - 35.75(35)^{\frac{4}{25}} + 0.4275(40)(35)^{\frac{4}{25}} \approx 28$

The wind chill is about 28°F.

61a. $2\pi\sqrt{\frac{L}{g}} = \frac{2\pi\sqrt{L}}{\sqrt{g}} = \frac{2\pi\sqrt{L}}{\sqrt{g}} \cdot \frac{\sqrt{g}}{\sqrt{g}} = \frac{2\pi\sqrt{Lg}}{g}$

b. $t = \frac{2\pi\sqrt{(0.35)(9.8)}}{9.8} \approx 1.2$

It will take about 1.2 s to complete one swing.

62. $\sqrt[4]{20x^3}$

$(20x^3)^{\frac{1}{4}}$

$20^{\frac{1}{4}}(x^3)^{\frac{1}{4}}$

$20^{\frac{1}{4}}x^{\frac{3}{4}}$

63. $(5x)^{\frac{7}{2}}$

64. $\left(\sqrt[5]{-9}\sqrt[3]{x}\right)^4$

$\left(\sqrt[5]{-9}\right)^4\left(\sqrt[3]{x}\right)^4$

$(-9)^{\frac{4}{5}}x^{\frac{4}{3}}$

65. $\left(\sqrt[4]{11x^8}\right)^6$

$(11x^8)^{\frac{6}{4}}$

$11^{\frac{6}{4}}(x^8)^{\frac{6}{4}}$

$11^{\frac{3}{2}}x^{12}$

66. $\left(-8x^{12}\right)^{\frac{2}{3}}$

$(-8)^{\frac{2}{3}}\left(x^{12}\right)^{\frac{2}{3}}$

$\left((-2)^3\right)^{\frac{2}{3}}x^8$

$(-2)^2x^8$

$4x^8$

67. $5^{\frac{7}{4}}x^{\frac{4}{3}}$

$5^1 \cdot 5^{\frac{3}{4}} \cdot x^{\frac{3}{4}}$

$5 \cdot (5x)^{\frac{3}{4}}$

$5\sqrt[4]{(5x)^3}$

$5\sqrt[4]{125x^3}$

68. $\left(-12x^{15}\right)^{\frac{3}{5}}$

$(-12)^{\frac{3}{5}}\left(x^{15}\right)^{\frac{3}{5}}$

$x^9\sqrt[5]{(-12)^3}$

$x^9\sqrt[5]{(-2)^6 \cdot (-3)^3}$

$x^9\sqrt[5]{(-2)^5} \cdot \sqrt[5]{(-2)(-3)^3}$

$-2x^9\sqrt[5]{54}$

69. $\left(a^2b^4\right)^{\frac{1}{3}}$

$\left(a^2b \cdot b^3\right)^{\frac{1}{3}}$

$\left(a^2b\right)^{\frac{1}{3}} \cdot \left(b^3\right)^{\frac{1}{3}}$

$\left(a^2b\right)^{\frac{1}{3}} \cdot b$

$b\sqrt[3]{a^2b}$

70. $\left(\frac{a^4}{b}\right)^{\frac{1}{4}}$

$\frac{\left(a^4\right)^{\frac{1}{4}}}{b^{\frac{1}{4}}}$

$\frac{a^1}{\sqrt[4]{b}}$

$\frac{a}{\sqrt[4]{b}} \cdot \frac{\sqrt[4]{b}}{\sqrt[4]{b}} \cdot \frac{\sqrt[4]{b}}{\sqrt[4]{b}} \cdot \frac{\sqrt[4]{b}}{\sqrt[4]{b}}$

$\frac{a\sqrt[4]{b^3}}{b}$

71. $a^{\frac{3}{4}}\left(4b^6\right)^{\frac{1}{4}}$

$\left(a^3\right)^{\frac{1}{4}}\left(4b^2 \cdot b^4\right)^{\frac{1}{4}}$

$\left(a^3\right)^{\frac{1}{4}} \cdot \left(4b^2\right)^{\frac{1}{4}} \cdot \left(b^4\right)^{\frac{1}{4}}$

$\left(4a^3b^2\right)^{\frac{1}{4}} \cdot b^1$

$b\sqrt[4]{4a^3b^2}$

72. $m(24) = 100 \cdot 2^{\frac{24}{60}} \approx 132$

The mass is about 132 kg after 24 h.

73. Always; possible answer: $\sqrt[3]{x^6} = x^{\frac{6}{3}} = x^2$ for all real numbers.

74. Never; possible answer: if x is positive, $(x)^{\frac{1}{3}}$ is positive and $(-x)^{\frac{1}{3}}$ is negative; therefore, $(x)^{\frac{1}{3}} \neq (-x)^{\frac{1}{3}}$. If x is negative, $(x)^{\frac{1}{3}}$ is negative and $(-x)^{\frac{1}{3}}$ is positive; therefore, $(x)^{\frac{1}{3}} \neq (-x)^{\frac{1}{3}}$.

75. Never; possible answer: simplify the left side of the equation: $-\sqrt[4]{x^8} = -x^{\frac{8}{4}} = -x^2$. The expression $-x^2$ is negative for all nonzero real numbers. Simplify the right side of the equation: $x^{-2} = \frac{1}{x^2}$. The expression $\frac{1}{x^2}$ is positive for all nonzero real numbers. Therefore, $-\sqrt[4]{x^8} \neq x^{-2}$.

76. Sometimes; possible answer: if x is positive, $-\sqrt[3]{x}$ is less than 0. If x is negative, $-\sqrt[3]{x}$ is greater than 0. Therefore, the inequality is true only for positive values of x.

77. 2 and 3; about 2.62

78. 3 and 4; about 3.76

79. -5 and -4; about -4.31

80a. $P = 14.7(10)^{-0.000014(5280)} \approx 12.4$

The air pressure in Denver is about 12.4 psi.

b. $P = 14.7(10)^{-0.000014(29028)} \approx 5.8$

The air pressure at the top of Mount Everest is about 5.8 psi.

81. A is incorrect. The Quotient of Powers Property is incorrectly applied. To simplify $625^{\frac{1}{3}} \div 625^{\frac{4}{3}}$, you should subtract the exponents rather than dividing them.

82. 4 values; 1, 2, 3, 6

83. Possible answer: Raise 10 to the $\frac{1}{6}$ power, or use the $\sqrt[x]{\ }$ function to find the sixth root of 10.

84. Possible answer: The exponent 2.4 is rational because it can be expressed as the ratio of 2 integers. For example, the exponent can be expressed as the ratio of the integers 24 and 10 because $2.4 = \frac{24}{10}$.

TEST PREP

85. A

86. H;

$(4\pi)^{\frac{1}{3}}(3(8V))^{\frac{2}{3}}$

$8^{\frac{2}{3}}(4\pi)^{\frac{1}{3}}(3V)^{\frac{2}{3}}$

$4(4\pi)^{\frac{1}{3}}(3V)^{\frac{2}{3}} = 4S$

87. A;

$\sqrt[4]{a} = \sqrt[4]{x^6}$

$= x^{\frac{6}{4}}$

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

88. F;

$\sqrt[3]{\frac{56a^6}{7}}$

$\sqrt[3]{8a^6}$

$\sqrt[3]{2^3 \cdot a^3 \cdot a^3}$

$\sqrt[3]{2^3} \cdot \sqrt[3]{a^3} \cdot \sqrt[3]{a^3}$

$2a^2$

CHALLENGE AND EXTEND

89. $\left(\left(20^{\frac{1}{2}}\right)^{\frac{1}{2}}\right)^{\frac{1}{2}} = 20^{\left(\frac{1}{2}\right)^3}$

$= 20^{\frac{1}{8}}$

90. $2^{\frac{1}{3}} \cdot 4^{\frac{1}{6}} \cdot 8^{\frac{1}{9}}$

$2^{\frac{1}{3}} \cdot \left(2^2\right)^{\frac{1}{6}} \cdot \left(2^3\right)^{\frac{1}{9}}$

$2^{\frac{1}{3}} \cdot 2^{\frac{1}{3}} \cdot 2^{\frac{1}{3}}$

$2^{\frac{1}{3} \cdot 3}$

$2^1 = 2$

91. $\sqrt[3]{a} > a$

a is positive.

$1 > \sqrt[3]{a^2}$

$1 > a^2$

$-1 < a < 1$

The solution in this case is $0 < a < 1$.

a is negative.

$1 < \sqrt[3]{a^2}$

$1 < a^2$

$a < -1$ or $a > 1$

The solution in this case is $a < -1$.

The solution to the inequality is $a < -1$ or $0 < a < 1$.

92. $1^3 = 1 \cdot 1 \cdot 1 = 1$;

$\left(\frac{-1 + i\sqrt{3}}{2}\right)^3 = \frac{\left(-1 + i\sqrt{3}\right)\left(-1 + i\sqrt{3}\right)\left(-1 + i\sqrt{3}\right)}{8}$

$= \frac{\left(-2 - 2i\sqrt{3}\right)\left(-1 + i\sqrt{3}\right)}{8} = \frac{8}{8} = 1$;

$\left(\frac{-1 - i\sqrt{3}}{2}\right)^3 = \frac{\left(-1 - i\sqrt{3}\right)\left(-1 - i\sqrt{3}\right)\left(-1 - i\sqrt{3}\right)}{8}$

$= \frac{\left(-2 + 2i\sqrt{3}\right)\left(-1 - i\sqrt{3}\right)}{8} = \frac{8}{8} = 1$

SPIRAL REVIEW

93. $\begin{bmatrix} 7 & 7 & -2 \\ 9 & 5 & 5 \end{bmatrix}$

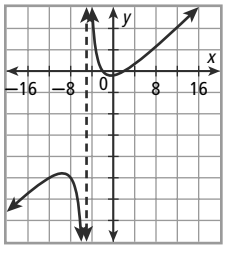
94. $\begin{bmatrix} -4 & -8 \\ 0 & 2 \end{bmatrix}$

95. $\begin{bmatrix} 6 & 6 \\ 0 & -6 \end{bmatrix}$

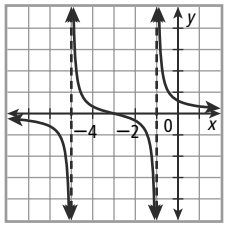
96. $g(x) = \frac{1}{3}(x - 1)^2$

97. $h(x) = -x^2 + 3$

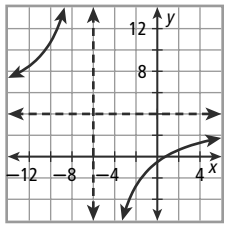
98. zeros: ± 2;
asymptote: $x = -5$



99. zero: -3;
asymptotes: $x = -5$, $x = -1$, $y = 0$



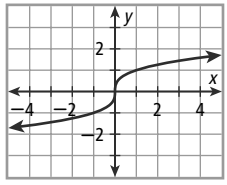
100. zero: $\frac{3}{4}$;
asymptotes: $x = -6$, $y = 4$



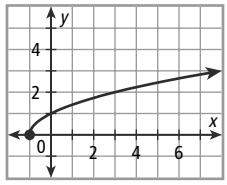
8-7 RADICAL FUNCTIONS, PAGES 619–627

CHECK IT OUT!

