INSTRUCTOR'S SOLUTIONS MANUAL

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ALGEBRA AND TRIGONOMETRY

SIXTH EDITION

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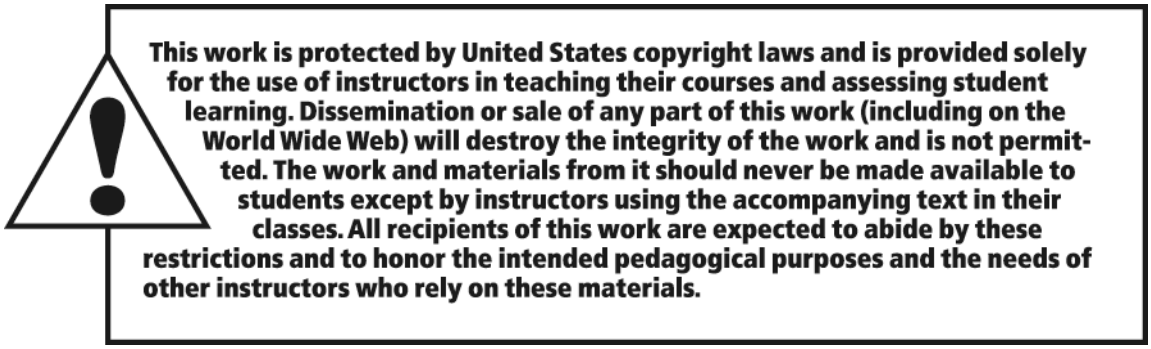
Pearson



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Chapter P
Fundamental Concepts of Algebra

Section P.1

Check Point Exercises

1. $8+6(x-3)^2 = 8+6(13-3)^2$
$= 8+6(10)^2$
$= 8+6(100)$
$= 8+600$
$= 608$

2. **a.** Since 2014 is 14 years after 2000, substitute 14 for x.
$T = 4x^2+330x+3310$
$= 4(14)^2+330(14)+3310$
$= 8714$
The average cost of tuition and fees at public U.S. colleges for the school year ending in 2014 was \$8714.

b. The formula underestimates the actual answer by \$179.

3. The elements common to {3, 4, 5, 6, 7} and {3, 7, 8, 9} are 3 and 7.
$\{3,4,5,6,7\}\cap\{3,7,8,9\} = \{3,7\}$

4. The union is the set containing all the elements of either set.
$\{3,4,5,6,7\}\cup\{3,7,8,9\} = \{3,4,5,6,7,8,9\}$

5. $\left\{-9,\ -1.3,\ 0,\ 0.\overline{3},\ \frac{\pi}{2},\ \sqrt{9},\ \sqrt{10}\right\}$

a. Natural numbers: $\sqrt{9}$ because $\sqrt{9}=3$

b. Whole numbers: $0,\ \sqrt{9}$

c. Integers: $-9,\ 0,\ \sqrt{9}$

d. Rational numbers: $-9,\ -1.3,\ 0,\ 0.\overline{3},\ \sqrt{9}$

e. Irrational numbers: $\frac{\pi}{2},\ \sqrt{10}$

f. Real numbers: $-9,\ -1.3,\ 0,\ 0.\overline{3},\ \frac{\pi}{2},\ \sqrt{9},\ \sqrt{10}$

6. **a.** $\left|1-\sqrt{2}\right|$
Because $\sqrt{2}\approx 1.4,$ the number inside the absolute value bars is negative. The absolute value of x when $x<0$ is $-x$. Thus,
$\left|1-\sqrt{2}\right| = -\left(1-\sqrt{2}\right) = \sqrt{2}-1$

b. $|\pi-3|$
Because $\pi\approx 3.14,$ the number inside the absolute value bars is positive. The absolute value of a positive number is the number itself. Thus,
$|\pi-3| = \pi-3.$

c. $\frac{|x|}{x}$
Because $x>0,\ \ |x| = x.$
Thus, $\frac{|x|}{x} = \frac{x}{x} = 1$

7. $|-4-(5)| = |-9| = 9$
The distance between –4 and 5 is 9.

8. $7(4x^2+3x)+2(5x^2+x)$
$= 7(4x^2+3x)+2(5x^2+x)$
$= 28x^2+21x+10x^2+2x$
$= 38x^2+23x$

9. $6+4[7-(x-2)]$
$= 6+4[7-x+2)]$
$= 6+4[9-x]$
$= 6+36-4x$
$= 42-4x$

Concept and Vocabulary Check P.1

1. expression

2. b to the nth power; base; exponent

3. formula; modeling; models

4. intersection; $A\cap B$

5. union; $A\cup B$

6. natural

7. whole

8. integers

9. rational

10. irrational

11. rational; irrational

12. absolute value; x, $-x$

13. $b+a$; ba

14. $a+(b+c)$; $(ab)c$

15. $ab+ac$

16. 0; inverse; 0; identity

17. inverse; 1; identity

18. simplified

19. a

Exercise Set P.1

1. $7+5(10)=7+50=57$

2. $8+6(5)=8+30=38$

3. $6(3)-8=18-8=10$

4. $8(3)-4=24-4=20$

5. $8^2+3(8)=64+24=88$

6. $6^2+5(6)=36+30=66$

7. $7^2-6(7)+3=49-42+3=7+3=10$

8. $8^2-7(8)+4=64-56+4=8+4=12$

9. $4+5(9-7)^3=4+5(2)^3$
$=4+5(8)=4+40=44$

10. $6+5(8-6)^3=6+5(2)^3$
$=6+5(8)$
$=6+40=46$

11. $8^2-3(8-2)=64-3(6)$
$=64-18=46$

12. $8^2-4(8-3)=64-4(5)=64-20=44$

13. $\dfrac{5(x+2)}{2x-14}=\dfrac{5(10+2)}{2(10)-14}$
$=\dfrac{5(12)}{6}$
$=5\cdot 2$
$=10$

14. $\dfrac{7(x-3)}{2x-16}=\dfrac{7(9-3)}{2(9)-16}=\dfrac{7(6)}{2}=7\cdot 3=21$

15. $\dfrac{2x+3y}{x+1}; x=-2, y=4$
$=\dfrac{2(-2)+3(4)}{-2+1}=\dfrac{-4+12}{-1}=\dfrac{8}{-1}=-8$

16. $\dfrac{2x+y}{xy-2x}$; $x=-2$ and $y=4$
$\dfrac{2(-2)+4}{(-2)(4)-2(-2)}=\dfrac{-4+4}{-8+4}=\dfrac{0}{4}=0$

17. $C=\dfrac{5}{9}(50-32)=\dfrac{5}{9}(18)=10$
50°F is equivalent to 10°C.

18. $C=\dfrac{5}{9}(F-32)=\dfrac{5}{9}(86-32)=\dfrac{5}{9}(54)=30$
86°F is equivalent to 30°C.

19. $h=4+60t-16t^2=4+60(2)-16(2)^2$
$=4+120-16(4)=4+120-64$
$=124-64=60$
Two seconds after it is kicked, the ball's height is 60 feet.

20. $h = 4 + 60t - 16t^2$

$= 4 + 60(3) - 16(3)^2$

$= 4 + 180 - 16(9)$

$= 4 + 180 - 144$

$= 184 - 144 = 40$

Three seconds after it is kicked, the ball's height is 40 feet.

21. $\{1,2,3,4\} \cap \{2,4,5\} = \{2,4\}$

22. $\{1,3,7\} \cap \{2,3,8\} = \{3\}$

23. $\{s,e,t\} \cap \{t,e,s\} = \{s,e,t\}$

24. $\{r,e,a,l\} \cap \{l,e,a,r\} = \{r,e,a,l\}$

25. $\{1,3,5,7\} \cap \{2,4,6,8,10\} = \{\ \}$

The empty set is also denoted by $\varnothing$.

26. $\{1,3,5,7\} \cap \{-5,-3,-1\} = \{\ \}$ or $\varnothing$

27. $\{a,b,c,d\} \cap \varnothing = \varnothing$

28. $\{w,y,z\} \cap \varnothing = \varnothing$

29. $\{1,2,3,4\} \cup \{2,4,5\} = \{1,2,3,4,5\}$

30. $\{1,3,7,8\} \cup \{2,3,8\} = \{1,2,3,7,8\}$

31. $\{1,3,5,7\} \cup \{2,4,6,8,10\}$

$= \{1,2,3,4,5,6,7,8,10\}$

32. $\{0,1,3,5\} \cup \{2,4,6\} = \{0,1,2,3,4,5,6\}$

33. $\{a,e,i,o,u\} \cup \varnothing = \{a,e,i,o,u\}$

34. $\{e,m,p,t,y\} \cup \varnothing = \{e,m,p,t,y\}$

35. **a.** $\sqrt{100}$

b. $0, \sqrt{100}$

c. $-9, 0, \sqrt{100}$

d. $-9, -\frac{4}{5}, 0, 0.25, 9.2, \sqrt{100}$

e. $\sqrt{3}$

f. $-9, -\frac{4}{5}, 0, 0.25, \sqrt{3}, 9.2, \sqrt{100}$

36. **a.** $\sqrt{49}$

b. $0, \sqrt{49}$

c. $-7, 0, \sqrt{49}$

d. $-7, -0.\overline{6}, 0, \sqrt{49}$

e. $\sqrt{50}$

f. $-7, -0.\overline{6}, 0, \sqrt{49}, \sqrt{50}$

37. **a.** $\sqrt{64}$

b. $0, \sqrt{64}$

c. $-11, 0, \sqrt{64}$

d. $-11, -\frac{5}{6}, 0, 0.75, \sqrt{64}$

e. $\sqrt{5}, \pi$

f. $-11, -\frac{5}{6}, 0, 0.75, \sqrt{5}, \pi, \sqrt{64}$

38. **a.** $\sqrt{4}$

b. $0, \sqrt{4}$

c. $-5, 0, \sqrt{4}$

d. $-5, -0.\overline{3}, 0, \sqrt{4}$

e. $\sqrt{2}$

f. $-5, -0.\overline{3}, 0, \sqrt{2}, \sqrt{4}$

39. 0

40. Answers will vary. An example is $\frac{1}{2}$.

41. Answers will vary. An example is 2.

42. Answers will vary. An example is -2.

43. true; -13 is to the left of -2 on the number line.

44. false; -6 is to the left of 2 on the number line.

45. true; 4 is to the right of -7 on the number line.

46. true; –13 is to the left of –5 on the number line.

47. true; $-\pi = -\pi$

48. true; –3 is to the right of –13 on the number line.

49. true; 0 is to the right of –6 on the number line.

50. true; 0 is to the right of –13 on the number line.

51. $|300| = 300$

52. $|-203| = 203$

53. $|12 - \pi| = 12 - \pi$

54. $|7 - \pi| = 7 - \pi$

55. $|\sqrt{2} - 5| = 5 - \sqrt{2}$

56. $|\sqrt{5} - 13| = 13 - \sqrt{5}$

57. $\dfrac{-3}{|-3|} = \dfrac{-3}{3} = -1$

58. $\dfrac{-7}{|-7|} = \dfrac{-7}{7} = -1$

59. $\big||-3| - |-7|\big| = |3 - 7| = |-4| = 4$

60. $\big||-5| - |-13|\big| = |5 - 13| = |-8| = 8$

61. $|x + y| = |2 + (-5)| = |-3| = 3$

62. $|x - y| = |2 - (-5)| = |7| = 7$

63. $|x| + |y| = |2| + |-5| = 2 + 5 = 7$

64. $|x| - |y| = |2| - |-5| = 2 - 5 = -3$

65. $\dfrac{y}{|y|} = \dfrac{-5}{|-5|} = \dfrac{-5}{5} = -1$

66. $\dfrac{|x|}{x} + \dfrac{|y|}{y} = \dfrac{|2|}{2} + \dfrac{|-5|}{-5} = \dfrac{2}{2} + \dfrac{5}{-5} = 1 + (-1) = 0$

67. The distance is $|2 - 17| = |-15| = 15$.

68. The distance is $|4 - 15| = |-11| = 11$.

69. The distance is $|-2 - 5| = |-7| = 7$.

70. The distance is $|-6 - 8| = |-14| = 14$.

71. The distance is $|-19 - (-4)| = |-19 + 4| = |-15| = 15$.

72. The distance is $|-26 - (-3)| = |-26 + 3| = |-23| = 23$.

73. The distance is
$|-3.6 - (-1.4)| = |-3.6 + 1.4| = |-2.2| = 2.2$.

74. The distance is
$|-5.4 - (-1.2)| = |-5.4 + 1.2| = |-4.2| = 4.2$.

75. $6 + (-4) = (-4) + 6$;
commutative property of addition

76. $11 \cdot (7 + 4) = 11 \cdot 7 + 11 \cdot 4$;
distributive property of multiplication over addition

77. $6 + (2 + 7) = (6 + 2) + 7$;
associative property of addition

78. $6 \cdot (2 \cdot 3) = 6 \cdot (3 \cdot 2)$;
commutative property of multiplication

79. $(2 + 3) + (4 + 5) = (4 + 5) + (2 + 3)$;
commutative property of addition

80. $7 \cdot (11 \cdot 8) = (11 \cdot 8) \cdot 7$;
commutative property of multiplication

81. $2(-8 + 6) = -16 + 12$;
distributive property of multiplication over addition

82. $-8(3 + 11) = -24 + (-88)$;
distributive property of multiplication over addition

83. $\dfrac{1}{x+3}(x+3) = 1; x \neq -3$,
inverse property of multiplication

84. $(x+4) + \big[-(x+4)\big] = 0$;
inverse property of addition

85. $\begin{aligned} 5(3x+4) - 4 &= 5 \cdot 3x + 5 \cdot 4 - 4 \\ &= 15x + 20 - 4 \\ &= 15x + 16 \end{aligned}$

86. $2(5x+4)-3 = 2\cdot 5x+2\cdot 4-3$
$= 10x+8-3$
$= 10x+5$

87. $5(3x-2)+12x = 5\cdot 3x-5\cdot 2+12x$
$= 15x-10+12x$
$= 27x-10$

88. $2(5x-1)+14x = 2\cdot 5x-2\cdot 1+14x$
$= 10x-2+14x$
$= 24x-2$

89. $7(3y-5)+2(4y+3)$
$= 7\cdot 3y-7\cdot 5+2\cdot 4y+2\cdot 3$
$= 21y-35+8y+6$
$= 29y-29$

90. $4(2y-6)+3(5y+10)$
$= 4\cdot 2y-4\cdot 6+3\cdot 5y+3\cdot 10$
$= 8y-24+15y+30$
$= 23y+6$

91. $5(3y-2)-(7y+2) = 15y-10-7y-2$
$= 8y-12$

92. $4(5y-3)-(6y+3) = 20y-12-6y-3$
$= 14y-15$

93. $7-4\left[3-(4y-5)\right] = 7-4[3-4y+5]$
$= 7-4[8-4y]$
$= 7-32+16y$
$= 16y-25$

94. $6-5[8-(2y-4)] = 6-5[8-2y+4]$
$= 6-5[12-2y]$
$= 6-60+10y$
$= 10y-54$

95. $18x^2+4-\left[6\left(x^2-2\right)+5\right]$
$= 18x^2+4-\left[6x^2-12+5\right]$
$= 18x^2+4-\left[6x^2-7\right]$
$= 18x^2+4-6x^2+7$
$= 18x^2-6x^2+4+7$
$= (18-6)x^2+11 = 12x^2+11$

96. $14x^2+5-\left[7\left(x^2-2\right)+4\right]$
$= 14x^2+5-\left[7x^2-14+4\right]$
$= 14x^2+5-\left[7x^2-10\right]$
$= 14x^2+5-7x^2+10$
$= 14x^2-7x^2+5+10$
$= (14-7)x^2+15$
$= 7x^2+15$

97. $-(-14x) = 14x$

98. $-(-17y) = 17y$

99. $-(2x-3y-6) = -2x+3y+6$

100. $-(5x-13y-1) = -5x+13y+1$

101. $\frac{1}{3}(3x)+[(4y)+(-4y)] = x+0 = x$

102. $\frac{1}{2}(2y)+[(-7x)+7x] = y+0 = y$

103. $|-6| \square |-3|$
$6 \square 3$
$6 > 3$
Since $6>3$, $|-6|>|-3|$.

104. $|-20| \square |-50|$
$20 \square 50$
$20 < 50$
Since $20<50$, $|-20|<|-50|$.

105. $\left|\frac{3}{5}\right| \square |-0.6|$
$|0.6| \square |-0.6|$
$0.6 \square 0.6$
$0.6 = 0.6$
Since $0.6=0.6$, $\left|\frac{3}{5}\right| = |-0.6|$.

106. $\left|\frac{5}{2}\right| \square |-2.5|$

$|2.5| \square |-2.5|$

$2.5 \square 2.5$

$2.5 = 2.5$

Since $2.5 = 2.5$, $\left|\frac{5}{2}\right| = |-2.5|$.

107. $\frac{30}{40} - \frac{3}{4} \square \frac{14}{15} \cdot \frac{15}{14}$

$\frac{30}{40} - \frac{30}{40} \square \frac{\cancel{14}}{\cancel{15}} \cdot \frac{\cancel{15}}{\cancel{14}}$

$0 \square 1$

$0 < 1$

Since $0 < 1$, $\frac{30}{40} - \frac{3}{4} < \frac{14}{15} \cdot \frac{15}{14}$.

108. $\frac{17}{18} \cdot \frac{18}{17} \square \frac{50}{60} - \frac{5}{6}$

$\frac{\cancel{17}}{\cancel{18}} \cdot \frac{\cancel{18}}{\cancel{17}} \square \frac{50}{60} - \frac{50}{60}$

$1 \square 0$

$1 > 0$

Since $1 > 0$, $\frac{17}{18} \cdot \frac{18}{17} > \frac{50}{60} - \frac{5}{6}$.

109. $\frac{8}{13} \div \frac{8}{13} \square |-1|$

$\frac{8}{13} \cdot \frac{13}{8} \square 1$

$1 \square 1$

$1 = 1$

Since $1 = 1$, $\frac{8}{13} \div \frac{8}{13} = |-1|$.

110. $|-2| \square \frac{4}{17} \div \frac{4}{17}$

$2 \square \frac{4}{17} \cdot \frac{17}{4}$

$2 \square 1$

$2 > 1$

Since $2 > 1$, $|-2| > \frac{4}{17} \div \frac{4}{17}$.

111. $8^2 - 16 \div 2^2 \cdot 4 - 3 = 64 - 16 \div 4 \cdot 4 - 3$

$= 64 - 4 \cdot 4 - 3$

$= 64 - 16 - 3$

$= 48 - 3$

$= 45$

112. $10^2 - 100 \div 5^2 \cdot 2 - 3 = 100 - 100 \div 25 \cdot 2 - 3$

$= 100 - 4 \cdot 2 - 3$

$= 100 - 8 - 3$

$= 92 - 3$

$= 89$

113. $\frac{5 \cdot 2 - 3^2}{[3^2 - (-2)]^2} = \frac{5 \cdot 2 - 9}{[9 - (-2)]^2}$

$= \frac{10 - 9}{[9 + 2]^2}$

$= \frac{10 - 9}{11^2}$

$= \frac{1}{121}$

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

$= \frac{17}{6^2}$

$= \frac{17}{36}$

115. $8 - 3[-2(2 - 5) - 4(8 - 6)] = 8 - 3[-2(-3) - 4(2)]$

$= 8 - 3[6 - 8]$

$= 8 - 3[-2]$

$= 8 + 6$

$= 14$

116. $8 - 3[-2(5 - 7) - 5(4 - 2)] = 8 - 3[-2(-2) - 5(2)]$

$= 8 - 3[4 - 10]$

$= 8 - 3[-6]$

$= 8 + 18$

$= 26$

117. $\frac{2(-2) - 4(-3)}{5 - 8} = \frac{-4 + 12}{-3}$

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

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

118. $\dfrac{6(-4)-5(-3)}{9-10} = \dfrac{-24+15}{-1}$

$= \dfrac{-9}{-1}$

$= 9$

119. $\dfrac{(5-6)^2-2\left|3-7\right|}{89-3\cdot 5^2} = \dfrac{(-1)^2-2\left|-4\right|}{89-3\cdot 25}$

$= \dfrac{1-2(4)}{89-75}$

$= \dfrac{1-8}{14}$

$= \dfrac{-7}{14}$

$= -\dfrac{1}{2}$

120. $\dfrac{12\div 3\cdot 5\left|2^2+3^2\right|}{7+3-6^2} = \dfrac{12\div 3\cdot 5\left|4+9\right|}{7+3-36}$

$= \dfrac{4\cdot 5\left|13\right|}{10-36}$

$= \dfrac{20(13)}{-26}$

$= \dfrac{260}{-26}$

$= -10$

121. $x-(x+4) = x-x-4 = -4$

122. $x-(8-x) = x-8+x = 2x-8$

123. $6(-5x) = -30x$

124. $10(-4x) = -40x$

125. $5x-2x = 3x$

126. $6x-(-2x) = 6x+2x = 8x$

127. $8x-(3x+6) = 8x-3x-6 = 5x-6$

128. $8-3(x+6) = 8-3x-18 = -3x-10$

129. **a.** $H = \dfrac{7}{10}(220-a)$

$H = \dfrac{7}{10}(220-20)$

$= \dfrac{7}{10}(200)$

$= 140$

The lower limit of the heart rate for a 20-year-old with this exercise goal is 140 beats per minute.

b. $H = \dfrac{4}{5}(220-a)$

$H = \dfrac{4}{5}(220-20)$

$= \dfrac{4}{5}(200)$

$= 160$

The upper limit of the heart rate for a 20-year-old with this exercise goal is 160 beats per minute.

130. **a.** $H = \dfrac{1}{2}(220-a)$

$H = \dfrac{1}{2}(220-30)$

$= \dfrac{1}{2}(190)$

$= 95$

The lower limit of the heart rate for a 30-year-old with this exercise goal is 95 beats per minute.

b. $H = \dfrac{3}{5}(220-a)$

$H = \dfrac{3}{5}(220-30)$

$= \dfrac{3}{5}(190)$

$= 114$

The upper limit of the heart rate for a 30-year-old with this exercise goal is 114 beats per minute.

131. **a.** $T = 21x^2+862x+15{,}552$

$= 21(14)^2+862(14)+15{,}552$

$= 31{,}736$

The formula estimates the cost to have been \$31,736 in 2014.

b. This overestimates the value in the graph by \$35.

c. $T = 21x^2 + 862x + 15{,}552$
$= 21(20)^2 + 862(20) + 15{,}552$
$= 41{,}192$
The formula projects the cost to be \$41,192 in 2020.

132. a. $T = 21x^2 + 862x + 15{,}552$
$= 21(12)^2 + 862(12) + 15{,}552$
$= 28{,}920$
The formula estimates the cost to have been \$28,920 in 2012.

b. This underestimates the value in the graph by \$136.

c. $T = 21x^2 + 862x + 15{,}552$
$= 21(22)^2 + 862(22) + 15{,}552$
$= 44{,}680$
The formula projects the cost to be \$44,680 in 2022.

133. a. $0.05x + 0.12(10{,}000 - x)$
$= 0.05x + 1200 - 0.12x$
$= 1200 - 0.07x$

b. $1200 - 0.07x = 1200 - 0.07(6000)$
$= \$780$

134. a. $0.06t + 0.5(50 - t) = 0.06t + 25 - 0.5t$
$= 25 - 0.44t$

b. $0.06(20) + 0.5(50 - 20)$
$= 1.2 + 0.5(30)$
$= 1.2 + 15$
$= 16.2$ miles

135. – 143. Answers will vary.

144. does not make sense; Explanations will vary. Sample explanation: Models do not always accurately predict future values.

145. does not make sense; Explanations will vary. Sample explanation: To use the model, substitute 0 for x.

146. makes sense

147. does not make sense; Explanations will vary. Sample explanation: The commutative property changes order and the associative property changes groupings.

148. false; Changes to make the statement true will vary. A sample change is: Some rational numbers are not integers.

149. false; Changes to make the statement true will vary. A sample change is: All whole numbers are integers.

150. true

151. false; Changes to make the statement true will vary. A sample change is: Some irrational numbers are negative.

152. false; Changes to make the statement true will vary. A sample change is: The term x has a coefficient of 1.

153. false; Changes to make the statement true will vary. A sample change is:
$5 + 3(x - 4) = 5 + 3x - 12 = 3x - 7.$

154. false; Changes to make the statement true will vary. A sample change is: $-x - x = -2x.$

155. true

156. $\sqrt{2} \approx 1.4$
$1.4 < 1.5$
$\sqrt{2} < 1.5$

157. $-\pi > -3.5$

158. $-\frac{3.14}{2} = -1.57$
$-\frac{\pi}{2} \approx -1.571$
$-1.57 > -1.571$
$-\frac{3.14}{2} > -\frac{\pi}{2}$

159. a. $b^4 \cdot b^3 = (b \cdot b \cdot b \cdot b)(b \cdot b \cdot b) = b^7$

b. $b^5 \cdot b^5 = (b \cdot b \cdot b \cdot b \cdot b)(b \cdot b \cdot b \cdot b \cdot b) = b^{10}$

c. add the exponents

160. a. $\dfrac{b^7}{b^3} = \dfrac{b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b}{b \cdot b \cdot b} = b^4$

b. $\dfrac{b^8}{b^2} = \dfrac{b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b}{b \cdot b} = b^6$

c. subtract the exponents

161. $6.2 \times 10^3 = 6.2 \times 10 \times 10 \times 10 = 6200$
It moves the decimal point 3 places to the right.

Section P.2

Check Point Exercises

1. a. $3^3 \cdot 3^2 = 3^{3+2} = 3^5$ or 243

b. $\left(4x^3y^4\right)\left(10x^2y^6\right) = 4 \cdot 10 \cdot x^3 \cdot x^2 \cdot y^4 \cdot y^6$
$= 40x^{3+2} \cdot y^{4+6}$
$= 40x^5y^{10}$

2. a. $\dfrac{(-3)^6}{(-3)^3} = (-3)^3 = -27$

b. $\dfrac{27x^{14}y^8}{3x^3y^5} = \dfrac{27}{3} \cdot \dfrac{x^{14}}{x^3} \cdot \dfrac{y^8}{y^5} = 9x^{14-3}y^{8-5} = 9x^{11}y^3$

3. a. $5^{-2} = \dfrac{1}{5^2} = \dfrac{1}{25}$

b. $(-3)^{-3} = \dfrac{1}{(-3)^3} = \dfrac{1}{-27} = -\dfrac{1}{27}$

c. $\dfrac{1}{4^{-2}} = \dfrac{1}{\frac{1}{4^2}} = 1 \cdot \dfrac{4^2}{1} = 4^2 = 16$

d. $3x^{-6}y^4 = 3 \cdot \dfrac{1}{x^6} \cdot y^4 = \dfrac{3y^4}{x^6}$

4. a. $\left(3^3\right)^2 = 3^{3 \cdot 2} = 3^6$ or 729

b. $\left(y^7\right)^{-2} = y^{7(-2)} = y^{-14} = \dfrac{1}{y^{14}}$

c. $\left(b^{-3}\right)^{-4} = b^{-3(-4)} = b^{12}$

5. $(-4x)^3 = (-4)^3(x)^3 = -64x^3$

6. a. $\left(-\dfrac{2}{y}\right)^5 = \dfrac{(-2)^5}{y^5} = \dfrac{-32}{y^5}$

b. $\left(\dfrac{x^5}{3}\right)^3 = \dfrac{\left(x^5\right)^3}{3^3} = \dfrac{x^{15}}{27}$

7. a. $\left(2x^3y^6\right)^4 = (2)^4\left(x^3\right)^4\left(y^6\right)^4 = 16x^{12}y^{24}$

b. $\left(-6x^2y^5\right)\left(3xy^3\right) = (-6) \cdot 3 \cdot x^2 \cdot x \cdot y^5 \cdot y^3$
$= -18x^3y^8$

c. $\dfrac{100x^{12}y^2}{20x^{16}y^{-4}} = \left(\dfrac{100}{20}\right)\left(\dfrac{x^{12}}{x^{16}}\right)\left(\dfrac{y^2}{y^{-4}}\right)$
$= 5x^{12-16}y^{2-(-4)}$
$= 5x^{-4}y^6$
$= \dfrac{5y^6}{x^4}$

d. $\left(\dfrac{5x}{y^4}\right)^{-2} = \dfrac{(5)^{-2}(x)^{-2}}{\left(y^4\right)^{-2}}$
$= \dfrac{(5)^{-2}(x)^{-2}}{\left(y^4\right)^{-2}}$
$= \dfrac{5^{-2}x^{-2}}{y^{-8}}$
$= \dfrac{y^8}{5^2x^2}$
$= \dfrac{y^8}{25x^2}$

8. a. $-2.6 \times 10^9 = -2,600,000,000$

b. $3.017 \times 10^{-6} = 0.000003017$

9. a. $5,210,000,000 = 5.21 \times 10^9$

b. $-0.00000006893 = -6.893 \times 10^{-8}$

10. $410\times10^7 = \left(4.1\times10^2\right)\times10^7$
$= 4.1\times\left(10^2\times10^7\right)$
$= 4.1\times10^9$

11 a. $\left(7.1\times10^5\right)\left(5\times10^{-7}\right)$
$= 7.1\cdot5\times10^5\cdot10^{-7}$
$= 35.5\times10^{-2}$
$= \left(3.55\times10^1\right)\times10^{-2}$
$= 3.55\times\left(10^1\times10^{-2}\right)$
$= 3.55\times10^{-1}$

b. $\dfrac{1.2\times10^6}{3\times10^{-3}} = \dfrac{1.2}{3}\cdot\dfrac{10^6}{10^{-3}}$
$= 0.4\times10^{6-(-3)}$
$= 0.4\times10^9$
$= 4\times10^8$

12. $\dfrac{4.08\times10^{10}}{680,000} = \dfrac{4.08\times10^{10}}{6.8\times10^5} = \dfrac{4.08}{6.8}\cdot\dfrac{10^{10}}{10^5}$
$= 0.6\times10^5$
$= 60,000$
The average salary was \$60,000 per U.S. police officer.