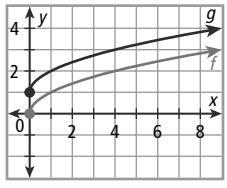
1a. D: $\{x \mid x \in \mathbb{R}\}$;
R: $\{y \mid y \in \mathbb{R}\}$



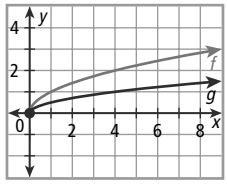
b. D: $\{x \mid x \geq -1\}$;
R: $\{y \mid y \geq 0\}$



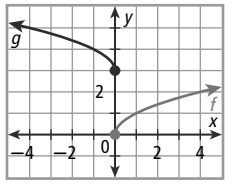
2a. *g* is *f* translated 1 unit up.



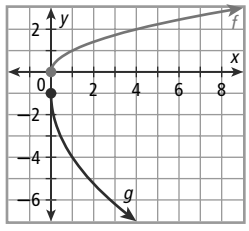
b. *g* is *f* vertically compressed by a factor of $\frac{1}{2}$.



3a. *g* is *f* reflected across the *y*-axis and translated 3 units up.



b. *g* is *f* vertically stretched by a factor of 3, reflected across the *x*-axis, and translated 1 unit down.



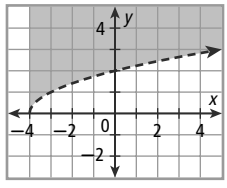
4. $g(x) = -2\sqrt{x} + 1$

5. $h(x) = \sqrt{64x \div \frac{25}{4}} = \sqrt{\frac{256}{25}x}$;

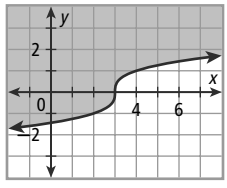
$h(50) = \sqrt{\frac{256}{25}(50)} \approx 23$

The downward velocity is about 23 ft/s.

6a.

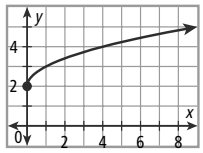
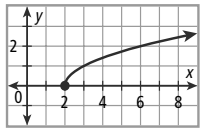
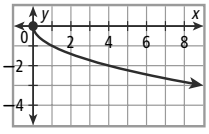
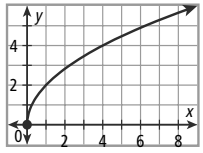


b.



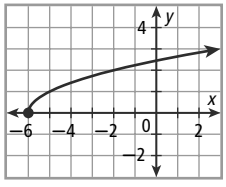
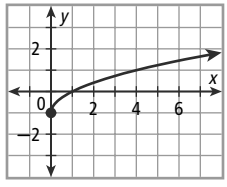
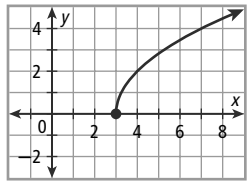
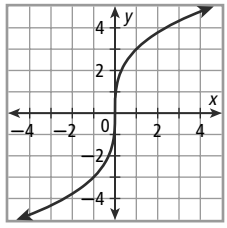
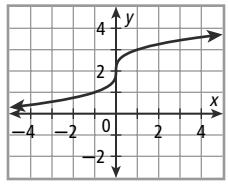
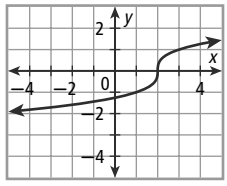
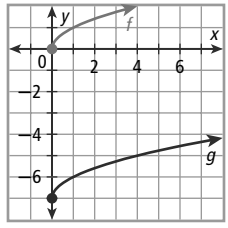
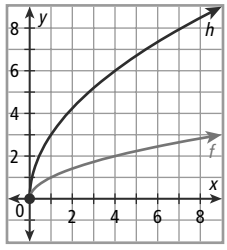
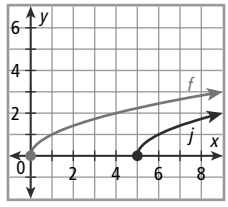
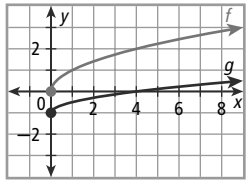
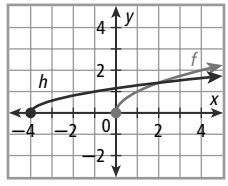
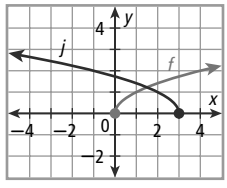
THINK AND DISCUSS

1. Possible answer: No; an asymptote is a line that a curve approaches as $|x|$ or $|y|$ becomes very large. There is no such line in the graphs of radical functions.
2. Possible answer: The radicand must be nonnegative, so $2x + 2$ must be greater than or equal to 0. Solve this inequality for x.
   $2x + 2 \geq 0$
   $x \geq -1$
   The domain of the function is $x \geq -1$.
3. Possible answer:

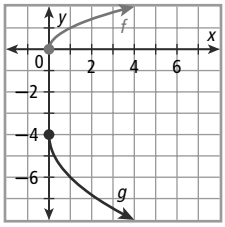
Transformation	Equation	Graph
Vertical translation	$g(x) = \sqrt{x} + 2$	
Horizontal translation	$g(x) = \sqrt{x - 2}$	
Reflection	$g(x) = -\sqrt{x}$	
Vertical stretch	$g(x) = 2\sqrt{x}$	

EXERCISES

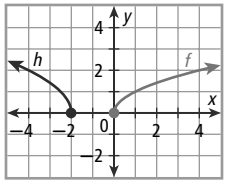
GUIDED PRACTICE

1. Possible answer: The function rule is a radical expression that contains a variable in the radicand.
2. D: $\{x \mid x \geq -6\}$; R: $\{y \mid y \geq 0\}$

3. D: $\{x \mid x \geq 0\}$; R: $\{y \mid y \geq -1\}$

4. D: $\{x \mid x \geq 3\}$; R: $\{y \mid y \geq 0\}$

5. D: $\{x \mid x \in \mathbb{R}\}$; R: $\{y \mid y \in \mathbb{R}\}$

6. D: $\{x \mid x \in \mathbb{R}\}$; R: $\{y \mid y \in \mathbb{R}\}$

7. D: $\{x \mid x \in \mathbb{R}\}$; R: $\{y \mid y \in \mathbb{R}\}$

8. g is f translated 7 units down.

9. h is f vertically stretched by a factor of 3.

10. j is f translated 5 units right.

11. g is f compressed vertically by a factor of $\frac{1}{2}$ and translated 1 unit down.

12. h is f stretched horizontally by a factor of 3 and translated 4 units left.

13. j is f reflected across the y-axis and then translated 3 units right.


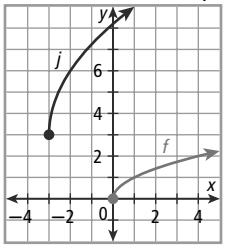
14. g is f reflected across the x-axis, vertically stretched by a factor of 2, and then translated 4 units down.



15. h is f reflected across the y-axis, horizontally compressed by a factor of $\frac{1}{2}$, and then translated 2 units left.



16. j is f vertically stretched by a factor of 3 and then translated 3 units up and 3 units left.



17. $g(x) = 4\sqrt{(x+5)} - 2$

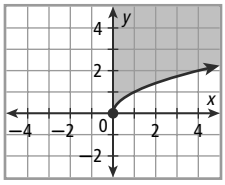
18. $g(x) = \sqrt{-2(x-7)}$

19. $g(x) = \frac{6}{5}\sqrt{\frac{5}{9}x}$;

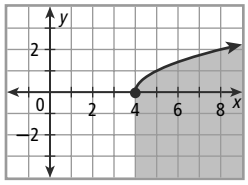
$g(6) = \frac{6}{5}\sqrt{\frac{5}{9}(6)} \approx 2.2$

The distance to the horizon is about 2.2 mi.

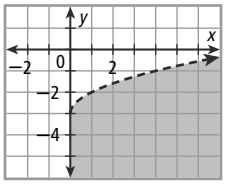
20.



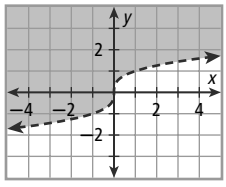
21.



22.

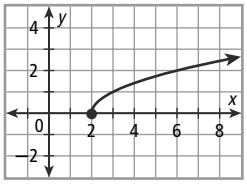


23.

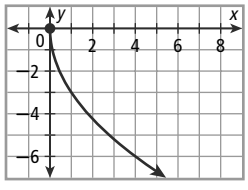


PRACTICE AND PROBLEM SOLVING

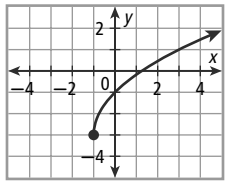
24. D: $\{x \mid x \geq 2\}$;
R: $\{y \mid y \geq 0\}$



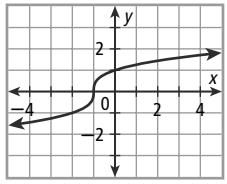
25. D: $\{x \mid x \geq 0\}$;
R: $\{y \mid y \leq 0\}$



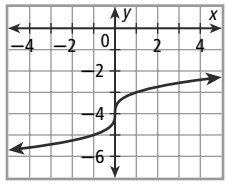
26. D: $\{x \mid x \geq -1\}$;
R: $\{y \mid y \geq -3\}$



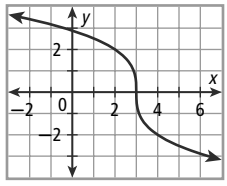
27. D: $\{x \mid x \in \mathbb{R}\}$;
R: $\{y \mid y \in \mathbb{R}\}$



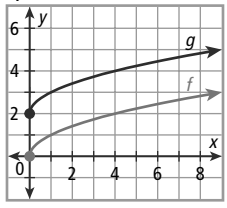
28. D: $\{x \mid x \in \mathbb{R}\}$;
R: $\{y \mid y \in \mathbb{R}\}$



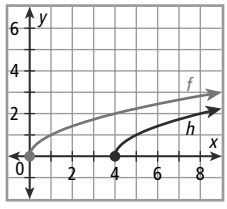
29. D: $\{x \mid x \in \mathbb{R}\}$;
R: $\{y \mid y \in \mathbb{R}\}$



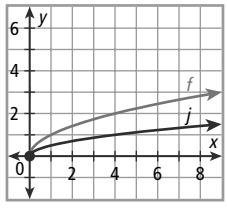
30. g is f translated 2 units up.



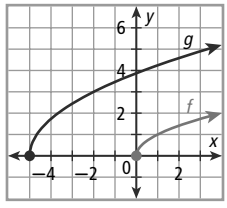
31. h is f translated 4 units right.



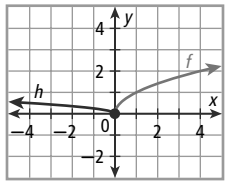
32. j is f vertically compressed by a factor of 0.5.



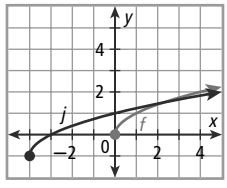
33. g is f horizontally compressed by a factor of $\frac{1}{3}$ and then translated 5 units left.



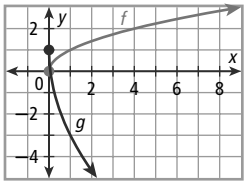
34. h is f vertically compressed by a factor of $\frac{1}{4}$ and then reflected across the y-axis.



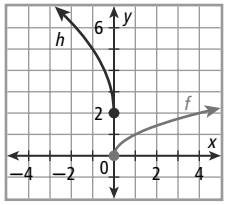
35. j is f translated 4 units left and 1 unit down.



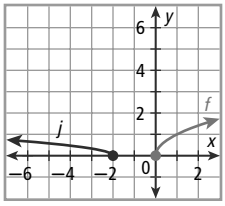
36. g is f reflected across the x-axis, vertically stretched by a factor of 4, and then translated 1 unit up.



37. h is f reflected across the y-axis, vertically stretched by a factor of 3, and then translated 2 units up.



38. j is f reflected across the y-axis, vertically compressed by a factor of $\frac{1}{3}$, and then translated 2 units left.



39. $g(x) = \frac{1}{3}\sqrt{x+3}$

40. $g(x) = \sqrt{-\frac{1}{6}(x-2)}$

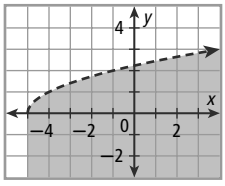
41. $g(x) = -\sqrt{x+1} - 4$

42. $g(x) = \sqrt{\frac{x}{40} \div \frac{3}{5}} = \sqrt{\frac{x}{24}}$;

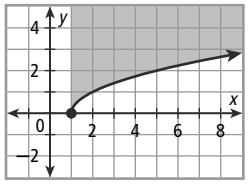
$g(216) = \sqrt{\frac{216}{24}} = 3$

The radius of the can is 3 cm.

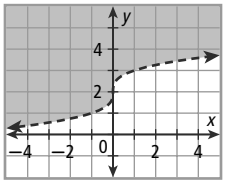
43.



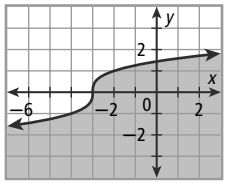
44.



45.



46.



47a. $h(0.01) = 241(0.01)^{-\frac{1}{4}} \approx 762$

The resting heart rate is about 762 beats/min.

b. $h(300) = 241(300)^{-\frac{1}{4}} \approx 58$

The resting heart rate is about 58 beats/min.

48. a vertical stretch by a factor of 6 followed by a translation 1 unit left

49. a vertical stretch by a factor of 3 followed by a translation 1 unit right and 9 units down

50. a reflection across the x-axis followed by a translation 3 units right and 7 units down

51. D

52. B

53. A

54. C

55a. $D(11000) = 3.56\sqrt{11000} \approx 373$

The approximate distance is 373 km.

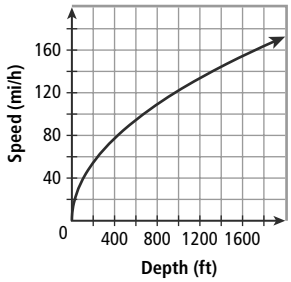
b. $A = 11000 - 4000 = 7000$

$D(7000) = 3.56\sqrt{7000} \approx 297$

$373 - 297 = 76$

It will appear to decrease by about 76 km.

56. The speed is about 150 mi/h.



57. Yes; $M_j = 100\sqrt{\frac{(-263 + 273)^3}{1000}} = 100$ and so $M > M_j$.

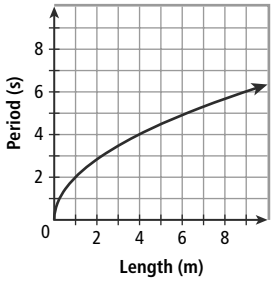
58. $v_{\text{Earth}} = \sqrt{4909(32)(3960)} \approx 24941.3$

$v_{\text{Moon}} = \sqrt{4909(1/6)(32)(1080)} \approx 5317.5$

$24941.3 - 5317.5 \approx 19624$

The vehicle need to travel about 19,624 mi/h faster on Earth than on the Moon.

59a.



b. Possible answer: The graph of T is a vertical stretch of the graph of f by a factor of 2π and a horizontal stretch of the graph of f by a factor of 9.8.

c. by a factor of 4

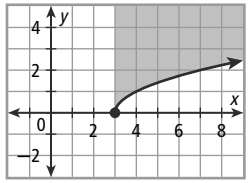
60. sometimes

61. sometimes

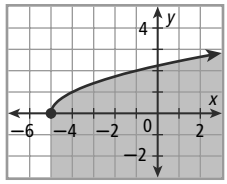
62. always

63. never

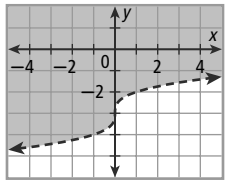
64. no



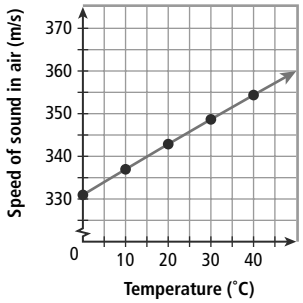
65. yes



66. yes



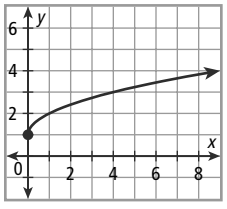
67a.



b. The speed of sound at 25˚C is about 346 m/s.

c. Possible answer: Because k is positive, the value of the function is 0 only when $T + 273.15 = 0$. The value of T that makes this equation true is −273.15˚C.

68a. s is f translated 1 unit up.



b. $s(45) = \sqrt{45} + 1 \approx 7.7$
8 samples should be taken.

69. $t_1 = \sqrt{\frac{240}{4}} \approx 3.9$
$t_2 = \sqrt{\frac{100}{4}} = 2.5$
$3.9 - 2.5 = 1.4$
it will take about 1.4 s longer.

70. Possible answer: A vertical compression of the parent function by a factor of $\frac{1}{2}$ can be represented by $g(x) = \frac{1}{2}\sqrt{x}$. A horizontal stretch of the parent function by a factor of 4 can be represented by $h(x) = \sqrt{\frac{1}{4}x}$. The expression $\sqrt{\frac{1}{4}x}$ can be simplified as follows: $\sqrt{\frac{1}{4}x} = \sqrt{\frac{1}{4}} \cdot \sqrt{x} = \frac{1}{2} \cdot \sqrt{x}$. Therefore, $g(x) = h(x) = \frac{1}{2}\sqrt{x}$.

71. Possible answer: Only nonnegative radicands have real square roots; therefore, the domain of square-root functions is limited to values of x that make the radicand nonnegative. By contrast, all real radicands have cube roots; therefore, the domain of cube-root functions is not limited.

72. Possible answer: A horizontal translation affects the domain, but not the range. The domain of the translated function is $x \geq h$, where h is the number of units the function is translated horizontally. A vertical translation affects the range, but not the domain. The range of the translated function is $f(x) \geq k$, where k is the number of units the function is translated vertically.

TEST PREP

73. D **74.** J

75. A **76.** J

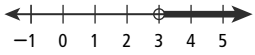
77. Possible answer: The graph was reflected across the y-axis and then translated 4 units right; $g(x) = \sqrt{-(x-4)}$.

CHALLENGE AND EXTEND

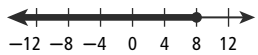
78. $g(x) = -\sqrt{x-3} + 2$ **79.** $f(x) = -2\sqrt{\frac{1}{5}(x+3)} + 4$ or equivalent function

SPIRAL REVIEW

80. $-4x + 5 < -7$
$-4x < -12$
$x > 3$



81. $12 \geq 4(x-5)$
$3 \geq x - 5$
$x \leq 8$



82. $2(x+1) \geq x - 2$
$2x + 2 \geq x - 2$
$x \geq -4$

83. $y = 2x - 10$ ①
$2x + y = 14$ ②
Substitute equation 1 into equation 2.
$2x + (2x - 10) = 14$
$4x = 24$
$x = 6$
Substitute $x = 6$ into equation 2.
$y = 2(6) - 10$
$y = 2$

84. $y = 3x - 2$ ①
$3x = 2y$ ②
Substitute equation 1 into equation 2.
$3x = 2(3x - 2)$
$3x = 6x - 4$
$x = \frac{4}{3}$
Substitute $x = \frac{4}{3}$ into equation 1.
$y = 3\left(\frac{4}{3}\right) - 2$
$y = 2$

85. $-8x + y = 36$ ①
$y = x - 4$ ②
Substitute equation 2 into equation 1.
$-8x + (x - 4) = 36$
$-7x = 40$
$x = -\frac{40}{7}$
Substitute $x = -\frac{40}{7}$ into equation 2.
$y = -\frac{40}{7} - 4$
$y = -\frac{68}{7}$

86. $\frac{7}{x} + x = \frac{16}{3}$

$\frac{7}{x}(3x) + x(3x) = \frac{16}{3}(3x)$

$21 + 3x^2 = 16x$

$3x^2 - 16x + 21 = 0$

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

$x - 3 = 0$ or $3x - 7 = 0$

$x = 3$ or $x = \frac{7}{3}$

87. $4 + \frac{2}{x} = \frac{9}{2}$

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

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

$x = 4$

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

$-5x^2 = 3x - 2$

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

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

$x + 1 = 0$ or $5x - 2 = 0$

$x = -1$ or $x = \frac{2}{5}$

8-8 SOLVING RADICAL EQUATIONS AND INEQUALITIES, PAGES 628–635

CHECK IT OUT!