Concept and Vocabulary Check P.2

1. b^{m+n}; add

2. b^{m-n}; subtract

3. 1

4. $\dfrac{1}{b^n}$

5. false

6. b^n

7. true

8. a number greater than or equal to 1 and less than 10; integer

9. true

10. false

Exercise Set P.2

1. $5^2\cdot2 = (5\cdot5)\cdot2 = 25\cdot2 = 50$

2. $6^2\cdot2 = (6\cdot6)\cdot2 = 36\cdot2 = 72$

3. $(-2)^6 = (-2)(-2)(-2)(-2)(-2)(-2) = 64$

4. $(-2)^4 = (-2)(-2)(-2)(-2) = 16$

5. $-2^6 = -2\cdot2\cdot2\cdot2\cdot2\cdot2 = -64$

6. $-2^4 = -2\cdot2\cdot2\cdot2 = -16$

7. $(-3)^0 = 1$

8. $(-9)^0 = 1$

9. $-3^0 = -1$

10. $-9^0 = -1$

11. $4^{-3} = \dfrac{1}{4^3} = \dfrac{1}{4\cdot4\cdot4} = \dfrac{1}{64}$

12. $2^{-6} = \dfrac{1}{2^6} = \dfrac{1}{2\cdot2\cdot2\cdot2\cdot2\cdot2} = \dfrac{1}{64}$

13. $2^2\cdot2^3 = 2^{2+3} = 2^5 = 2\cdot2\cdot2\cdot2\cdot2 = 32$

14. $3^3\cdot3^2 = 3^{3+2} = 3^5 = 3\cdot3\cdot3\cdot3\cdot3 = 243$

15. $(2^2)^3 = 2^{2\cdot3} = 2^6 = 2\cdot2\cdot2\cdot2\cdot2\cdot2 = 64$

16. $(3^3)^2 = 3^{3\cdot2} = 3^6 = 3\cdot3\cdot3\cdot3\cdot3\cdot3 = 729$

17. $\dfrac{2^8}{2^4} = 2^{8-4} = 2^4 = 2\cdot2\cdot2\cdot2 = 16$

18. $\dfrac{3^8}{3^4} = 3^{8-4} = 3^4 = 3\cdot3\cdot3\cdot3 = 81$

19. $3^{-3}\cdot3 = 3^{-3+1} = 3^{-2} = \dfrac{1}{3^2} = \dfrac{1}{3\cdot3} = \dfrac{1}{9}$

20. $2^{-3}\cdot2 = 2^{-3+1} = 2^{-2} = \dfrac{1}{2^2} = \dfrac{1}{2\cdot2} = \dfrac{1}{4}$

21. $\dfrac{2^3}{2^7} = 2^{3-7} = 2^{-4} = \dfrac{1}{2^4} = \dfrac{1}{2\cdot2\cdot2\cdot2} = \dfrac{1}{16}$

22. $\dfrac{3^4}{3^7} = 3^{4-7} = 3^{-3} = \dfrac{1}{3^3} = \dfrac{1}{3\cdot 3\cdot 3} = \dfrac{1}{27}$

23. $x^{-2}y = \dfrac{1}{x^2}\cdot y = \dfrac{y}{x^2}$

24. $xy^{-3} = x\cdot\dfrac{1}{y^3} = \dfrac{x}{y^3}$

25. $x^0y^5 = 1\cdot y^5 = y^5$

26. $x^7\cdot y^0 = x^7\cdot 1 = x^7$

27. $x^3\cdot x^7 = x^{3+7} = x^{10}$

28. $x^{11}\cdot x^5 = x^{11+5} = x^{16}$

29. $x^{-5}\cdot x^{10} = x^{-5+10} = x^5$

30. $x^{-6}\cdot x^{12} = x^{-6+12} = x^6$

31. $(x^3)^7 = x^{3\cdot 7} = x^{21}$

32. $(x^{11})^5 = x^{11\cdot 5} = x^{55}$

33. $(x^{-5})^3 = x^{-5\cdot 3} = x^{-15} = \dfrac{1}{x^{15}}$

34. $(x^{-6})^4 = x^{-6\cdot 4} = x^{-24} = \dfrac{1}{x^{24}}$

35. $\dfrac{x^{14}}{x^7} = x^{14-7} = x^7$

36. $\dfrac{x^{30}}{x^{10}} = x^{30-10} = x^{20}$

37. $\dfrac{x^{14}}{x^{-7}} = x^{14-(-7)} = x^{14+7} = x^{21}$

38. $\dfrac{x^{30}}{x^{-10}} = x^{30-(-10)} = x^{30+10} = x^{40}$

39. $(8x^3)^2 = 8^2(x^3)^2 = 8^2x^{3\cdot 2} = 64x^6$

40. $(6x^4)^2 = (6)^2(x^4)^2 = 6^2x^{4\cdot 2} = 36x^8$

41. $\left(-\dfrac{4}{x}\right)^3 = \dfrac{(-4)^3}{x^3} = -\dfrac{64}{x^3}$

42. $\left(-\dfrac{6}{y}\right)^3 = \dfrac{(-6)^3}{y^3} = -\dfrac{216}{y^3}$

43. $\begin{aligned}(-3x^2y^5)^2 &= (-3)^2(x^2)^2\cdot(y^5)^2\\ &= 9x^{2\cdot 2}y^{5\cdot 2}\\ &= 9x^4y^{10}\end{aligned}$

44. $\begin{aligned}(-3x^4y^6)^3 &= (-3)^3(x^4)^3(y^6)^3\\ &= -27x^{4\cdot 3}y^{6\cdot 3}\\ &= -27x^{12}y^{18}\end{aligned}$

45. $(3x^4)(2x^7) = 3\cdot 2x^4\cdot x^7 = 6x^{4+7} = 6x^{11}$

46. $(11x^5)(9x^{12}) = 11\cdot 9x^5x^{12} = 99x^{5+12} = 99x^{17}$

47. $\begin{aligned}(-9x^3y)(-2x^6y^4) &= (-9)(-2)x^3x^6yy^4\\ &= 18x^{3+6}y^{1+4}\\ &= 18x^9y^5\end{aligned}$

48. $\begin{aligned}(-5x^4y)(-6x^7y^{11}) &= (-5)(-6)x^4x^7yy^{11}\\ &= 30x^{4+7}y^{1+11}\\ &= 30x^{11}y^{12}\end{aligned}$

49. $\dfrac{8x^{20}}{2x^4} = \left(\dfrac{8}{2}\right)\left(\dfrac{x^{20}}{x^4}\right) = 4x^{20-4} = 4x^{16}$

50. $\dfrac{20x^{24}}{10x^6} = \left(\dfrac{20}{10}\right)\left(\dfrac{x^{24}}{x^6}\right) = 2x^{24-6} = 2x^{18}$

51. $\begin{aligned}\dfrac{25a^{13}\cdot b^4}{-5a^2\cdot b^3} &= \left(\dfrac{25}{-5}\right)\left(\dfrac{a^{13}}{a^2}\right)\left(\dfrac{b^4}{b^3}\right)\\ &= -5a^{13-2}b^{4-3}\\ &= -5a^{11}b\end{aligned}$

52. $\begin{aligned}\dfrac{35a^{14}b^6}{-7a^7b^3} &= \left(\dfrac{35}{-7}\right)\left(\dfrac{a^{14}}{a^7}\right)\left(\dfrac{b^6}{b^3}\right)\\ &= -5a^{14-7}b^{6-3}\\ &= -5a^7b^3\end{aligned}$

53. $\dfrac{14b^7}{7b^{14}} = \left(\dfrac{14}{7}\right)\left(\dfrac{b^7}{b^{14}}\right) = 2\cdot b^{7-14} = 2b^{-7} = \dfrac{2}{b^7}$

54. $\dfrac{20b^{10}}{10b^{20}} = \left(\dfrac{20}{10}\right)\left(\dfrac{b^{10}}{b^{20}}\right)$

$= 2b^{10-20}$

$= 2b^{-10}$

$= \dfrac{2}{b^{10}}$

55. $(4x^3)^{-2} = (4^{-2})(x^3)^{-2}$

$= 4^{-2}x^{-6}$

$= \dfrac{1}{4^2 x^6}$

$= \dfrac{1}{16x^6}$

56. $(10x^2)^{-3} = 10^{-3}x^{2\cdot(-3)}$

$= 10^{-3}x^{-6}$

$= \dfrac{1}{10^3 x^6}$

$= \dfrac{1}{1000x^6}$

57. $\dfrac{24x^3 \cdot y^5}{32x^7 y^{-9}} = \dfrac{3}{4}x^{3-7}y^{5-(-9)}$

$= \dfrac{3}{4}x^{-4}y^{14}$

$= \dfrac{3y^{14}}{4x^4}$

58. $\dfrac{10x^4 y^9}{30x^{12}y^{-3}} = \dfrac{1}{3}x^{4-12}y^{9-(-3)}$

$= \dfrac{1}{3}x^{-8}y^{12}$

$= \dfrac{y^{12}}{3x^8}$

59. $\left(\dfrac{5x^3}{y}\right)^{-2} = \dfrac{5^{-2}x^{-6}}{y^{-2}} = \dfrac{y^2}{25x^6}$

60. $\left(\dfrac{3x^4}{y}\right)^{-3} = \left(\dfrac{y}{3x^4}\right)^3$

$= \dfrac{y^3}{3^3 x^{4\cdot 3}}$

$= \dfrac{y^3}{27x^{12}}$

61. $\left(\dfrac{-15a^4b^2}{5a^{10}b^{-3}}\right)^3 = \left(\dfrac{-3b^{2-(-3)}}{a^{10-4}}\right)^3$

$= \left(\dfrac{-3b^5}{a^6}\right)^3$

$= \dfrac{-27b^{15}}{a^{18}}$

62. $\left(\dfrac{-30a^{14}b^8}{10a^{17}b^{-2}}\right)^3 = \left(\dfrac{-3b^{8-(-2)}}{a^{17-14}}\right)^3$

$= \left(\dfrac{-3b^{10}}{a^3}\right)^3$

$= \dfrac{-27b^{30}}{a^9}$

63. $\left(\dfrac{3a^{-5}b^2}{12a^3b^{-4}}\right)^0 = 1$

64. $\left(\dfrac{4a^{-5}b^3}{12a^3b^{-5}}\right)^0 = 1$

65. $3.8\times10^2 = 380$

66. $9.2\times10^2 = 920$

67. $6\times10^{-4} = 0.0006$

68. $7\times10^{-5} = 0.00007$

69. $-7.16\times10^6 = -7{,}160{,}000$

70. $-8.17\times10^6 = -8{,}170{,}000$

71. $7.9\times10^{-1} = 0.79$

72. $6.8\times10^{-1} = 0.68$

73. $-4.15\times10^{-3} = -0.00415$

74. $-3.14\times10^{-3} = -0.00314$

75. $-6.00001\times10^{10} = -60,000,100,000$

76. $-7.00001\times10^{10} = -70,000,100,000$

77. $32,000 = 3.2\times10^{4}$

78. $64,000 = 6.4\times10^{4}$

79. $638,000,000,000,000,000$
$= 6.38\times10^{17}$

80. $579,000,000,000,000,000 = 5.79\times10^{17}$

81. $-5716 = -5.716\times10^{3}$

82. $-3829 = -3.829\times10^{3}$

83. $0.0027 = 2.7\times10^{-3}$

84. $0.0083 = 8.3\times10^{-3}$

85. $-0.00000000504 = -5.04\times10^{-9}$

86. $-0.00000000405 = -4.05\times10^{-9}$

87. $\left(3\times10^{4}\right)\left(2.1\times10^{3}\right) = (3\times2.1)\left(10^{4}\times10^{3}\right)$
$= 6.3\times10^{4+3} = 6.3\times10^{7}$

88. $\left(2\times10^{4}\right)\left(4.1\times10^{3}\right) = 8.2\times10^{7}$

89. $\left(1.6\times10^{15}\right)\left(4\times10^{-11}\right) = (1.6\times4)\left(10^{15}\times10^{-11}\right)$
$= 6.4\times10^{15+(-11)}$
$= 6.4\times10^{4}$

90. $\left(1.4\times10^{15}\right)\left(3\times10^{-11}\right) = (1.4\times3)\left(10^{15}\times10^{-11}\right)$
$= 4.2\times10^{15+(-11)}$
$= 4.2\times10^{4}$

91. $\left(6.1\times10^{-8}\right)\left(2\times10^{-4}\right) = (6.1\times2)\left(10^{-8}\times10^{-4}\right)$
$= 12.2\times10^{-8+(-4)}$
$= 12.2\times10^{-12}$
$= 1.22\times10^{-11}$

92. $\left(5.1\times10^{-8}\right)\left(3\times10^{-4}\right) = 15.3\times10^{-12}$
$= 1.53\times10^{-11}$

93. $\left(4.3\times10^{8}\right)\left(6.2\times10^{4}\right)$
$= (4.3\times6.2)\left(10^{8}\times10^{4}\right)$
$= 26.66\times10^{8+4}$
$= 26.66\times10^{12}$
$= 2.666\times10^{13} \approx 2.67\times10^{13}$

94. $\left(8.2\times10^{8}\right)\left(4.6\times10^{4}\right)$
$= 37.72\times10^{8+4} = 37.72\times10^{12}$
$= 3.772\times10^{13} \approx 3.77\times10^{13}$

95. $\dfrac{8.4\times10^{8}}{4\times10^{5}} = \dfrac{8.4}{4}\times\dfrac{10^{8}}{10^{5}}$
$= 2.1\times10^{8-5} = 2.1\times10^{3}$

96. $\dfrac{6.9\times10^{8}}{3\times10^{5}} = 2.3\times10^{8-5} = 2.3\times10^{3}$

97. $\dfrac{3.6\times10^{4}}{9\times10^{-2}} = \dfrac{3.6}{9}\times\dfrac{10^{4}}{10^{-2}}$
$= 0.4\times10^{4-(-2)}$
$= 0.4\times10^{6} = 4\times10^{5}$

98. $\dfrac{1.2\times10^{4}}{2\times10^{-2}} = 0.6\times10^{4-(-2)} = 0.6\times10^{6}$
$= \left(6\times10^{-1}\right)\times10^{6} = 6\times10^{5}$

99. $\dfrac{4.8\times10^{-2}}{2.4\times10^{6}} = \dfrac{4.8}{2.4}\times\dfrac{10^{-2}}{10^{6}}$
$= 2\times10^{-2-6} = 2\times10^{-8}$

100. $\dfrac{7.5\times10^{-2}}{2.5\times10^{6}} = 3\times10^{-2-6} = 3\times10^{-8}$

101. $\dfrac{2.4\times10^{-2}}{4.8\times10^{-6}} = \dfrac{2.4}{4.8}\times\dfrac{10^{-2}}{10^{-6}}$
$= 0.5\times10^{-2-(-6)}$
$= 0.5\times10^{4} = 5\times10^{3}$

102. $\dfrac{1.5\times10^{-2}}{5\times10^{-6}} = 0.5\times10^{-2-(-6)}$

$= 0.5\times10^{4} = 5\times10^{3}$

103. $\dfrac{480,000,000,000}{0.00012} = \dfrac{4.8\times10^{11}}{1.2\times10^{-4}}$

$= \dfrac{4.8}{1.2}\times\dfrac{10^{11}}{10^{-4}}$

$= 4\times10^{11-(-4)}$

$= 4\times10^{15}$

104. $\dfrac{282,000,000,000}{0.00141} = \dfrac{2.82\times10^{11}}{1.41\times10^{-3}}$

$= 2\times10^{11-(-3)}$

$= 2\times10^{14}$

105. $\dfrac{0.00072\times0.003}{0.00024}$

$= \dfrac{\left(7.2\times10^{-4}\right)\left(3\times10^{-3}\right)}{2.4\times10^{-4}}$

$= \dfrac{7.2\times3}{2.4}\times\dfrac{10^{-4}\cdot10^{-3}}{10^{-4}} = 9\times10^{-3}$

106. $\dfrac{66000\times0.001}{0.003\times0.002} = \dfrac{\left(6.6\times10^{4}\right)\left(1\times10^{-3}\right)}{\left(3\times10^{-3}\right)\left(2\times10^{-3}\right)}$

$= \dfrac{6.6\times10^{1}}{6\times10^{-6}} = 1.1\times10^{1-(-6)}$

$= 1.1\times10^{7}$

107. $\dfrac{\left(x^{-2}y\right)^{-3}}{\left(x^{2}y^{-1}\right)^{3}} = \dfrac{x^{6}y^{-3}}{x^{6}y^{-3}}$

$= x^{6-6}y^{-3-(-3)} = x^{0}y^{0} = 1$

108. $\dfrac{\left(xy^{-2}\right)^{-2}}{\left(x^{-2}y\right)^{-3}} = \dfrac{x^{-2}y^{4}}{x^{6}y^{-3}}$

$= x^{-2-6}y^{4-(-3)} = x^{-8}y^{7} = \dfrac{y^{7}}{x^{8}}$

109. $\left(2x^{-3}yz^{-6}\right)(2x)^{-5} = 2x^{-3}yz^{-6}\cdot2^{-5}x^{\cdot-5}$

$= 2^{-4}x^{-8}yz^{-6} = \dfrac{y}{2^{4}x^{8}z^{6}} = \dfrac{y}{16x^{8}z^{6}}$

110. $\left(3x^{-4}yz^{-7}\right)(3x)^{-3} = 3x^{-4}yz^{-7}\cdot3^{-3}x^{\cdot-3}$

$= 3^{-2}x^{-7}yz^{-7} = \dfrac{y}{3^{2}x^{7}z^{7}} = \dfrac{y}{9x^{7}z^{7}}$

111. $\left(\dfrac{x^{3}y^{4}z^{5}}{x^{-3}y^{-4}z^{-5}}\right)^{-2} = \left(x^{6}y^{8}z^{10}\right)^{-2}$

$= x^{-12}y^{-16}z^{-20} = \dfrac{1}{x^{12}y^{16}z^{20}}$

112. $\left(\dfrac{x^{4}y^{5}z^{6}}{x^{-4}y^{-5}z^{-6}}\right)^{-4} = \left(x^{8}y^{10}z^{12}\right)^{-4}$

$= x^{-32}y^{-40}z^{-48} = \dfrac{1}{x^{32}y^{40}z^{48}}$

113. $\dfrac{\left(2^{-1}x^{-2}y^{-1}\right)^{-2}\left(2x^{-4}y^{3}\right)^{-2}\left(16x^{-3}y^{3}\right)^{0}}{\left(2x^{-3}y^{-5}\right)^{2}}$

$= \dfrac{\left(2^{2}x^{2}y^{2}\right)\left(2^{-2}x^{8}y^{-6}\right)(1)}{\left(2^{2}x^{-6}y^{-10}\right)}$

$= \dfrac{x^{18}y^{6}}{4}$

114. $\dfrac{\left(2^{-1}x^{-3}y^{-1}\right)^{-2}\left(2x^{-6}y^{4}\right)^{-2}\left(9x^{3}y^{-3}\right)^{0}}{\left(2x^{-4}y^{-6}\right)^{2}}$

$= \dfrac{\left(2^{2}x^{6}y^{2}\right)\left(2^{-2}x^{12}y^{-8}\right)(1)}{\left(2^{2}x^{-8}y^{-12}\right)}$

$= \dfrac{x^{26}y^{6}}{4}$

115. **a.** 3.18×10^{12}

b. 3.20×10^{8}

c. $\dfrac{3.18\times10^{12}}{3.20\times10^{8}} = \dfrac{3.18}{3.20}\times\dfrac{10^{12}}{10^{8}}$

$\approx 0.9938\times10^{4}$

≈ 9938

\$9938 per American

116. **a.** 3.02×10^{12}

b. 3.19×10^{8}

c. $\dfrac{3.02\times10^{12}}{3.19\times10^{8}} = \dfrac{3.02}{3.19}\times\dfrac{10^{12}}{10^{8}}$
$\approx 0.9467\times10^{4}$
≈ 9467
\$9467 per American

117. a. 1.89×10^{13}

b. 6×10^{4}

c. $\dfrac{1.89\times10^{13}}{6\times10^{4}} = \dfrac{1.89}{6}\times\dfrac{10^{13}}{10^{4}}$
$= 0.315\times10^{9}$
$= 3.15\times10^{8}$
$= 315,000,000$
315,00,000 Americans

118. a. 1.89×10^{13}

b. 2.54×10^{11}

c. $\dfrac{1.89\times10^{13}}{2.54\times10^{11}} = \dfrac{1.89}{2.54}\times\dfrac{10^{13}}{10^{11}}$
$\approx 0.74\times10^{2}$
≈ 74
approximately 74 years

119. a. 1.09×10^{12}

b. 3.2×10^{7}

c. $\dfrac{1.09\times10^{12}}{3.2\times10^{7}} = \dfrac{1.09}{3.2}\times\dfrac{10^{12}}{10^{7}}$
$= 0.340625\times10^{5}$
$= 34,062.5$
34,062.5 years

120. – 128. Answers will vary.

129. does not make sense; Explanations will vary.
Sample explanation: $36(x^3)^9 = 36x^{27}$ not $36x^{12}$.

130. makes sense

131. does not make sense; Explanations will vary.
Sample explanation: 4.6×10^{12} represents over 4 trillion. The entire world population is measured in billions (10^9).

132. makes sense

133. false; Changes to make the statement true will vary.
A sample change is: $4^{-2} > 4^{-3}$.

134. true

135. false; Changes to make the statement true will vary.
A sample change is: $(-2)^4 \neq 2^{-4}$ because $16 \neq \dfrac{1}{16}$.

136. false; Changes to make the statement true will vary.
A sample change is: $5^2 \cdot 5^{-2} = 2^5 \cdot 2^{-5}$.

137. false; Changes to make the statement true will vary.
A sample change is: $534.7 \neq 5347$.

138. false; Changes to make the statement true will vary.
A sample change is:
$\dfrac{8\times10^{30}}{2\times10^{-5}} = 4\times10^{30-(-5)} = 4\times10^{35}$.

139. false; Changes to make the statement true will vary.
A sample change is:
$(7\times10^{5}) + (2\times10^{-3}) = 700,000.002$.

140. true

141. The doctor has gathered:
$2^{-1} + 2^{-2} = \dfrac{1}{2} + \dfrac{1}{2^2} = \dfrac{2}{4} + \dfrac{1}{4} = \dfrac{3}{4}$
So, $1 - \dfrac{3}{4} = \dfrac{1}{4}$ is remaining.

142. $b^A = MN, b^C = M, b^D = N$
$b^A = b^C b^D$
$A = C + D$

143. $\dfrac{70 \text{ bts}}{\cancel{\text{min}}} \cdot \dfrac{60 \cancel{\text{min}}}{\cancel{\text{hr}}} \cdot \dfrac{24 \cancel{\text{hrs}}}{\cancel{\text{day}}} \cdot \dfrac{365 \cancel{\text{days}}}{\cancel{\text{yr}}} \cdot 80 \cancel{\text{yrs}}$
$= 70 \cdot 60 \cdot 24 \cdot 365 \cdot 80$ beats
$= 2943360000$ beats
$= 2.94336\times10^{9}$ beats
$\approx 2.94\times10^{9}$ beats
The heartbeats approximately 2.94×10^{9} times over a lifetime of 80 years.

144. Answers will vary.

145. a. $\sqrt{16}\cdot\sqrt{4}=4\cdot 2=8$

b. $\sqrt{16\cdot 4}=\sqrt{64}=8$

c. $\sqrt{16}\cdot\sqrt{4}=\sqrt{16\cdot 4}$

146. a. $\sqrt{300}\approx 17.32$

b. $10\sqrt{3}\approx 17.32$

c. $\sqrt{300}=10\sqrt{3}$

147. a. $21x+10x=31x$

b. $21\sqrt{2}+10\sqrt{2}=31\sqrt{2}$

Section P.3

Check Point Exercises

1. a. $\sqrt{81}=9$

b. $-\sqrt{9}=-3$

c. $\sqrt{\frac{1}{25}}=\frac{1}{5}$

d. $\sqrt{36+64}=\sqrt{100}=10$

e. $\sqrt{36}+\sqrt{64}=6+8=14$

2. a. $\sqrt{75}=\sqrt{25\cdot 3}=\sqrt{25}\sqrt{3}=5\sqrt{3}$

b.
$$\begin{aligned}\sqrt{5x}\cdot\sqrt{10x}&=\sqrt{5x\cdot 10x}\\&=\sqrt{50x^2}\\&=\sqrt{25\cdot 2x^2}\\&=\sqrt{25x^2}\cdot\sqrt{2}\\&=5x\sqrt{2}\end{aligned}$$

3. a. $\sqrt{\frac{25}{16}}=\frac{\sqrt{25}}{\sqrt{16}}=\frac{5}{4}$

b.
$$\begin{aligned}\frac{\sqrt{150x^3}}{\sqrt{2x}}&=\sqrt{\frac{150x^3}{2x}}\\&=\sqrt{75x^2}\\&=\sqrt{25x^2}\cdot\sqrt{3}\\&=5x\sqrt{3}\end{aligned}$$

4. a.
$$\begin{aligned}8\sqrt{13}+9\sqrt{13}&=(8+9)\sqrt{3}\\&=17\sqrt{13}\end{aligned}$$

b.
$$\begin{aligned}&\sqrt{17x}-20\sqrt{17x}\\&=1\sqrt{17x}-20\sqrt{17x}\\&=(1-20)\sqrt{17x}\\&=-19\sqrt{17x}\end{aligned}$$

5. a.
$$\begin{aligned}&5\sqrt{27}+\sqrt{12}\\&=5\sqrt{9\cdot 3}+\sqrt{4\cdot 3}\\&=5\cdot 3\sqrt{3}+2\sqrt{3}\\&=15\sqrt{3}+2\sqrt{3}\\&=(15+2)\sqrt{3}\\&=17\sqrt{3}\end{aligned}$$

b.
$$\begin{aligned}&6\sqrt{18x}-4\sqrt{8x}\\&=6\sqrt{9\cdot 2x}-4\sqrt{4\cdot 2x}\\&=6\cdot 3\sqrt{2x}-4\cdot 2\sqrt{2x}\\&=18\sqrt{2x}-8\sqrt{2x}\\&=(18-8)\sqrt{2x}\\&=10\sqrt{2x}\end{aligned}$$

6. a. If we multiply numerator and denominator by $\sqrt{3}$, the denominator becomes $\sqrt{3}\cdot\sqrt{3}=\sqrt{9}=3$. Therefore, multiply by 1, choosing $\frac{\sqrt{3}}{\sqrt{3}}$ for 1.

$$\frac{5}{\sqrt{3}}=\frac{5}{\sqrt{3}}\cdot\frac{\sqrt{3}}{\sqrt{3}}=\frac{5\sqrt{3}}{\sqrt{9}}=\frac{5\sqrt{3}}{3}$$

b. The *smallest* number that will produce a perfect square in the denominator of $\frac{6}{\sqrt{12}}$ is $\sqrt{3}$ because $\sqrt{12}\cdot\sqrt{3}=\sqrt{36}=6$. So multiply by 1, choosing $\frac{\sqrt{3}}{\sqrt{3}}$ for 1.

$$\frac{6}{\sqrt{12}}=\frac{6}{\sqrt{12}}\cdot\frac{\sqrt{3}}{\sqrt{3}}=\frac{6\sqrt{3}}{\sqrt{36}}=\frac{6\sqrt{3}}{6}=\sqrt{3}$$

7. Multiply by $\frac{4-\sqrt{5}}{4-\sqrt{5}}$.

$$\frac{8}{4+\sqrt{5}} = \frac{8}{4+\sqrt{5}} \cdot \frac{4-\sqrt{5}}{4-\sqrt{5}}$$
$$= \frac{8(4-\sqrt{5})}{4^2-(\sqrt{5})^2}$$
$$= \frac{8(4-\sqrt{5})}{16-5}$$
$$= \frac{8(4-\sqrt{5})}{11} \text{ or } \frac{32-8\sqrt{5}}{11}$$

8. **a.** $\sqrt[3]{40} = \sqrt[3]{8 \cdot 5} = \sqrt[3]{8} \cdot \sqrt[3]{5} = 2\sqrt[3]{5}$

b. $\sqrt[5]{8} \cdot \sqrt[5]{8} = \sqrt[5]{64} = \sqrt[5]{32} \cdot \sqrt[5]{2} = 2\sqrt[5]{2}$

c. $\sqrt[3]{\frac{125}{27}} = \frac{\sqrt[3]{125}}{\sqrt[3]{27}} = \frac{5}{3}$

9. $3\sqrt[3]{81} - 4\sqrt[3]{3}$
$= 3\sqrt[3]{27 \cdot 3} - 4\sqrt[3]{3}$
$= 3 \cdot 3\sqrt[3]{3} - 4\sqrt[3]{3}$
$= 9\sqrt[3]{3} - 4\sqrt[3]{3}$
$= (9-4)\sqrt[3]{3}$
$= 5\sqrt[3]{3}$

10. **a.** $25^{\frac{1}{2}} = \sqrt{25} = 5$

b. $8^{\frac{1}{3}} = \sqrt[3]{8} = 2$

c. $-81^{\frac{1}{4}} = -\sqrt[4]{81} = -3$

d. $(-8)^{\frac{1}{3}} = \sqrt[3]{-8} = -2$

e. $27^{-\frac{1}{3}} = \frac{1}{27^{\frac{1}{3}}} = \frac{1}{\sqrt[3]{27}} = \frac{1}{3}$

11. **a.** $27^{\frac{4}{3}} = \left(\sqrt[3]{27}\right)^4 = (3)^4 = 81$

b. $4^{\frac{3}{2}} = \left(\sqrt[2]{4}\right)^3 = (2)^3 = 8$

c. $32^{-\frac{2}{5}} = \frac{1}{32^{\frac{2}{5}}} = \frac{1}{\left(\sqrt[5]{32}\right)^2} = \frac{1}{2^2} = \frac{1}{4}$

12. **a.** $\left(2x^{4/3}\right)\left(5x^{8/3}\right)$
$= 2 \cdot 5x^{4/3} \cdot x^{8/3}$
$= 10x^{(4/3)+(8/3)}$
$= 10x^{12/3}$
$= 10x^4$

b. $\frac{20x^4}{5x^{3/2}} = \left(\frac{20}{5}\right)\left(\frac{x^4}{x^{3/2}}\right)$
$= 4x^{4-(3/2)}$
$= 4x^{(8/2)-(3/2)}$
$= 4x^{5/2}$

13. $\sqrt[6]{x^3} = x^{3/6} = x^{1/2} = \sqrt{x}$

Concept and Vocabulary Check P.3

1. principal

2. 8^2

3. $|a|$

4. $\sqrt{a} \cdot \sqrt{b}$

5. $\frac{\sqrt{a}}{\sqrt{b}}$

6. $18\sqrt{3}$

7. 5; $6\sqrt{3}$

8. $7 - \sqrt{3}$

9. $\sqrt{10} + \sqrt{2}$

10. index; radicand

11. $(-2)^5$

12. a; $|a|$

13. $\sqrt[n]{a}$

14. 2; 8

Exercise Set P.3

1. $\sqrt{36} = \sqrt{6^2} = 6$

2. $\sqrt{25} = \sqrt{5^2} = 5$

3. $-\sqrt{36} = -\sqrt{6^2} = -6$

4. $-\sqrt{25} = -\sqrt{5^2} = -5$

5. $\sqrt{-36}$, The square root of a negative number is not real.

6. $\sqrt{-25}$, The square root of a negative number is not real.

7. $\sqrt{25-16} = \sqrt{9} = 3$

8. $\sqrt{144+25} = \sqrt{169} = 13$

9. $\sqrt{25} - \sqrt{16} = 5 - 4 = 1$

10. $\sqrt{144} + \sqrt{25} = 12 + 5 = 17$

11. $\sqrt{(-13)^2} = \sqrt{169} = 13$

12. $\sqrt{(-17)^2} = \sqrt{289} = 17$

13. $\sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25}\sqrt{2} = 5\sqrt{2}$

14. $\sqrt{27} = \sqrt{9 \cdot 3} = \sqrt{9}\sqrt{3} = 3\sqrt{3}$

15. $\sqrt{45x^2} = \sqrt{9x^2 \cdot 5}$
$= \sqrt{9x^2}\sqrt{5}$
$= \sqrt{9}\sqrt{x^2}\sqrt{5}$
$= 3|x|\sqrt{5}$

16. $\sqrt{125x^2} = \sqrt{25x^2 \cdot 5}$
$= \sqrt{25x^2}\sqrt{5}$
$= \sqrt{25}\sqrt{x^2}\sqrt{5}$
$= 5|x|\sqrt{5}$

17. $\sqrt{2x} \cdot \sqrt{6x} = \sqrt{2x \cdot 6x}$
$= \sqrt{12x^2}$
$= \sqrt{4x^2} \cdot \sqrt{3}$
$= 2x\sqrt{3}$

18. $\sqrt{10x} \cdot \sqrt{8x} = \sqrt{10x \cdot 8x}$
$= \sqrt{80x^2}$
$= \sqrt{16x^2} \cdot \sqrt{5}$
$= 4x\sqrt{5}$

19. $\sqrt{x^3} = \sqrt{x^2} \cdot \sqrt{x} = x\sqrt{x}$

20. $\sqrt{y^3} = \sqrt{y^2} \cdot \sqrt{y} = y\sqrt{y}$

21. $\sqrt{2x^2} \cdot \sqrt{6x} = \sqrt{2x^2 \cdot 6x}$
$= \sqrt{12x^3}$
$= \sqrt{4x^2} \cdot \sqrt{3x}$
$= 2x\sqrt{3x}$

22. $\sqrt{6x} \cdot \sqrt{3x^2} = \sqrt{6x \cdot 3x^2}$
$= \sqrt{18x^3}$
$= \sqrt{9x^2} \cdot \sqrt{2x}$
$= 3x\sqrt{2x}$

23. $\sqrt{\frac{1}{81}} = \frac{\sqrt{1}}{\sqrt{81}} = \frac{1}{9}$

24. $\sqrt{\frac{1}{49}} = \frac{\sqrt{1}}{\sqrt{49}} = \frac{1}{7}$

25. $\sqrt{\frac{49}{16}} = \frac{\sqrt{49}}{\sqrt{16}} = \frac{7}{4}$

26. $\sqrt{\frac{121}{9}} = \frac{\sqrt{121}}{\sqrt{9}} = \frac{11}{3}$

27. $\frac{\sqrt{48x^3}}{\sqrt{3x}} = \sqrt{\frac{48x^3}{3x}} = \sqrt{16x^2} = 4x$

28. $\frac{\sqrt{72x^3}}{\sqrt{8x}} = \sqrt{\frac{72x^3}{8x}} = \sqrt{9x^2} = 3x$

29. $\dfrac{\sqrt{150x^4}}{\sqrt{3x}} = \sqrt{\dfrac{150x^4}{3x}}$
$= \sqrt{50x^3}$
$= \sqrt{25x^2} \cdot \sqrt{2x}$
$= 5x\sqrt{2x}$

30. $\dfrac{\sqrt{24x^4}}{\sqrt{3x}} = \sqrt{\dfrac{24x^4}{3x}}$
$= \sqrt{8x^3}$
$= \sqrt{4x^2} \cdot \sqrt{2x}$
$= 2x\sqrt{2x}$

31. $\dfrac{\sqrt{200x^3}}{\sqrt{10x^{-1}}} = \sqrt{\dfrac{200x^3}{10x^{-1}}}$
$= \sqrt{20x^{3-(-1)}}$
$= \sqrt{20x^4}$
$= \sqrt{4 \cdot 5x^4}$
$= 2x^2\sqrt{5}$

32. $\dfrac{\sqrt{500x^3}}{\sqrt{10x^{-1}}} = \sqrt{\dfrac{500x^3}{10x^{-1}}} = \sqrt{50x^{3-(-1)}}$
$= \sqrt{50x^4} = \sqrt{25 \cdot 2x^4} = 5x^2\sqrt{2}$

33. $7\sqrt{3} + 6\sqrt{3} = (7+6)\sqrt{3} = 13\sqrt{3}$

34. $8\sqrt{5} + 11\sqrt{5} = (8+11)\sqrt{5} = 19\sqrt{5}$

35. $6\sqrt{17x} - 8\sqrt{17x} = (6-8)\sqrt{17x} = -2\sqrt{17x}$

36. $4\sqrt{13x} - 6\sqrt{13x} = (4-6)\sqrt{13x} = -2\sqrt{13x}$

37. $\sqrt{8} + 3\sqrt{2} = \sqrt{4 \cdot 2} + 3\sqrt{2}$
$= 2\sqrt{2} + 3\sqrt{2}$
$= (2+3)\sqrt{2}$
$= 5\sqrt{2}$

38. $\sqrt{20} + 6\sqrt{5} = \sqrt{4 \cdot 5} + 6\sqrt{5}$
$= 2\sqrt{5} + 6\sqrt{5}$
$= (2+6)\sqrt{5}$
$= 8\sqrt{5}$

39. $\sqrt{50x} - \sqrt{8x} = \sqrt{25 \cdot 2x} - \sqrt{4 \cdot 2x}$
$= 5\sqrt{2x} - 2\sqrt{2x}$
$= (5-2)\sqrt{2x}$
$= 3\sqrt{2x}$

40. $\sqrt{63x} - \sqrt{28x} = \sqrt{9 \cdot 7x} - \sqrt{4 \cdot 7x}$
$= 3\sqrt{7x} - 2\sqrt{7x}$
$= (3-2)\sqrt{7x}$
$= \sqrt{7x}$

41. $3\sqrt{18} + 5\sqrt{50} = 3\sqrt{9 \cdot 2} + 5\sqrt{25 \cdot 2}$
$= 3 \cdot 3\sqrt{2} + 5 \cdot 5\sqrt{2}$
$= 9\sqrt{2} + 25\sqrt{2}$
$= (9+25)\sqrt{2}$
$= 34\sqrt{2}$

42. $4\sqrt{12} - 2\sqrt{75} = 4\sqrt{4 \cdot 3} - 2\sqrt{25 \cdot 3}$
$= 4 \cdot 2\sqrt{3} - 2 \cdot 5\sqrt{3}$
$= 8\sqrt{3} - 10\sqrt{3}$
$= (8-10)\sqrt{3}$
$= -2\sqrt{3}$

43. $3\sqrt{8} - \sqrt{32} + 3\sqrt{72} - \sqrt{75}$
$= 3\sqrt{4 \cdot 2} - \sqrt{16 \cdot 2} + 3\sqrt{36 \cdot 2} - \sqrt{25 \cdot 3}$
$= 3 \cdot 2\sqrt{2} - 4\sqrt{2} + 3 \cdot 6\sqrt{2} - 5\sqrt{3}$
$= 6\sqrt{2} - 4\sqrt{2} + 18\sqrt{2} - 5\sqrt{3}$
$= 20\sqrt{2} - 5\sqrt{3}$

44. $3\sqrt{54} - 2\sqrt{24} - \sqrt{96} + 4\sqrt{63}$
$= 3\sqrt{9 \cdot 6} - 2\sqrt{4 \cdot 6} - \sqrt{16 \cdot 6} + 4\sqrt{9 \cdot 7}$
$= 3 \cdot 3\sqrt{6} - 2 \cdot 2\sqrt{6} - 4\sqrt{6} + 4 \cdot 3\sqrt{7}$
$= 9\sqrt{6} - 4\sqrt{6} - 4\sqrt{6} + 12\sqrt{7}$
$= \sqrt{6} + 12\sqrt{7}$

45. $\dfrac{1}{\sqrt{7}} = \dfrac{1}{\sqrt{7}} \cdot \dfrac{\sqrt{7}}{\sqrt{7}} = \dfrac{\sqrt{7}}{7}$

46. $\dfrac{2}{\sqrt{10}} = \dfrac{2}{\sqrt{10}} \cdot \dfrac{\sqrt{10}}{\sqrt{10}} = \dfrac{2\sqrt{10}}{10} = \dfrac{\sqrt{10}}{5}$

47. $\dfrac{\sqrt{2}}{\sqrt{5}} = \dfrac{\sqrt{2}}{\sqrt{5}} \cdot \dfrac{\sqrt{5}}{\sqrt{5}} = \dfrac{\sqrt{10}}{5}$

48. $\dfrac{\sqrt{7}}{\sqrt{3}} = \dfrac{\sqrt{7}}{\sqrt{3}} \cdot \dfrac{\sqrt{3}}{\sqrt{3}} = \dfrac{\sqrt{21}}{3}$

49. $\dfrac{13}{3+\sqrt{11}} = \dfrac{13}{3+\sqrt{11}} \cdot \dfrac{3-\sqrt{11}}{3-\sqrt{11}}$

$$= \frac{13(3-\sqrt{11})}{3^2-(\sqrt{11})^2}$$

$$= \frac{13(3-\sqrt{11})}{9-11}$$

$$= \frac{13(3-\sqrt{11})}{-2}$$

50. $\dfrac{3}{3+\sqrt{7}} = \dfrac{3}{3+\sqrt{7}} \cdot \dfrac{3-\sqrt{7}}{3-\sqrt{7}}$

$$= \frac{3(3-\sqrt{7})}{3^2-(\sqrt{7})^2}$$

$$= \frac{3(3-\sqrt{7})}{9-7}$$

$$= \frac{3(3-\sqrt{7})}{2}$$

51. $\dfrac{7}{\sqrt{5}-2} = \dfrac{7}{\sqrt{5}-2} \cdot \dfrac{\sqrt{5}+2}{\sqrt{5}+2}$

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

$$= \frac{7(\sqrt{5}+2)}{5-4}$$

$$= 7(\sqrt{5}+2)$$

52. $\dfrac{5}{\sqrt{3}-1} = \dfrac{5}{\sqrt{3}-1} \cdot \dfrac{\sqrt{3}+1}{\sqrt{3}+1}$

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

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

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

53. $\dfrac{6}{\sqrt{5}+\sqrt{3}} = \dfrac{6}{\sqrt{5}+\sqrt{3}} \cdot \dfrac{\sqrt{5}-\sqrt{3}}{\sqrt{5}-\sqrt{3}}$

$$= \frac{6(\sqrt{5}-\sqrt{3})}{(\sqrt{5})^2-(\sqrt{3})^2}$$

$$= \frac{6(\sqrt{5}-\sqrt{3})}{5-3}$$

$$= \frac{6(\sqrt{5}-\sqrt{3})}{2}$$

$$= 3(\sqrt{5}-\sqrt{3})$$

54. $\dfrac{11}{\sqrt{7}-\sqrt{3}} = \dfrac{11}{\sqrt{7}-\sqrt{3}} \cdot \dfrac{\sqrt{7}+\sqrt{3}}{\sqrt{7}+\sqrt{3}}$

$$= \frac{11(\sqrt{7}+\sqrt{3})}{(\sqrt{7})^2-(\sqrt{3})^2}$$

$$= \frac{11(\sqrt{7}+\sqrt{3})}{7-3}$$

$$= \frac{11(\sqrt{7}+\sqrt{3})}{4}$$

55. $\sqrt[3]{125} = \sqrt[3]{5^3} = 5$

56. $\sqrt[3]{8} = \sqrt[3]{2^3} = 2$

57. $\sqrt[3]{-8} = \sqrt[3]{(-2)^3} = -2$

58. $\sqrt[3]{-125} = \sqrt[3]{(-5)^3} = -5$

59. $\sqrt[4]{-16}$ is not a real number.

60. $\sqrt[4]{-81}$ is not a real number.

61. $\sqrt[4]{(-3)^4} = |-3| = 3$

62. $\sqrt[4]{(-2)^4} = |-2| = 2$

63. $\sqrt[5]{(-3)^5} = -3$

64. $\sqrt[5]{(-2)^5} = -2$

65. $\sqrt[5]{-\dfrac{1}{32}} = \sqrt[5]{-\dfrac{1}{2^5}} = -\dfrac{1}{2}$

66. $\sqrt[6]{\dfrac{1}{64}} = \dfrac{\sqrt[6]{1}}{\sqrt[6]{2^6}} = \dfrac{1}{2}$

67. $\sqrt[3]{32} = \sqrt[3]{8 \cdot 4} = \sqrt[3]{8}\,\sqrt[3]{4} = 2 \cdot \sqrt[3]{4}$

68. $\sqrt[3]{150}$ cannot be simplified further.

69. $\sqrt[3]{x^4} = \sqrt[3]{x^3 \cdot x} = x \cdot \sqrt[3]{x}$

70. $\sqrt[3]{x^5} = \sqrt[3]{x^3 x^2} = x\sqrt[3]{x^2}$

71. $\sqrt[3]{9} \cdot \sqrt[3]{6} = \sqrt[3]{54} = \sqrt[3]{27 \cdot 2} = \sqrt[3]{27}\sqrt[3]{2} = 3\sqrt[3]{2}$

72. $\sqrt[3]{12} \cdot \sqrt[3]{4} = \sqrt[3]{48} = \sqrt[3]{8 \cdot 6} = 2\sqrt[3]{6}$

73. $\dfrac{\sqrt[5]{64x^6}}{\sqrt[5]{2x}} = \sqrt[5]{\dfrac{64x^6}{2x}} = \sqrt[5]{32x^5} = 2x$

74. $\dfrac{\sqrt[4]{162x^5}}{\sqrt[4]{2x}} = \sqrt[4]{\dfrac{162x^5}{2x}} = \sqrt[4]{81x^4} = 3x$

75. $4\sqrt[5]{2} + 3\sqrt[5]{2} = 7\sqrt[5]{2}$

76. $6\sqrt[5]{3} + 2\sqrt[5]{3} = 8\sqrt[5]{3}$

77. $5\sqrt[3]{16} + \sqrt[3]{54} = 5\sqrt[3]{8 \cdot 2} + \sqrt[3]{27 \cdot 2}$
$= 5 \cdot 2\sqrt[3]{2} + 3\sqrt[3]{2}$
$= 10\sqrt[3]{2} + 3\sqrt[3]{2}$
$= 13\sqrt[3]{2}$

78. $3\sqrt[3]{24} + \sqrt[3]{81} = \sqrt[3]{8 \cdot 3} + \sqrt[3]{27 \cdot 3}$
$= 3 \cdot 2\sqrt[3]{3} + 3\sqrt[3]{3}$
$= 6\sqrt[3]{3} + 3\sqrt[3]{3}$
$= 9\sqrt[3]{3}$

79. $\sqrt[3]{54xy^3} - y\sqrt[3]{128x}$
$= \sqrt[3]{27 \cdot 2xy^3} - y\sqrt[3]{64 \cdot 2x}$
$= 3y\sqrt[3]{2x} - 4y\sqrt[3]{2x}$
$= -y\sqrt[3]{2x}$

80. $\sqrt[3]{24xy^3} - y\sqrt[3]{81x}$
$= \sqrt[3]{8 \cdot 3xy^3} - y\sqrt[3]{27 \cdot 3x}$
$= 2y\sqrt[3]{3x} - 3y\sqrt[3]{3x}$
$= -y\sqrt[3]{3x}$

81. $\sqrt{2} + \sqrt[3]{8} = \sqrt{2} + 2$

82. $\sqrt{3} + \sqrt[3]{15}$ will not simplify.

83. $36^{1/2} = \sqrt{36} = 6$

84. $121^{1/2} = \sqrt{121} = 11$

85. $8^{1/3} = \sqrt[3]{8} = 2$

86. $27^{1/3} = \sqrt[3]{27} = 3$

87. $125^{2/3} = \left(\sqrt[3]{125}\right)^2 = 5^2 = 25$

88. $8^{2/3} = \left(\sqrt[3]{8}\right)^2 = 4$

89. $32^{-4/5} = \dfrac{1}{32^{4/5}} = \dfrac{1}{2^4} = \dfrac{1}{16}$

90. $16^{-5/2} = \dfrac{1}{16^{5/2}} = \dfrac{1}{(\sqrt{16})^5} = \dfrac{1}{4^5} = \dfrac{1}{1024}$

91. $\left(7x^{1/3}\right)\left(2x^{1/4}\right) = 7 \cdot 2x^{1/3} \cdot x^{1/4}$
$= 14 \cdot x^{1/3+1/4}$
$= 14x^{7/12}$

92. $(3x^{2/3})(4x^{3/4}) = 3 \cdot 4x^{2/3} \cdot x^{3/4}$
$= 12 \cdot x^{2/3+3/4}$
$= 12x^{17/12}$

93. $\dfrac{20x^{1/2}}{5x^{1/4}} = \left(\dfrac{20}{5}\right)\left(\dfrac{x^{1/2}}{x^{1/4}}\right)$
$= 4 \cdot x^{1/2-1/4}$
$= 4x^{1/4}$

94. $\dfrac{72x^{3/4}}{9x^{1/3}} = \left(\dfrac{72}{9}\right)\left(\dfrac{x^{3/4}}{x^{1/3}}\right) = 8 \cdot x^{3/4-1/3} = 8x^{5/12}$

95. $\left(x^{2/3}\right)^3 = x^{2/3\cdot 3} = x^2$

96. $(x^{4/5})^5 = x^{4/5\cdot 5} = x^4$

97. $(25x^4y^6)^{1/2} = 25^{1/2}x^{4\cdot 1/2}y^{6\cdot 1/2} = 5x^2|y|^3$

98. $(125x^9y^6)^{1/3} = 125^{1/3}x^{9/3}y^{6/3} = 5x^3y^2$

99. $\dfrac{\left(3y^{\frac{1}{4}}\right)^3}{y^{\frac{1}{12}}} = \dfrac{27y^{\frac{3}{4}}}{y^{\frac{1}{12}}} = 27y^{\frac{3}{4}-\frac{1}{12}}$

$= 27y^{\frac{8}{12}} = 27y^{\frac{2}{3}}$

100. $\dfrac{\left(2y^{1/5}\right)^4}{y^{3/10}} = \dfrac{2^4\left(y^{1/5}\right)^4}{y^{3/10}}$

$= \dfrac{16y^{4/5}}{y^{3/10}} = 16y^{4/5-3/10} = 16y^{1/2}$

101. $\sqrt[4]{5^2} = 5^{2/4} = 5^{1/2} = \sqrt{5}$

102. $\sqrt[4]{7^2} = 7^{2/4} = 7^{1/2} = \sqrt{7}$

103. $\sqrt[3]{x^6} = x^{6/3} = x^2$

104. $\sqrt[4]{x^{12}} = x^{12/4} = |x|^3$

105. $\sqrt[6]{x^4} = \sqrt[6/2]{x^{4/2}} = \sqrt[3]{x^2}$

106. $\sqrt[9]{x^6} = \sqrt[9/3]{x^{6/3}} = \sqrt[3]{x^2}$

107. $\sqrt[9]{x^6y^3} = x^{\frac{6}{9}}y^{\frac{3}{9}} = x^{\frac{2}{3}}y^{\frac{1}{3}} = \sqrt[3]{x^2y}$

108. $\sqrt[12]{x^4y^8} = |x|^{\frac{4}{12}}|y|^{\frac{8}{12}} = |x|^{\frac{1}{3}}|y|^{\frac{2}{3}} = \sqrt[3]{|x|\,y^2}$

109. $\sqrt[3]{\sqrt[4]{16}+\sqrt{625}} = \sqrt[3]{2+25} = \sqrt[3]{27} = 3$

110. $\sqrt[3]{\sqrt{\sqrt{169}+\sqrt{9}}+\sqrt{\sqrt[3]{1000}+\sqrt[3]{216}}}$

$= \sqrt[3]{\sqrt{13+3}+\sqrt{10+6}}$

$= \sqrt[3]{\sqrt{16}+\sqrt{16}}$

$= \sqrt[3]{4+4} = \sqrt[3]{8}$

$= 2$

111. $\left(49x^{-2}y^4\right)^{-1/2}\left(xy^{1/2}\right)$

$= (49)^{-1/2}\left(x^{-2}\right)^{-1/2}\left(y^4\right)^{-1/2}\left(xy^{1/2}\right)$

$= \dfrac{1}{49^{1/2}}x^{(-2)(-1/2)}y^{(4)(-1/2)}\left(xy^{1/2}\right)$

$= \dfrac{1}{7}x^1y^{-2}\cdot xy^{1/2} = \dfrac{1}{7}x^{1+1}y^{-2+(1/2)}$

$= \dfrac{1}{7}x^2y^{-3/2} = \dfrac{x^2}{7y^{3/2}}$

112. $\left(8x^{-6}y^3\right)^{1/3}\left(x^{5/6}y^{-1/3}\right)^6$

$= 8^{1/3}x^{(-6)(1/3)}y^{(3)(1/3)}x^{(5/6)(6)}y^{(-1/3)(6)}$

$= 2x^{-2}y^1x^5y^{-2} = 2x^{-2+5}y^{1+(-2)}$

$= 2x^3y^{-1} = \dfrac{2x^3}{y}$

113. $\left(\dfrac{x^{-5/4}y^{1/3}}{x^{-3/4}}\right)^{-6} = \left(x^{(-5/4)-(-3/4)}y^{1/3}\right)^{-6}$

$= \left(x^{-2/4}y^{1/3}\right)^{-6} = x^{(-2/4)(-6)}y^{(1/3)(-6)}$

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

114. $\left(\dfrac{x^{1/2}y^{-7/4}}{y^{-5/4}}\right)^{-4} = \left(x^{1/2}y^{(-7/4)-(-5/4)}\right)^{-4}$

$= \left(x^{1/2}y^{-2/4}\right)^{-4} = x^{(1/2)(-4)}y^{(-2/4)(-4)}$

$= x^{-2}y^2 = \dfrac{y^2}{x^2}$

115. The message is "Paige Fox is bad at math."

116. a. For 2030: $E = 5.8\sqrt{x} + 56.4$

$= 5.8\sqrt{10} + 56.4$

For 2060: $E = 5.8\sqrt{x} + 56.4$

$= 5.8\sqrt{40} + 56.4$

$= 5.8 \cdot 2\sqrt{10} + 56.4$

$= 11.6\sqrt{10} + 56.4$

Difference:

$(11.6\sqrt{10} + 56.4) - (5.8\sqrt{10} + 56.4)$

$= 11.6\sqrt{10} + 56.4 - 5.8\sqrt{10} - 56.4$

$= 11.6\sqrt{10} - 5.8\sqrt{10} + 56.4 - 56.4$

$= 5.8\sqrt{10}$

The difference is $5.8\sqrt{10}$.

b. $5.8\sqrt{10} \approx 18.3$

This underestimates the difference projected by the graph of $98.2 - 74.1 = 24.1$ by 5.8. This represents a difference of 5.8 million people.

117. $\dfrac{2}{\sqrt{5}-1} \cdot \dfrac{\sqrt{5}+1}{\sqrt{5}+1} = \dfrac{2(\sqrt{5}+1)}{5-1}$

$= \dfrac{2(\sqrt{5}+1)}{4}$

$= \dfrac{\sqrt{5}+1}{2}$

≈ 1.62

About 1.62 to 1.

118. $R_a = R_f\sqrt{1-\left(\dfrac{v}{c}\right)^2}$

$= R_f\sqrt{1-\left(\dfrac{0.9c}{c}\right)^2}$

$= R_f\sqrt{1-(0.9)^2}$

$= R_f\sqrt{0.19}$

$\approx 0.44R_f$

$R_a = 0.44R_f$

$44 = 0.44R_f$

$\dfrac{44}{0.44} = \dfrac{0.44R_f}{0.44}$

$100 = R_f$

If you are gone for 44 weeks, then 100 weeks will have passed for your friend.

119. Perimeter:

$P = 2l + 2w$

$= 2 \cdot \sqrt{125} + 2 \cdot 2\sqrt{20}$

$= 2 \cdot \sqrt{25 \cdot 5} + 4\sqrt{4 \cdot 5}$

$= 2 \cdot 5\sqrt{5} + 4 \cdot 2\sqrt{5}$

$= 10\sqrt{5} + 8\sqrt{5}$

$= 18\sqrt{5}$ feet

Area:

$A = lw$

$= \sqrt{125} \cdot 2\sqrt{20}$

$= 2\sqrt{125 \cdot 20}$

$= 2\sqrt{2500}$

$= 2 \cdot 50$

$= 100$ square feet

120. Perimeter:

$P = 2l + 2w$

$= 2 \cdot 4\sqrt{20} + 2 \cdot \sqrt{80}$

$= 8\sqrt{4 \cdot 5} + 2\sqrt{16 \cdot 5}$

$= 8 \cdot 2\sqrt{5} + 2 \cdot 4\sqrt{5}$

$= 16\sqrt{5} + 8\sqrt{5}$

$= 24\sqrt{5}$ feet

Area:

$A = lw$

$= 4\sqrt{20} \cdot \sqrt{80}$

$= 4\sqrt{20 \cdot 80}$

$= 4\sqrt{1600}$

$= 4 \cdot 40$

$= 160$ square feet

121. – 128. Answers will vary.

129. does not make sense; Explanations will vary. Sample explanation: The denominator is rationalized correctly.

130. makes sense

131. does not make sense; Explanations will vary. Sample explanation: $2\sqrt{20} + 4\sqrt{75}$ simplifies to $4\sqrt{5} + 20\sqrt{3}$ and thus the radical terms are not common.

132. does not make sense; Explanations will vary. Sample explanation: Finding the nth root first often gives smaller numbers on the middle step.

133. false; Changes to make the statement true will vary. A sample change is: $7^{1/2} \cdot 7^{1/2} = 7^1 = 7$.

134. false; Changes to make the statement true will vary. A sample change is: $(8)^{-\frac{1}{3}} = \dfrac{1}{(8)^{\frac{1}{3}}} = \dfrac{1}{\sqrt[3]{8}} = \dfrac{1}{2}$.

135. false; Changes to make the statement true will vary. The cube root of –8 is the real number –2.

136. false; Changes to make the statement true will vary. A sample change is: $\dfrac{\sqrt{20}}{8} = \dfrac{\sqrt{5}}{4}$.

137. $\left(5+\sqrt{\boxed{3}}\right)\left(5-\sqrt{\boxed{3}}\right) = 22$

$$25 - \boxed{3} = 22$$

$$\boxed{3} = 3$$

138. $\sqrt{\boxed{25}x^{\boxed{14}}} = 5x^7$

139. $\sqrt{13+\sqrt{2}+\dfrac{7}{3+\sqrt{2}}}$

$$= \sqrt{13+\sqrt{2}+\frac{7}{3+\sqrt{2}} \cdot \frac{3-\sqrt{2}}{3-\sqrt{2}}}$$

$$= \sqrt{13+\sqrt{2}+\frac{21-7\sqrt{2}}{9-2}}$$

$$= \sqrt{13+\sqrt{2}+\frac{21-7\sqrt{2}}{7}}$$

$$= \sqrt{13+\sqrt{2}+3-\sqrt{2}}$$

$$= \sqrt{16}$$

$$= 4$$

140. a. $3^{\frac{1}{2}} \boxed{>} 3^{\frac{1}{3}}$

Calculator Check: $1.7321 > 1.4422$

b. $\sqrt{7}+\sqrt{18} \boxed{>} \sqrt{7+18}$

Calculator Check: $6.8884 > 5$

141. a. $\dfrac{ab}{a^2+ab+b^2} + \left(\dfrac{ac-ad-bc+bd}{ac-ad+bc-bd} \div \dfrac{a^3-b^3}{a^3+b^3}\right) = \dfrac{ab}{a^2+ab+b^2} + \left(\dfrac{a(c-d)-b(c-d)}{a(c-d)+b(c-d)} \cdot \dfrac{a^3+b^3}{a^3-b^3}\right)$

$$= \frac{ab}{a^2+ab+b^2} + \left(\frac{\cancel{(c-d)}\cancel{(a-b)}}{\cancel{(c-d)}\cancel{(a+b)}} \cdot \frac{\cancel{(a+b)}\left(a^2-ab+b^2\right)}{\cancel{(a-b)}\left(a^2+ab+b^2\right)}\right) = \frac{ab}{a^2+ab+b^2} + \frac{a^2-ab+b^2}{a^2+ab+b^2}$$

$$= \frac{ab+a^2-ab+b^2}{a^2+ab+b^2} = \frac{a^2+b^2}{a^2+ab+b^2}$$

Her son is 8 years old.

b. Son's portion:

$$\frac{8^{-\frac{4}{3}}+2^{-2}}{16^{-\frac{3}{4}}+2^{-1}}=\frac{\frac{1}{\left(\sqrt[3]{8}\right)^4}+\frac{1}{2^2}}{\frac{1}{\left(\sqrt[4]{16}\right)^3}+\frac{1}{2}}$$

$$=\frac{\frac{1}{2^4}+\frac{1}{4}}{\frac{1}{2^3}+\frac{1}{2}}$$

$$=\frac{\frac{1}{16}+\frac{1}{4}}{\frac{1}{8}+\frac{1}{2}}$$

$$=\frac{\frac{5}{16}}{\frac{5}{8}}$$

$$=\frac{8}{16}$$

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

Mom's portion:

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

142. $(2x^3y^2)(5x^4y^7)=10x^7y^9$

143. $2x^4(8x^4+3x)=2x^4(8x^4)+2x^4(3x)$

$$=16x^8+6x^5$$

144. $2x(x^2+4x+5)+3(x^2+4x+5)$

$=2x^3+8x^2+10x+3x^2+12x+15$

$=2x^3+8x^2+3x^2+10x+12x+15$

$=2x^3+11x^2+22x+15$

Section P.4

Check Point Exercises

1. **a.** $(-17x^3+4x^2-11x-5)+(16x^3-3x^2+3x-15)$

$=(-17x^3+16x^3)+(4x^2-3x^2)+(-11x+3x)+(-5-15)$

$=-x^3+x^2-8x-20$

b. $(13x^2-9x^2-7x+1)-(-7x^3+2x^2-5x+9)$
$=(13x^3-9x^2-7x+1)+(7x^3-2x^2+5x-9)$
$=(13x^3+7x^3)+(-9x^2-2x^2)+(-7x+5x)+(1-9)$
$=20x^3-11x^2-2x-8$

2. $(5x-2)(3x^2-5x+4)$
$=5x(3x^2-5x+4)-2(3x^2-5x+4)$
$=5x\cdot 3x^2-5x\cdot 5x+5x\cdot 4-2\cdot 3x^2+2\cdot 5x-2\cdot 4$
$=15x^3-25x^2+20x-6x^2+10x-8$
$=15x^3-31x^2+30x-8$

3. $(7x-5)(4x-3)=7x\cdot 4x+7x(-3)+(-5)4x+(-5)(-3)$
$=28x^2-21x-20x+15$
$=28x^2-41x+15$

4. **a.** Use the special-product formula shown.
$(A+B)(A-B)=A^2-B^2$
$(7x+8)(7x-8)=(7x)^2-(8)^2$
$=49x^2-64$

b. Use the special-product formula shown.
$(A+B)(A-B)=A^2-B^2$
$(2y^3-5)(2y^3+5)=(2y^3+5)(2y^3-5)$
$=(2y^3)^2-(5)^2$
$=4y^6-25$

5. **a.** Use the special-product formula shown.
$(A+B)^2=A^2+2AB+B^2$
$(x+10)^2=x^2+2(x)(10)+10^2$
$=x^2+20x+100$

b. Use the special-product formula shown.
$(A+B)^2=A^2+2AB+B^2$
$(5x+4)^2=(5x)^2+2(5x)(4)+4^2$
$=25x^2+40x+16$

6. **a.** Use the special-product formula shown.
$(A-B)^2=A^2-2AB+B^2$
$(x-9)^2=x^2-2(x)(9)+9^2$
$=x^2-18x+81$

b. Use the special-product formula shown.

$$(A-B)^2 = A^2 - 2AB + B^2$$
$$(7x-3)^2 = (7x)^2 - 2(7x)(3) + 3^2$$
$$= 49x^2 - 42x + 9$$

7. $(x^3 - 4x^2y + 5xy^2 - y^3) - (x^3 - 6x^2y + y^3)$
$= (x^3 - 4x^2y + 5xy^2 - y^3) + (-x^3 + 6x^2y - y^3)$
$= (x^3 - x^3) + (-4x^2y + 6x^2y) + (5xy^2) + (-y^3 - y^3)$
$= 2x^2y + 5xy^2 - 2y^3$

8. **a.** $(7x-6y)(3x-y) = (7x)(3x) + (7x)(-y) + (-6y)(3x) + (-6y)(-y)$
$= 21x^2 - 7xy - 18xy + 6y^2$
$= 21x^2 - 25xy + 6y^2$

b. $(2x+4y)^2 = (2x)^2 + 2(2x)(4y) + (4y)^2$
$= 4x^2 + 16xy + 16y^2$

Concept and Vocabulary Check P.4

1. whole

2. standard

3. monomial

4. binomial

5. trinomial

6. n

7. like;

8. distributive; $4x^3 - 8x^2 + 6$; $7x^3$

9. $5x$; 3; like

10. $3x^2$; $5x$; $21x$; 35

11. $A^2 - B^2$; minus

12. $A^2 + 2AB + B^2$; squared; product of the terms; squared

13. $A^2 - 2AB + B^2$; minus; product of the terms; plus

14. $n + m$

Exercise Set P.4

1. yes; $2x+3x^2-5=3x^2+2x-5$

2. no; The term $3x^{-1}$ does not have a whole number exponent.

3. no; The form of a polynomial involves addition and subtraction, not division.

4. yes; $x^2-x^3+x^4-5=x^4-x^3+x^2-5$

5. $3x^2$ has degree 2
$-5x$ has degree 1
4 has degree 0
$3x^2-5x+4$ has degree 2.

6. $-4x^3$ has degree 3
$7x^2$ has degree 2
-11 has degree 0
$-4x^3+7x^2-11$ has degree 3.

7. x^2 has degree 2
$-4x^3$ has degree 3
$9x$ has degree 1
$-12x^4$ has degree 4
63 has degree 0
$x^2-4x^3+9x-12x^4+63$ has degree 4.

8. x^2 has degree 2
$-8x^3$ has degree 3
$15x^4$ has degree 4
91 has degree 0
$x^2-8x^3+15x^4+91$ has degree 4.

9. $(-6x^3+5x^2-8x+9)+(17x^3+2x^2-4x-13)=(-6x^3+17x^3)+(5x^2+2x^2)+(-8x-4x)+(9-13)$
$=11x^3+7x^2-12x-4$
The degree is 3.

10. $(-7x^3+6x^2-11x+13)+(19x^3-11x^2+7x-17)=(-7x^3+19x^3)+(6x^2-11x^2)+(-11x+7x)+(13-17)$
$=12x^3-5x^2-4x-4$
The degree is 3.

11. $(17x^3-5x^2+4x-3)-(5x^3-9x^2-8x+11)=(17x^3-5x^2+4x-3)+(-5x^3+9x^2+8x-11)$
$=(17x^3-5x^3)+(-5x^2+9x^2)+(4x+8x)+(-3-11)$
$=12x^3+4x^2+12x-14$
The degree is 3.

12. $(18x^4-2x^3-7x+8)-(9x^4-6x^3-5x+7)=(18x^4-2x^3-7x+8)+(-9x^4+6x^3+5x-7)$
$=(18x^4-9x^4)+(-2x^3+6x^3)+(-7x+5x)+(8-7)$
$=9x^4+4x^3-2x+1$

The degree is 4.

13. $(5x^2-7x-8)+(2x^2-3x+7)-(x^2-4x-3)=(5x^2-7x-8)+(2x^2-3x+7)+(-x^2+4x+3)$
$=(5x^2+2x^2-x^2)+(-7x-3x+4x)+(-8+7+3)$
$=6x^2-6x+2$

The degree is 2.

14. $(8x^2+7x-5)-(3x^2-4x)-(-6x^3-5x^2+3)=(8x^2+7x-5)+(-3x^2+4x)+(6x^3+5x^2-3)$
$=6x^3+(8x^2-3x^2+5x^2)+(7x+4x)+(-5-3)$
$=6x^3+10x^2+11x-8$

The degree is 3.