1a. $4 + \sqrt{x-1} = 5$

$\sqrt{x-1} = 1$

$\left(\sqrt{x-1}\right)^2 = 1^2$

$x - 1 = 1$

$x = 2$

b. $\sqrt[3]{3x-4} = 2$

$\left(\sqrt[3]{3x-4}\right)^3 = 2^3$

$3x - 4 = 8$

$3x = 12$

$x = 4$

c. $6\sqrt{x+10} = 42$

$\sqrt{x+10} = 7$

$\left(\sqrt{x+10}\right)^2 = 7^2$

$x + 10 = 49$

$x = 39$

2a. $\sqrt{8x+6} = 3\sqrt{x}$

$\left(\sqrt{8x+6}\right)^2 = \left(3\sqrt{x}\right)^2$

$8x + 6 = 9x$

$x = 6$

b. $\sqrt[3]{x+6} = 2\sqrt[3]{x-1}$

$\left(\sqrt[3]{x+6}\right)^3 = \left(2\sqrt[3]{x-1}\right)^3$

$x + 6 = 8(x - 1)$

$14 = 7x$

$x = 2$

3a. $\sqrt{2x+14} = x + 3$

$\left(\sqrt{2x+14}\right)^2 = (x+3)^2$

$2x + 14 = x^2 + 6x + 9$

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

$0 = (x - 1)(x + 5)$

$x - 1 = 0$ or $x + 5 = 0$

$x = 1$ or $x = -5$

$x = -5$ is extraneous, the only solution is $x = 1$.

b. $\sqrt{-9x+28} = -x + 4$

$\left(\sqrt{-9x+28}\right)^2 = (-x+4)^2$

$-9x + 28 = x^2 - 8x + 16$

$0 = x^2 + x - 12$

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

$x - 3 = 0$ or $x + 4 = 0$

$x = 3$ or $x = -4$

4a. $(x+5)^{\frac{1}{3}} = 3$

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

$\left(\sqrt[3]{x+5}\right)^3 = 3^3$

$x + 5 = 27$

$x = 22$

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

$\sqrt{2x+15} = x$

$\left(\sqrt{2x+15}\right)^2 = (x)^2$

$2x + 15 = x^2$

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

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

$x - 5 = 0$ or $x + 3 = 0$

$x = 5$ or $x = -3$ ✓

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

$3\sqrt{x+6} = 9$

$\left(3\sqrt{x+6}\right)^2 = 9^2$

$9(x + 6) = 81$

$x + 6 = 9$

$x = 3$

5a. $\sqrt{x-3} + 2 \le 5$

$\sqrt{x-3} \le 3$

$\left(\sqrt{x-3}\right)^2 \le (3)^2$

$x - 3 \le 9$

$x \le 12$;

$x - 3 \ge 0$

$x \ge 3$;

$3 \le x \le 12$

b. $\sqrt[3]{x+2} \ge 1$

$\left(\sqrt[3]{x+2}\right)^3 \ge 1^3$

$x + 2 \ge 1$

$x \ge -1$

6. Possible answer:

$s = \sqrt{30fd}$

$30 = \sqrt{30(0.7)d}$

$30 = \sqrt{21d}$

$(30)^2 = \sqrt{21d^2}$

$900 = 21d$

$43 \approx d$

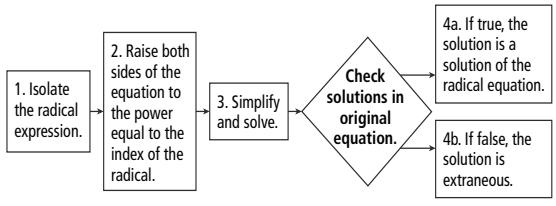
If the car were traveling 30 mi/h, its skid marks would have measured about 43 ft. Because the actual skid marks measure less than 43 ft, the car was not speeding.

THINK AND DISCUSS

1. Possible answer: The equation can be solved algebraically by squaring both sides, or it can be solved by graphing both sides of the equation.

2. Possible answer: To solve $x^2 = a$, take the square root of each side.
To solve $\sqrt{x} = b$, square each side. The operations used to solve each equation are inverses of each other.

3. Possible answer:



EXERCISES

GUIDED PRACTICE

1. No; the expression under the radical does not contain a variable.

2. $\sqrt{x-9}=5$

$\left(\sqrt{x-9}\right)^2=5^2$

$x-9=25$

$x=34$

3. $\sqrt{3x}=6$

$\left(\sqrt{3x}\right)^2=6^2$

$3x=36$

$x=12$

4. $\sqrt[3]{x-2}=2$

$\left(\sqrt[3]{x-2}\right)^3=2^3$

$x-2=8$

$x=10$

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

$\left(\sqrt{3x-1}\right)^2=\left(\sqrt{2x+4}\right)^2$

$3x-1=2x+4$

$x=5$

6. $2\sqrt{x}=\sqrt{x+9}$

$(2\sqrt{x})^2=\left(\sqrt{x+9}\right)^2$

$4x=x+9$

$3x=9$

$x=3$

7. $\sqrt[5]{x+4}=\sqrt[5]{3x-2}$

$\left(\sqrt[5]{x+4}\right)^5=\left(\sqrt[5]{3x-2}\right)^5$

$x+4=3x-2$

$6=2x$

$x=3$

8. $2\sqrt[3]{x}=\sqrt[3]{x+7}$

$\left(2\sqrt[3]{x}\right)^3=\left(\sqrt[3]{x+7}\right)^3$

$8x=x+7$

$7x=7$

$x=1$

9. $\sqrt{x+6}-\sqrt{2x-4}=0$

$\sqrt{x+6}=\sqrt{2x-4}$

$\left(\sqrt{x+6}\right)^2=\left(\sqrt{2x-4}\right)^2$

$x+6=2x-4$

$x=10$

10. $4\sqrt{x+1}=3\sqrt{x+2}$

$\left(4\sqrt{x+1}\right)^2=\left(3\sqrt{x+2}\right)^2$

$16(x+1)=9(x+2)$

$7x=2$

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

11. $\sqrt{x+56}=x$

$\left(\sqrt{x+56}\right)^2=x^2$

$x+56=x^2$

$0=x^2-x-56$

$0=(x-8)(x+7)$

$x-8=0$ or $x+7=0$

$x=8$ ✓

12. $\sqrt{x+18}=x-2$

$\left(\sqrt{x+18}\right)^2=(x-2)^2$

$x+18=x^2-4x+4$

$0=x^2-5x-14$

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

$x-7=0$ or $x+2=0$

$x=7$ $(x-2\geq 0)$ ✓

13. $\sqrt{3x-11}=x-3$

$\left(\sqrt{3x-11}\right)^2=(x-3)^2$

$3x-11=x^2-6x+9$

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

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

$x-4=0$ or $x-5=0$

$x=4$ or $x=5$

14. $\sqrt{x+6}-x=4$

$\sqrt{x+6}=x+4$

$\left(\sqrt{x+6}\right)^2=(x+4)^2$

$x+6=x^2+8x+16$

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

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

$x+2=0$ or $x+5=0$

$x=-2$ $(x+4\geq 0)$ ✓

15. $\sqrt{-x-1}=x+1$

$\left(\sqrt{-x-1}\right)^2=(x+1)^2$

$-x-1=x^2+2x+1$

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

$0=(x+1)(x+2)$

$x+1=0$ or $x+2=0$

$x=-1$ $(x+1\geq 0)$ ✓

16. $\sqrt{15x+10}=2x+3$

$\left(\sqrt{15x+10}\right)^2=(2x+3)^2$

$15x+10=4x^2+12x+9$

$0=4x^2-3x-1$

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

$x-1=0$ or $4x+1=0$

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

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

$\sqrt{x-5}=3$

$\left(\sqrt{x-5}\right)^2=3^2$

$x-5=9$

$x=14$

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

$\sqrt[3]{2x+1}=2$

$\left(\sqrt[3]{2x+1}\right)^3=2^3$

$2x+1=8$

$2x=7$

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

19. $(4x+5)^{\frac{1}{2}}=x$

$\sqrt{4x+5}=x$

$\left(\sqrt{4x+5}\right)^2=x^2$

$4x+5=x^2$

$0=x^2-4x-5$

$0=(x-5)(x+1)$

$x-5=0$ or $x+1=0$

$x=5$ $(x\geq 0)$ ✓

20. $2(x-50)^{\frac{1}{3}}=-10$

$2\sqrt[3]{x-50}=-10$

$\left(2\sqrt[3]{x-50}\right)^3=(-10)^3$

$8(x-50)=-1000$

$x-50=-125$

$x=-75$

21. $2(x+1)^{\frac{1}{2}}=1$

$2\sqrt{x+1}=1$

$\left(2\sqrt{x+1}\right)^2=1^2$

$4(x+1)=1$

$4x=-3$

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

22. $(45-9x)^{\frac{1}{2}}=x-5$

$\sqrt{45-9x}=x-5$

$\left(\sqrt{45-9x}\right)^2=(x-5)^2$

$45-9x=x^2-10x+25$

$0=x^2-x-20$

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

$x-5=0$ or $x+4=0$

$x=5$ $(x-5\geq 0)$ ✓

23. $\sqrt{x+5}-1\leq 4$

$\sqrt{x+5}\leq 5$

$\left(\sqrt{x+5}\right)^2\leq 5^2$

$x+5\leq 25$

$x\leq 20$;

$x+5\geq 0$

$x\geq -5$;

$-5\leq x\leq 20$

24. $\sqrt{2x} + 6 \le 10$

$\sqrt{2x} \le 4$

$\left(\sqrt{2x}\right)^2 \le 4^2$

$2x \le 16$

$x \le 8$;

$2x \ge 0$

$x \ge 0$;

$0 \le x \le 8$

25. $\sqrt{2x+5} < 5$

$\left(\sqrt{2x+5}\right)^2 < 5^2$

$2x + 5 < 25$

$2x < 20$

$x < 10$;

$2x + 5 \ge 0$

$2x \ge -5$

$x \ge -\frac{5}{2}$;

$-\frac{5}{2} \le x < 10$

26. $s = \sqrt{21d}$

$64 = \sqrt{21d}$

$64^2 = \left(\sqrt{21d}\right)^2$

$4096 = 21d$

$195 \approx d$

$200 - 195 = 5$

There will be about 5 ft distance.