15. $(x+1)(x^2-x+1)=x(x^2)-x\cdot x+x\cdot 1+1(x^2)-1\cdot x+1\cdot 1$
$=x^3-x^2+x+x^2-x+1$
$=x^3+1$

16. $(x+5)\left(x^2-5x+25\right)=x(x^2)-x(5x)+x(25)+5(x^2)-5(5x)+5(25)$
$=x^3-5x^2+25x+5x^2-25x+125)$
$=x^3+125$

17. $(2x-3)(x^2-3x+5)=(2x)(x^2)+(2x)(-3x)+(2x)(5)+(-3)(x^2)+(-3)(-3x)+(-3)(5)$
$=2x^3-6x^2+10x-3x^2+9x-15$
$=2x^3-9x^2+19x-15$

18. $(2x-1)(x^2-4x+3)=(2x)(x^2)+(2x)(-4x)+(2x)(3)+(-1)(x^2)+(-1)(-4x)+(-1)(3)$
$=2x^3-8x^2+6x-x^2+4x-3$
$=2x^3-9x^2+10x-3$

19. $(x+7)(x+3)=x^2+3x+7x+21=x^2+10x+21$

20. $(x+8)(x+5)=x^2+5x+8x+40=x^2+13x+40$

21. $(x-5)(x+3)=x^2+3x-5x-15=x^2-2x-15$

22. $(x-1)(x+2)=x^2+2x-x-2=x^2+x-2$

23. $(3x+5)(2x+1)=(3x)(2x)+3x(1)+5(2x)+5=6x^2+3x+10x+5=6x^2+13x+5$

24. $(7x+4)(3x+1)=(7x)(3x)+7x(1)+4(3x)+4(1)=21x^2+7x+12x+4=21x^2+19x+4$

25. $(2x-3)(5x+3)=(2x)(5x)+(2x)(3)+(-3)(5x)+(-3)(3)=10x^2+6x-15x-9=10x^2-9x-9$

26. $(2x-5)(7x+2) = (2x)(7x)+(2x)(2)+(-5)(7x)+(-5)(2) = 14x^2+4x-35x-10 = 14x^2-31x-10$

27. $(5x^2-4)(3x^2-7) = (5x^2)(3x^2)+(5x^2)(-7)+(-4)(3x^2)+(-4)(-7) = 15x^4-35x^2-12x^2+28 = 15x^4-47x^2+28$

28. $(7x^2-2)(3x^2-5) = (7x^2)(3x^2)+(7x^2)(-5)+(-2)(3x^2)+(-2)(-5) = 21x^4-35x^2-6x^2+10 = 21x^4-41x^2+10$

29. $\left(8x^3+3\right)\left(x^2-5\right) = \left(8x^3\right)\left(x^2\right)+\left(8x^3\right)(-5)+(3)\left(x^2\right)+(3)(-5) = 8x^5-40x^3+3x^2-15$

30. $\left(7x^3+5\right)\left(x^2-2\right) = \left(7x^3\right)\left(x^2\right)+\left(7x^3\right)(-2)+(5)\left(x^2\right)+(5)(-2) = 7x^5-14x^3+5x^2-10$

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

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

33. $(3x+2)(3x-2) = (3x)^2-2^2 = 9x^2-4$

34. $(2x+5)(2x-5) = (2x)^2-5^2 = 4x^2-25$

35. $(5-7x)(5+7x) = 5^2-(7x)^2 = 25-49x^2$

36. $(4-3x)(4+3x) = 4^2-(3x)^2 = 16-9x^2$

37. $(4x^2+5x)(4x^2-5x) = (4x^2)^2-(5x)^2 = 16x^4-25x^2$

38. $(3x^2+4x)(3x^2-4x) = (3x^2)^2-(4x)^2 = 9x^4-16x^2$

39. $\left(1-y^5\right)\left(1+y^5\right) = (1)^2-\left(y^5\right)^2 = 1-y^{10}$

40. $\left(2-y^5\right)\left(2+y^5\right) = (2)^2-\left(y^5\right)^2 = 4-y^{10}$

41. $(x+2)^2 = x^2+2\cdot x\cdot 2+2^2 = x^2+4x+4$

42. $(x+5)^2 = x^2+2\cdot x\cdot 5+5^2 = x^2+10x+25$

43. $(2x+3)^2 = (2x)^2+2(2x)(3)+3^2 = 4x^2+12x+9$

44. $(3x+2)^2 = (3x)^2+2(3x)(2)+2^2 = 9x^2+12x+4$

45. $(x-3)^2 = x^2-2\cdot x\cdot 3+3^2 = x^2-6x+9$

46. $(x-4)^2 = x^2-2\cdot x\cdot 4+4^2 = x^2-8x+16$

47. $(4x^2-1)^2 = (4x^2)^2-2(4x^2)(1)+1^2 = 16x^4-8x^2+1$

48. $(5x^2-3)^2 = (5x^2)^2-2(5x^2)(3)+3^2 = 25x^4-30x^2+9$

49. $(7-2x)^2 = 7^2 - 2(7)(2x) + (2x)^2 = 49 - 28x + 4x^2 = 4x^2 - 28x + 49$

50. $(9-5x)^2 = 9^2 - 2(9)(5x) + (5x)^2 = 81 - 90x + 25x^2$ or $25x^2 - 90x + 81$

51. $(x+1)^3 = x^3 + 3 \cdot x^2 \cdot 1 + 3x \cdot 1^2 + 1^3 = x^3 + 3x^2 + 3x + 1$

52. $(x+2)^3 = x^3 + 3 \cdot x^2 \cdot 2 + 3 \cdot x \cdot 2^2 + 2^3 = x^3 + 6x^2 + 12x + 8$

53. $(2x+3)^3 = (2x)^3 + 3 \cdot (2x)^2 \cdot 3 + 3(2x) \cdot 3^2 + 3^3 = 8x^3 + 36x^2 + 54x + 27$

54. $(3x+4)^3 = (3x)^3 + 3(3x)^2 \cdot 4 + 3(3x) \cdot 4^2 + 4^3 = 27x^3 + 108x^2 + 144x + 64$

55. $(x-3)^3 = x^3 - 3 \cdot x^3 \cdot 3 + 3 \cdot x \cdot 3^2 - 3^3 = x^3 - 9x^2 + 27x - 27$

56. $(x-1)^3 = x^3 - 3x^2 \cdot 1 + 3x \cdot 1^2 - 1^3 = x^3 - 3x^2 + 3x - 1$

57. $(3x-4)^3 = (3x)^3 - 3(3x)^2 \cdot 4 + 3(3x) \cdot 4^2 - 4^3 = 27x^3 - 108x^2 + 144x - 64$

58. $(2x-3)^3 = (2x)^3 - 3(2x)^2 \cdot 3 + 3(2x) \cdot 3^2 - 3^3 = 8x^3 - 36x^2 + 54x - 27$

59.
$$\begin{aligned}(5x^2y - 3xy) + (2x^2y - xy) &= (5x^2y + 2x^2y) + (-3xy - xy) \\ &= (5+2)x^2y + (-3-1)xy \\ &= 7x^2y - 4xy \text{ is of degree 3.}\end{aligned}$$

60.
$$\begin{aligned}(-2x^2y + xy) + (4x^2y + 7xy) &= (-2x^2y + 4x^2y) + (xy + 7xy) \\ &= (-2+4)x^2y + (1+7)xy \\ &= 2x^2y + 8xy \text{ is of degree 3.}\end{aligned}$$

61.
$$\begin{aligned}(4x^2y + 8xy + 11) + (-2x^2y + 5xy + 2) &= (4x^2y - 2x^2y) + (8xy + 5xy) + (11+2) \\ &= (4-2)x^2y + (8+5)xy + 13 \\ &= 2x^2y + 13xy + 13 \text{ is of degree 3.}\end{aligned}$$

62.
$$\begin{aligned}(7x^4y^2 - 5x^2y^2 + 3xy) + (-18x^4y^2 - 6x^2y^2 - xy) &= (7x^4y^2 - 18x^4y^2) + (-5x^2y^2 - 6x^2y^2) + (3xy - xy) \\ &= (7-18)x^4y^2 + (-5-6)x^2y^2 + (3-1)xy \\ &= -11x^4y^2 - 11x^2y^2 + 2xy \text{ is of degree 6.}\end{aligned}$$

63.
$$\begin{aligned}(x^3 + 7xy - 5y^2) - (6x^3 - xy + 4y^2) &= (x^3 + 7xy - 5y^2) \\ &= (x^3 - 6x^3) + (7xy + xy) + (-5y^2 - 4y^2) \\ &= (1-6)x^3 + (7+1)xy + (-5-4)y^2 \\ &= -5x^3 + 8xy - 9y^2 \text{ is of degree 3.}\end{aligned}$$

64. $(x^4 - 7xy - 5y^3) - (6x^4 - 3xy + 4y^3) = (x^4 - 7xy - 5y^3) + (-6x^4 + 3xy - 4y^3)$
$= (x^4 - 6x^4) + (-7xy + 3xy) + (-5y^3 - 4y^3)$
$= (1-6)x^4 + (-7+3)xy + (-5-4)y^3$
$= -5x^4 - 4xy - 9y^3$ is of degree 4.

65. $(3x^4y^2 + 5x^3y - 3y) - (2x^4y^2 - 3x^3y - 4y + 6x) = (3x^4y^2 + 5x^3y - 3y) + (-2x^4y^2 + 3x^3y + 4y - 6x)$
$= (3x^4y^2 - 2x^4y^2) + (5x^3y + 3x^3y) + (-3y + 4y) - 6x$
$= (3-2)x^4y^2 + (5+3)x^3y + (-3+4)y - 6x$
$= x^4y^2 + 8x^3y + y - 6x$ is of degree 6.

66. $(5x^4y^2 + 6x^3y - 7y) - (3x^4y^2 - 5x^3y - 6y + 8x) = (5x^4y^2 + 6x^3y - 7y) + (-3x^4y^2 + 5x^3y + 6y - 8x)$
$= (5x^4y^2 - 3x^4y^2) + (6x^3y + 5x^3y) + (-7y + 6y) - 8x$
$= (5-3)x^4y^2 + (6+5)x^3y + (-7+6)y - 8x$
$= 2x^4y^2 + 11x^3y - y - 8x$ is of degree 6.

67. $(x + 5y)(7x + 3y) = x(7x) + x(3y) + (5y)(7x) + (5y)(3y)$
$= 7x^2 + 3xy + 35xy + 15y^2$
$= 7x^2 + 38xy + 15y^2$

68. $(x + 9y)(6x + 7y) = x(6x) + x(7y) + (9y)(6x) + (9y)(7y)$
$= 6x^2 + 7xy + 54xy + 63y^2$
$= 6x^2 + 61xy + 63y^2$

69. $(x - 3y)(2x + 7y) = x(2x) + x(7y) + (-3y)(2x) + (-3y)(7y)$
$= 2x^2 + 7xy - 6xy - 21y^2$
$= 2x^2 + xy - 21y^2$

70. $(3x - y)(2x + 5y) = (3x)(2x) + (3x)(5y) + (-y)(2x) + (-y)(5y)$
$= 6x^2 + 15xy - 2xy - 5y^2$
$= 6x^2 + 13xy - 5y^2$

71. $(3xy - 1)(5xy + 2) = (3xy)(5xy) + (3xy)(2) + (-1)(5xy) + (-1)(2)$
$= 15x^2y^2 + 6xy - 5xy - 2$
$= 15x^2y^2 + xy - 2$

72. $(7x^2y + 1)(2x^2y - 3) = (7x^2y)(2x^2y) + (7x^2y)(-3) + (1)2x^2y + (1)(-3)$
$= 14x^4y^2 - 21x^2y + 2x^2y - 3$
$= 14x^4y^2 - 19x^2y - 3$

73. $(7x + 5y)^2 = (7x)^2 + 2(7x)(5y) + (5y)^2 = 49x^2 + 70xy + 25y^2$

74. $(9x + 7y)^2 = (9x)^2 + 2(9x)(7y) + (7y)^2 = 81x^2 + 126xy + 49y^2$

75. $(x^2y^2-3)^2=(x^2y^2)^2-2(x^2y^2)(3)+3^2=x^4y^4-6x^2y^2+9$

76. $(x^2y^2-5)^2=(x^2y^2)^2-2(x^2y^2)(5)+5^2=x^4y^4-10x^2y^2+25$

77. $(x-y)(x^2+xy+y^2)=x(x^2)+x(xy)+x(y^2)+(-y)(x^2)+(-y)(xy)+(-y)(y^2)$

$=x^3+x^2y+xy^2-x^2y-xy^2-y^3$

$=x^3-y^3$

78. $(x+y)(x^2-xy+y^2)=x(x^2)+x(-xy)+x(y^2)+y(x^2)+y(-xy)+y(y^2)$

$=x^3-x^2y+xy^2+x^2y-xy^2+y^3$

$=x^3+y^3$

79. $(3x+5y)(3x-5y)=(3x)^2-(5y)^2=9x^2-25y^2$

80. $(7x+3y)(7x-3y)=(7x)^2-(3y)^2=49x^2-9y^2$

81. $\left(7xy^2-10y\right)\left(7xy^2+10y\right)=\left(7xy^2\right)^2-\left(10y\right)^2=49x^2y^4-100y^2$

82. $\left(3xy^2-4y\right)\left(3xy^2+4y\right)=\left(3xy^2\right)^2-\left(4y\right)^2=9x^2y^4-16y^2$

83. $(3x+4y)^2-(3x-4y)^2=\left[(3x)^2+2(3x)(4y)+(4y)^2\right]-\left[(3x)^2-2(3x)(4y)+(4y)^2\right]$

$=\left(9x^2+24xy+16y^2\right)-\left(9x^2-24xy+16y^2\right)$

$=9x^2+24xy+16y^2-9x^2+24xy-16y^2$

$=48xy$

84. $(5x+2y)^2-(5x-2y)^2=\left[(5x)^2+2(5x)(2y)+(2y)^2\right]-\left[(5x)^2-2(5x)(2y)+(2y)^2\right]$

$=\left(25x^2+20xy+4y^2\right)-\left(25x^2-20xy+4y^2\right)$

$=25x^2+20xy+4y^2-25x^2+20xy-4y^2$

$=40xy$

85. $(5x-7)(3x-2)-(4x-5)(6x-1)$

$=\left[15x^2-10x-21x+14\right]-\left[24x^2-4x-30x+5\right]$

$=\left(15x^2-31x+14\right)-\left(24x^2-34x+5\right)$

$=15x^2-31x+14-24x^2+34x-5$

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

86. $(3x+5)(2x-9)-(7x-2)(x-1)$

$=\left(6x^2-27x+10x-45\right)-\left(7x^2-7x-2x+2\right)$

$=\left(6x^2-17x-45\right)-\left(7x^2-9x+2\right)$

$=6x^2-17x-45-7x^2+9x-2$

$=-x^2-8x-47$

87. $(2x+5)(2x-5)\left(4x^2+25\right)$

$=\left[(2x)^2-5^2\right]\left(4x^2+25\right)$

$=\left(4x^2-25\right)\left(4x^2+25\right)$

$=\left(4x^2\right)^2-(25)^2$

$=16x^4-625$

88. $(3x+4)(3x-4)\left(9x^2+16\right)$

$=\left[(3x)^2-4^2\right]\left(9x^2+16\right)$

$=\left(9x^2-16\right)\left(9x^2+16\right)$

$=\left(9x^2\right)^2-(16)^2$

$=81x^4-256$

89. $\dfrac{(2x-7)^5}{(2x-7)^3}=(2x-7)^{5-3}$

$=(2x-7)^2$

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

$=4x^2-28x+49$

90. $\dfrac{(5x-3)^6}{(5x-3)^4}=(5x-3)^{6-4}$

$=(5x-3)^2$

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

$=25x^2-30x+9$

91. **a.** $S=0.2x^3-1.5x^2+3.4x+25+\left(0.1x^3-1.3x^2+3.3x+5\right)$

$S=0.2x^3-1.5x^2+3.4x+25+0.1x^3-1.3x^2+3.3x+5$

$S=0.3x^3-2.8x^2+6.7x+30$

b. $S = 0.3x^3 - 2.8x^2 + 6.7x + 30$

$S = 0.3(5)^3 - 2.8(5)^2 + 6.7(5) + 30$

$S = 31$

The model gives a score of 31 for the group in the 45-54 age range which is the same as the score displayed by the bar graph.

92. **a.** $S = -0.02x^3 + 0.4x^2 + 1.2x + 22 + \left(-0.01x^3 - 0.2x^2 + 1.1x + 2\right)$

$S = -0.02x^3 + 0.4x^2 + 1.2x + 22 - 0.01x^3 - 0.2x^2 + 1.1x + 2$

$S = -0.03x^3 + 0.2x^2 + 2.3x + 24$

b. $S = -0.03x^3 + 0.2x^2 + 2.3x + 24$

$S = -0.03(5)^3 + 0.2(5)^2 + 2.3(5) + 24$

$S = 36.75$

The model gives a score of 36.75 for the group of slightly conservative political identification group. This underestimates the score shown on the bar graph by 0.25.

93. $x(8-2x)(10-2x) = x\left(80 - 36x + 4x^2\right)$

$= 80x - 36x^2 + 4x^3$

$= 4x^3 - 36x^2 + 80x$

94. $x(8-2x)(5-2x) = x\left(40 - 26x + 4x^2\right)$

$= 40x - 26x^2 + 4x^3$

$= 4x^3 - 26x^2 + 40x$

95. $(x+9)(x+3) - (x+5)(x+1)$

$= x^2 + 12x + 27 - \left(x^2 + 6x + 5\right)$

$= x^2 + 12x + 27 - x^2 - 6x - 5$

$= 6x + 22$

96. $(x+4)(x+3) - (x+2)(x+1)$

$= x^2 + 7x + 12 - \left(x^2 + 3x + 2\right)$

$= x^2 + 7x + 12 - x^2 - 3x - 2$

$= 4x + 10$

97. – 102. Answers will vary.

103. makes sense

104. does not make sense; Explanations will vary. Sample explanation: FOIL is used to multiply two binomials.

105. makes sense

106. makes sense, although answers may vary

107. false; Changes to make the statement true will vary. A sample change is: $(3x^3 + 2)(3x^3 - 2) = 9x^6 - 4$

108. false; Changes to make the statement true will vary. A sample change is: $(x-5)^2 = x^2 - 10x + 25$

109. false; Changes to make the statement true will vary. A sample change is: $(x+1)^2 = x^2 + 2x + 1$

110. true

111. $[(7x+5)+4y][(7x+5)-4y] = (7x+5)^2 - 4y^2$
$= (7x)^2 + 2(7x)(5) + 5^2 - 16y^2$
$= 49x^2 + 70x + 25 - 16y^2$

112. $[(3x+y)+1]^2$
$= (3x+y)^2 + 2(3x+y)(1) + 1^2$
$= (3x)^2 + 2(3x)y + y^2 + 6x + 2y + 1$
$= 9x^2 + 6xy + y^2 + 6x + 2y + 1$

113. $(x^n+2)(x^n-2) - (x^n-3)^2$
$(x^n+2)(x^n-2) - (x^n-3)^2$
$= (x^{2n} - 4) - (x^{2n} - 6x^n + 9)$
$= x^{2n} - 4 - x^{2n} + 6x^n - 9$
$= 6x^n - 13$

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

115. $(x+3)(x+\boxed{4}) = x^2 + 7x + 12$

116. $(x-\boxed{2})(x-12) = x^2 - 14x + 24$

117. $(4x+1)(2x-\boxed{3}) = 8x^2 - 10x - 3$

Mid-Chapter P Check Point

1. $(3x+5)(4x-7) = (3x)(4x) + (3x)(-7) + (5)(4x) + (5)(-7)$
$= 12x^2 - 21x + 20x - 35$
$= 12x^2 - x - 35$

2. $(3x+5) - (4x-7) = 3x + 5 - 4x + 7$
$= 3x - 4x + 5 + 7$
$= -x + 12$

3. $\sqrt{6} + 9\sqrt{6} = 10\sqrt{6}$

4. $3\sqrt{12} - \sqrt{27} = 3 \cdot 2\sqrt{3} - 3\sqrt{3} = 6\sqrt{3} - 3\sqrt{3} = 3\sqrt{3}$

5. $7x+3\left[9-(2x-6)\right]=7x+3\left[9-2x+6\right]=7x+3\left[15-2x\right]=7x+45-6x=x+45$

6. $(8x-3)^2=(8x)^2-2(8x)(3)+(3)^2=64x^2-48x+9$

7. $\left(x^{\frac{1}{3}}y^{-\frac{1}{2}}\right)^6=x^{\frac{1}{3}\cdot 6}y^{-\frac{1}{2}\cdot 6}=x^2y^{-3}=\dfrac{x^2}{y^3}$

8. $\left(\dfrac{2}{7}\right)^0-32^{-\frac{2}{5}}=1-\dfrac{1}{\left(\sqrt[5]{32}\right)^2}=1-\dfrac{1}{(2)^2}=1-\dfrac{1}{4}=\dfrac{3}{4}$

9. $(2x-5)-(x^2-3x+1)=2x-5-x^2+3x-1=-x^2+5x-6$

10.
$$\begin{aligned}(2x-5)(x^2-3x+1)&=2x(x^2-3x+1)-5(x^2-3x+1)\\&=2x(x^2-3x+1)-5(x^2-3x+1)\\&=2x^3-6x^2+2x-5x^2+15x-5\\&=2x^3-6x^2-5x^2+2x+15x-5\\&=2x^3-11x^2+17x-5\end{aligned}$$

11. $x^3+x^3-x^3\cdot x^3=2x^3-x^6=-x^6+2x^3$

12.
$$\begin{aligned}(9a-10b)(2a+b)&=(9a)(2a)+(9a)(b)+(-10b)(2a)+(-10b)(b)\\&=(9a)(2a)+(9a)(b)+(-10b)(2a)+(-10b)(b)\\&=18a^2+9ab-20ab-10b^2\\&=18a^2-11ab-10b^2\end{aligned}$$

13. $\{a,c,d,e\}\cup\{c,d,f,h\}=\{a,c,d,e,f,h\}$

14. $\{a,c,d,e\}\cap\{c,d,f,h\}=\{c,d\}$

15.
$$\begin{aligned}\left(3x^2y^3-xy+4y^2\right)-\left(-2x^2y^3-3xy+5y^2\right)&=3x^2y^3-xy+4y^2+2x^2y^3+3xy-5y^2\\&=3x^2y^3-xy+4y^2+2x^2y^3+3xy-5y^2\\&=3x^2y^3+2x^2y^3-xy+3xy+4y^2-5y^2\\&=5x^2y^3+2xy-y^2\end{aligned}$$

16. $\dfrac{24x^2y^{13}}{-2x^5y^{-2}}=-12x^{2-5}y^{13-(-2)}=-12x^{-3}y^{15}=-\dfrac{12y^{15}}{x^3}$

17. $\left(\dfrac{1}{3}x^{-5}y^4\right)\left(18x^{-2}y^{-1}\right)=6x^{-5-2}y^{4-1}=\dfrac{6y^3}{x^7}$

18. $\sqrt[12]{x^4}=x^{\frac{4}{12}}=\left|x^{\frac{1}{3}}\right|=\left|\sqrt[3]{x}\right|$

19. $\dfrac{24\times10^3}{2\times10^6}=\dfrac{24}{2}\cdot\dfrac{10^3}{10^6}=12\times10^{-3}=\left(1.2\times10^1\right)\times10^{-3}=1.2\times\left(10^1\times10^{-3}\right)=1.2\times10^{-2}$

20. $\dfrac{\sqrt[3]{32}}{\sqrt[3]{2}}=\sqrt[3]{\dfrac{32}{2}}=\sqrt[3]{16}=\sqrt[3]{2^4}=2\sqrt[3]{2}$

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

22. $(x^2+2)^2=(x^2)^2+2(x^2)(2)+(2)^2=x^4+4x^2+4$

23. $\sqrt{50}\cdot\sqrt{6}=5\sqrt{2}\cdot\sqrt{6}=5\sqrt{2\cdot6}=5\sqrt{12}=5\cdot2\sqrt{3}=10\sqrt{3}$

24. $\dfrac{11}{7-\sqrt{3}}=\dfrac{11}{7-\sqrt{3}}\cdot\dfrac{7+\sqrt{3}}{7+\sqrt{3}}=\dfrac{77+11\sqrt{3}}{49-3}=\dfrac{77+11\sqrt{3}}{46}$

25. $\dfrac{11}{\sqrt{3}}=\dfrac{11}{\sqrt{3}}\cdot\dfrac{\sqrt{3}}{\sqrt{3}}=\dfrac{11\sqrt{3}}{3}$

26. $\left\{-11,\ -\dfrac{3}{7},\ 0,\ 0.45,\ \sqrt{25}\right\}$

27. Since $2-\sqrt{13}<0$ then $\left|2-\sqrt{13}\right|=\sqrt{13}-2$

28. Since $x<0$ then $|x|=-x$. Thus $x^2|x|=-x^2x=-x^3$

29. $4.6\cdot3.0\times10^8=4.6\times10^8=13.8\times10^8=1.38\times10^9$
The U.S. produces 1.38×10^9 pounds of garbage per day.

30. $\dfrac{3\times10^{10}}{7.5\times10^9}=\dfrac{3}{7.5}\cdot\dfrac{10^{10}}{10^9}=0.4\times10=4$
A human brain has 4 times as many neurons as a gorilla brain.

31. **a.** Model 1:
$D=1188x+16,218$
$D=1188(1)+16,218$
$D=17,406$
Model 2:
$D=46x^2+541x+17,650$
$D=46(1)^2+541(1)+17,650$
$D=18,237$

Model 1 best describes the data in 2001.

b. $D=46x^2+541x+17,650$
$D=46(13)^2+541(13)+17,650$
$D=32,457$
Model 2 underestimates the average student-loan debt in 2013 by \$593.

Section P.5

Check Point Exercises

1. **a.** $10x^3 - 4x^2$
$= 2x^2(5x) - 2x^2(2)$
$= 2x^2(5x - 2)$

b. $2x(x-7) + 3(x-7)$
$= (x-7)(2x+3)$

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

3. Find two numbers whose product is 40 and whose sum is 13. The required integers are 8 and 5. Thus, $x^2 + 13x + 40 = (x+8)(x+5)$ or $(x+5)(x+8)$.

4. Find two numbers whose product is –14 and whose sum is –5. The required integers are –7 and 2. Thus, $x^2 - 5x - 14 = (x-7)(x+2)$ or $(x+2)(x-7)$.

5. Find two First terms whose product is $6x^2$.
$6x^2 + 19x - 7 = (6x \quad)(x \quad)$
$6x^2 + 19x - 7 = (3x \quad)(2x \quad)$

Find two Last terms whose product is –7.
The possible factors are 1(–7) and –1(7).

Try various combinations of these factors to find the factorization in which the sum of the Outside and Inside products is $19x$.

Possible Factors of $6x^2 + 19x - 7$	Sum of Outside and Inside Products (Should Equal $19x$)
$(6x+1)(x-7)$	$-42x + x = -41x$
$(6x-7)(x+1)$	$6x - 7x = -x$
$(6x-1)(x+7)$	$42x - x = 41x$
$(6x+7)(x-1)$	$-6x + 7x = x$
$(3x+1)(2x-7)$	$-21x + 2x = -19x$
$(3x-7)(2x+1)$	$3x - 14x = -11x$
$(3x-1)(2x+7)$	$21x - 2x = 19x$
$(3x+7)(2x-1)$	$-3x + 14x = 11x$

Thus, $6x^2 + 19x - 7 = (3x-1)(2x+7)$ or $(2x+7)(3x-1)$.

6. Find two First terms whose product is $3x^2$.
$3x^2 - 13xy + 4y^2 = (3x \quad)(x \quad)$

Find two Last terms whose product is $4y^2$.
The possible factors are $(2y)(2y)$, $(-2y)(-2y)$, $(4y)(y)$, and $(-4y)(-y)$.

Try various combinations of these factors to find the factorization in which the sum of the Outside and Inside products is $-13xy$.

$3x^2 - 13xy + y^2 = (3x - y)(x - 4y)$ or $(x - 4y)(3x - y)$.

7. Express each term as the square of some monomial. Then use the formula for factoring $A^2 - B^2$.

a. $x^2 - 81 = x^2 - 9^2 = (x + 9)(x - 9)$

b. $36x^2 - 25 = (6x)^2 - 5^2 = (6x + 5)(6x - 5)$

8. Express $81x^4 - 16$ as the difference of two squares and use the formula for factoring $A^2 - B^2$.
$81x^4 - 16 = (9x^2)^2 - 4^2 = (9x^2 + 4)(9x^2 - 4)$

The factor $9x^2 - 4$ is the difference of two squares and can be factored. Express $9x^2 - 4$ as the difference of two squares and again use the formula for factoring $A^2 - B^2$.
$(9x^2 + 4)(9x^2 - 4) = (9x^2 + 4)\left[(3x)^2 - 2^2\right] = (9x^2 + 4)(3x + 2)(3x - 2)$

Thus, factored completely,
$81x^4 - 16 = (9x^2 + 4)(3x + 2)(3x - 2)$.

9. **a.** $x^2 + 14x + 49 = x^2 + 2 \cdot x \cdot 7 + 7^2 = (x + 7)^2$

b. Since $16x^2 = (4x)^2$ and $49 = 7^2$, check to see if the middle term can be expressed as twice the product of $4x$ and 7. Since $2 \cdot 4x \cdot 7 = 56x$, $16x^2 - 56x + 49$ is a perfect square trinomial. Thus, $16x^2 - 56x + 49 = (4x)^2 - 2 \cdot 4x \cdot 7 + 7^2$
$= (4x - 7)^2$

10. **a.** $x^3 + 1 = x^3 + 1^3$
$= (x + 1)(x^2 - x \cdot 1 + 1^2)$
$= (x + 1)(x^2 - x + 1)$

b. $125x^3 - 8 = (5x)^3 - 2^3$
$= (5x - 2)\left[(5x)^2 + (5x)(2) + 2^2\right]$
$= (5x - 2)(25x^2 + 10x + 4)$

11. Factor out the greatest common factor.
$3x^3 - 30x^2 + 75x = 3x\left(x^2 - 10x + 25\right)$
Factor the perfect square trinomial.
$3x\left(x^2 - 10x + 25\right) = 3x(x - 5)^2$

12. Reorder to write as a difference of squares.

$$\begin{aligned}
&x^2 - 36a^2 + 20x + 100 \\
&= x^2 + 20x + 100 - 36a^2 \\
&= \left(x^2 + 20x + 100\right) - 36a^2 \\
&= \left(x+10\right)^2 - 36a^2 \\
&= \left(x+10+6a\right)\left(x+10-6a\right)
\end{aligned}$$

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

$$\begin{aligned}
&= \left(x-1\right)^{-\frac{1}{2}}\left[x + \left(x-1\right)^{\frac{1}{2}-\left(-\frac{1}{2}\right)}\right] \\
&= \left(x-1\right)^{-\frac{1}{2}}\left[x + \left(x-1\right)\right] \\
&= \left(x-1\right)^{-\frac{1}{2}}\left(2x-1\right) \\
&= \frac{2x-1}{\left(x-1\right)^{\frac{1}{2}}}
\end{aligned}$$

Concept and Vocabulary Check P.5

1. d

2. g

3. b

4. c

5. c

6. a

7. f

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

Exercise Set P.5

1. $18x + 27 = 9 \cdot 2x + 9 \cdot 3 = 9(2x+3)$

2. $16x - 24 = 8(2x) + 8(-3) = 8(2x - 3)$

3. $3x^2 + 6x = 3x \cdot x + 3x \cdot 2 = 3x(x+2)$

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

5.
$$\begin{aligned}
&9x^4 - 18x^3 + 27x^2 \\
&= 9x^2(x^2) + 9x^2(-2x) + 9x^2(3) \\
&= 9x^2(x^2 - 2x + 3)
\end{aligned}$$

6.
$$\begin{aligned}
&6x^4 - 18x^3 + 12x^2 \\
&= 6x^2(x^2) + 6x^2(-3x) + 6x^2(2) \\
&= 6x^2\left(x^2 - 3x + 2\right)
\end{aligned}$$

7. $x(x + 5) + 3(x + 5) = (x + 5)(x + 3)$

8. $x(2x + 1) + 4(2x + 1) = (2x + 1)(x + 4)$

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

10. $x^2\left(2x+5\right) + 17\left(2x+5\right) = \left(2x+5\right)\left(x^2+17\right)$

11.
$$\begin{aligned}
x^3 - 2x^2 + 5x - 10 &= x^2(x-2) + 5(x-2) \\
&= (x^2+5)(x-2)
\end{aligned}$$

12.
$$\begin{aligned}
x^3 - 3x^2 + 4x - 12 &= x^2\left(x-3\right) + 4\left(x-3\right) \\
&= \left(x-3\right)\left(x^2+4\right)
\end{aligned}$$

13.
$$\begin{aligned}
x^3 - x^2 + 2x - 2 &= x^2(x-1) + 2(x-1) \\
&= (x-1)(x^2+2)
\end{aligned}$$

14.
$$\begin{aligned}
x^3 + 6x^2 - 2x - 12 &= x^2\left(x+6\right) - 2\left(x+6\right) \\
&= \left(x+6\right)\left(x^2-2\right)
\end{aligned}$$

15.
$$\begin{aligned}
3x^3 - 2x^2 - 6x + 4 &= x^2(3x-2) - 2(3x-2) \\
&= (3x-2)(x^2-2)
\end{aligned}$$

16.
$$\begin{aligned}
x^3 - x^2 - 5x + 5 &= x^2\left(x-1\right) - 5\left(x-1\right) \\
&= \left(x-1\right)\left(x^2-5\right)
\end{aligned}$$

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

18. $x^2 + 8x + 15 = (x+3)(x+5)$

19. $x^2 - 2x - 15 = (x - 5)(x + 3)$

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

21. $x^2 - 8x + 15 = (x - 5)(x - 3)$

22. $x^2 - 14x + 45 = (x-5)(x-9)$

23. $3x^2 - x - 2 = (3x + 2)(x - 1)$

24. $2x^2+5x-3=(2x-1)(x+3)$

25. $3x^2-25x-28=(3x-28)(x+1)$

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

27. $6x^2-11x+4=(2x-1)(3x-4)$

28. $6x^2-17x+12=(2x-3)(3x-4)$

29. $4x^2+16x+15=(2x+3)(2x+5)$

30. $8x^2+33x+4=(8x+1)(x+4)$

31. $9x^2-9x+2=(3x-1)(3x-2)$

32. $9x^2+5x-4=(9x-4)(x+1)$

33. $20x^2+27x-8=(5x+8)(4x-1)$

34. $15x^2-19x+6=(3x-2)(5x-3)$

35. $2x^2+3xy+y^2=(2x+y)(x+y)$

36. $3x^2+4xy+y^2=(3x+y)(x+y)$

37. $6x^2-5xy-6y^2=(3x+2y)(2x-3y)$

38. $6x^2-7xy-5y^2=(3x-5y)(2x+y)$

39. $x^2-100=x^2-10^2=(x+10)(x-10)$

40. $x^2-144=x^2-12^2=(x+12)(x-12)$

41. $36x^2-49=(6x)^2-7^2=(6x+7)(6x-7)$

42. $64x^2-81=(8x)^2-9^2=(8x+9)(8x-9)$

43. $9x^2-25y^2=(3x)^2-(5y)^2$
$=(3x+5y)(3x-5y)$

44. $36x^2-49y^2=(6x)^2-(7y)^2$
$=(6x+7y)(6x-7y)$

45. $x^4-16=(x^2)^2-4^2$
$=(x^2+4)(x^2-4)$
$=(x^2+4)(x+2)(x-2)$

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

47. $16x^4-81=(4x^2)^2-9^2$
$=(4x^2+9)(4x^2-9)$
$=(4x^2+9)[(2x)^2-3^2]$
$=(4x^2+9)(2x+3)(2x-3)$

48. $81x^4-1=(9x^2)^2-1^2$
$=(9x^2+1)(9x^2-1)$
$=(9x^2+1)[(3x)^2-1^2]$
$=(9x^2+1)(3x+1)(3x-1)$

49. $x^2+2x+1=x^2+2\cdot x\cdot 1+1^2=(x+1)^2$

50. $x^2+4x+4=x^2+2\cdot x\cdot 2+2^2=(x+2)^2$

51. $x^2-14x+49=x^2-2\cdot x\cdot 7+7^2$
$=(x-7)^2$

52. $x^2-10x+25=x^2-2\cdot x\cdot 5+5^2=(x-5)^2$

53. $4x^2+4x+1=(2x)^2+2\cdot 2x\cdot 1+1^2$
$=(2x+1)^2$

54. $25x^2+10x+1=(5x)^2+2\cdot 5x\cdot 1+1^2=(5x+1)^2$

55. $9x^2-6x+1=(3x)^2-2\cdot 3x\cdot 1+1^2$
$=(3x-1)^2$

56. $64x^2-16x+1=(8x)^2-2\cdot 8x\cdot 1+1^2=(8x-1)^2$

57. $x^3+27=x^3+3^3$
$=(x+3)(x^2-x\cdot 3+3^2)$
$=(x+3)(x^2-3x+9)$

58. $x^3+64=x^3+4^3$
$=(x+4)(x^2-x\cdot 4+4^2)$
$=(x+4)(x^2-4x+16)$

59. $x^3-64=x^3-4^3$
$=(x-4)(x^2+x\cdot 4+4^2)$
$=(x-4)(x^2+4x+16)$

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

61. $8x^3 - 1 = (2x)^3 - 1^3$
$= (2x-1)[(2x)^2 + (2x)(1) + 1^2]$
$= (2x-1)(4x^2 + 2x + 1)$

62. $27x^3 - 1 = (3x)^3 - 1^3$
$= (3x-1)[(3x)^2 + (3x)(1) + 1^2]$
$= (3x-1)(9x^2 + 3x + 1)$

63. $64x^3 + 27 = (4x)^3 + 3^3$
$= (4x+3)[(4x)^2 - (4x)(3) + 3^2]$
$= (4x+3)(16x^2 - 12x + 9)$

64. $8x^3 + 125 = (2x)^3 + 5^3$
$= (2x+5)[(2x)^2 - (2x)(5) + 5^2]$
$= (2x+5)(4x^2 - 10x + 25)$

65. $3x^3 - 3x = 3x(x^2 - 1) = 3x(x+1)(x-1)$

66. $5x^3 - 45x = 5x(x^2 - 9) = 5x(x+3)(x-3)$

67. $4x^2 - 4x - 24 = 4(x^2 - x - 6)$
$= 4(x+2)(x-3)$

68. $6x^2 - 18x - 60 = 6(x^2 - 3x - 10)$
$= 6(x+2)(x-5)$

69. $2x^4 - 162 = 2(x^4 - 81)$
$= 2[(x^2)^2 - 9^2]$
$= 2(x^2 + 9)(x^2 - 9)$
$= 2(x^2 + 9)(x^2 - 3^2)$
$= 2(x^2 + 9)(x+3)(x-3)$

70. $7x^4 - 7 = 7(x^4 - 1)$
$= 7[(x^2)^2 - 1^2]$
$= 7(x^2 + 1)(x^2 - 1)$
$= 7(x^2 + 1)(x+1)(x-1)$

71. $x^3 + 2x^2 - 9x - 18 = (x^3 + 2x^2) - (9x + 18)$
$= x^2(x+2) - 9(x+2)$
$= (x^2 - 9)(x+2)$
$= (x^2 - 3^2)(x+2)$
$= (x-3)(x+3)(x+2)$

72. $x^3 + 3x^2 - 25x - 75 = (x^3 + 3x^2) - (25x + 75)$
$= x^2(x+3) - 25(x+3)$
$= (x^2 - 25)(x+3)$
$= (x^2 - 5^2)(x+3)$
$= (x-5)(x+5)(x+3)$

73. $2x^2 - 2x - 112 = 2(x^2 - x - 56) = 2(x-8)(x+7)$

74. $6x^2 - 6x - 12 = 6(x^2 - x - 2)$
$= 6(x-2)(x+1)$

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

76. $9x^3 - 9x = 9x(x^2 - 1) = 9x(x-1)(x+1)$

77. $x^2 + 64$ is prime.

78. $x^2 + 36$ is prime.

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

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

81. y^5-81y
$=y(y^4-81)=y[(y^2)^2-9^2]=y(y^2+9)(y^2-9)=y(y^2+9)(y^2-3^2)=y(y^2+9)(y+3)(y-3)$

82. y^5-16y
$=y(y^4-16)=y[(y^2)^2-4^2]=y(y^2+4)(y^2-4)=y(y^2+4)(y^2-2^2)=y(y^2+4)(y+2)(y-2)$

83. $20y^4-45y^2=5y^2(4y^2-9)=5y^2[(2y)^2-3^2]=5y^2(2y+3)(2y-3)$

84. $48y^4-3y^2=3y^2(16y^2-1)=3y^2[(4y)^2-1^2]=3y^2(4y+1)(4y-1)$

85. $x^2-12x+36-49y^2=\left(x^2-12x+36\right)-49y^2=\left(x-6\right)^2-49y^2=(x-6+7y)\left(x-6-7y\right)$

86. $x^2-10x+25-36y^2=(x^2-10x+25)-36y^2=(x-5)^2-36y^2=\left(x-5+6y\right)\left(x-5-6y\right)$

87. $9b^2x-16y-16x+9b^2y$
$=\left(9b^2x+9b^2y\right)+\left(-16x-16y\right)=9b^2\left(x+y\right)-16\left(x+y\right)=\left(x+y\right)\left(9b^2-16\right)=\left(x+y\right)\left(3b+4\right)\left(3b-4\right)$

88. $16a^2x-25y-25x+16a^2y$
$=\left(16a^2x+16a^2y\right)+\left(-25y-25x\right)=16a^2\left(x+y\right)-25\left(x+y\right)=\left(x+y\right)\left(16a^2-25\right)=\left(x+y\right)\left(4a+5\right)\left(4a-5\right)$

89. $x^2y-16y+32-2x^2$
$=\left(x^2y-16y\right)+\left(-2x^2+32\right)=y\left(x^2-16\right)-2\left(x^2-16\right)=\left(x^2-16\right)\left(y-2\right)=\left(x+4\right)\left(x-4\right)\left(y-2\right)$

90. $12x^2y-27y-4x^2+9$
$=\left(12x^2y-27y\right)+\left(-4x^2+9\right)=3y\left(4x^2-9\right)-1\left(4x^2-9\right)=\left(4x^2-9\right)\left(3y-1\right)=\left(2x+3\right)\left(2x-3\right)\left(3y-1\right)$

91. $2x^3-8a^2x+24x^2+72x$
$=2x\left(x^2-4a^2+12x+36\right)=2x\left[\left(x^2+12x+36\right)-4a^2\right]=2x\left[\left(x+6\right)^2-4a^2\right]=2x\left(x+6-2a\right)\left(x+6+2a\right)$

92. $2x^3-98a^2x+28x^2+98x$
$=2x\left(x^2-49a^2+14x+49\right)=2x\left[\left(x^2+14x+49\right)-49a^2\right]=2x\left[\left(x+7\right)^2-49a^2\right]=2x\left(x+7-7a\right)\left(x+7+7a\right)$

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

94. $x^{\frac{3}{4}} - x^{\frac{1}{4}} = x^{\frac{1}{4}}\left(x^{\frac{3}{4}-\frac{1}{4}} - 1\right) = x^{\frac{1}{4}}\left(x^{\frac{1}{2}} - 1\right)$

95. $4x^{-\frac{2}{3}} + 8x^{\frac{1}{3}} = 4x^{-\frac{2}{3}}\left(1 + 2x^{\frac{1}{3}-\left(-\frac{2}{3}\right)}\right) = 4x^{-\frac{2}{3}}(1+2x) = \dfrac{4(1+2x)}{x^{\frac{2}{3}}}$

96. $12x^{-\frac{3}{4}} + 6x^{\frac{1}{4}} = 6x^{-\frac{3}{4}}\left(2 + x^{\frac{1}{4}-\left(-\frac{3}{4}\right)}\right) = 6x^{-\frac{3}{4}}(2+x) = \dfrac{6(x+2)}{x^{\frac{3}{4}}}$

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

98. $\left(x^2+4\right)^{\frac{3}{2}} + \left(x^2+4\right)^{\frac{7}{2}} = \left(x^2+4\right)^{\frac{3}{2}}\left[1 + \left(x^2+4\right)^{\frac{7}{2}-\frac{3}{2}}\right] = \left(x^2+4\right)^{\frac{3}{2}}\left[1 + \left(x^2+4\right)^2\right] = \left(x^2+4\right)^{\frac{3}{2}}\left(x^4+8x^2+17\right)$

99. $(x+5)^{-\frac{1}{2}} - (x+5)^{-\frac{3}{2}} = (x+5)^{-\frac{3}{2}}\left[(x+5)^{-\frac{1}{2}-\left(-\frac{3}{2}\right)} - 1\right] = (x+5)^{-\frac{3}{2}}\left[(x+5)-1\right] = (x+5)^{-\frac{3}{2}}(x+4) = \dfrac{x+4}{(x+5)^{\frac{3}{2}}}$

100. $\left(x^2+3\right)^{-\frac{2}{3}} + \left(x^2+3\right)^{-\frac{5}{3}} = \left(x^2+3\right)^{-\frac{5}{3}}\left[\left(x^2+3\right)^{-\frac{2}{3}-\left(-\frac{5}{3}\right)} + 1\right] = \left(x^2+3\right)^{-\frac{5}{3}}\left[\left(x^2+3\right)+1\right] = \dfrac{x^2+4}{(x^2+3)^{5/3}}$

101. $(4x-1)^{\frac{1}{2}} - \dfrac{1}{3}(4x-1)^{\frac{3}{2}}$

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

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

102. $-8(4x+3)^{-2} + 10(5x+1)(4x+3)^{-1} = 2(4x+3)^{-2}\left[-4 + 5(5x+1)(4x+3)\right] = \dfrac{2(100x^2+95x+11)}{(4x+3)^2}$

103. $10x^2(x+1) - 7x(x+1) - 6(x+1) = (x+1)\left(10x^2 - 7x - 6\right) = (x+1)(5x-6)(2x+1)$

104. $12x^2(x-1) - 4x(x-1) - 5(x-1) = (x-1)\left(12x^2 - 4x - 5\right) = (x-1)(6x-5)(2x+1)$

105. $6x^4 + 35x^2 - 6 = \left(x^2+6\right)\left(6x^2-1\right)$

106. $7x^4 + 34x^2 - 5 = \left(7x^2-1\right)\left(x^2+5\right)$

107. $y^7 + y = y\left(y^6 + 1\right) = y\left[\left(y^2\right)^3 + 1^3\right] = y\left(y^2 + 1\right)\left(y^4 - y^2 + 1\right)$

108. $(y+1)^3 + 1 = (y+1)^3 + 1^3 = \left[(y+1)+1\right]\left[(y+1)^2 - (y+1) + 1\right] = (y+2)\left[\left(y^2 + 2y + 1\right) - y - 1 + 1\right]$
$= (y+2)\left(y^2 + 2y + 1 - y - 1 + 1\right) = (y+2)\left(y^2 + y + 1\right)$

109. $x^4 - 5x^2y^2 + 4y^4 = \left(x^2 - 4y^2\right)\left(x^2 - y^2\right) = (x+2y)(x-2y)(x+y)(x-y)$

110. $x^4 - 10x^2y^2 + 9y^4 = \left(x^2 - 9y^2\right)\left(x^2 - y^2\right) = (x+3y)(x-3y)(x+y)(x-y)$

111. $(x-y)^4 - 4(x-y)^2$
$= (x-y)^2\left((x-y)^2 - 4\right) = (x-y)^2\left((x-y)+2\right)\left((x-y)-2\right) = (x-y)^2(x-y+2)(x-y-2)$

112. $(x+y)^4 - 100(x+y)^2 = (x+y)^2\left((x+y)^2 - 100\right) = (x+y)^2(x+y-10)(x+y+10)$

113. $2x^2 - 7xy^2 + 3y^4 = \left(2x - y^2\right)\left(x - 3y^2\right)$

114. $3x^2 + 5xy^2 + 2y^4 = \left(3x + 2y^2\right)\left(x + y^2\right)$

115. a. $(x - 0.4x) - 0.4(x - 0.4x) = (x - 0.4x)(1 - 0.4) = (0.6x)(0.6) = 0.36x$

b. No, the computer is selling at 36% of its original price.

116. a. $(x - 0.3x) - 0.3(x - 0.3x) = (x - 0.3x)(1 - 0.3) = (0.7x)(0.7) = 0.49x$

b. No, the computer is selling at 49% of its original price.

117. a. $(3x)^2 - 4 \cdot 2^2 = 9x^2 - 16$

b. $9x^2 - 16 = (3x+4)(3x-4)$

118. a. $(7x)^2 - 4 \cdot 3^2 = 49x^2 - 36$

b. $49x^2 - 36 = (7x+6)(7x-6)$

119. a. $x(x+y) - y(x+y)$

b. $x(x+y) - y(x+y) = (x+y)(x-y)$

120. a. $x^2 + xy + xy + y^2 = x^2 + 2xy + y^2$

b. $x^2 + 2xy + y^2 = (x+y)^2$

121. $V_{\text{shaded}} = V_{\text{outside}} - V_{\text{inside}}$
$= a \cdot a \cdot 4a - b \cdot b \cdot 4a$
$= 4a^3 - 4ab^2$
$= 4a\left(a^2 - b^2\right)$
$= 4a(a+b)(a-b)$

122. $V_{shaded} = V_{outside} - V_{inside}$
$= a \cdot a \cdot 3a - b \cdot b \cdot 3a$
$= 3a^3 - 3ab^2$
$= 3a\left(a^2 - b^2\right)$
$= 3a(a+b)(a-b)$

123. – 129. Answers will vary.

130. makes sense

131. makes sense

132. does not make sense; Explanations will vary. Sample explanation: $4x^2 - 100 = 4(x^2 - 25) = 4(x+5)(x-5)$

133. makes sense

134. false; Changes to make the statement true will vary. A sample change is:
$x^4 - 16 = (x^2 + 4)(x^2 - 4) = (x^2 + 4)(x+2)(x-2)$

135. true

136. false; Changes to make the statement true will vary. A sample change is: The binomial $x^2 + 36$ is prime.

137. false; Changes to make the statement true will vary. A sample change is: $x^3 - 64 = (x-4)(x+4x+16)$

138. $x^{2n} + 6x^n + 8 = \left(x^n + 4\right)\left(x^n + 2\right)$

139. $-x^2 - 4x + 5 = -1\left(x^2 + 4x - 5\right) = -1(x+5)(x-1) = -(x+5)(x-1)$

140. $x^4 - y^4 - 2x^3y + 2xy^3$
$= \left(x^4 - y^4\right) + \left(-2x^3y + 2xy^3\right)$
$= \left(x^2 - y^2\right)\left(x^2 + y^2\right) - 2xy\left(x^2 - y^2\right)$
$= \left(x^2 - y^2\right)\left(x^2 + y^2 - 2xy\right)$
$= (x-y)(x+y)\left(x^2 - 2xy + y^2\right)$
$= (x-y)(x+y)(x-y)^2$
$= (x-y)^3(x+y)$

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

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

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

142. $x^2+bx+15$, b =16, – 16, 8 or –8

143. b = 0, 3, 4, or $-c(c+4)$, where $c > 0$ is an integer.

144. $\dfrac{x^2+6x+5}{x^2-25}=\dfrac{(x+5)(x+1)}{(x+5)(x-5)}=\dfrac{x+1}{x-5}$

145. $\dfrac{5}{4}\cdot\dfrac{8}{15}=\dfrac{5}{4}\cdot\dfrac{4\cdot2}{5\cdot3}$

$$=\frac{1}{1}\cdot\frac{2}{3}$$

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

146. $\dfrac{1}{2}+\dfrac{2}{3}=\dfrac{3}{6}+\dfrac{4}{6}$

$$=\frac{7}{6}$$

Section P.6

Check Point Exercises

1. a. The denominator would equal zero if $x=-5$, so –5 must be excluded from the domain.

b. $x^2-36=(x+6)(x-6)$

The denominator would equal zero if $x=-6$ or x = 6, so –6 and 6 both must be excluded from the domain.

c. $x^2-5x-14=(x+2)(x-7)$

The denominator would equal zero if $x=-2$ or x = 7, so –2 and 7 both must be excluded from the domain.

2. a. $\dfrac{x^3+3x^2}{x+3}=\dfrac{x^2(x+3)}{x+3}$

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

$$=x^2,\ x\neq-3$$

Because the denominator is x + 3, $x\neq-3$

b. $\dfrac{x^2-1}{x^2+2x+1}=\dfrac{(x-1)(x+1)}{(x+1)(x+1)}=\dfrac{x-1}{x+1},x\neq-1$

Because the denominator is $(x+1)(x+1), x\neq-1$

3. $\dfrac{x+3}{x^2-4}\cdot\dfrac{x^2-x-6}{x^2+6x+9}$

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

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

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

Because the denominator has factors of $x+2,\ x-2,$ and $x+3,\ x\neq -2,\ x\neq 2,$ and $x\neq -3.$

4. $\dfrac{x^2-2x+1}{x^3+x}\div\dfrac{x^2+x-2}{3x^2+3}$

$=\dfrac{x^2-2x+1}{x^3+x}\cdot\dfrac{3x^2+3}{x^2+x-2}$

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

$=\dfrac{3(x-1)}{x(x+2)},\ x\neq 1,\ x\neq 0,\ x\neq -2$

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

$=\dfrac{-2x-2}{x+1}$

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

$=-2, x\neq -1$

6. Factor each denominator completely.

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

$x-1=1(x-1)$

List the factors of the first denominator.

$1,\ x+1$

Add any unlisted factors from the second denominator.

$1,\ x+1,\ x-1$

The least common denominator is the product of all factors in the final list.

$1(x+1)(x-1)$ or $(x+1)(x-1)$ is the least common denominator.

7. Factor each denominator completely.

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

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

List the factors of the first denominator.

$x-3,\ x-3$

Add any unlisted factors from the second denominator.

$x-3,\ x-3,\ x+3$

The least common denominator is the product of all factors in the final list.

$(x-3)(x-3)(x+3)$ or $(x-3)^2(x+3)$ is the least common denominator.

8. Find the least common denominator.

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

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

The least common denominator is $(x-3)(x+3)$. Write all rational expressions in terms of the least common denominator.

$\dfrac{x}{x-3}+\dfrac{x-1}{x+3}$

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

Add numerators, putting this sum over the least common denominator.

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

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

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

$=\dfrac{2x^2-x+3}{(x-3)(x+3)},\ x\neq 3, x\neq -3$

9. Find the least common denominator.

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

$2x-10=2(x-5)$

The least common denominator is $2(x-5)(x-5)$. Write all rational expressions in terms of the least common denominator.

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

Add numerators, putting this sum over the least common denominator.

$$=\frac{2x-(x-4)(x-5)}{2(x-5)(x-5)}$$
$$=\frac{2x-(x^2-5x-4x+20)}{2(x-5)(x-5)}$$
$$=\frac{2x-x^2+5x+4x-20}{2(x-5)(x-5)}$$
$$=\frac{2x-x^2+5x+4x-20}{2(x-5)(x-5)}$$
$$=\frac{-x^2+11x-20}{2(x-5)(x-5)}$$
$$=\frac{-x^2+11x-20}{2(x-5)^2},\ x\neq 5$$

10.
$$\frac{\frac{1}{x}-\frac{3}{2}}{\frac{1}{x}+\frac{3}{4}}=\frac{\frac{2}{2x}-\frac{3x}{2x}}{\frac{4}{4x}+\frac{3x}{4x}},\ x\neq 0$$
$$=\frac{\frac{2-3x}{2x}}{\frac{4+3x}{4x}},\ x\neq\frac{-4}{3}$$
$$=\frac{2-3x}{2x}\div\frac{4+3x}{4x}$$
$$=\frac{2-3x}{2x}\cdot\frac{4x}{4+3x}$$
$$=\frac{2-3x}{4+3x}\cdot\frac{4}{2}$$
$$=\frac{2-3x}{4+3x}\cdot\frac{2}{1}$$
$$=\frac{2(2-3x)}{4+3x},\ x\neq 0,\ x\neq\frac{-4}{3}$$

11. Multiply each of the three terms, $\frac{1}{x+7}$, $\frac{1}{x}$, and 7 by the least common denominator of $x(x+7)$.

$$\frac{\frac{1}{x+7}-\frac{1}{x}}{7}=\frac{x(x+7)\left(\frac{1}{x+7}\right)-x(x+7)\left(\frac{1}{x}\right)}{7x(x+7)}$$
$$=\frac{x-(x+7)}{7x(x+7)}$$
$$=\frac{-7}{7x(x+7)}$$
$$=-\frac{1}{x(x+7)},\ x\neq 0,\ x\neq -7$$

Concept and Vocabulary Check P.6

1. polynomials

2. domain; 0

3. factoring; common factors

4. $\frac{x^2}{15}$

5. $\frac{3}{5}$

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

7. $x+3$ and $x-2$; $x+3$ and $x+1$; $(x+3)(x-2)(x+1)$

8. $3x+4$

9. complex; complex

10. x; $x+3$; -3; $\frac{1}{x(x+3)}$

Exercise Set P.6

1. $\frac{7}{x-3}, x\neq 3$

2. $\frac{13}{x+9}, x\neq -9$

3. $\dfrac{x+5}{x^2-25}=\dfrac{x+5}{(x+5)(x-5)}, x\neq 5,-5$

4. $\dfrac{x+7}{x^2-49}=\dfrac{x+7}{(x+7)(x-7)}, x\neq 7,-7$

5. $\dfrac{x-1}{x^2+11x+10}=\dfrac{x-1}{(x+1)(x+10)}, x\neq -1,-10$

6. $\dfrac{x-3}{x^2+4x-45}=\dfrac{x-3}{(x+9)(x-5)}, x\neq -9,5$

7. $\dfrac{3x-9}{x^2-6x+9}=\dfrac{3(x-3)}{(x-3)(x-3)}$

$=\dfrac{3}{x-3}, x\neq 3$

8. $\dfrac{4x-8}{x^2-4x+4}=\dfrac{4(x-2)}{(x-2)(x-2)}=\dfrac{4}{x-2}, \ x\neq 2$

9. $\dfrac{x^2-12x+36}{4x-24}=\dfrac{(x-6)(x-6)}{4(x-6)}=\dfrac{x-6}{4}.$

$x\neq 6$

10. $\dfrac{x^2-8x+16}{3x-12}=\dfrac{(x-4)(x-4)}{3(x-4)}=\dfrac{x-4}{3}, \ x\neq 4$

11. $\dfrac{y^2+7y-18}{y^2-3y+2}=\dfrac{(y+9)(y-2)}{(y-2)(y-1)}=\dfrac{y+9}{y-1},$

$y\neq 1, 2$

12. $\dfrac{y^2-4y-5}{y^2+5y+4}=\dfrac{(y-5)(y+1)}{(y+4)(y+1)}=\dfrac{y-5}{y+4}, y\neq -4,-1$

13. $\dfrac{x^2+12x+36}{x^2-36}=\dfrac{(x+6)^2}{(x+6)(x-6)}=\dfrac{x+6}{x-6},$

$x\neq 6, -6$

14. $\dfrac{x^2-14x+49}{x^2-49}=\dfrac{(x-7)^2}{(x-7)(x+7)}$

$=\dfrac{x-7}{x+7},$

$x\neq 7, -7$

15. $\dfrac{x-2}{3x+9}\cdot\dfrac{2x+6}{2x-4}=\dfrac{x-2}{3(x+3)}\cdot\dfrac{2(x+3)}{2(x-2)}$

$=\dfrac{2}{6}=\dfrac{1}{3}, x\neq 2,-3$

16. $\dfrac{6x+9}{3x-15}\cdot\dfrac{x-5}{4x+6}=\dfrac{3(2x+3)}{3(x-5)}\cdot\dfrac{x-5}{2(2x+3)}$

$=\dfrac{3}{6}$

$=\dfrac{1}{2},$

$x\neq 5,-\dfrac{3}{2}$

17. $\dfrac{x^2-9}{x^2}\cdot\dfrac{x^2-3x}{x^2+x-12}$

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

$=\dfrac{(x-3)(x+3)}{x(x+4)}, x\neq 0,-4,3$

18. $\dfrac{x^2-4}{x^2-4x+4}\cdot\dfrac{2x-4}{x+2}=\dfrac{(x+2)(x-2)}{(x-2)^2}\cdot\dfrac{2(x-2)}{x+2}$

$=2,$

$x\neq 2, -2$

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

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

$=\dfrac{x-1}{x+2}, \ x\neq -2,-1,2,3$

20. $\dfrac{x^2+5x+6}{x^2+x-6}\cdot\dfrac{x^2-9}{x^2-x-6}$

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

$x\neq -3,-2,2,3$

21. $\dfrac{x^3-8}{x^2-4}\cdot\dfrac{x+2}{3x}=\dfrac{(x-2)(x^2+2x+4)}{(x-2)(x+2)}\cdot\dfrac{x+2}{3x}$

$=\dfrac{x^2+2x+4}{3x}, x\neq -2,0,2$

22. $\dfrac{x^2+6x+9}{x^3+27}\cdot\dfrac{1}{x+3}$

$=\dfrac{(x+3)(x+3)}{(x+3)(x^2-3x+9)}\cdot\dfrac{1}{x+3}=\dfrac{1}{x^2-3x+9},$

$x\neq -3$

23. $\dfrac{x+1}{3} \div \dfrac{3x+3}{7} = \dfrac{x+1}{3} \div \dfrac{3(x+1)}{7}$

$= \dfrac{x+1}{3} \cdot \dfrac{7}{3(x+1)}$

$= \dfrac{7}{9}, x \neq -1$

24. $\dfrac{x+5}{7} \div \dfrac{4x+20}{9} = \dfrac{x+5}{7} \div \dfrac{4(x+5)}{9}$

$= \dfrac{x+5}{7} \cdot \dfrac{9}{4(x+5)}$

$= \dfrac{9}{28},$

$x \neq -5$

25. $\dfrac{x^2-4}{x} \div \dfrac{x+2}{x-2} = \dfrac{(x-2)(x+2)}{x} \cdot \dfrac{x-2}{x+2}$

$= \dfrac{(x-2)^2}{x}; x \neq 0, -2, 2$

26. $\dfrac{x^2-4}{x-2} \div \dfrac{x+2}{4x-8} = \dfrac{(x-2)(x+2)}{x-2} \div \dfrac{x+2}{4(x-2)}$

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

$= 4(x-2),$

$x \neq 2, -2$

27. $\dfrac{4x^2+10}{x-3} \div \dfrac{6x^2+15}{x^2-9}$

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

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

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

28. $\dfrac{x^2+x}{x^2-4} \div \dfrac{x^2-1}{x^2+5x+6}$

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

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

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

$x \neq 2, 1, -1, -2, -3$

29. $\dfrac{x^2-25}{2x-2} \div \dfrac{x^2+10x+25}{x^2+4x-5}$

$= \dfrac{(x-5)(x+5)}{2(x-1)} \div \dfrac{(x+5)^2}{(x+5)(x-1)}$

$= \dfrac{(x-5)(x+5)}{2(x-1)} \cdot \dfrac{(x+5)(x-1)}{(x+5)^2}$

$= \dfrac{x-5}{2}, x \neq 1, -5$

30. $\dfrac{x^2-4}{x^2+3x-10} \div \dfrac{x^2+5x+6}{x^2+8x+15}$

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

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

$= 1$

$x \neq 2, -2, -3, -5$

31. $\dfrac{x^2+x-12}{x^2+x-30} \cdot \dfrac{x^2+5x+6}{x^2-2x-3} \div \dfrac{x+3}{x^2+7x+6}$

$= \dfrac{(x+4)(x-3)}{(x+6)(x-5)} \cdot \dfrac{(x+2)(x+3)}{(x+1)(x-3)} \cdot \dfrac{(x+6)(x+1)}{x+3}$

$= \dfrac{(x+4)(x+2)}{x-5}$

$x \neq -6, -3, -1, 3, 5$

32. $\dfrac{x^3-25x}{4x^2} \cdot \dfrac{2x^2-2}{x^2-6x+5} \div \dfrac{x^2+5x}{7x+7}$

$= \dfrac{x(x-5)(x+5)}{4x^2} \cdot \dfrac{2(x-1)(x+1)}{(x-1)(x-5)} \cdot \dfrac{7(x+1)}{x(x+5)}$

$= \dfrac{7(x+1)^2}{2x^2}$

$x \neq 0, 1, -1, 5, -5$

33. $\dfrac{4x+1}{6x+5} + \dfrac{8x+9}{6x+5} = \dfrac{4x+1+8x+9}{6x+5}$

$= \dfrac{12x+10}{6x+5}$

$= \dfrac{2(6x+5)}{6x+5} = 2, x \neq -\dfrac{5}{6}$

34. $\dfrac{3x+2}{3x+4}+\dfrac{3x+6}{3x+4}=\dfrac{3x+2+3x+6}{3x+4}$

$=\dfrac{6x+8}{3x+4}$

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

$=2$

$x\neq -\dfrac{4}{3}$

35. $\dfrac{x^2-2x}{x^2+3x}+\dfrac{x^2+x}{x^2+3x}=\dfrac{x^2-2x+x^2+x}{x^2+3x}$

$=\dfrac{2x^2-x}{x^2+3x}$

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

$=\dfrac{2x-1}{x+3},\ x\neq 0,-3$

36. $\dfrac{x^2-4x}{x^2-x-6}+\dfrac{4x-4}{x^2-x-6}=\dfrac{x^2-4x+4x-4}{x^2-x-6}$

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

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

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

$x\neq -2,\ 3$

37. $\dfrac{4x-10}{x-2}-\dfrac{x-4}{x-2}=\dfrac{4x-10-(x-4)}{x-2}$

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

$=\dfrac{3x-6}{x-2}$

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

$=3,\ x\neq 2$

38. $\dfrac{2x+3}{3x-6}-\dfrac{3-x}{3x-6}=\dfrac{2x+3-(3-x)}{3x-6}$

$=\dfrac{2x+3-3+x}{3x-6}$

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

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

$x\neq 2$

39. $\dfrac{x^2+3x}{x^2+x-12}-\dfrac{x^2-12}{x^2+x-12}$

$=\dfrac{x^2+3x-(x^2-12)}{x^2+x-12}$

$=\dfrac{x^2+3x-x^2+12}{x^2+x-12}$

$=\dfrac{3x+12}{x^2+x-12}$

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

$=\dfrac{3}{x-3},\ x\neq 3,-4$

40. $\dfrac{x^2-4x}{x^2-x-6}-\dfrac{x-6}{x^2-x-6}$

$=\dfrac{x^2-4x-(x-6)}{x^2-x-6}$

$=\dfrac{x^2-4x-x+6}{x^2-x-6}$

$=\dfrac{x^2-5x+6}{x^2-x-6}$

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

$=\dfrac{x-2}{x+2},\ x\neq -2,\ 3$

41. $\dfrac{3}{x+4}+\dfrac{6}{x+5}=\dfrac{3(x+5)+6(x+4)}{(x+4)(x+5)}$

$=\dfrac{3x+15+6x+24}{(x+4)(x+5)}$

$=\dfrac{9x+39}{(x+4)(x+5)},\ x\neq -4,\ -5$

42. $\dfrac{8}{x-2}+\dfrac{2}{x-3}=\dfrac{8(x-3)+2(x-2)}{(x-2)(x-3)}$

$=\dfrac{8x-24+2x-4}{(x-2)(x-3)}$

$=\dfrac{10x-28}{(x-2)(x-3)},$

$x\neq 2,\ 3$

43. $\dfrac{3}{x+1}-\dfrac{3}{x}=\dfrac{3x-3(x+1)}{x(x+1)}$

$=\dfrac{3x-3x-3}{x(x+1)}=-\dfrac{3}{x(x+1)}$, $x\neq -1, 0$

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

$=\dfrac{4x+12-3x}{x(x+3)}$

$=\dfrac{x+12}{x(x+3)}$

$x\neq -3, 0$

45. $\dfrac{2x}{x+2}+\dfrac{x+2}{x-2}=\dfrac{2x(x-2)+(x+2)(x+2)}{(x+2)(x-2)}$

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

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

46. $\dfrac{3x}{x-3}-\dfrac{x+4}{x+2}=\dfrac{3x(x+2)-(x+4)(x-3)}{(x-3)(x+2)}$

$=\dfrac{3x^2+6x-\left(x^2+x-12\right)}{(x-3)(x+2)}$

$=\dfrac{2x^2+5x+12}{(x-3)(x+2)}$,

$x\neq 3, -2$

47. $\dfrac{x+5}{x-5}+\dfrac{x-5}{x+5}$

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

$=\dfrac{x^2+10x+25+x^2-10x+25}{(x-5)(x+5)}$

$=\dfrac{2x^2+50}{(x-5)(x+5)}$, $x\neq -5, 5$

48. $\dfrac{x+3}{x-3}+\dfrac{x-3}{x+3}=\dfrac{(x+3)(x+3)+(x-3)(x-3)}{(x-3)(x+3)}$