PRACTICE AND PROBLEM SOLVING

27. $\sqrt{x-12} = 9$

$\left(\sqrt{x-12}\right)^2 = 9^2$

$x - 12 = 81$

$x = 93$

28. $\sqrt[3]{2x+1} - 3 = 0$

$\sqrt[3]{2x+1} = 3$

$\left(\sqrt[3]{2x+1}\right)^3 = 3^3$

$2x + 1 = 27$

$2x = 26$

$x = 13$

29. $5\sqrt{x+7} = 25$

$\sqrt{x+7} = 5$

$\left(\sqrt{x+7}\right)^2 = 5^2$

$x + 7 = 25$

$x = 18$

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

$\left(\sqrt[4]{2x+6}\right)^4 = 2^4$

$2x + 6 = 16$

$2x = 10$

$x = 5$

31. $3 = \frac{1}{4}\sqrt{3x+30}$

$12 = \sqrt{3x+30}$

$12^2 = \left(\sqrt{3x+30}\right)^2$

$144 = 3x + 30$

$114 = 3x$

$38 = x$

32. $-3 = 2\sqrt{x-7} - 7$

$2 = \sqrt{x-7}$

$2^2 = \left(\sqrt{x-7}\right)^2$

$4 = x - 7$

$11 = x$

33. $\sqrt{4x+12} = \sqrt{6x}$

$\left(\sqrt{4x+12}\right)^2 = \left(\sqrt{6x}\right)^2$

$4x + 12 = 6x$

$12 = 2x$

$6 = x$

34. $5\sqrt{x-1} = \sqrt{x+1}$

$\left(5\sqrt{x-1}\right)^2 = \left(\sqrt{x+1}\right)^2$

$25(x-1) = x + 1$

$24x = 26$

$x = \frac{13}{12}$

35. $\sqrt[3]{4x} = \sqrt[3]{x+7}$

$\left(\sqrt[3]{4x}\right)^3 = \left(\sqrt[3]{x+7}\right)^3$

$4x = x + 7$

$3x = 7$

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

36. $x + 3 = \sqrt{x+5}$

$(x+3)^2 = \left(\sqrt{x+5}\right)^2$

$x^2 + 6x + 9 = x + 5$

$x^2 + 5x + 4 = 0$

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

$x + 1 = 0$ or $x + 4 = 0$

$x = -1 (x + 3 \ge 0)$ ✓

37. $\sqrt{3x+13} + 3 = 2x$

$\sqrt{3x+13} = 2x - 3$

$\left(\sqrt{3x+13}\right)^2 = (2x-3)^2$

$3x + 13 = 4x^2 - 12x + 9$

$0 = 4x^2 - 15x - 4$

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

$x - 4 = 0$ or $4x + 1 = 0$

$x = 4 (2x \ge 0)$ ✓

38. $\sqrt{x+8} - x = -4$

$\sqrt{x+8} = x - 4$

$\left(\sqrt{x+8}\right)^2 = (x-4)^2$

$x + 8 = x^2 - 8x + 16$

$0 = x^2 - 9x + 8$

$0 = (x-1)(x-8)$

$x - 1 = 0$ or $x - 8 = 0$

$x = 8 (x - 4 \ge 0)$ ✓

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

$\sqrt{x-9} = 4$

$\left(\sqrt{x-9}\right)^2 = 4^2$

$x - 9 = 16$

$x = 25$

40. $(5x+1)^{\frac{1}{4}} = 4$

$\sqrt[4]{5x+1} = 4$

$\left(\sqrt[4]{5x+1}\right)^4 = 4^4$

$5x + 1 = 256$

$5x = 255$

$x = 51$

41. $(3x+28)^{\frac{1}{2}} = x$

$\sqrt{3x+28} = x$

$\left(\sqrt{3x+28}\right)^2 = x^2$

$3x + 28 = x^2$

$0 = x^2 - 3x - 28$

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

$x - 7 = 0$ or $x + 4 = 0$

$x = 7 (x \ge 0)$ ✓

42. $\sqrt{3x+3} \le 6$

$\left(\sqrt{3x+3}\right)^2 \le 6^2$

$3x + 3 \le 36$

$3x \le 33$

$x \le 11$;

$3x + 3 \ge 0$

$3x \ge -3$

$x \ge -1$;

$-1 \le x \le 11$

43. $\sqrt{x-3} \le 4$

$\left(\sqrt{x-3}\right)^2 \le 4^2$

$x - 3 \le 16$

$x \le 19$;

$x - 3 \ge 0$

$x \ge 3$;

$3 \le x \le 19$

44. $\sqrt{8x+1} \ge 7$

$\left(\sqrt{8x+1}\right)^2 \ge 7^2$

$8x + 1 \ge 49$

$8x \ge 48$

$x \ge 6$;

$8x + 1 \ge 0$

$8x \ge -1$

$x \ge -\frac{1}{8}$;

$x \ge 6$

45. $d = \frac{\sqrt{15w}}{\pi}$

$1.5 = \frac{\sqrt{15w}}{\pi}$

$1.5\pi = \sqrt{15w}$

$(1.5\pi)^2 = \left(\sqrt{15w}\right)^2$

$22.2 \approx 15w$

$1.5 \approx x$

About 1.5 tons weight can be lifted.

46a. $d = \sqrt{\ell^2 + w^2 + h^2}$

$18 = \sqrt{13^2 + 5^2 + h^2}$

$18^2 = \left(\sqrt{194 + h^2}\right)^2$

$324 = 194 + h^2$

$130 = h^2$

$11.4 \approx h$

The height of the prism is about 11.4 cm.

b. The length of the diagonal will double.

47. $r = \sqrt{\frac{A}{\pi}}$

$r^2 = \left(\sqrt{\frac{A}{\pi}}\right)^2$

$r^2 = \frac{A}{\pi}$

$A = \pi r^2$

48. $r = \sqrt[3]{\frac{3V}{4\pi}}$

$r^3 = \left(\sqrt[3]{\frac{3V}{4\pi}}\right)^3$

$r^3 = \frac{3V}{4\pi}$

$3V = 4\pi r^3$

$V = \frac{4}{3}\pi r^3$

49. $v = \sqrt{\frac{2E}{m}}$

$v^2 = \left(\sqrt{\frac{2E}{m}}\right)^2$

$v^2 = \frac{2E}{m}$

$2E = mv^2$

$E = \frac{1}{2}mv^2$

50a. $V = k(F + 2)^{\frac{3}{2}}$

$113 = k(2 + 2)^{\frac{3}{2}}$

$113 = k(4)^{\frac{3}{2}}$

$113 = 8k$

$14 \approx k$

b. $V = 14(6 + 2)^{\frac{3}{2}} \approx 317$

The minimum wind velocity is about 317 mi/h.

c. $600 = 14(F + 2)^{\frac{3}{2}}$

$42.86 \approx \sqrt{(F + 2)^3}$

$42.86^2 \approx \left(\sqrt{(F + 2)^3}\right)^2$

$1837 \approx (F + 2)^3$

$12 \approx F + 2$

$10 \approx F$

The wind velocity is in the F10 category.

51a. $v = \sqrt{ar}$

$14 = \sqrt{39.2r}$

$14^2 = \left(\sqrt{39.2r}\right)^2$

$196 = 39.2r$

$5 = r$

The smallest radius is 5 m.

b. $v = \sqrt{ar}$

$8 = \sqrt{2.5a}$

$8^2 = \left(\sqrt{2.5a}\right)^2$

$64 = 2.5a$

$25.6 = a$

The acceleration is 25.6 m/s^2.

52a. $T = 2\pi\sqrt{\frac{L}{9.8}}$

$2.2 = 2\pi\sqrt{\frac{L}{9.8}}$

$0.35 \approx \sqrt{\frac{L}{9.8}}$

$0.35^2 \approx \left(\sqrt{\frac{L}{9.8}}\right)^2$

$0.1225 \approx \frac{L}{9.8}$

$1.20 \approx L$

The length of the pendulum is about 1.20 m.

b. $T = 2\pi\sqrt{\frac{L}{9.8}}$

$\frac{60}{120} = 2\pi\sqrt{\frac{L}{9.8}}$

$0.08 \approx \sqrt{\frac{L}{9.8}}$

$0.08^2 \approx \left(\sqrt{\frac{L}{9.8}}\right)^2$

$0.0064 \approx \frac{L}{9.8}$

$0.06 \approx L$

The length of the pendulum is about 0.06 m.

53a. $\pi r^2 \leq A$

$r^2 \leq \frac{A}{\pi}$

$r \leq \sqrt{\frac{A}{\pi}}$

b. No; if $A = 80$, then r must be less than or equal to about 5.04. Therefore, 20 would not be a reasonable value of r.

54. Solution B is incorrect; possible answer: in the first step, the coefficient of the radical should have been squared along with the rest of the equation.

55. $x \approx 5.84$

56. $x \approx -2.38$ or $x \approx -12.42$

57. $x \approx 2.35$

58a. $d = 1.2116\sqrt{h} = 1.2116\sqrt{15} \approx 4.7$

The captain can see about 4.7 mi.

b. $d = 1.2116\sqrt{h} = 1.2116\sqrt{120} \approx 13.3$

$13.3 - 4.7 = 8.6$

The sailor can see about 8.6 mi farther.

c. 8.6 mi ÷ 10 mi/h = 0.86 h ≈ 52 min

The sailor will see the pirate ship about 52 min sooner than the captain will.

59. $s = \sqrt[3]{\frac{m}{\rho}}$

$s^3 = \left(\sqrt[3]{\frac{m}{\rho}}\right)^3$

$s^3 = \frac{m}{\rho}$

$\rho s^3 = m$

$m_{gold} - m_{lead} = 19.3(5)^3 - 11.34(5)^3 = 995$

The mass of the cube of gold is 995 g greater.

60. Possible answer: Subtracting 5 from each side results in the equation $\sqrt{5x + 17} = -7$. Because the $\sqrt{\ }$ symbol indicates the principal, or nonnegative, square root, the value of the left side

of the equation cannot be negative. Therefore, the equation has no real solution.

61. Possible answer: When solving both types of equations, you must check for extraneous solutions.

TEST PREP

62. D;

$\sqrt[3]{2x+4} = 3$

$\left(\sqrt[3]{2x+4}\right)^3 = 3^3$

$2x + 4 = 27$

$2x = 23$

$x = 11.5$

63. H;

$x - 1 = \sqrt{5x-9}$

$(x-1)^2 = \left(\sqrt{5x-9}\right)^2$

$x^2 - 2x + 1 = 5x - 9$

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

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

$x - 2 = 0$ or $x - 5 = 0$

$x = 2$ or $x = 5$

64. B;

$40 = \pi\sqrt{8^2 + h^2}$

$12.7 \approx \sqrt{64 + h^2}$

$12.7^2 \approx \left(\sqrt{64 + h^2}\right)^2$

$162 \approx 64 + h^2$

$98 \approx h^2$

$10 \approx h$

65. F;

$V = \left(\frac{A}{6}\right)^{\frac{3}{2}}$

$V = \sqrt{\left(\frac{A}{6}\right)^3}$

$V^2 = \left(\sqrt{\left(\frac{A}{6}\right)^3}\right)^2$

$V^2 = \left(\frac{A}{6}\right)^3$

$\sqrt[3]{V^2} = \frac{A}{6}$

$6V^{\frac{2}{3}} = A$

66. $(2x-3)^{\frac{1}{4}} = 3$

$\sqrt[4]{2x-3} = 3$

$\left(\sqrt[4]{2x-3}\right)^4 = 3^4$

$2x - 3 = 81$

$2x = 84$

$x = 42$

CHALLENGE AND EXTEND

67. always true

68. never true

69. always true

70. never true

71. $\sqrt{x} = \frac{9}{\sqrt{x}}$

$\sqrt{x} \cdot \sqrt{x} = 9$

$(\sqrt{x})^2 = 9$

$x = 9$

72. $\sqrt{\sqrt{x+2}} = 4$

$\left(\sqrt{\sqrt{x+2}}\right)^2 = 4^2$

$\sqrt{x+2} = 16$

$\left(\sqrt{x+2}\right)^2 = 16^2$

$x + 2 = 256$

$x = 254$

73. $\sqrt{x^2 - 64} = x - 4$

$\left(\sqrt{x^2 - 64}\right)^2 = (x-4)^2$

$x^2 - 64 = x^2 - 8x + 16$

$8x = 80$

$x = 10$

74. $S_{17} = \sqrt{\frac{(1 + 75\%)h(1 + 350\%)m}{36}} = \sqrt{\frac{7.875hm}{36}}$

$= \sqrt{7.875} \cdot \sqrt{\frac{hm}{36}} \approx 2.81S_4$

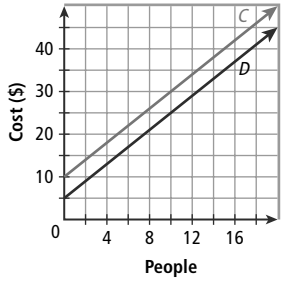
$\frac{2.81S_4 - S_4}{S_4} \times 100\% = 181\%$

The surface area increased by about 181%.