$=\dfrac{x^2+6x+9+x^2-6x+9}{(x-3)(x+3)}$

$=\dfrac{2x^2+18}{(x-3)(x+3)}$,

$x\neq -3, 3$

49. $\dfrac{3}{2x+4}+\dfrac{2}{3x+6}=\dfrac{3}{2(x+2)}+\dfrac{2}{3(x+2)}$

$=\dfrac{9}{6(x+2)}+\dfrac{4}{6(x+2)}$

$=\dfrac{9+4}{6(x+2)}$

$=\dfrac{13}{6(x+2)}$

$x\neq -2$

50. $\dfrac{5}{2x+8}+\dfrac{7}{3x+12}=\dfrac{5}{2(x+4)}+\dfrac{7}{3(x+4)}$

$=\dfrac{15}{6(x+4)}+\dfrac{14}{6(x+4)}$

$=\dfrac{15+14}{6(x+4)}$

$=\dfrac{29}{6(x+4)}$

$x\neq -4$

51. $\dfrac{4}{x^2+6x+9}+\dfrac{4}{x+3}=\dfrac{4}{(x+3)^2}+\dfrac{4}{x+3}$

$=\dfrac{4+4(x+3)}{(x+3)^2}=\dfrac{4+4x+12}{(x+3)^2}=\dfrac{4x+16}{(x+3)^2}$,

$x\neq -3$

52. $\dfrac{3}{5x+2}+\dfrac{5x}{25x^2-4}=\dfrac{3}{5x+2}+\dfrac{5x}{(5x-2)(5x+2)}$

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

$=\dfrac{15x-6+5x}{(5x-2)(5x+2)}$

$=\dfrac{20x-6}{(5x-2)(5x+2)}$,

$x\neq -\dfrac{2}{5}, \dfrac{2}{5}$

53. $\dfrac{3x}{x^2+3x-10}-\dfrac{2x}{x^2+x-6}$

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

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

$=\dfrac{3x^2+9x-2x^2-10x}{(x+5)(x-2)(x+3)}$

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

54. $\dfrac{x}{x^2-2x-24}-\dfrac{x}{x^2-7x+6}$

$=\dfrac{x}{(x-6)(x+4)}-\dfrac{x}{(x-6)(x-1)}$

$=\dfrac{x(x-1)-x(x+4)}{(x-6)(x+4)(x-1)}$

$=\dfrac{x^2-x-x^2-4x}{(x-6)(x+4)(x-1)}$

$=-\dfrac{5x}{(x-6)(x-1)(x+4)}$,

$x\neq 6, 1, -4$

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

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

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

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

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

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

$x\neq 1, -1$

56. $\dfrac{x+5}{x^2-4}-\dfrac{x+1}{x-2}$

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

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

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

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

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

$x\neq 2, -2$

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

$=\dfrac{4x^2+x-6}{(x+1)(x+2)}+\dfrac{-3x}{x+1}+\dfrac{5}{x+2}$

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

$=\dfrac{4x^2+x-6-3x^2-6x+5x+5}{(x+1)(x+2)}$

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

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

$=\dfrac{x-1}{x+2}; x\neq -2, -1$

58. $\dfrac{6x^2+17x-40}{x^2+x-20}+\dfrac{3}{x-4}-\dfrac{5x}{x+5}$

$=\dfrac{6x^2+17x-40}{(x+5)(x-4)}+\dfrac{3}{x-4}-\dfrac{5x}{x+5}$

$=\dfrac{6x^2+17x-40+3(x+5)-5x(x-4)}{(x+5)(x-4)}$

$=\dfrac{6x^2+17x-40+3x+15-5x^2+20x}{(x+5)(x-4)}$

$=\dfrac{x^2+40x-25}{(x+5)(x-4)}; x\neq -5, 4$

59. $\dfrac{\frac{x}{3}-1}{x-3}=\dfrac{3\left[\frac{x}{3}-1\right]}{3[x-3]}=\dfrac{x-3}{3(x-3)}=\dfrac{1}{3},\ x\neq 3$

60. $\dfrac{\frac{x}{4}-1}{x-4}=\dfrac{4\left[\frac{x}{4}-1\right]}{4(x-4)}=\dfrac{x-4}{4(x-4)}=\dfrac{1}{4},\ x\neq 4$

61. $\dfrac{1+\frac{1}{x}}{3-\frac{1}{x}}=\dfrac{x\left[1+\frac{1}{x}\right]}{x\left[3-\frac{1}{x}\right]}=\dfrac{x+1}{3x-1},\ x\neq 0,\dfrac{1}{3}$

62. $\dfrac{8+\frac{1}{x}}{4-\frac{1}{x}}=\dfrac{x\left[8+\frac{1}{x}\right]}{x\left[4-\frac{1}{x}\right]}=\dfrac{8x+1}{4x-1},\ x\neq 0,\dfrac{1}{4}$

63. $\dfrac{\frac{1}{x}+\frac{1}{y}}{x+y}=\dfrac{xy\left[\frac{1}{x}+\frac{1}{y}\right]}{xy[x+y]}=\dfrac{y+x}{xy(x+y)}=\dfrac{1}{xy},$
$x\neq 0,\ y\neq 0,\ x\neq -y$

64. $\dfrac{1-\frac{1}{x}}{xy}=\dfrac{x\left[1-\frac{1}{x}\right]}{x(xy)}=\dfrac{x-1}{x^2y},\ x\neq 0,\ y\neq 0$

65. $\dfrac{x-\frac{x}{x+3}}{x+2}=\dfrac{(x+3)\left[x-\frac{x}{x+3}\right]}{(x+3)(x+2)}=\dfrac{x(x+3)-x}{(x+3)(x+2)}$
$=\dfrac{x^2+3x-x}{(x+3)(x+2)}=\dfrac{x^2+2x}{(x+3)(x+2)}$
$=\dfrac{x(x+2)}{(x+3)(x+2)}=\dfrac{x}{x+3},\ x\neq -2,-3$

66. $\dfrac{x-3}{x-\frac{3}{x-2}}=\dfrac{(x-2)[x-3]}{(x-2)\left[x-\frac{3}{x-2}\right]}=\dfrac{(x-2)(x-3)}{x(x-2)-3}$
$=\dfrac{(x-2)(x-3)}{x^2-2x-3}$
$=\dfrac{(x-2)(x-3)}{(x-3)(x+1)}=\dfrac{x-2}{x+1},\ x\neq 2,3,-1$

67. $\dfrac{\frac{3}{x-2}-\frac{4}{x+2}}{\frac{7}{x^2-4}}=\dfrac{\frac{3}{x-2}-\frac{4}{x+2}}{\frac{7}{(x-2)(x+2)}}$
$=\dfrac{\left[\frac{3}{x-2}-\frac{4}{x+2}\right](x-2)(x+2)}{\left[\frac{7}{(x-2)(x+2)}\right](x-2)(x+2)}$
$=\dfrac{3(x+2)-4(x-2)}{7}$
$=\dfrac{3x+6-4x+8}{7}=\dfrac{-x+14}{7}$
$=-\dfrac{x-14}{7}\quad x\neq -2,\ 2$

68. $\dfrac{\frac{x}{x-2}+1}{\frac{3}{x^2-4}+1}=\dfrac{\frac{x}{x-2}+1}{\frac{3}{(x-2)(x+2)}+1}$
$=\dfrac{\left[\frac{x}{x-2}+1\right](x-2)(x+2)}{\left[\frac{3}{(x-2)(x+2)}+1\right](x-2)(x+2}$
$=\dfrac{x(x+2)+(x-2)(x+2)}{3+(x-2)(x+2)}$
$=\dfrac{x^2+2x+x^2-4}{3+x^2-4}=\dfrac{2x^2+2x-4}{x^2-1}$
$=\dfrac{2(x^2+x-2)}{(x-1)(x+1)}$
$=\dfrac{2(x+2)(x-1)}{(x-1)(x+1)}=\dfrac{2(x+2)}{x+1},$
$x\neq 1,-1,\ 2,\ -2$

69. $\dfrac{\frac{1}{x+1}}{\frac{1}{x^2-2x-3}+\frac{1}{x-3}}=\dfrac{\frac{1}{x+1}}{\frac{1}{(x+1)(x-3)}+\frac{1}{x-3}}$
$=\dfrac{\frac{(x+1)(x-3)}{x+1}}{\frac{(x+1)(x-3)}{(x+1)(x-3)}+\frac{(x+1)(x-3)}{x-3}}$
$=\dfrac{x-3}{1+x+1}$
$=\dfrac{x-3}{x+2}\quad x\neq -2,-1,3$

70.
$$\frac{\dfrac{6}{x^2+2x-15}-\dfrac{1}{x-3}}{\dfrac{1}{x+5}+1}=\frac{\dfrac{6}{(x+5)(x-3)}-\dfrac{1}{x-3}}{\dfrac{1}{x+5}+1}$$
$$=\frac{\dfrac{6(x+5)(x-3)}{(x+5)(x-3)}-\dfrac{(x+5)(x-3)}{x-3}}{\dfrac{(x+5)(x-3)}{x+5}+(x+5)(x-3)}$$
$$=\frac{6-(x+5)}{(x-3)+(x+5)(x-3)}$$
$$=\frac{6-x-5}{x-3+x^2+2x-15}$$
$$=\frac{1-x}{x^2+3x-18}$$
$$=\frac{1-x}{(x+6)(x-3)} \quad x\neq -6,-5,3$$

71.
$$\frac{\dfrac{1}{(x+h)^2}-\dfrac{1}{x^2}}{h}=\frac{\dfrac{x^2(x+h)^2}{(x+h)^2}-\dfrac{x^2(x+h)^2}{x^2}}{hx^2(x+h)^2}$$
$$=\frac{x^2-(x+h)^2}{hx^2(x+h)^2}$$
$$=\frac{x^2-(x^2+2hx+h^2)}{hx^2(x+h)^2}$$
$$=\frac{x^2-x^2-2hx-h^2}{hx^2(x+h)^2}$$
$$=\frac{-2hx-h^2}{hx^2(x+h)^2}$$
$$=\frac{-h(2x+h)}{hx^2(x+h)^2}$$
$$=-\frac{(2x+h)}{x^2(x+h)^2}$$

72.
$$\frac{\dfrac{x+h}{x+h+1}-\dfrac{x}{x+1}}{h}=\frac{\dfrac{(x+h)(x+h+1)(x+1)}{x+h+1}-\dfrac{x(x+h+1)(x+1)}{x+1}}{h(x+h+1)(x+1)}$$
$$=\frac{(x+h)(x+1)-x(x+h+1)}{h(x+h+1)(x+1)}$$
$$=\frac{x^2+x+hx+h-x^2-hx-x}{h(x+h+1)(x+1)}$$
$$=\frac{h}{h(x+h+1)(x+1)}$$
$$=\frac{1}{(x+h+1)(x+1)}$$

73. $\left(\dfrac{2x+3}{x+1}\cdot\dfrac{x^2+4x-5}{2x^2+x-3}\right)-\dfrac{2}{x+2}=\left(\dfrac{\cancel{(2x+3)}}{x+1}\cdot\dfrac{(x+5)\cancel{(x-1)}}{\cancel{(2x+3)}\cancel{(x-1)}}\right)-\dfrac{2}{x+2}=\dfrac{x+5}{x+1}-\dfrac{2}{x+2}$

$=\dfrac{(x+5)(x+2)}{(x+1)(x+2)}-\dfrac{2(x+1)}{(x+1)(x+2)}=\dfrac{(x+5)(x+2)-2(x+1)}{(x+1)(x+2)}=\dfrac{x^2+2x+5x+10-2x-2}{(x+1)(x+2)}=\dfrac{x^2+5x+8}{(x+1)(x+2)}$

74. $\dfrac{1}{x^2-2x-8}\cdot\left(\dfrac{1}{x-4}-\dfrac{1}{x+2}\right)=\dfrac{1}{(x-4)(x+2)}\div\left(\dfrac{(x+2)}{(x-4)(x+2)}-\dfrac{(x-4)}{(x-4)(x+2)}\right)$

$=\dfrac{1}{(x-4)(x+2)}\div\left(\dfrac{x+2-x+4}{(x-4)(x+2)}\right)=\dfrac{1}{(x-4)(x+2)}\div\left(\dfrac{6}{(x-4)(x+2)}\right)=\dfrac{1}{(x-4)(x+2)}\cdot\dfrac{(x-4)(x+2)}{6}=\dfrac{1}{6}$

75. $\left(2-\dfrac{6}{x+1}\right)\left(1+\dfrac{3}{x-2}\right)=\left(\dfrac{2(x+1)}{(x+1)}-\dfrac{6}{(x+1)}\right)\left(\dfrac{(x-2)}{(x-2)}+\dfrac{3}{(x-2)}\right)$

$=\left(\dfrac{2x+2-6}{x+1}\right)\left(\dfrac{x-2+3}{x-2}\right)=\left(\dfrac{2x-4}{x+1}\right)\left(\dfrac{x+1}{x-2}\right)=\dfrac{2\cancel{(x-2)}\cancel{(x+1)}}{\cancel{(x+1)}\cancel{(x-2)}}=2$

76. $\left(4-\dfrac{3}{x+2}\right)\left(1+\dfrac{5}{x-1}\right)=\left(\dfrac{4(x+2)}{x+2}-\dfrac{3}{x+2}\right)\left(\dfrac{(x-1)}{x-1}+\dfrac{5}{x-1}\right)$

$=\left(\dfrac{4x+8-3}{x+2}\right)\left(\dfrac{x-1+5}{x-1}\right)=\dfrac{4x+5}{x+2}\cdot\dfrac{x+4}{x-1}=\dfrac{(4x+5)(x+4)}{(x+2)(x-1)}$

77. $\dfrac{y^{-1}-(y+5)^{-1}}{5}=\dfrac{\dfrac{1}{y}-\dfrac{1}{y+5}}{5}$

$\text{LCD}=y(y+5)$

$\dfrac{\dfrac{1}{y}-\dfrac{1}{y+5}}{5}=\dfrac{y(y+5)\left(\dfrac{1}{y}-\dfrac{1}{y+5}\right)}{y(y+5)(5)}=\dfrac{y+5-y}{5y(y+5)}=\dfrac{5}{5y(y+5)}=\dfrac{1}{y(y+5)}$

78. $\dfrac{y^{-1}-(y+2)^{-1}}{2}=\dfrac{\dfrac{1}{y}-\dfrac{1}{y+2}}{2}$

$\text{LCD}=y(y+2)$

$\dfrac{\dfrac{1}{y}-\dfrac{1}{y+2}}{2}=\dfrac{y(y+2)\left(\dfrac{1}{y}-\dfrac{1}{y+2}\right)}{y(y+2)(2)}=\dfrac{y+2-y}{2y(y+2)}=\dfrac{2}{2y(y+2)}=\dfrac{1}{y(y+2)}$

79. $\left(\dfrac{1}{a^3-b^3}\cdot\dfrac{ac+ad-bc-bd}{1}\right)-\dfrac{c-d}{a^2+ab+b^2}=\left(\dfrac{1}{(a-b)\left(a^2+ab+b^2\right)}\cdot\dfrac{a(c+d)-b(c+d)}{1}\right)-\dfrac{c-d}{a^2+ab+b^2}$

$=\left(\dfrac{1}{\cancel{(a-b)}\left(a^2+ab+b^2\right)}\cdot\dfrac{(c+d)\cancel{(a-b)}}{1}\right)-\dfrac{c-d}{a^2+ab+b^2}=\dfrac{c+d}{a^2+ab+b^2}-\dfrac{c-d}{a^2+bd+b^2}$

$=\dfrac{c+d-c+d}{a^2+ab+b^2}=\dfrac{2d}{a^2+ab+b^2}$

80. $\dfrac{ab}{a^2+ab+b^2}+\left(\dfrac{ac-ad-bc+bd}{ac-ad+bc-bd}\div\dfrac{a^3-b^3}{a^3+b^3}\right)=\dfrac{ab}{a^2+ab+b^2}+\left(\dfrac{a(c-d)-b(c-d)}{a(c-d)+b(c-d)}\cdot\dfrac{a^3+b^3}{a^3-b^3}\right)$

$=\dfrac{ab}{a^2+ab+b^2}+\left(\dfrac{\cancel{(c-d)}\cancel{(a-b)}}{\cancel{(c-d)}\cancel{(a+b)}}\cdot\dfrac{\cancel{(a+b)}\left(a^2-ab+b^2\right)}{\cancel{(a-b)}\left(a^2+ab+b^2\right)}\right)=\dfrac{ab}{a^2+ab+b^2}+\dfrac{a^2-ab+b^2}{a^2+ab+b^2}$

$=\dfrac{ab+a^2-ab+b^2}{a^2+ab+b^2}=\dfrac{a^2+b^2}{a^2+ab+b^2}$

81. **a.** $\dfrac{130x}{100-x}$ is equal to

1. $\dfrac{130\cdot40}{100-40}=\dfrac{130\cdot40}{60}=86.67$, when $x=40$
2. $\dfrac{130\cdot80}{100-80}=\dfrac{130\cdot80}{20}=520$, when $x=80$
3. $\dfrac{130\cdot90}{100-90}=\dfrac{130\cdot90}{10}=1170$, when $x=90$

It costs \$86,670,000 to inoculate 40% of the population against this strain of flu, and \$520,000,000 to inoculate 80% of the population, and \$1,170,000,000 to inoculate 90% of the population.

b. For $x=100$, the function is not defined.

c. As x approaches 100, the value of the function increases rapidly. So it costs an astronomical amount of money to inoculate almost all of the people, and it is impossible to inoculate 100% of the population.

82. $\dfrac{2d}{\dfrac{d}{r_1}+\dfrac{d}{r_2}}$

LCD = $r_1 r_2$

$$\frac{2d}{\dfrac{d}{r_1}+\dfrac{d}{r_2}} = \frac{r_1 r_2 (2d)}{r_1 r_2\left(\dfrac{d}{r_1}+\dfrac{d}{r_2}\right)}$$

$$= \frac{2r_1 r_2 d}{r_2 d + r_1 d}$$

$$= \frac{2r_1 r_2 d}{d(r_2 + r_1)} = \frac{2r_1 r_2}{r_2 + r_1}$$

If $r_1 = 40$ and $r_2 = 30$, the value of this expression will be

$$\frac{2 \cdot 40 \cdot 30}{30+40} = \frac{2400}{70}$$

$$= 34\frac{2}{7}.$$

Your average speed will be $34\dfrac{2}{7}$ miles per hour.

83. **a.** Substitute 4 for x in the model.

$W = -66x^2 + 526x + 1030$

$W = -66(4)^2 + 526(4) + 1030$

$W = 2078$

According to the model, women between the ages of 19 and 30 with this lifestyle need 2078 calories per day. This underestimates the actual value shown in the bar graph by 22 calories.

b. Substitute 4 for x in the model.

$M = -120x^2 + 998x + 590$

$M = -120(4)^2 + 998(4) + 590$

$M = 2662$

According to the model, men between the ages of 19 and 30 with this lifestyle need 2662 calories per day. This underestimates the actual value shown in the bar graph by 38 calories.

c. $$\frac{W}{M} = \frac{-66x^2 + 526x + 1030}{-120x^2 + 998x + 590}$$

$$= \frac{2(-33x^2 + 263x + 515)}{2(-60x^2 + 499x + 295)}$$

$$= \frac{-33x^2 + 263x + 515}{-60x^2 + 499x + 295}$$

84. $P = 2L + 2W$

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

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

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

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

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

85. $P = 2L + 2W$

$$= 2\left(\frac{x}{x+5}\right) + 2\left(\frac{x}{x+6}\right)$$

$$= \frac{2x}{x+5} + \frac{2x}{x+6}$$

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

$$= \frac{2x^2 + 12x + 2x^2 + 10x}{(x+5)(x+6)}$$

$$= \frac{4x^2 + 22x}{(x+5)(x+6)}$$

86. – 97. Answers will vary.

98. does not make sense; Explanations will vary. Sample explanation: $\frac{3x-3}{4x(x-1)} = \frac{3(1)-3}{4(1)(1-1)} = \frac{0}{0}$ which is undefined.

99. does not make sense; Explanations will vary. Sample explanation: The numerator and denominator of $\frac{7}{14+x}$ do not share a common factor.

100. does not make sense; Explanations will vary. Sample explanation: The first step is to invert the second fraction.

101. makes sense

102. false; Changes to make the statement true will vary. A sample change is: $\frac{x^2-25}{x-5} = \frac{(x+5)(x-5)}{x-5} = x+5$

103. true

104. true

105. false; Changes to make the statement true will vary. A sample change is: $6 + \frac{1}{x} = \frac{6x}{x} + \frac{1}{x} = \frac{6x+1}{x}$

106. $\dfrac{1}{x^n-1}-\dfrac{1}{x^n+1}-\dfrac{1}{x^{2n}-1}$

$=\dfrac{x^n+1}{x^{2n}-1}-\dfrac{x^n-1}{x^{2n}-1}-\dfrac{1}{x^{2n}-1}$

$=\dfrac{x^n+1-x^n+1-1}{x^{2n}-1}$

$=\dfrac{1}{x^{2n}-1}$

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

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

$=\dfrac{x-1}{\cancel{x}}\cdot\dfrac{\cancel{x}}{\cancel{x+1}}\cdot\dfrac{\cancel{x+1}}{\cancel{x+2}}\cdot\dfrac{\cancel{x+2}}{x+3}=\dfrac{x-1}{x+3}$

108. $(x-y)^{-1}+(x-y)^{-2}=\dfrac{1}{(x-y)}+\dfrac{1}{(x-y)^2}=\dfrac{(x-y)}{(x-y)(x-y)}+\dfrac{1}{(x-y)^2}=\dfrac{x-y+1}{(x-y)^2}$

109. It cubes x.

$$\frac{\frac{1}{x}+\frac{1}{x^2}+\frac{1}{x^3}}{\frac{1}{x^4}+\frac{1}{x^5}+\frac{1}{x^6}}=\frac{\frac{x^6}{x}+\frac{x^6}{x^2}+\frac{x^6}{x^3}}{\frac{x^6}{x^4}+\frac{x^6}{x^5}+\frac{x^6}{x^6}}=\frac{x^5+x^4+x^3}{x^2+x+1}=\frac{x^3\left(x^2+x+1\right)}{x^2+x+1}=x^3$$

110. $y=4-x^2$

111. $y=1-x^2$

112. $y=|x+1|$

x	$y=\lvert x+1\rvert$
-4	$\lvert-4+1\rvert=3$
-3	$\lvert-3+1\rvert=2$
-2	$\lvert-2+1\rvert=1$
-1	$\lvert-1+1\rvert=0$
0	$\lvert0+1\rvert=1$
1	$\lvert1+1\rvert=2$
2	$\lvert2+1\rvert=3$

Chapter P Review Exercises

1. $3+6(x-2)^3 = 3+6(4-2)^3$
$= 3+6(2)^3$
$= 3+6(8)$
$= 3+48$
$= 51$

2. $x^2-5(x-y) = 6^2-5(6-2)$
$= 36-5(4)$
$= 36-20$
$= 16$

3. $S = 0.015x^2 + x + 10$
$S = 0.015(60)^2 + (60) + 10$
$= 0.015(3600) + 60 + 10$
$= 54 + 60 + 10$
$= 124$

4. $A = \{a,b,c\} \quad B = \{a,c,d,e\}$
$\{a,b,c\} \cap \{a,c,d,e\} = \{a,c\}$

5. $A = \{a,b,c\} \quad B = \{a,c,d,e\}$
$\{a,b,c\} \cup \{a,c,d,e\} = \{a,b,c,d,e\}$

6. $A = \{a,b,c\} \quad C = \{a,d,f,g\}$
$\{a,b,c\} \cup \{a,d,f,g\} = \{a,b,c,d,f,g\}$

7. $A = \{a,b,c\} \quad C = \{a,d,f,g\}$
$\{a,d,f,g\} \cap \{a,b,c\} = \{a\}$

8. **a.** $\sqrt{81}$

b. $0, \sqrt{81}$

c. $-17, 0, \sqrt{81}$

d. $-17, -\frac{9}{13}, 0, 0.75, \sqrt{81}$

e. $\sqrt{2}, \pi$

f. $-17, -\frac{9}{13}, 0, 0.75, \sqrt{2}, \pi, \sqrt{81}$

9. $|-103| = 103$

10. $|\sqrt{2}-1| = \sqrt{2}-1$

11. $|3-\sqrt{17}| = \sqrt{17}-3$ since $\sqrt{17}$ is greater than 3.

12. $|4-(-17)| = |4+17| = |21| = 21$

13. $3 + 17 = 17 + 3$;
commutative property of addition.

14. $(6\cdot 3)\cdot 9 = 6\cdot(3\cdot 9)$;
associative property of multiplication.

15. $\sqrt{3}(\sqrt{5}+\sqrt{3}) = \sqrt{15}+3$;
distributive property of multiplication over addition.

16. $(6\cdot 9)\cdot 2 = 2\cdot(6\cdot 9)$;
commutative property of multiplication.

17. $\sqrt{3}(\sqrt{5}+\sqrt{3}) = (\sqrt{5}+\sqrt{3})\sqrt{3}$;
commutative property of multiplication.

18. $(3\cdot 7)+(4\cdot 7) = (4\cdot 7)+(3\cdot 7)$;
commutative property of addition.

19. $5(2x-3)+7x = 10x-15+7x = 17x-15$

20. $\frac{1}{5}(5x)+[(3y)+(-3y)]-(-x) = x+[0]+x = 2x$

21. $3(4y-5)-(7y+2) = 12y-15-7y-2 = 5y-17$

22. $8-2[3-(5x-1)] = 8-2[3-5x+1]$
$= 8-2[4-5x]$
$= 8-8+10x$
$= 10x$

23. $D = 0.005x^2 + 0.55x + 34$
$D = 0.005(30)^2 + 0.55(30) + 34$
$= 55$
The U.S. diversity index was 55% in 2010.
This is the same as the value displayed in the bar graph.

24. $(-3)^3(-2)^2 = (-27)\cdot(4) = -108$

25. $2^{-4}+4^{-1}=\frac{1}{2^4}+\frac{1}{4}$
$=\frac{1}{16}+\frac{1}{4}$
$=\frac{1}{16}+\frac{4}{16}$
$=\frac{5}{16}$

26. $5^{-3}\cdot 5=5^{-3}5^{1}=5^{-3+1}=5^{-2}=\frac{1}{5^2}=\frac{1}{25}$

27. $\frac{3^3}{3^6}=3^{3-6}=3^{-3}=\frac{1}{3^3}=\frac{1}{27}$

28. $(-2x^4y^3)^3=(-2)^3(x^4)^3(y^3)^3$
$=(-2)^3x^{4\cdot 3}y^{3\cdot 3}$
$=-8x^{12}y^9$

29. $(-5x^3y^2)(-2x^{-11}y^{-2})$
$=(-5)(-2)x^3x^{-11}y^2y^{-2}$
$=10\cdot x^{3-11}y^{2-2}$
$=10x^{-8}y^0$
$=\frac{10}{x^8}$

30. $(2x^3)^{-4}=(2)^{-4}(x^3)^{-4}$
$=2^{-4}x^{-12}$
$=\frac{1}{2^4x^{12}}$
$=\frac{1}{16x^{12}}$

31. $\frac{7x^5y^6}{28x^{15}y^{-2}}=\left(\frac{7}{28}\right)(x^{5-15})(y^{6-(-2)})$
$=\frac{1}{4}x^{-10}y^8$
$=\frac{y^8}{4x^{10}}$

32. $3.74\times 10^4=37,400$

33. $7.45\times 10^{-5}=0.0000745$

34. $3,590,000=3.59\times 10^6$

35. $0.00725=7.25\times 10^{-3}$

36. $(3\times 10^3)(1.3\times 10^2)=(3\times 1.3)\times(10^3\times 10^2)$
$=3.9\times 10^5$
$=390,000$

37. $\frac{6.9\times 10^3}{3\times 10^5}=\left(\frac{6.9}{3}\right)\times 10^{3-5}$
$=2.3\times 10^{-2}$
$=0.023$

38. 1.35×10^{12}

39. $32,000,000=3.2\times 10^7$

40. $\frac{1.35\times 10^{12}}{3.2\times 10^7}=\frac{1.35}{3.2}\cdot\frac{10^{12}}{10^7}\approx 0.42188\times 10^5=42,188$
1.35×10^{12} seconds is approximately 42,188 years.

41. $\sqrt{300}=\sqrt{100\cdot 3}=\sqrt{100}\cdot\sqrt{3}=10\sqrt{3}$

42. $\sqrt{12x^2}=\sqrt{4x^2\cdot 3}=\sqrt{4x^2}\cdot\sqrt{3}=2|x|\sqrt{3}$

43. $\sqrt{10x}\cdot\sqrt{2x}=\sqrt{20x^2}$
$=\sqrt{4x^2}\cdot\sqrt{5}$
$=2x\sqrt{5}$

44. $\sqrt{r^3}=\sqrt{r^2}\cdot\sqrt{r}=r\sqrt{r}$

45. $\sqrt{\frac{121}{4}}=\frac{\sqrt{121}}{\sqrt{4}}=\frac{11}{2}$

46. $\frac{\sqrt{96x^3}}{\sqrt{2x}}=\sqrt{\frac{96x^3}{2x}}$
$=\sqrt{48x^2}$
$=\sqrt{16x^2}\cdot\sqrt{3}$
$=4x\sqrt{3}$

47. $7\sqrt{5}+13\sqrt{5}=(7+13)\sqrt{5}=20\sqrt{5}$

48. $2\sqrt{50}+3\sqrt{8}=2\sqrt{25\cdot 2}+3\sqrt{4\cdot 2}$
$=2\cdot 5\sqrt{2}+3\cdot 2\sqrt{2}$
$=10\sqrt{2}+6\sqrt{2}$
$=16\sqrt{2}$

49. $4\sqrt{72}-2\sqrt{48}=4\sqrt{36\cdot 2}-2\sqrt{16\cdot 3}$
$=4\cdot 6\sqrt{2}-2\cdot 4\sqrt{3}$
$=24\sqrt{2}-8\sqrt{3}$

50. $\dfrac{30}{\sqrt{5}}=\dfrac{30}{\sqrt{5}}\cdot\dfrac{\sqrt{5}}{\sqrt{5}}=\dfrac{30\sqrt{5}}{5}=6\sqrt{5}$

51. $\dfrac{\sqrt{2}}{\sqrt{3}}=\dfrac{\sqrt{2}}{\sqrt{3}}\cdot\dfrac{\sqrt{3}}{\sqrt{3}}=\dfrac{\sqrt{6}}{3}$

52. $\dfrac{5}{6+\sqrt{3}}=\dfrac{5}{6+\sqrt{3}}\cdot\dfrac{6-\sqrt{3}}{6-\sqrt{3}}$
$=\dfrac{5(6-\sqrt{3})}{36-3}$
$=\dfrac{5(6-\sqrt{3})}{33}$

53. $\dfrac{14}{\sqrt{7}-\sqrt{5}}=\dfrac{14}{\sqrt{7}-\sqrt{5}}\cdot\dfrac{\sqrt{7}+\sqrt{5}}{\sqrt{7}+\sqrt{5}}$
$=\dfrac{14(\sqrt{7}+\sqrt{5})}{7-5}$
$=\dfrac{14(\sqrt{7}+\sqrt{5})}{2}$
$=7(\sqrt{7}+\sqrt{5})$

54. $\sqrt[3]{125}=5$

55. $\sqrt[5]{-32}=-2$

56. $\sqrt[4]{-125}$ is not a real number.

57. $\sqrt[4]{(-5)^4}=\sqrt[4]{625}=\sqrt[4]{5^4}=5$

58. $\sqrt[3]{81}=\sqrt[3]{27\cdot 3}=\sqrt[3]{27}\cdot\sqrt[3]{3}=3\sqrt[3]{3}$

59. $\sqrt[3]{y^5}=\sqrt[3]{y^3y^2}=y\sqrt[3]{y^2}$

60. $\sqrt[4]{8}\cdot\sqrt[4]{10}=\sqrt[4]{80}=\sqrt[4]{16\cdot 5}=\sqrt[4]{16}\cdot\sqrt[4]{5}=2\sqrt[4]{5}$

61. $4\sqrt[3]{16}+5\sqrt[3]{2}=4\sqrt[3]{8\cdot 2}+5\sqrt[3]{2}$
$=4\cdot 2\sqrt[3]{2}+5\sqrt[3]{2}$
$=8\sqrt[3]{2}+5\sqrt[3]{2}$
$=13\sqrt[3]{2}$

62. $\dfrac{\sqrt[4]{32x^5}}{\sqrt[4]{16x}}=\sqrt[4]{\dfrac{32x^5}{16x}}=\sqrt[4]{2x^4}=x\sqrt[4]{2}$

63. $16^{1/2}=\sqrt{16}=4$

64. $25^{-1/2}=\dfrac{1}{25^{1/2}}=\dfrac{1}{\sqrt{25}}=\dfrac{1}{5}$

65. $125^{1/3}=\sqrt[3]{125}=5$

66. $27^{-1/3}=\dfrac{1}{27^{1/3}}=\dfrac{1}{\sqrt[3]{27}}=\dfrac{1}{3}$

67. $64^{2/3}=(\sqrt[3]{64})^2=4^2=16$

68. $27^{-4/3}=\dfrac{1}{27^{4/3}}=\dfrac{1}{(\sqrt[3]{27})^4}=\dfrac{1}{3^4}=\dfrac{1}{81}$

69. $(5x^{2/3})(4x^{1/4})=5\cdot 4x^{2/3+1/4}=20x^{11/12}$

70. $\dfrac{15x^{3/4}}{5x^{1/2}}=\left(\dfrac{15}{5}\right)x^{3/4-1/2}=3x^{1/4}$

71. $(125\cdot x^6)^{2/3}=(\sqrt[3]{125x^6})^2$
$=(5x^2)^2$
$=25x^4$

72. $\sqrt[6]{y^3}=(y^3)^{1/6}=y^{3\cdot 1/6}=y^{1/2}=\sqrt{y}$

73. $(-6x^3+7x^2-9x+3)+(14x^3+3x^2-11x-7)=(-6x^3+14x^3)+(7x^2+3x^2)+(-9x-11x)+(3-7)$
$=8x^3+10x^2-20x-4$

The degree is 3.

74. $(13x^4-8x^3+2x^2)-(5x^4-3x^3+2x^2-6)=(13x^4-8x^3+2x^2)+(-5x^4+3x^3-2x^2+6)$
$=(13x^4-5x^4)+(-8x^3+3x^3)+(2x^2-2x^2)+6$
$=8x^4-5x^3+6$

The degree is 4.

75. $(3x-2)(4x^2+3x-5)=(3x)(4x^2)+(3x)(3x)+(3x)(-5)+(-2)(4x^2)+(-2)(3x)+(-2)(-5)$
$=12x^3+9x^2-15x-8x^2-6x+10$
$=12x^3+x^2-21x+10$

76. $(3x-5)(2x+1)=(3x)(2x)+(3x)(1)+(-5)(2x)+(-5)(1)$
$=6x^2+3x-10x-5$
$=6x^2-7x-5$

77. $(4x+5)(4x-5)=(4x^2)-5^2=16x^2-25$

78. $(2x+5)^2=(2x)^2+2(2x)\cdot 5+5^2=4x^2+20x+25$

79. $(3x-4)^2=(3x)^2-2(3x)\cdot 4+(-4)^2=9x^2-24x+16$

80. $(2x+1)^3=(2x)^3+3(2x)^2(1)+3(2x)(1)^2+1^3=8x^3+12x^2+6x+1$

81. $(5x-2)^3=(5x)^3-3(5x)^2(2)+3(5x)(2)^2-2^3=125x^3-150x^2+60x-8$

82. $(7x^2-8xy+y^2)+(-8x^2-9xy-4y^2)=(7x^2-8x^2)+(-8xy-9xy)+(y^2-4y^2)$
$=-x^2-17xy-3y^2$

The degree is 2.

83. $(13x^3y^2-5x^2y-9x^2)-(-11x^3y^2-6x^2y+3x^2-4)$
$=(13x^3y^2-5x^2y-9x^2)+(11x^3y^2+6x^2y-3x^2+4)$
$=(13x^3y^2+11x^3y^2)+(-5x^2y+6x^2y)+(-9x^2-3x^2)+4$
$=24x^3y^2+x^2y-12x^2+4$

The degree is 5.

84. $(x+7y)(3x-5y)=x(3x)+(x)(-5y)+(7y)(3x)+(7y)(-5y)$
$=3x^2-5xy+21xy-35y^2$
$=3x^2+16xy-35y^2$

85. $(3x-5y)^2=(3x)^2-2(3x)(5y)+(-5y)^2$
$=9x^2-30xy+25y^2$

86. $(3x^2+2y)^2 = (3x^2)^2 + 2(3x^2)(2y) + (2y)^2$
$= 9x^4 + 12x^2y + 4y^2$

87. $(7x+4y)(7x-4y) = (7x)^2 - (4y)^2$
$= 49x^2 - 16y^2$

88. $(a-b)(a^2+ab+b^2)$
$= a(a^2) + a(ab) + a(b^2) + (-b)(a^2)$
$+(-b)(ab) + (-b)(b^2)$
$= a^3 + a^2b + ab^2 - a^2b - ab^2 - b^3$
$= a^3 - b^3$

89. $15x^3 + 3x^2 = 3x^2 \cdot 5x + 3x^2 \cdot 1$
$= 3x^2(5x+1)$

90. $x^2 - 11x + 28 = (x-4)(x-7)$

91. $15x^2 - x - 2 = (3x+1)(5x-2)$

92. $64 - x^2 = 8^2 - x^2 = (8-x)(8+x)$

93. $x^2 + 16$ is prime.

94. $3x^4 - 9x^3 - 30x^2 = 3x^2(x^2 - 3x - 10)$
$= 3x^2(x-5)(x+2)$

95. $20x^7 - 36x^3 = 4x^3(5x^4 - 9)$

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

97. $16x^2 - 40x + 25 = (4x-5)(4x-5)$
$= (4x-5)^2$

98. $x^4 - 16 = (x^2)^2 - 4^2$
$= (x^2+4)(x^2-4)$
$= (x^2+4)(x+2)(x-2)$

99. $y^3 - 8 = y^3 - 2^3 = (y-2)(y^2+2y+4)$

100. $x^3 + 64 = x^3 + 4^3 = (x+4)(x^2-4x+16)$

101. $3x^4 - 12x^2 = 3x^2(x^2-4)$
$= 3x^2(x-2)(x+2)$

102. $27x^3 - 125 = (3x)^3 - 5^3$
$= (3x-5)[(3x)^2 + (3x)(5) + 5^2]$
$= (3x-5)(9x^2 + 15x + 25)$

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

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

105. $x^2 + 18x + 81 - y^2 = \left(x^2 + 18x + 81\right) - y^2$
$= \left(x+9\right)^2 - y^2$
$= \left(x+9-y\right)\left(x+9+y\right)$

106. $16x^{-3/4} + 32x^{1/4} = 16x^{-3/4}\left(1 + 2x^{1/4-(-3/4)}\right)$
$= 16x^{-3/4}\left(1+2x\right)$
$= \dfrac{16\left(1+2x\right)}{x^{3/4}}$

107. $\left(x^2-4\right)\left(x^2+3\right)^{\frac{1}{2}} - \left(x^2-4\right)^2\left(x^2+3\right)^{\frac{3}{2}}$
$= \left(x^2-4\right)\left(x^2+3\right)^{\frac{1}{2}}\left[1 - \left(x^2-4\right)\left(x^2+3\right)\right]$
$= \left(x-2\right)\left(x+2\right)\left(x^2+3\right)^{\frac{1}{2}}\left[1 - \left(x-2\right)\left(x+2\right)\left(x^2+3\right)\right]$
$= (x-2)(x+2)(x^2+3)^{\frac{1}{2}}(-x^4 + x^2 + 13)$

108. $12x^{-\frac{1}{2}} + 6x^{-\frac{3}{2}} = 6x^{-\frac{3}{2}}\left(2x+1\right) = \dfrac{6(2x+1)}{x^{\frac{3}{2}}}$

109. $\dfrac{x^3+2x^2}{x+2} = \dfrac{x^2(x+2)}{x+2} = x^2$, $x \neq -2$

110. $\dfrac{x^2+3x-18}{x^2-36} = \dfrac{(x+6)(x-3)}{(x+6)(x-6)} = \dfrac{x-3}{x-6}$,
$x \neq -6, 6$

111. $\dfrac{x^2+2x}{x^2+4x+4} = \dfrac{x(x+2)}{(x+2)^2} = \dfrac{x}{x+2}$,
$x \neq -2$

112. $\dfrac{x^2+6x+9}{x^2-4}\cdot\dfrac{x+3}{x-2}=\dfrac{(x+3)^2}{(x-2)(x+2)}\cdot\dfrac{x+3}{x-2}$

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

$x\neq 2,-2$

113. $\dfrac{6x+2}{x^2-1}\div\dfrac{3x^2+x}{x-1}$

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

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

$=\dfrac{2}{x(x+1)}$,

$x\neq 0,1,-1,-\dfrac{1}{3}$

114. $\dfrac{x^2-5x-24}{x^2-x-12}\div\dfrac{x^2-10x+16}{x^2+x-6}$

$=\dfrac{(x-8)(x+3)}{(x-4)(x+3)}\div\dfrac{(x-2)(x-8)}{(x+3)(x-2)}$

$=\dfrac{x-8}{x-4}\cdot\dfrac{x+3}{x-8}$

$=\dfrac{x+3}{x-4}$,

$x\neq -3,4,2,8$

115. $\dfrac{2x-7}{x^2-9}-\dfrac{x-10}{x^2-9}=\dfrac{2x-7-(x-10)}{x^2-9}$

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

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

$x\neq 3,-3$

116. $\dfrac{3x}{x+2}+\dfrac{x}{x-2}=\dfrac{3x}{x+2}\cdot\dfrac{x-2}{x-2}+\dfrac{x}{x-2}\cdot\dfrac{x+2}{x+2}$

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

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

$=\dfrac{4x(x-1)}{(x+2)(x-2)}$,

$x\neq 2,-2$

117. $\dfrac{x}{x^2-9}+\dfrac{x-1}{x^2-5x+6}$

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

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

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

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

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

$x\neq 3,-3,2$

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

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

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

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

$=\dfrac{12x^2+8x-3x-2-x^2-6x-9}{(2x-1)(x+3)(3x+2)}$

$=\dfrac{11x^2-x-11}{(2x-1)(x+3)(3x+2)}$,

$x\neq\dfrac{1}{2},-3,-\dfrac{2}{3}$

119. $\dfrac{\frac{1}{x}-\frac{1}{2}}{\frac{1}{3}-\frac{x}{6}}=\dfrac{\frac{1}{x}-\frac{1}{2}}{\frac{1}{3}-\frac{x}{6}}\cdot\dfrac{6x}{6x}$

$=\dfrac{6-3x}{2x-x^2}$

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

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

$x\neq 0,2$

120. $$\frac{3+\frac{12}{x}}{1-\frac{16}{x^2}} = \frac{3+\frac{12}{x}}{1-\frac{16}{x^2}} \cdot \frac{x^2}{x^2}$$
$$= \frac{3x^2+12x}{x^2-16}$$
$$= \frac{3x(x+4)}{(x+4)(x-4)}$$
$$= \frac{3x}{x-4},$$
$$x \neq 0, 4, -4$$

121. $$\frac{3-\frac{1}{x+3}}{3+\frac{1}{x+3}} = \frac{3-\frac{1}{x+3}}{3+\frac{1}{x+3}} \cdot \frac{x+3}{x+3}$$
$$= \frac{3(x+3)-1}{3(x+3)+1}$$
$$= \frac{3x+9-1}{3x+9+1}$$
$$= \frac{3x+8}{3x+10},$$
$$x \neq -3, -\frac{10}{3}$$

Chapter P Test

1. $$5(2x^2-6x)-(4x^2-3x) = 10x^2-30x-4x^2+3x$$
$$= 6x^2-27x$$

2. $$7+2[3(x+1)-2(3x-1)]$$
$$= 7+2[3x+3-6x+2]$$
$$= 7+2[-3x+5]$$
$$= 7-6x+10$$
$$= -6x+17$$

3. $$\{1,2,5\} \cap \{5,a\} = \{5\}$$

4. $$\{1,2,5\} \cup \{5,a\} = \{1,2,5,a\}$$

5. $$(2x^2y^3-xy+y^2)-(-4x^2y^3-5xy-y^2)$$
$$= 2x^2y^3-xy+y^2+4x^2y^3+5xy+y^2$$
$$= 2x^2y^3+4x^2y^3-xy+5xy+y^2+y^2$$
$$= 6x^2y^3+4xy+2y^2$$

6. $$\frac{30x^3y^4}{6x^9y^{-4}} = 5x^{3-9}y^{4-(-4)} = 5x^{-6}y^8 = \frac{5y^8}{x^6}$$

7. $$\sqrt{6r}\cdot\sqrt{3r} = \sqrt{18r^2} = \sqrt{9r^2}\cdot\sqrt{2} = 3r\sqrt{2}$$

8. $$4\sqrt{50}-3\sqrt{18} = 4\sqrt{25\cdot 2}-3\sqrt{9\cdot 2}$$
$$= 4\cdot 5\sqrt{2}-3\cdot 3\sqrt{2}$$
$$= 20\sqrt{2}-9\sqrt{2}$$
$$= 11\sqrt{2}$$

9. $$\frac{3}{5+\sqrt{2}} = \frac{3}{5+\sqrt{2}}\cdot\frac{5-\sqrt{2}}{5-\sqrt{2}}$$
$$= \frac{3(5-\sqrt{2})}{25-2}$$
$$= \frac{3(5-\sqrt{2})}{23}$$

10. $$\sqrt[3]{16x^4} = \sqrt[3]{8x^3\cdot 2x}$$
$$= \sqrt[3]{8x^3}\cdot\sqrt[3]{2x}$$
$$= 2x\sqrt[3]{2x}$$

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

12. $$\frac{5\times 10^{-6}}{20\times 10^{-8}} = \frac{5}{20}\cdot\frac{10^{-6}}{10^{-8}} = 0.25\times 10^2 = 2.5\times 10^1$$

13. $$(2x-5)(x^2-4x+3)$$
$$= 2x^3-8x^2+6x-5x^2+20x-15$$
$$= 2x^3-13x^2+26x-15$$

14. $$(5x+3y)^2 = (5x)^2+2(5x)(3y)+(3y)^2$$
$$= 25x^2+30xy+9y^2$$

15. $$\frac{2x+8}{x-3}\div\frac{x^2+5x+4}{x^2-9}$$
$$= \frac{2(x+4)}{x-3}\div\frac{(x+1)(x+4)}{(x-3)(x+3)}$$
$$= \frac{2(x+4)}{x-3}\cdot\frac{(x-3)(x+3)}{(x+1)(x+4)}$$
$$= \frac{2(x+3)}{x+1},$$
$$x \neq 3, -1, -4, -3$$

16. $\dfrac{x}{x+3}+\dfrac{5}{x-3}$

$=\dfrac{x}{x+3}\cdot\dfrac{x-3}{x-3}+\dfrac{5}{x-3}\cdot\dfrac{x+3}{x+3}$

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

$=\dfrac{x^2-3x+5x+15}{(x+3)(x-3)}$

$=\dfrac{x^2+2x+15}{(x+3)(x-3)}, x\neq 3,-3$

17. $\dfrac{2x+3}{x^2-7x+12}-\dfrac{2}{x-3}$

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

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

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

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

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

$=\dfrac{11}{(x-3)(x-4)},$

$x\neq 3, 4$

18. $\dfrac{\frac{1}{x}-\frac{1}{3}}{\frac{1}{x}}=\dfrac{\frac{1}{x}-\frac{1}{3}}{\frac{1}{x}}\cdot\dfrac{3x}{3x}=\dfrac{3-x}{3},$

$x\neq 0$

19. $x^2-9x+18=(x-3)(x-6)$

20. $x^3+2x^2+3x+6=x^2(x+2)+3(x+2)$

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

21. $25x^2-9=(5x)^2-3^2=(5x-3)(5x+3)$

22. $36x^2-84x+49=(6x)^2-2(6x)\cdot 7+7^2$

$=(6x-7)^2$

23. $y^3-125=y^3-5^3=(y-5)(y^2+5y+25)$

24. $(x^2+10x+25)-9y^2$

$=(x+5)^2-9y^2$

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

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

$=(x+3)^{-\frac{3}{5}}\left[x+(x+3)\right]$

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

26. $-7,-\dfrac{4}{5},0,0.25,\sqrt{4},\dfrac{22}{7}$ are rational numbers.

27. $3(2+5)=3(5+2)$;
commutative property of addition

28. $6(7+4)=6\cdot 7+6\cdot 4$
distributive property of multiplication over addition

29. $0.00076=7.6\times10^{-4}$

30. $27^{-\frac{5}{3}}=\dfrac{1}{27^{\frac{5}{3}}}=\dfrac{1}{\left(\sqrt[3]{27}\right)^5}=\dfrac{1}{(3)^5}=\dfrac{1}{243}$

31. $2\left(6.6\times10^9\right)=13.2\times10^9=1.32\times10^{10}$

32. a. 2003 is 14 years after 1989.

$M=-0.28n+47$

$M=-0.28(14)+47$

$=43.08$

In 2003, 43.08% of bachelor's degrees were awarded to men. This overestimates the actual percent shown by the bar graph by 0.08%.

b. $R=\dfrac{M}{W}=\dfrac{-0.28n+47}{0.28n+53}$

c. $R=\dfrac{-0.28n+47}{0.28n+53}$

$R=\dfrac{-0.28(25)+47}{0.28(25)+53}$

$=\dfrac{2}{3}$

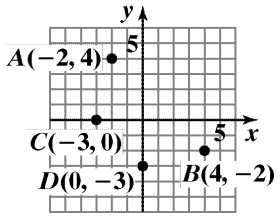
Three women received bachelor's degrees for every two men. This describes the data exactly.

Chapter 1
Equations and Inequalities

Section 1.1

Check Point Exercises

1. Plot points:



2. $x = -3,\ y = 7$

$x = -2,\ y = 6$

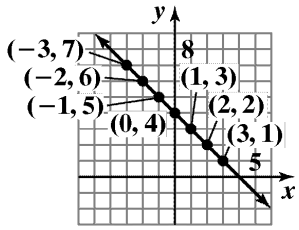
$x = -1,\ y = 5$

$x = 0,\ y = 4$

$x = 1,\ y = 3$

$x = 2,\ y = 2$

$x = 3,\ y = 1$



$y = 4 - x$

3. $x = -4,\ y = 3$

$x = -3,\ y = 2$

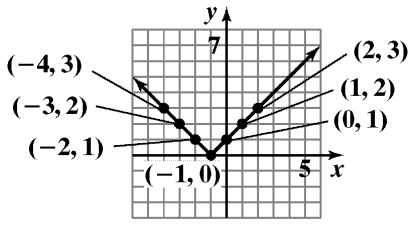
$x = -2,\ y = 1$

$x = -1,\ y = 0$

$x = 0,\ y = 1$

$x = 1,\ y = 2$

$x = 2,\ y = 3$



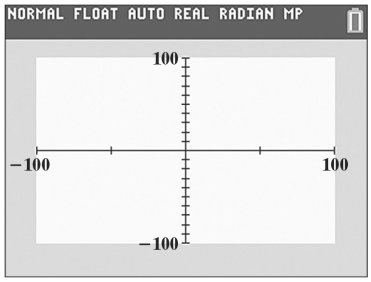
$y = |x + 1|$

4. The meaning of a $[-100,100,50]$ by $[-100,100,10]$ viewing rectangle is as follows:

$$[\ \overbrace{-100}^{\substack{\text{minimum}\\ x\text{-value}}}\ ,\ \overbrace{100}^{\substack{\text{maximum}\\ x\text{-value}}}\ ,\ \overbrace{50}^{\substack{\text{distance}\\ \text{between}\\ x\text{-axis}\\ \text{tick}\\ \text{marks}}}\ ]$$

by

$$[\ \overbrace{-100}^{\substack{\text{minimum}\\ y\text{-value}}}\ ,\ \overbrace{100}^{\substack{\text{maximum}\\ y\text{-value}}}\ ,\ \overbrace{10}^{\substack{\text{distance}\\ \text{between}\\ y\text{-axis}\\ \text{tick}\\ \text{marks}}}\ ]$$



5. **a.** The graph crosses the x-axis at (–3, 0).
Thus, the x-intercept is –3.
The graph crosses the y-axis at (0, 5).
Thus, the y-intercept is 5.

b. The graph does not cross the x-axis.
Thus, there is no x-intercept.
The graph crosses the y-axis at (0, 4).
Thus, the y-intercept is 4.

c. The graph crosses the x- and y-axes at the origin (0, 0).
Thus, the x-intercept is 0 and the y-intercept is 0.

d. The graph crosses the x-axis at (–1, 0) and (1, 0).
Thus, the x-intercepts are –1 and 1.
The graph crosses the y-axis at (0, 3).
Thus, the y-intercept is 3.

6. **a.** $d = 4n + 5$

$d = 4(15) + 5 = 65$

65% of marriages end in divorce after 15 years when the wife is under 18 at the time of marriage.

b. According to the line graph, 60% of marriages end in divorce after 15 years when the wife is under 18 at the time of marriage.

c. The mathematical model overestimates the actual percentage shown in the graph by 5%.

Concept and Vocabulary Check 1.1

1. *x*-axis

2. *y*-axis

3. origin

4. quadrants; four

5. *x*-coordinate; *y*-coordinate

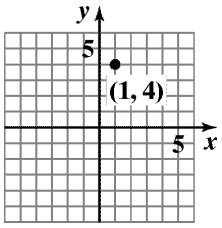
6. solution; satisfies

7. *x*-intercept; zero

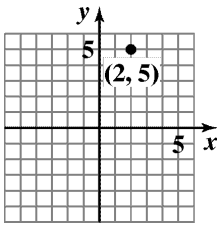
8. *y*-intercept; zero

Exercise Set 1.1

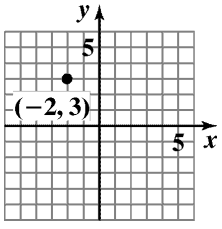
1.



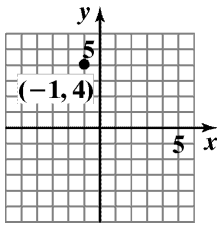
2.



3.



4.



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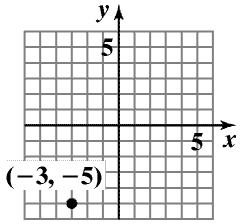

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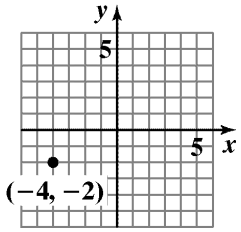

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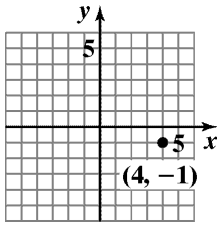

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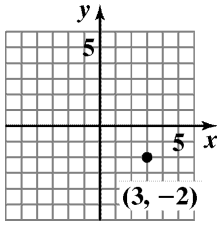

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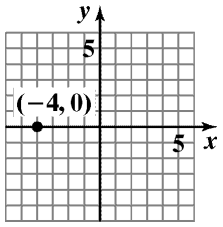

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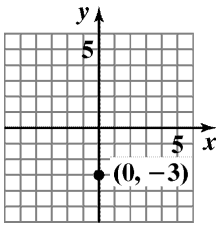
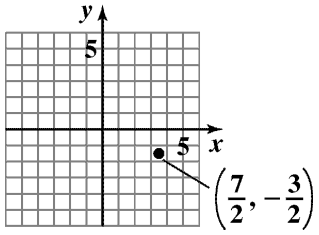


11.



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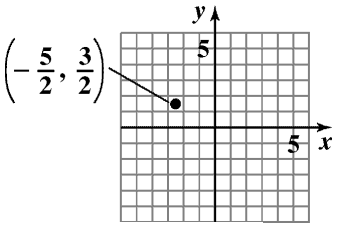
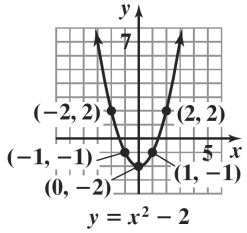


13.



$x = -3,\ y = 7$

$x = -2,\ y = 2$

$x = -1,\ y = -1$

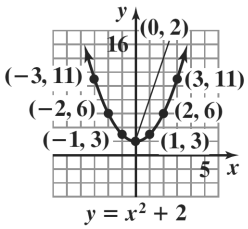
$x = 0,\ y = -2$

$x = 1,\ y = -1$

$x = 2,\ y = 2$

$x = 3,\ y = 7$

14.



$x = -3,\ y = 11$

$x = -2,\ y = 6$

$x = -1,\ y = 3$

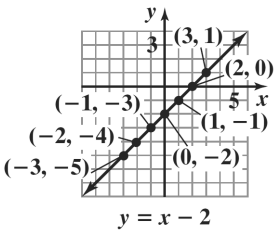
$x = 0,\ y = 2$

$x = 1,\ y = 3$

$x = 2,\ y = 6$

$x = 3,\ y = 11$

15.



$x = -3,\ y = -5$

$x = -2,\ y = -4$

$x = -1,\ y = -3$

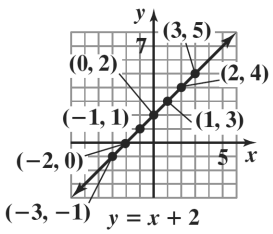
$x = 0,\ y = -2$

$x = 1,\ y = -1$

$x = 2,\ y = 0$

$x = 3,\ y = 1$

16.



$x = -3,\ y = -1$

$x = -2,\ y = 0$

$x = -1,\ y = 1$

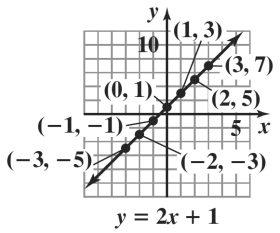
$x = 0,\ y = 2$

$x = 1,\ y = 3$

$x = 2,\ y = 4$

$x = 3,\ y = 5$

17.



$x = -3,\ y = -5$

$x = -2,\ y = -3$

$x = -1,\ y = -1$

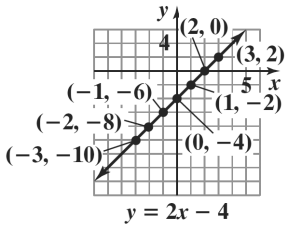
$x = 0,\ y = 1$

$x = 1,\ y = 3$

$x = 2,\ y = 5$

$x = 3,\ y = 7$

18.



$x = -3,\ y = -10$

$x = -2,\ y = -8$

$x = -1,\ y = -6$

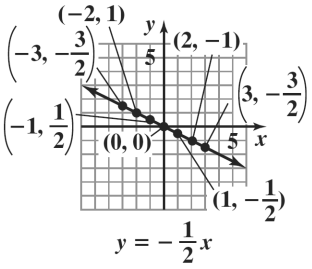
$x = 0,\ y = -4$

$x = 1,\ y = -2$

$x = 2,\ y = 0$

$x = 3,\ y = 2$

19.



$x = -3,\ y = \dfrac{3}{2}$

$x = -2,\ y = 1$

$x = -1,\ y = \dfrac{1}{2}$

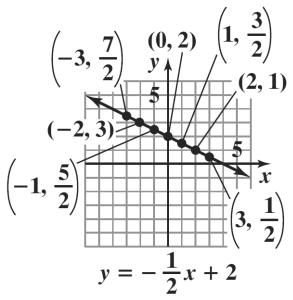
$x = 0,\ y = 0$

$x = 1,\ y = -\dfrac{1}{2}$

$x = 2,\ y = -1$

$x = 3,\ y = -\dfrac{3}{2}$

20.



$x = -3,\ y = \dfrac{7}{2}$

$x = -2,\ y = 3$

$x = -1,\ y = \dfrac{5}{2}$

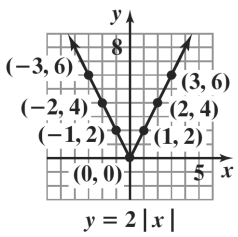
$x = 0,\ y = 2$

$x = 1,\ y = \dfrac{3}{2}$

$x = 2,\ y = 1$

$x = 3,\ y = \dfrac{1}{2}$

21.



$y = 2|x|$

$x = -3, y = 6$

$x = -2, y = 4$

$x = -1, y = 2$

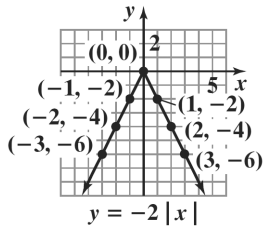
$x = 0, y = 0$

$x = 1, y = 2$

$x = 2, y = 4$

$x = 3, y = 6$

22.



$y = -2|x|$

$x = -3, y = -6$

$x = -2, y = -4$

$x = -1, y = -2$

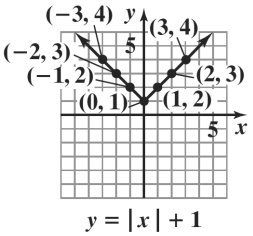
$x = 0, y = 0$

$x = 1, y = -2$

$x = 2, y = -4$

$x = 3, y = -6$

23.



$y = |x| + 1$

$x = -3, y = 4$

$x = -2, y = 3$

$x = -1, y = 2$

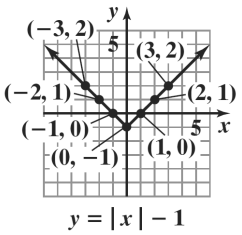
$x = 0, y = 1$

$x = 1, y = 2$

$x = 2, y = 3$

$x = 3, y = 4$

24.



$y = |x| - 1$

$x = -3, y = 2$

$x = -2, y = 1$

$x = -1, y = 0$

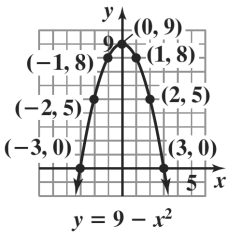
$x = 0, y = -1$

$x = 1, y = 0$

$x = 2, y = 1$

$x = 3, y = 2$

25.



$y = 9 - x^2$

$x = -3, y = 0$

$x = -2, y = 5$

$x = -1, y = 8$

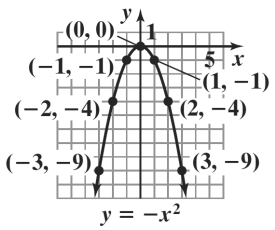
$x = 0, y = 9$

$x = 1, y = 8$

$x = 2, y = 5$

$x = 3, y = 0$

26.



$x = -3, y = -9$

$x = -2, y = -4$

$x = -1, y = -1$

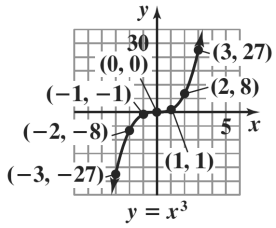
$x = 0, y = 0$

$x = 1, y = -1$

$x = 2, y = -4$

$x = 3, y = -9$

27.



$x = -3, y = -27$

$x = -2, y = -8$

$x = -1, y = 1$

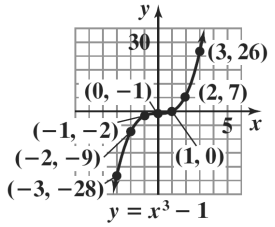
$x = 0, y = 0$

$x = 1, y = 1$

$x = 2, y = 8$

$x = 3, y = 27$

28.



$x = -3, y = -28$

$x = -2, y = -9$

$x = -1, y = -2$

$x = 0, y = -1$

$x = 1, y = 0$

$x = 2, y = 7$

$x = 3, y = 26$

29. (c) x-axis tick marks –5, –4, –3, –2, –1, 0, 1, 2, 3, 4, 5; y-axis tick marks are the same.

30. (d) x-axis tick marks –10, –8, –6, –4, –2, 0, 2, 4, 6, 8, 10; y-axis tick marks –4, –2, 0, 2, 4

31. (b); x-axis tick marks –20, –10, 0, 10, 20, 30, 40, 50, 60, 70, 80; y-axis tick marks –30, –20, –10, 0, 10, 20, 30, 40, 50, 60, 70

32. (a) x-axis tick marks –40, –20, 0, 20, 40; y-axis tick marks –1000, –900, –800, –700, . . . , 700, 800, 900, 1000

33. The equation that corresponds to Y_2 in the table is (c), $y_2 = 2 - x$. We can tell because all of the points $(-3, 5)$, $(-2, 4)$, $(-1, 3)$, $(0, 2)$, $(1, 1)$, $(2, 0)$, and $(3, -1)$ are on the line $y = 2 - x$, but all are not on any of the others.