SPIRAL REVIEW

75a. $D(n) = 2.00n + 5.00$

b.



c. vertical translation 5 units down

76. $f^{-1}(x) = 2x - 8$

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

78. $f^{-1}(x) = 7x + 2$

79. $\sqrt[3]{64x^9}$

$\sqrt[3]{4^3 \cdot x^3 \cdot x^3 \cdot x^3}$

$\sqrt[3]{4^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3}$

$4 \cdot x \cdot x \cdot x$

$4x^3$

80. $\sqrt[4]{\frac{x^8}{81}}$

$\frac{\sqrt[4]{x^4 \cdot x^4}}{\sqrt[4]{3^4}}$

$\frac{\sqrt[4]{x^4} \cdot \sqrt[4]{x^4}}{3}$

$\frac{x \cdot x}{3}$

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

81. $\sqrt[3]{\frac{18x^2}{x^4}}$

$\sqrt[3]{\frac{18x}{x^3}}$

$\frac{\sqrt[3]{18x}}{\sqrt[3]{x^3}}$

$\frac{\sqrt[3]{18x}}{x}$

READY TO GO ON? PAGE 637

1. $\sqrt{32x^3}$

$\sqrt{2^2 \cdot 2^2 \cdot x^2 \cdot 2x}$

$\sqrt{2^2} \cdot \sqrt{2^2} \cdot \sqrt{x^2} \cdot \sqrt{2x}$

$2 \cdot 2 \cdot x \cdot \sqrt{2x}$

$4x\sqrt{2x}$

2. $\sqrt[3]{8y^{12}z^6}$

$\sqrt[3]{2^3 \cdot y^3 \cdot y^3 \cdot y^3 \cdot y^3 \cdot z^3 \cdot z^3}$

$\sqrt[3]{2^3} \cdot \sqrt[3]{y^3} \cdot \sqrt[3]{y^3} \cdot \sqrt[3]{y^3} \cdot \sqrt[3]{y^3} \cdot \sqrt[3]{z^3} \cdot \sqrt[3]{z^3}$

$2 \cdot y \cdot y \cdot y \cdot y \cdot z \cdot z$

$2y^4z^2$

3. $\sqrt[4]{\frac{a^4}{9}}$

$\frac{\sqrt[4]{a^4}}{\sqrt[4]{3^2}}$

$\frac{a}{\sqrt[4]{3^2}} \cdot \frac{\sqrt[4]{3^2}}{\sqrt[4]{3^2}}$

$\frac{a\sqrt[4]{3^2}}{\sqrt[4]{3^4}}$

$\frac{a\sqrt{3}}{3}$

4. $4^{\frac{3}{2}}$

$\sqrt{4^3}$

$\sqrt{64}$

8

5. $16^{\frac{5}{4}}$

$\left(\sqrt[4]{16}\right)^5$

$(2)^5$

32

6. $(-27)^{\frac{2}{3}}$

$\left(\sqrt[3]{-27}\right)^2$

$(-3)^2$

9

7. $8^{\frac{3}{4}}$

8. $243^{\frac{2}{5}}$

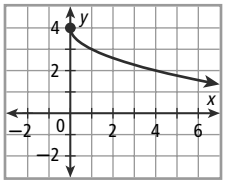
9. $(-1000)^{\frac{2}{3}}$

10. $t = 24 \times 7 = 168$

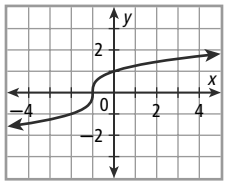
$n(168) = 112 \cdot 2^{\frac{168}{50}} \approx 1150$

The population is about 1150 after 1 week.

11. D: $\{x \mid x \geq 0\}$;
R: $\{y \mid y \leq 4\}$



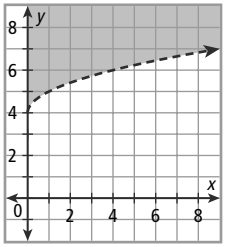
12. D: $\mathbb{R}$;
R: $\mathbb{R}$



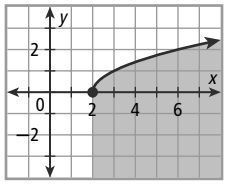
13. $g(x) = \sqrt{64(x-6)}$;
$g(10) = \sqrt{64(10-6)} = 16$
The speed is 16 ft/s.

14. $g(x) = -\sqrt{x-2} - 3$

15.



16.



17. $-2\sqrt[3]{5x-5} = -10$

$\sqrt[3]{5x-5} = 5$

$\left(\sqrt[3]{5x-5}\right)^3 = 5^3$

$5x - 5 = 125$

$5x = 130$

$x = 26$

18. $\sqrt{x+4} = x - 8$

$\left(\sqrt{x+4}\right)^2 = (x-8)^2$

$x + 4 = x^2 - 16x + 64$

$0 = x^2 - 17x + 60$

$0 = (x-5)(x-12)$

$x - 5 = 0$ or $x - 12 = 0$

$x = 12$ $(x - 8 \geq 0)$ ✓

19. $3\sqrt[3]{x-2} = \sqrt[3]{6x}$

$\left(3\sqrt[3]{x-2}\right)^3 = \left(\sqrt[3]{6x}\right)^3$

$27(x-2) = 6x$

$21x = 54$

$x = \frac{18}{7}$

20. $d = \sqrt[3]{\frac{4w}{0.02847}}$

$7 = \sqrt[3]{\frac{4w}{0.02847}}$

$7^3 = \left(\sqrt[3]{\frac{4w}{0.02847}}\right)^3$

$343 = \frac{4w}{0.02847}$

$9.77 \approx 4w$

$2.4 \approx w$

The weight of the cultured pearl is about 2.4 carats.

21. $\sqrt{x+5} < 4$

$\left(\sqrt{x+5}\right)^2 < 4^2$

$x + 5 < 16$

$x < 11$;

$x + 5 \geq 0$

$x \geq -5$;

$-5 \leq x \leq 11$

22. $\sqrt[3]{2x} \geq -2$

$\left(\sqrt[3]{2x}\right)^3 \geq (-2)^3$

$2x \geq -8$

$x \geq -4$

23. $\sqrt{x-6} - 10 \leq 4$

$\sqrt{x-6} \leq 14$

$\left(\sqrt{x-6}\right)^2 \leq 14^2$

$x - 6 \leq 196$

$x \leq 202$;

$x - 6 \geq 0$

$x \geq 6$;

$6 \leq x \leq 202$

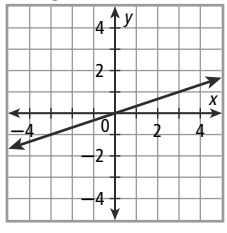
STUDY GUIDE: REVIEW, PAGES 638–641

1. rational function

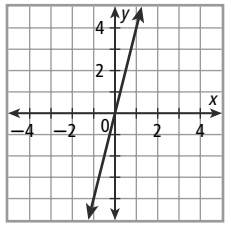
2. direct variation; constant of variation

LESSON 8-1

3. $y = \frac{1}{3}x$



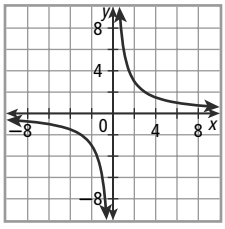
4. $y = 4x$



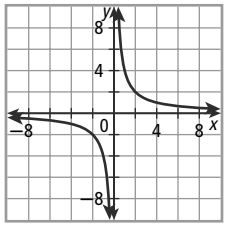
5. $n = ka$
$180 = k(20)$
$9 = k$
$n = 9a = 9(34) = 306$
The number of tiles needed is 306.

6. $I = kPr$
$264 = k(1100)(0.12)$
$2 = k$
$I = 2Pr$
$360 = 2P(0.09)$
$360 = 0.18P$
$2000 = P$
The principle P is \$2000.

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



8. $y = \frac{4}{x}$



9. $I = \frac{k}{R}$
$8 = \frac{k}{15}$
$120 = k$
$I = \frac{120}{R}$
$5 = \frac{120}{R}$
$24 = R$
The resistance R is 24 ohms.

10. inverse variation

LESSON 8-2

11. $\frac{24x^{14}}{9x^{16}}$
$\frac{24}{9} \cdot x^{14-16}$
$\frac{8}{3}x^{-2}$
$\frac{8}{3x^2}; x \neq 0$

12. $\frac{6x^3}{3x + 12}$
$\frac{6x^3}{3(x + 4)}$
$\frac{2x^3}{x + 4}; x \neq -4$

13. $\frac{x^2 + x - 12}{x^2 + 5x + 4}$
$\frac{(x + 4)(x - 3)}{(x + 4)(x + 1)}$
$\frac{x - 3}{x + 1};$
$x \neq -4$ and $x \neq -1$

14. $\frac{x + 5}{3x + 1} \cdot \frac{9x + 3}{x^2 - 25}$
$\frac{x + 5}{3x + 1} \cdot \frac{3(3x + 1)}{(x + 5)(x - 5)}$
$\frac{3}{x - 5}$

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

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

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

18. $\frac{x^3y}{4xy^4} \div \frac{x}{8y^2}$
$\frac{x^2}{4y^3} \cdot \frac{8y^2}{x}$
$\frac{2x}{y}$

19. $\frac{x^2 + 2x - 15}{x - 2} \div \frac{x^2 - 9}{2x - 4}$
$\frac{(x + 5)(x - 3)}{x - 2} \cdot \frac{2(x - 2)}{(x + 3)(x - 3)}$
$\frac{2(x + 5)}{x + 3}$

20. $\frac{3x - 21}{3x} \div \frac{x^2 - 49}{x^2 + 7x}$
$\frac{3(x - 7)}{3x} \cdot \frac{x(x + 7)}{(x - 7)(x + 7)}$
$\frac{x - 7}{x} \cdot \frac{x}{x - 7}$
1

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

LESSON 8-3

22. $\frac{4}{x^2 + 4} + \frac{x^2 + 8}{x^2 + 4}$
$\frac{4 + x^2 + 8}{x^2 + 4}$
$\frac{x^2 + 12}{x^2 + 4}$

23. $\frac{1}{x + 3} + \frac{1}{x - 3}$
$\frac{1}{x + 3}\left(\frac{x - 3}{x - 3}\right) + \frac{1}{x - 3}\left(\frac{x + 3}{x + 3}\right)$
$\frac{x - 3 + x + 3}{(x + 3)(x - 3)}$
$\frac{2x}{(x + 3)(x - 3)}; x \neq \pm 3$

24. $\frac{x}{x^2 - 4} + \frac{1}{x - 2}$
$\frac{x}{(x + 2)(x - 2)} + \frac{1}{x - 2}\left(\frac{x + 2}{x + 2}\right)$
$\frac{x + x + 2}{(x + 2)(x - 2)}$
$\frac{2x + 2}{(x + 2)(x - 2)}$
$\frac{2(x + 1)}{(x + 2)(x - 2)}; x \neq \pm 2$

25. $\frac{2x - 3}{3x + 7} + \frac{6}{4x - 1}$
$\frac{2x - 3}{3x + 7}\left(\frac{4x - 1}{4x - 1}\right) + \frac{6}{4x - 1}\left(\frac{3x + 7}{3x + 7}\right)$
$\frac{(2x - 3)(4x - 1) + 6(3x + 7)}{(3x + 7)(4x - 1)}$
$\frac{8x^2 + 4x + 45}{(3x + 7)(4x - 1)}; x \neq -\frac{7}{3}$ and $x \neq \frac{1}{4}$

26. $x^2 - 9 = (x + 3)(x - 3)$
$x^2 - 6x + 9 = (x - 3)^2$
The LCD is $(x + 3)(x - 3)^2$.

27. $x^2 + 2x - 35 = (x + 7)(x - 5)$
$x^2 + 9x + 14 = (x + 7)(x + 2)$
The LCD is $(x - 5)(x + 2)(x + 7)$.

28. $\frac{2x}{x+4} - \frac{3}{x+4}$
$\frac{2x-3}{x+4}; x \neq -4$

29. $\frac{x}{x+5} - \frac{5}{x-5}$
$\frac{x}{x+5}\left(\frac{x-5}{x-5}\right) - \frac{5}{x-5}\left(\frac{x+5}{x+5}\right)$
$\frac{x(x-5) - 5(x+5)}{(x+5)(x-5)}$
$\frac{x^2 - 10x - 25}{(x+5)(x-5)}; x \neq \pm 5$

30. $\frac{1}{x^2 - x - 6} - \frac{x}{x+2}$
$\frac{1}{(x-3)(x+2)} - \frac{x}{x+2}\left(\frac{x-3}{x-3}\right)$
$\frac{1 - x(x-3)}{(x-3)(x+2)}$
$\frac{-x^2 + 3x + 1}{(x-3)(x+2)}; x \neq -2$ and $x \neq 3$

31. $\frac{2x}{2x+1} - \frac{7}{3x-1}$
$\frac{2x}{2x+1}\left(\frac{3x-1}{3x-1}\right) - \frac{7}{3x-1}\left(\frac{2x+1}{2x+1}\right)$
$\frac{2x(3x-1) - 7(2x+1)}{(3x-1)(2x+1)}$
$\frac{6x^2 - 16x - 7}{(2x+1)(3x-1)}; x \neq -\frac{1}{2}$ and $x \neq \frac{1}{3}$

32. $\frac{\frac{x-6}{5}}{\frac{x+2}{8}}$
$\frac{x-6}{5} \div \frac{x+2}{8}$
$\frac{x-6}{5} \cdot \frac{8}{x+2}$
$\frac{8(x-6)}{5(x+2)}$

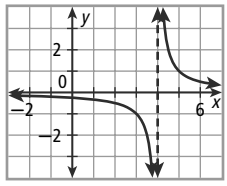
33. $\frac{\frac{x+3}{3x}}{\frac{x^2-9}{6x-9}}$
$\frac{x+3}{3x} \div \frac{x^2-9}{6x-9}$
$\frac{x+3}{3x} \cdot \frac{3(2x-3)}{(x+3)(x-3)}$
$\frac{2x-3}{x(x-3)}$

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

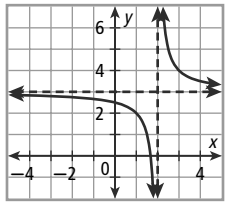
35. $\frac{2d}{\frac{d}{520} + \frac{d}{580}}$
$\frac{2d(15080)}{\frac{d}{520}(15080) + \frac{d}{580}(15080)}$
$\frac{30160d}{29d + 26d}$
$\frac{30160d}{55d} \approx 548$
The jet's average speed is about 548 mi/h.

LESSON 8-4

36. g is f translated 4 units right.



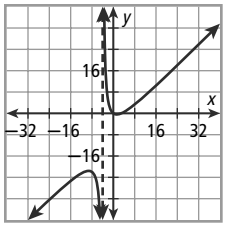
37. g is f translated 2 units right and 3 units up.



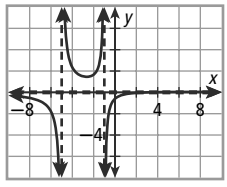
38. asymptotes: $x = 1$, $y = -3$;
D: $\{x \mid x \neq 1\}$; R: $\{y \mid y \neq -3\}$

39. asymptotes: $x = -2$, $y = 1$;
D: $\{x \mid x \neq -2\}$; R: $\{y \mid y \neq 1\}$

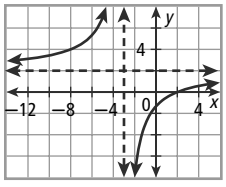
40. zeros: 0, 3;
asymptote: $x = -4$



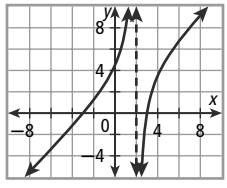
41. zero: 3;
asymptotes: $x = -5$, $x = -1$, $y = 0$



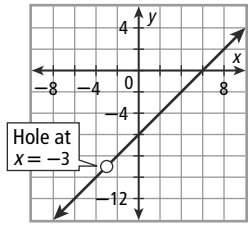
42. zero: 2;
asymptotes: $x = -3$, $y = 2$



43. zeros: −3, 3;
asymptote: $x = 2$



44. hole at $x = -3$



LESSON 8-5

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

$x(x) - \frac{6}{x}(x) = 1(x)$

$x^2 - 6 = x$

$x^2 - x - 6 = 0$

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

$x = 3$ or $x = -2$

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

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

$4x = 3x + 5$

$x = 5$

The solution $x = 5$ is extraneous.
Therefore there is no solution.

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

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

$3x = 2x + 2$

$x = 2$

48. $\frac{x}{x+4} + \frac{x}{2} = \frac{2x}{2x+8}$

$\left(\frac{x}{x+4}\right)2(x+4) + \left(\frac{x}{2}\right)2(x+4) = \left(\frac{2x}{2(x+4)}\right)2(x+4)$

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

$x(x+4) = 0$

$x = 0$ or $x = -4$

The solution $x = -4$ is extraneous.
The only solution is $x = 0$.

49. $\frac{x+4}{x} > -2$

x is positive.

$\left(\frac{x+4}{x}\right)x > -2(x)$

$x + 4 > -2x$

$3x > -4$

$x > -\frac{4}{3}$

The solution in this case is $x > 0$.

x is negative.

$\left(\frac{x+4}{x}\right)x < -2(x)$

$x + 4 < -2x$

$3x < -4$

$x < -\frac{4}{3}$

The solution in this case is $x < -\frac{4}{3}$.

The solution to the inequality is $x < -\frac{4}{3}$ or $x > 0$.

50. $\frac{2}{x-3} < 4$

$x - 3$ is positive.

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

$2 < 4x - 12$

$14 < 4x$

$x > \frac{7}{2}$;

$x - 3 > 0$

$x > 3$

The solution in this case is $x > \frac{7}{2}$.

$x - 3$ is negative.

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

$2 > 4x - 12$

$14 > 4x$

$x < \frac{7}{2}$;

$x - 3 < 0$

$x < 3$

The solution in this case is $x < 3$.

The solution to the inequality is $x < 3$ or $x > \frac{7}{2}$.

LESSON 8-6

51. $\sqrt[3]{27x^6}$

$\sqrt[3]{3^3 \cdot x^3 \cdot x^3}$

$\sqrt[3]{3^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3}$

$3x^2$

52. $\sqrt[4]{81x^{12}}$

$\sqrt[4]{3^4 \cdot x^4 \cdot x^4 \cdot x^4}$

$\sqrt[4]{3^4} \cdot \sqrt[4]{x^4} \cdot \sqrt[4]{x^4} \cdot \sqrt[4]{x^4}$

$3x^3$

53. $\sqrt[3]{\frac{8x^3}{3}}$

$\frac{\sqrt[3]{2^3 \cdot x^3}}{\sqrt[3]{3}}$

$\frac{\sqrt[3]{2^3} \cdot \sqrt[3]{x^3}}{\sqrt[3]{3}}$

$\frac{2x}{\sqrt[3]{3}}$

$\frac{2x}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}}$

$\frac{2x\sqrt[3]{9}}{3}$

54. $(-27)^{\frac{2}{3}}$

55. $16^{\frac{3}{4}}$

56. $9^{\frac{3}{2}}$

57. $17^{\frac{1}{3}} \cdot 17^{\frac{2}{3}}$

$17^{\frac{1}{3} + \frac{2}{3}}$

$17^1 = 17$

58. $\left(9^4\right)^{\frac{1}{2}}$

$9^{4 \cdot \frac{1}{2}}$

$9^2 = 81$

59. $\left(\frac{1}{16}\right)^{\frac{1}{4}}$

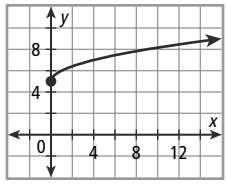
$\sqrt[4]{\frac{1}{16}}$

$\frac{\sqrt[4]{1}}{\sqrt[4]{16}}$

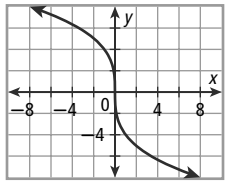
$\frac{1}{2}$

LESSON 8-7

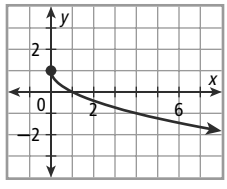
60. D: $\{x \mid x \geq 0\}$;
R: $\{y \mid y \geq 5\}$



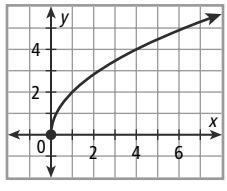
61. D: $\mathbb{R}$;
R: $\mathbb{R}$



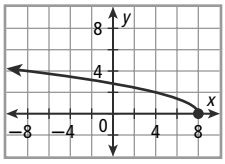
62. g is f reflected across the x-axis and translated 1 unit up.



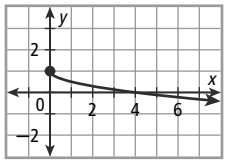
63. h is f compressed horizontally by a factor of $\frac{1}{4}$.



64. j is f reflected across the y-axis and translated 8 units right.

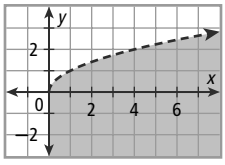


65. k is f reflected across the x-axis, compressed vertically by a factor of $\frac{1}{2}$, and translated 1 unit up.

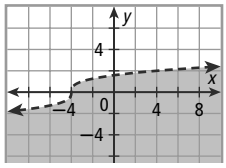


66. $g(x) = 3\sqrt{x+4}$

67.



68.



LESSON 8-8

69. $\sqrt{x+6} - 7 = -2$
$\sqrt{x+6} = 5$
$\left(\sqrt{x+6}\right)^2 = 5^2$
$x + 6 = 25$
$x = 19$

70. $\frac{\sqrt[3]{2x-2}}{6} = 1$
$\sqrt[3]{2x-2} = 6$
$\left(\sqrt[3]{2x-2}\right)^3 = 6^3$
$2x - 2 = 216$
$x = 109$

71. $\sqrt{10x} = 3\sqrt{x+1}$
$\left(\sqrt{10x}\right)^2 = \left(3\sqrt{x+1}\right)^2$
$10x = 9(x+1)$
$10x = 9x + 9$
$x = 9$

72. $2\sqrt[5]{x} = \sqrt[5]{64}$
$2\left(\sqrt[5]{x}\right)^5 = \left(\sqrt[5]{64}\right)^5$
$32x = 64$
$x = 2$

73. $\sqrt{6x-12} = x - 2$
$\left(\sqrt{6x-12}\right)^2 = (x-2)^2$
$6x - 12 = x^2 - 4x + 4$
$x^2 - 10x + 16 = 0$
$(x-2)(x-8) = 0$
$x = 2$ or $x = 8$

74. $\sqrt{x+1} = x - 5$
$\left(\sqrt{x+1}\right)^2 = (x-5)^2$
$x + 1 = x^2 - 10x + 25$
$x^2 - 11x + 24 = 0$
$(x-3)(x-8) = 0$
$x = 8$ $(x - 5 \geq 0)$ ✓

75. $(4x+7)^{\frac{1}{2}} = 3$
$\sqrt{4x+7} = 3$
$\left(\sqrt{4x+7}\right)^2 = 3^2$
$4x + 7 = 9$
$x = 0.5$

76. $(x-4)^{\frac{1}{4}} = 3$
$\sqrt[4]{x-4} = 3$
$\left(\sqrt[4]{x-4}\right)^4 = 3^4$
$x - 4 = 81$
$x = 85$

77. $x = (2x+35)^{\frac{1}{2}}$
$x = \sqrt{2x+35}$
$x^2 = \left(\sqrt{2x+35}\right)^2$
$x^2 = 2x + 35$
$x^2 - 2x - 35 = 0$
$(x-7)(x+5) = 0$
$x = 7$ $(x \geq 0)$ ✓

78. $(x+3)^{\frac{1}{3}} = -6$
$\sqrt[3]{x+3} = -6$
$\left(\sqrt[3]{x+3}\right)^3 = (-6)^3$
$x + 3 = -216$
$x = -219$

79. $\sqrt{x-4} \leq 3$
$\left(\sqrt{x-4}\right)^2 \leq 3^2$
$x - 4 \leq 9$
$x \leq 13$;
$x - 4 \geq 0$
$x \geq 4$;
$4 \leq x \leq 13$

80. $\sqrt{2x+7} - 6 > -1$
$\sqrt{2x+7} > 5$
$\left(\sqrt{2x+7}\right)^2 > 5^2$
$2x + 7 > 25$
$x > 9$;
$2x + 7 \geq 0$
$2x \geq -7$
$x \geq -3.5$;
$x > 9$

81. $\sqrt{3x} - 4 < 2$
$\sqrt{3x} < 6$
$\left(\sqrt{3x}\right)^2 < 6^2$
$3x < 36$
$x < 12$;
$3x \geq 0$
$x \geq 0$;
$0 \leq x < 12$

82. $\sqrt[3]{x-1} > -2$
$\left(\sqrt[3]{x-1}\right)^3 > (-2)^3$
$x - 1 > -8$
$x > -7$

83. $T = 2\pi\sqrt{\frac{L}{9.8}}$
$2.5 = 2\pi\sqrt{\frac{L}{9.8}}$
$0.4 \approx \sqrt{\frac{L}{9.8}}$
$0.4^2 \approx \left(\sqrt{\frac{L}{9.8}}\right)^2$
$0.16 \approx \frac{L}{9.8}$
$1.6 \approx L$
The length of the pendulum is about 1.6 m.

84. $s = \left(6V\sqrt{2}\right)^{\frac{1}{3}}$
$8 = \left(6V\sqrt{2}\right)^{\frac{1}{3}}$
$8^3 = \left(\sqrt[3]{6V\sqrt{2}}\right)^3$
$512 = 6V\sqrt{2}$
$60.3 \approx V$
The volume of the tetrahedron is about 60.3 m^3.

CHAPTER TEST, PAGE 642

1. $p = kb$

$19.80 = k(1100)$

$k = 0.018$

$p = 0.018b = 0.018(3000) = 54$

The payment p is \$54.

2. $t = \frac{k}{v}$

$\frac{25}{60} = \frac{k}{6}$

$k = 2.5$

$t = \frac{2.5}{v}$

$\frac{20}{60} = \frac{2.5}{v}$

$v = 7.5$

The speed v has to be 7.5 mi/h.

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

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

$\frac{x+2}{x-1}$; $x \neq 1$ and $x \neq 3$

4. $\frac{x-9}{2x-10} \cdot \frac{x-5}{x^2-81}$

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

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

5. $\frac{3x^3 - 9x^2}{x^2 - 16} \div \frac{2x-6}{x^2-8x+16}$

$\frac{3x^3 - 9x^2}{x^2 - 16} \cdot \frac{x^2-8x+16}{2x-6}$

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

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

6. $\frac{5}{x-5} + \frac{x}{2x-10}$

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

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

$\frac{x+10}{2(x-5)}$; $x \neq 5$

7. $\frac{5x}{x-7} - \frac{9x-6}{x+3}$

$\frac{5x}{x-7}\left(\frac{x+3}{x+3}\right) - \frac{9x-6}{x+3}\left(\frac{x-7}{x-7}\right)$

$\frac{5x(x+3) - (9x-6)(x-7)}{(x-7)(x+3)}$

$\frac{5x^2 + 15x - \left(9x^2 - 69x + 42\right)}{(x-7)(x+3)}$

$\frac{-4x^2 + 84x - 42}{(x-7)(x+3)}$

$\frac{-2\left(2x^2 - 42x + 21\right)}{(x-7)(x+3)}$; $x \neq 7$ and $x \neq -3$

8. Let n be the number of words on three pages.

$\frac{2n}{\frac{n}{62} + \frac{n}{45}}$

$\frac{2n(2790)}{\frac{n}{62}(2790) + \frac{n}{45}(2790)}$

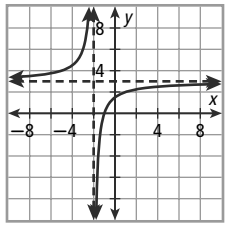
$\frac{5580n}{45n + 62n}$

$\frac{5580n}{107n} \approx 52$

Her average typing speed is about 52 words/min.

9. zero: -1;

asymptotes: $x = -2$, $y = 3$



10. $2 + \frac{3}{x-1} = 10$

$\frac{3}{x-1} = 8$

$\frac{3}{x-1}(x-1) = 8(x-1)$

$3 = 8x - 8$

$11 = 8x$

$\frac{11}{8} = x$

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

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

$3x + x(x-1) = 15$

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

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

$x = 3$ or $x = -5$

12. $\frac{1}{6}(2.4) + \frac{1}{h}(2.4) = 1$

$\frac{1}{6}(2.4)(6h) + \frac{1}{h}(2.4)(6h) = 1(6h)$

$2.4\,h + 14.4 = 6h$

$14.4 = 3.6h$

$4 = h$

It would take Mike 4 hours to tile the floor alone.

13. $\sqrt[3]{-32x^6}$

$\sqrt[3]{(-2)^3 \cdot 4 \cdot x^3 \cdot x^3}$

$\sqrt[3]{(-2)^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{x^3} \cdot \sqrt[3]{4}$

$-2x^2\left(\sqrt[3]{4}\right)$

14. $8^{-\frac{2}{3}}$

$\frac{1}{\sqrt[3]{8^2}}$

$\frac{1}{\sqrt[3]{64}}$

$\frac{1}{4}$

15. $\frac{27^{\frac{2}{3}}}{27^{\frac{1}{3}}}$

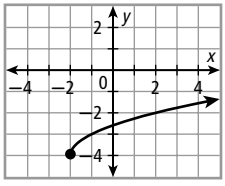
$27^{\frac{2}{3}-\frac{1}{3}}$

$27^{\frac{1}{3}}$

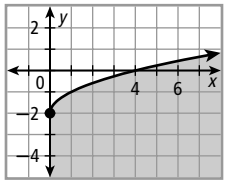
$\sqrt[3]{27} = 3$

16. $x^{\frac{2}{5}}$

17. D: $\{x \mid x \geq -2\}$;
R: $\{y \mid y \geq -4\}$



18.



19. $\sqrt{x+7} = 5$

$\left(\sqrt{x+7}\right)^2 = 5^2$

$x + 7 = 25$

$x = 18$

20. $\sqrt{2x+1} = \sqrt{x+9}$

$\left(\sqrt{2x+1}\right)^2 = \left(\sqrt{x+9}\right)^2$

$2x + 1 = x + 9$

$x = 8$

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

$\sqrt[3]{3x+1} = -2$

$\left(\sqrt[3]{3x+1}\right)^3 = (-2)^3$

$3x + 1 = -8$

$3x = -9$

$x = -3$

22. $s = \sqrt{\frac{A}{4.828}}$

$12.4 = \sqrt{\frac{A}{4.828}}$

$12.4^2 = \left(\sqrt{\frac{A}{4.828}}\right)^2$

$12.4^2 = \frac{A}{4.828}$

$742 \approx A$

The area is about 742 in^2.

23. $\sqrt{2x+1} > 3$

$\left(\sqrt{2x+1}\right)^2 > 3^2$

$2x + 1 > 9$

$2x > 8$

$x > 4$;

$2x + 1 \geq 0$

$2x \geq -1$

$x \geq -0.5$;

$x > 4$