34. The equation that corresponds to Y_1 in the table is (b), $y_1 = x^2$. We can tell because all of the points $(-3, 9)$, $(-2, 4)$, $(-1, 1)$, $(0, 0)$, $(1, 1)$, $(2, 4)$, and $(3, 9)$ are on the graph $y = x^2$, but all are not on any of the others.

35. No. It passes through the point $(0, 2)$.

36. Yes. It passes through the point $(0, 0)$.

37. $(2, 0)$

38. $(0, 2)$

39. The graphs of Y_1 and Y_2 intersect at the points $(-2, 4)$ and $(1, 1)$.

40. The values of Y_1 and Y_2 are the same when $x = -2$ and $x = 1$.

41. **a.** 2; The graph intersects the x-axis at (2, 0).

b. –4; The graph intersects the y-axis at (0,–4).

42. **a.** 1; The graph intersects the x-axis at (1, 0).

b. 2; The graph intersects the y-axis at (0, 2).

43. **a.** 1, –2; The graph intersects the x-axis at (1, 0) and (–2, 0).

b. 2; The graph intersects the y-axis at (0, 2).

44. **a.** 1, –1; The graph intersects the x-axis at (1, 0) and (–1, 0).

b. 1; The graph intersect the y-axis at (0, 1).

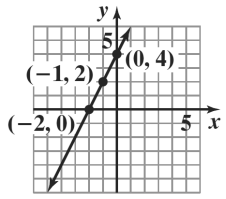
45. **a.** –1; The graph intersects the x-axis at (–1, 0).

b. none; The graph does not intersect the y-axis.

46. **a.** none; The graph does not intersect the x-axis.

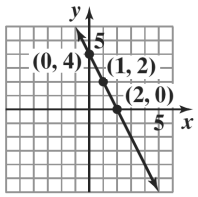
b. 2; The graph intersects the y-axis at (0, 2).

47.



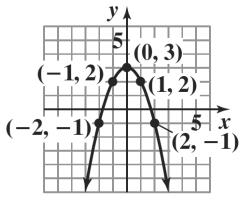
$y = 2x + 4$

48.



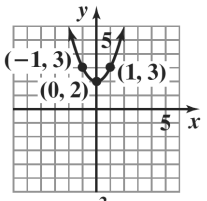
$y = 4 - 2x$

49.



$y = 3 - x^2$

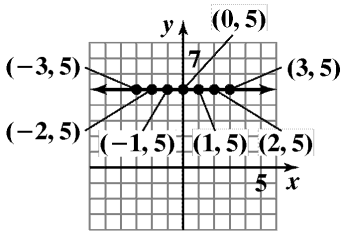
50.



$y = x^2 + 2$

51.

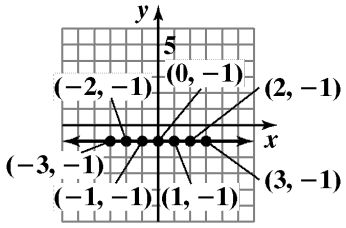
x	(x, y)
–3	(–3, 5)
–2	(–2, 5)
–1	(–1, 5)
0	(0, 5)
1	(1, 5)
2	(2, 5)
3	(3, 5)



$y = 5$

52.

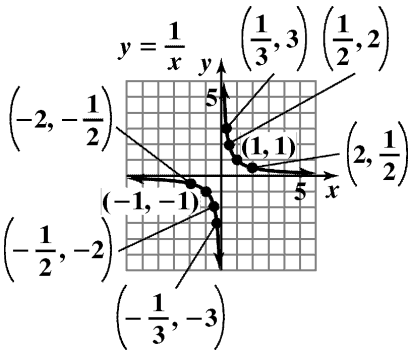
x	(x, y)
–3	(–3, –1)
–2	(–2, –1)
–1	(–1, –1)
0	(0, –1)
1	(1, –1)
2	(2, –1)
3	(3, –1)



$y = -1$

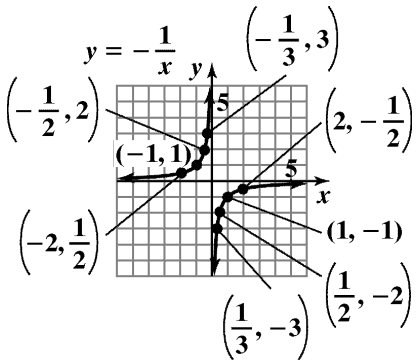
53.

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



54.

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



55. **a.** According to the line graph, about 44% of seniors used marijuana in 2010.

b. 2010 is 20 years after 1990.
$M = 0.1n + 43$
$M = 0.1(20) + 43 = 45$
According to formula, 45% of seniors used marijuana in 2010. It is greater than the estimate, although answers may vary.

c. According to the line graph, about 71% of seniors used alcohol in 2010.

d. 2010 is 20 years after 1990.
$A = -0.9n + 88$
$A = -0.9(20) + 88 = 70$
According to formula, 70% of seniors used alcohol in 2010. It is less than the estimate, although answers may vary.

e. The maximum for marijuana was reached in 2000.
According to the line graph, about 49% of seniors used marijuana in 1990.

56. **a.** According to the line graph, about 66% of seniors used alcohol in 2014.

b. 2014 is 24 years after 1990.
$A = -0.9n + 88$
$A = -0.9(24) + 88 = 66.4$
According to formula, 66.4% of seniors used alcohol in 2014. It is greater than the estimate, although answers may vary.

c. According to the line graph, about 44% of seniors used marijuana in 2014.

d. 2014 is 24 years after 1990.
$M = 0.1n + 43$
$M = 0.1(24) + 43 = 45.4$
According to formula, 45.4% of seniors used marijuana in 2014. It is greater than the estimate, although answers may vary.

e. The maximum for alcohol was reached in 1990. According to the line graph, about 90% of seniors used alcohol in 1990.

57. At age 8, women have the least number of awakenings, averaging about 1 awakening per night.

58. At age 65, men have the greatest number of awakenings, averaging about 8 awakenings per night.

59. The difference between the number of awakenings for 25-year-old men and women is about 1.9.

60. The difference between the number of awakenings for 18-year-old men and women is about 1.1.

61. – 66. Answers will vary.

67. makes sense

68. does not make sense; Explanations will vary. Sample explanation: Most graphing utilities do not display numbers on the axes.

69. does not make sense; Explanations will vary. Sample explanation: These three points are not collinear.

70. does not make sense; Explanations will vary. Sample explanation: As the time of day goes up, the total calories burned will also go up.

71. false; Changes to make the statement true will vary. A sample change is: The product of the coordinates of a point in quadrant III is also positive.

72. false; Changes to make the statement true will vary. A sample change is: A point on the x-axis will have $y = 0$.

73. true

74. false; Changes to make the statement true will vary. A sample change is: $3(5) - 2(2) \neq -4$.

75. I, III

76. II, IV

77. IV

78. II

79. (a)

80. (d)

81. (b)

82. (c)

83. (b)

84. (a)

85. (c)

86. (b)

87.
$$\begin{aligned} 2(x-3)-17 &= 13-3(x+2) \\ 2(6-3)-17 &= 13-3(6+2) \\ 2(3)-17 &= 13-3(8) \\ 6-17 &= 13-24 \\ -11 &= -11, \text{ true} \end{aligned}$$

88.
$$\begin{aligned} 12\left(\frac{x+2}{4}-\frac{x-1}{3}\right) &= 12\left(\frac{x+2}{4}\right)-12\left(\frac{x-1}{3}\right) \\ &= 3(x+2)-4(x-1) \\ &= 3x+6-4x+4 \\ &= -x+10 \end{aligned}$$

89.
$$\begin{aligned} (x-3)\ \frac{3}{x-3}+9 &= (x-3)\ \frac{3}{x-3}\ +(x-3)(9) \\ &= 3+9x-27 \\ &= 9x-24 \end{aligned}$$

Section 1.2

Check Point Exercises

1. $4x+5=29$

$4x+5-5=29-5$

$4x=24$

$\frac{4x}{4}=\frac{24}{4}$

$x=6$

Check:

$4x+5=29$

$4(6)+5=29$

$24+5=29$

$29=29$ true

The solution set is $\{6\}$.

2. $4(2x+1)=29+3(2x-5)$

$8x+4=29+6x-15$

$8x+4=6x+14$

$8x+4-6x=6x+14-6x$

$2x+4=14$

$2x+4-4=14-4$

$2x=10$

$\frac{2x}{2}=\frac{10}{2}$

$x=5$

Check:

$4(2x+1)=29+3(2x-5)$

$4[2(5)+1]=29+3[2(5)-5]$

$4[10+1]=29+3[10-5]$

$4[11]=29+3[5]$

$44=29+15$

$44=44$ true

The solution set is $\{5\}$.

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

$28\cdot\frac{x-3}{4}=28\left(\frac{5}{14}-\frac{x+5}{7}\right)$

$7(x-3)=2(5)-4(x+5)$

$7x-21=10-4x-20$

$7x-21=-4x-10$

$7x+4x=-10+21$

$11x=11$

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

$x=1$

Check:

$\frac{x-3}{4}=\frac{5}{14}-\frac{x+5}{7}$

$\frac{1-3}{4}=\frac{5}{14}-\frac{1+5}{7}$

$\frac{-2}{4}=\frac{5}{14}-\frac{6}{7}$

$-\frac{1}{2}=-\frac{1}{2}$

The solution set is $\{1\}$.

4. $\frac{5}{2x}=\frac{17}{18}-\frac{1}{3x}$, $x\neq 0$

$18x\cdot\frac{5}{2x}=18x\left(\frac{17}{18}-\frac{1}{3x}\right)$

$18\cdot\frac{5}{2x}=18x\cdot\frac{17}{18}-18x\cdot\frac{1}{3x}$

$45=17x-6$

$45+6=17x-6+6$

$51=17x$

$\frac{51}{17}=\frac{17x}{17}$

$3=x$

The solution set is $\{3\}$.

5. $\dfrac{x}{x-2}=\dfrac{2}{x-2}-\dfrac{2}{3}, \quad x\neq 2$

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

The solution set is the empty set, $\varnothing$.

6. Set $y_1 = y_2$.

$$\frac{1}{x+4}+\frac{1}{x-4}=\frac{22}{x^2-16}$$
$$\frac{1}{x+4}+\frac{1}{x-4}=\frac{22}{(x+4)(x-4)}$$
$$\frac{(x+4)(x-4)}{x+4}+\frac{(x+4)(x-4)}{x-4}=\frac{22(x+4)(x-4)}{(x+4)(x-4)}$$
$$(x-4)+(x+4)=22$$
$$x-4+x+4=22$$
$$2x=22$$
$$x=11$$

Check:

$$\frac{1}{x+4}+\frac{1}{x-4}=\frac{22}{x^2-16}$$
$$\frac{1}{11+4}+\frac{1}{11-4}=\frac{22}{11^2-16}$$
$$\frac{1}{15}+\frac{1}{7}=\frac{22}{105}$$
$$\frac{22}{105}=\frac{22}{105}\quad \text{true}$$

7. $4x-7=4(x-1)+3$

$4x-7=4(x-1)+3$

$4x-7=4x-4+3$

$4x-7=4x-1$

$-7=-1$

The original equation is equivalent to the statement $-7 = -1$, which is false for every value of x.
The solution set is the empty set, $\varnothing$.
The equation is an inconsistent equation.

8. $7x+9=9(x+1)-2x$

$7x+9=9(x+1)-2x$

$7x+9=9x+9-2x$

$7x+9=7x+9$

$9=9$

The original equation is equivalent to the statement $9 = 9$, which is true for every value of x.
The equation is an identity, and all real numbers are solutions. The solution set $\{x \mid x \text{ is a real number}\}$.

9. $D=\dfrac{10}{9}x+\dfrac{53}{9}$

$$10=\frac{10}{9}x+\frac{53}{9}$$
$$9\cdot 10=9\left(\frac{10}{9}x+\frac{53}{9}\right)$$
$$90=10x+53$$
$$90-53=10x+53-53$$
$$37=10x$$
$$\frac{37}{10}=\frac{10x}{10}$$
$$3.7=x$$
$$x=3.7$$

The formula indicates that if the low-humor group averages a level of depression of 10 in response to a negative life event, the intensity of that event is 3.7. This is shown as the point whose corresponding value on the vertical axis is 10 and whose value on the horizontal axis is 3.7.

Concept and Vocabulary Check 1.2

1. linear

2. equivalent

3. apply the distributive property

4. least common denominator**;** 12

5. 0

6. $2x$

7. $(x+5)(x+1)$

8. $x\neq 2$ **;** $x\neq 4$

9. $5(x+3)+3(x+4)=12x+9$

10. identity

11. inconsistent

Exercise Set 1.2

1. $7x - 5 = 72$
$7x = 77$
$x = 11$
Check:
$7x - 5 = 72$
$7(11) - 5 = 72$
$77 - 5 = 72$
$72 = 72$
The solution set is $\{11\}$.

2. $6x - 3 = 63$
$6x = 66$
$x = 11$
The solution set is $\{11\}$.

Check:
$6x - 3 = 63$
$6(11) - 3 = 63$
$66 - 3 = 63$
$63 = 63$

3. $11x - (6x - 5) = 40$
$11x - 6x + 5 = 40$
$5x + 5 = 40$
$5x = 35$
$x = 7$
The solution set is $\{7\}$.

Check:
$11x - (6x - 5) = 40$
$11(7) - [6(7) - 5] = 40$
$77 - (42 - 5) = 40$
$77 - (37) = 40$
$40 = 40$

4. $5x - (2x - 10) = 35$
$5x - 2x + 10 = 35$
$3x + 10 = 35$
$3x = 25$
$x = \frac{25}{3}$
The solution set is $\left\{\frac{25}{3}\right\}$.

Check:
$5x - (2x - 10) = 35$
$5\left(\frac{25}{3}\right) - \left[2\left(\frac{25}{3}\right) - 10\right] = 35$
$\frac{125}{3} - \left[\frac{50}{3} - 10\right] = 35$
$\frac{125}{3} - \frac{20}{3} = 35$
$\frac{105}{3} = 35$
$35 = 35$

5. $2x - 7 = 6 + x$
$x - 7 = 6$
$x = 13$
The solution set is $\{13\}$.

Check:
$2(13) - 7 = 6 + 13$
$26 - 7 = 19$
$19 = 19$

6. $3x + 5 = 2x + 13$
$x + 5 = 13$
$x = 8$
The solution set is $\{8\}$.

Check:
$3x + 5 = 2x + 13$
$3(8) + 5 = 2(8) + 13$
$24 + 5 = 16 + 13$
$29 = 29$

7. $7x + 4 = x + 16$
$6x + 4 = 16$
$6x = 12$
$x = 2$
The solution set is $\{2\}$.

Check:
$7(2) + 4 = 2 + 16$
$14 + 4 = 18$
$18 = 18$

8. $13x + 14 = 12x - 5$
$x + 14 = -5$
$x = -19$
The solution set is $\{-19\}$.

Check:
$13x + 14 = 12x - 5$
$13(-19) + 14 = 12(-19) - 5$
$-247 + 14 = -228 - 5$
$-233 = -233$

9. $3(x - 2) + 7 = 2(x + 5)$
$3x - 6 + 7 = 2x + 10$
$3x + 1 = 2x + 10$
$x + 1 = 10$
$x = 9$
The solution set is $\{9\}$.

Check:

$3(9 - 2) + 7 = 2(9 + 5)$
$3(7) + 7 = 2(14)$
$21 + 7 = 28$
$28 = 28$

10. $2(x - 1) + 3 = x - 3(x + 1)$
$2x - 2 + 3 = x - 3x - 3$
$2x + 1 = -2x - 3$
$4x + 1 = -3$
$4x = -4$
$x = -1$
The solution set is $\{-1\}$.

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

11. $3(x - 4) - 4(x - 3) = x + 3 - (x - 2)$
$3x - 12 - 4x + 12 = x + 3 - x + 2$
$-x = 5$
$x = -5$
The solution set is $\{-5\}$.

Check:
$3(-5 - 4) - 4(-5 - 3) = -5 + 3 - (-5 - 2)$
$3(-9) - 4(-8) = -2 - (-7)$
$-27 + 32 = -2 + 7$
$5 = 5$

12. $2 - (7x + 5) = 13 - 3x$
$2 - 7x - 5 = 13 - 3x$
$-7x - 3 = 13 - 3x$
$-4x = 16$
$x = -4$
The solution set is $\{-4\}$.

Check:
$2 - (7x + 5) = 13 - 3x$
$2 - [7(-4) + 5] = 13 - 3(-4)$
$2 - [-28 + 5] = 13 + 12$
$2 - [-23] = 15$
$2 + 23 = 25$
$25 = 25$

13. $16 = 3(x - 1) - (x - 7)$
$16 = 3x - 3 - x + 7$
$16 = 2x + 4$
$12 = 2x$
$6 = x$
The solution set is $\{6\}$.

Check:
$16 = 3(6 - 1) - (6 - 7)$
$16 = 3(5) - (-1)$
$16 = 15 + 1$
$16 = 16$

14. $5x - (2x + 2) = x + (3x - 5)$
$5x - 2x - 2 = x + 3x - 5$
$3x - 2 = 4x - 5$
$-x = -3$
$x = 3$
The solution set is $\{3\}$.

Check:
$5x - (2x + 2) = x + (3x - 5)$
$5(3) - [2(3) + 2] = 3 + [3(3) - 5]$
$15 - [6 + 2] = 3 + [9 - 5]$
$15 - 8 = 3 + 4$
$7 = 7$

15. $25-[2+5y-3(y+2)=-3(2y-5)-[5(y-1)-3y+3]$

$25-[2+5y-3y-6]=-6y+15-[5y-5-3y+3]$

$25-[2y-4]=-6y+15-[2y-2]$

$25-2y+4=-6y+15-2y+2$

$-2y+29=-8y+17$

$6y=-12$

$y=-2$

The solution set is $\{-2\}$.

Check:

$25-[2+5y-3(y+2)=-3(2y-5)-[5(y-1)-3y+3]$

$25-[2+5(-2)-3(-2+2)=-3[2(-2)-5]-[5(-2-1)-3(-2)+3]$

$25-[2-10-3(0)]=-3[-4-5]-[5(-3)+6+3]$

$25-[-8]=-3(-9)-[-15+9]$

$25+8=27-(-6)$

$33=27+6$

$33=33$

16. $45-[4-2y-4(y+7)]=-4(1+3y)-[4-3(y+2)-2(2y-5)]$

$45-[4-2y-4y-28]=-4-12y-[4-3y-6-4y+10]$

$45-[-6y-24]=-4-12y-[-7y+8]$

$45+6y+24=-4-12y+7y-8$

$6y+69=-5y-12$

$11y=-81$

$y=-\frac{81}{11}$

The solution set is $\left\{-\frac{81}{11}\right\}$.

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

$6\left[\frac{x}{3}=\frac{x}{2}-2\right]$

$2x=3x-12$

$12=3x-2x$

$x=12$

The solution set is $\{12\}$.

18. $\frac{x}{5}=\frac{x}{6}+1$

$30\left[\frac{x}{5}=\frac{x}{6}+1\right]$

$6x=5x+30$

$6x-5x=30$

$x=30$

The solution set is $\{30\}$.

19. $20-\frac{x}{3}=\frac{x}{2}$

$6\left[20-\frac{x}{3}=\frac{x}{2}\right]$

$120-2x=3x$

$120=3x+2x$

$120=5x$

$x=\frac{120}{5}$

$x=24$

The solution set is $\{24\}$.

20. $\frac{x}{5}-\frac{1}{2}=\frac{x}{6}$

$30\left[\frac{x}{5}-\frac{1}{2}=\frac{x}{6}\right]$

$6x-15=5x$

$6x-5x=15$

$x=15$

The solution set is $\{15\}$.

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

$15\left[\frac{3x}{5}=\frac{2x}{3}+1\right]$

$9x=10x+15$

$9x-10x=15$

$-x=15$

$x=-15$

The solution set is $\{-15\}$.

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

$4\left[\frac{x}{2}=\frac{3x}{4}+5\right]$

$2x=3x+20$

$2x-3x=20$

$-x=20$

$x=-20$

The solution set is $\{-20\}$.

23. $\frac{3x}{5}-x=\frac{x}{10}-\frac{5}{2}$

$10\left[\frac{3x}{5}-x=\frac{x}{10}-\frac{5}{2}\right]$

$6x-10x=x-25$

$-4x-x=-25$

$-5x=-25$

$x=5$

The solution set is $\{5\}$.

24. $2x-\frac{2x}{7}=\frac{x}{2}+\frac{17}{2}$

$14\left[2x-\frac{2x}{7}=\frac{x}{2}+\frac{17}{2}\right]$

$28x-4x=7x+119$

$24x-7x=119$

$17x=119$

$x=7$

The solution set is $\{7\}$.

25. $\frac{x+3}{6}=\frac{3}{8}+\frac{x-5}{4}$

$24\left[\frac{x+3}{6}=\frac{3}{8}+\frac{x-5}{4}\right]$

$4x+12=9+6x-30$

$4x-6x=-21-12$

$-2x=-33$

$x=\frac{33}{2}$

The solution set is $\left\{\frac{33}{2}\right\}$.

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

$12\left[\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}\right]$

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

$3x+4x=10-3$

$7x=7$

$x=1$

The solution set is $\{1\}$.

27. $\dfrac{x}{4} = 2 + \dfrac{x-3}{3}$

$12\left[\dfrac{x}{4} = 2 + \dfrac{x-3}{3}\right]$

$3x = 24 + 4x - 12$

$3x - 4x = 12$

$-x = 12$

$x = -12$

The solution set is $\{-12\}$.

28. $5 + \dfrac{x-2}{3} = \dfrac{x+3}{8}$

$24\left[5 + \dfrac{x-2}{3} = \dfrac{x+3}{8}\right]$

$120 + 8x - 16 = 3x + 9$

$8x - 3x = 9 - 104$

$5x = -95$

$x = -19$

The solution set is $\{-19\}$.

29. $\dfrac{x+1}{3} = 5 - \dfrac{x+2}{7}$

$21\left[\dfrac{x+1}{3} = 5 - \dfrac{x+2}{7}\right]$

$7x + 7 = 105 - 3x - 6$

$7x + 3x = 99 - 7$

$10x = 92$

$x = \dfrac{92}{10}$

$x = \dfrac{46}{5}$

The solution set is $\left\{\dfrac{46}{5}\right\}$.

30. $\dfrac{3x}{5} - \dfrac{x-3}{2} = \dfrac{x+2}{3}$

$30\left[\dfrac{3x}{5} - \dfrac{x-3}{2} = \dfrac{x+2}{3}\right]$

$18x - 15x + 45 = 10x + 20$

$3x - 10x = 20 - 45$

$-7x = -25$

$x = \dfrac{25}{7}$

The solution set is $\left\{\dfrac{25}{7}\right\}$.

31. a. $\dfrac{4}{x} = \dfrac{5}{2x} + 3 \; (x \neq 0)$

b. $\dfrac{4}{x} = \dfrac{5}{2x} + 3$

$8 = 5 + 6x$

$3 = 6x$

$\dfrac{1}{2} = x$

The solution set is $\left\{\dfrac{1}{2}\right\}$.

32. a. $\dfrac{5}{x} = \dfrac{10}{3x} + 4 \; (x \neq 0)$

b. $\dfrac{5}{x} = \dfrac{10}{3x} + 4$

$15 = 10 + 12x$

$5 = 12x$

$x = \dfrac{5}{12}$

The solution set is $\left\{\dfrac{5}{12}\right\}$.

33. a. $\dfrac{2}{x} + 3 = \dfrac{5}{2x} + \dfrac{13}{4} \; (x \neq 0)$

b. $\dfrac{2}{x} + 3 = \dfrac{5}{2x} + \dfrac{13}{4}$

$8 + 12x = 10 + 13x$

$-x = 2$

$x = -2$

The solution set is $\{-2\}$.

34. a. $\dfrac{7}{2x} - \dfrac{5}{3x} = \dfrac{22}{3} \; (x \neq 0)$

b. $\dfrac{7}{2x} - \dfrac{5}{3x} = \dfrac{22}{3}$

$21 - 10 = 44x$

$11 = 44x$

$x = \dfrac{1}{4}$

The solution set is $\left\{\dfrac{1}{4}\right\}$.

35. a. $\frac{2}{3x}+\frac{1}{4}=\frac{11}{6x}-\frac{1}{3}\,(x\neq 0)$

b.
$$\frac{2}{3x}+\frac{1}{4}=\frac{11}{6x}-\frac{1}{3}$$
$$8+3x=22-4x$$
$$7x=14$$
$$x=2$$
The solution set is $\{2\}$.

36. a. $\frac{5}{2x}-\frac{8}{9}=\frac{1}{18}-\frac{1}{3x}\,(x\neq 0)$

b.
$$\frac{5}{2x}-\frac{8}{9}=\frac{1}{18}-\frac{1}{3x}$$
$$45-16x=x-6$$
$$-17x=-51$$
$$x=3$$
The solution set is $\{3\}$.

37. a. $\frac{x-2}{2x}+1=\frac{x+1}{x}\quad (x\neq 0)$

b.
$$\frac{x-2}{2x}+1=\frac{x+1}{x}$$
$$x-2+2x=2x+2$$
$$x-2=2$$
$$x=4$$
The solution set is $\{4\}$.

38. a. $\frac{4}{x}=\frac{9}{5}-\frac{7x-4}{5x}\quad (x\neq 0)$

b.
$$\frac{4}{x}=\frac{9}{5}-\frac{7x-4}{5x}$$
$$20=9x-7x+4$$
$$16=2x$$
$$8=x$$
The solution set is $\{8\}$.

39. a. $\frac{1}{x-1}+5=\frac{11}{x-1}\,(x\neq 1)$

b.
$$\frac{1}{x-1}+5=\frac{11}{x-1}$$
$$1+5(x-1)=11$$
$$1+5x-5=11$$
$$5x-4=11$$
$$5x=15$$
$$x=3$$
The solution set is $\{3\}$.

40. a. $\frac{3}{x+4}-7=\frac{-4}{x+4}\,(x\neq -4)$

b.
$$\frac{3}{x+4}-7=\frac{-4}{x+4}$$
$$3-7(x+4)=-4$$
$$3-7x-28=-4$$
$$-7x=21$$
$$x=-3$$
The solution set is $\{-3\}$.

41. a. $\frac{8x}{x+1}=4-\frac{8}{x+1}\,(x\neq -1)$

b.
$$\frac{8x}{x+1}=4-\frac{8}{x+1}$$
$$8x=4(x+1)-8$$
$$8x=4x+4-8$$
$$4x=-4$$
$$x=-1\Rightarrow \text{ no solution}$$
The solution set is the empty set, $\varnothing$.

42. a. $\frac{2}{x-2}=\frac{x}{x-2}-2\,(x\neq 2)$

b.
$$\frac{2}{x-2}=\frac{x}{x-2}-2$$
$$2=x-2(x-2)$$
$$2=x-2x+4$$
$$x=2\Rightarrow \text{ no solution}$$
The solution set is the empty set, $\varnothing$.

43. a. $\frac{3}{2x-2}+\frac{1}{2}=\frac{2}{x-1}\,(x\neq 1)$

b.
$$\frac{3}{2x-2}+\frac{1}{2}=\frac{2}{x-1}$$
$$\frac{3}{2(x-1)}+\frac{1}{2}=\frac{2}{x-1}$$
$$3+1(x-1)=4$$
$$3+x-1=4$$
$$x=2$$
The solution set is $\{2\}$.

44. a. $\dfrac{3}{x+3}=\dfrac{5}{2x+6}+\dfrac{1}{x-2}\ (x\neq -3, x\neq 2)$

b.
$$\frac{3}{x+3}=\frac{5}{2(x+3)}+\frac{1}{x-2}$$
$$6(x-2)=5(x-2)+2(x+3)$$
$$6x-12=5x-10+2x+6$$
$$-x=8$$
$$x=-8$$
The solution set is $\{-8\}$.

45. a. $\dfrac{3}{x+2}+\dfrac{2}{x-2}=\dfrac{8}{(x+2)(x-2)};(x\neq -2, 2)$

b.
$$\frac{3}{x+2}+\frac{2}{x-2}=\frac{8}{(x+2)(x-2)}$$
$$(x\neq 2, x\neq -2)$$
$$3(x-2)+2(x+2)=8$$
$$3x-6+2x+4=8$$
$$5x=10$$
$$x=2 \Rightarrow \text{ no solution}$$
The solution set is the empty set, $\varnothing$.

46. a. $\dfrac{5}{x+2}+\dfrac{3}{x-2}=\dfrac{12}{(x+2)(x-2)}$
$(x\neq 2, x\neq -2)$

b.
$$\frac{5}{x+2}+\frac{3}{x-2}=\frac{12}{(x+2)(x-2)}$$
$$5(x-2)+3(x+2)=12$$
$$5x-10+3x+6=12$$
$$8x=16$$
$$x=2 \Rightarrow \text{ no solution}$$
The solution set is the empty set, $\varnothing$.

47. a. $\dfrac{2}{x+1}-\dfrac{1}{x-1}=\dfrac{2x}{x^2-1}\ (x\neq 1, x\neq -1)$

b.
$$\frac{2}{x+1}-\frac{1}{x-1}=\frac{2x}{x^2-1}$$
$$\frac{2}{x+1}-\frac{1}{x-1}=\frac{2x}{(x+1)(x-1)}$$
$$2(x-1)-1(x+1)=2x$$
$$2x-2-x-1=2x$$
$$-x=3$$
$$x=-3$$
The solution set is $\{-3\}$.

48. a. $\dfrac{4}{x+5}+\dfrac{2}{x-5}=\dfrac{32}{x^2-25};\ x\neq 5,-5$

b.
$$\frac{4}{x+5}+\frac{2}{x-5}=\frac{32}{(x+5)(x-5)}$$
$$(x\neq 5, x\neq -5)$$
$$4(x-5)+2(x+5)=32$$
$$4x-20+2x+10=32$$
$$6x=42$$
$$x=7$$
The solution set is $\{7\}$.

49. a. $\dfrac{1}{x-4}-\dfrac{5}{x+2}=\dfrac{6}{(x-4)(x+2)};(x\neq -2, 4)$

b.
$$\frac{1}{x-4}-\frac{5}{x+2}=\frac{6}{x^2-2x-8}$$
$$\frac{1}{x-4}-\frac{5}{x+2}=\frac{6}{(x-4)(x+2)}$$
$$(x\neq 4, x\neq -2)$$
$$1(x+2)-5(x-4)=6$$
$$x+2-5x+20=6$$
$$-4x=-16$$
$$x=4 \Rightarrow \text{ no solution}$$
The solution set is the empty set, $\varnothing$.

50. a. $\dfrac{6}{x+3}-\dfrac{5}{x-2}=\dfrac{-20}{x^2+x-6};\ x\neq -3, 2$

b.
$$\frac{6}{x+3}-\frac{5}{x-2}=\frac{-20}{(x-2)(x+3)}$$
$$(x\neq -3, x\neq 2)$$
$$6(x-2)-5(x+3)=-20$$
$$6x-12-5x-15=-20$$
$$x=7$$
The solution set is $\{7\}$.

51. Set $y_1 = y_2$.
$$5(2x-8)-2=5(x-3)+3$$
$$10x-40-2=5x-15+3$$
$$10x-42=5x-12$$
$$10x-5x=-12+42$$
$$5x=30$$
$$x=6$$
The solution set is $\{6\}$.

52. Set $y_1 = y_2$.

$$7(3x-2)+5 = 6(2x-1)+24$$
$$21x-14+5 = 12x-6+24$$
$$21x-9 = 12x+18$$
$$21x-12x = 18+9$$
$$9x = 27$$
$$x = 3$$

The solution set is $\{3\}$.

53. Set $y_1 - y_2 = 1$.

$$\frac{x-3}{5} - \frac{x-5}{4} = 1$$
$$20\cdot\frac{x-3}{5} - 20\cdot\frac{x-5}{4} = 20\cdot 1$$
$$4(x-3)-5(x-5) = 20$$
$$4x-12-5x+25 = 20$$
$$-x+13 = 20$$
$$-x = 7$$
$$x = -7$$

The solution set is $\{-7\}$.

54. Set $y_1 - y_2 = -4$.

$$\frac{x+1}{4} - \frac{x-2}{3} = -4$$
$$12\cdot\frac{x+1}{4} - 12\cdot\frac{x-2}{3} = 12(-4)$$
$$3(x+1)-4(x-2) = -48$$
$$3x+3-4x+8 = -48$$
$$-x+11 = -48$$
$$-x = -59$$
$$x = 59$$

The solution set is $\{59\}$.

55. Set $y_1 + y_2 = y_3$.

$$\frac{5}{x+4} + \frac{3}{x+3} = \frac{12x+19}{x^2+7x+12}$$
$$\frac{5}{x+4} + \frac{3}{x+3} = \frac{12x+19}{(x+4)(x+3)}$$
$$(x+4)(x+3)\left(\frac{5}{x+4} + \frac{3}{x+3}\right) = (x+4)(x+3)\frac{12x+19}{(x+4)(x+3)}$$
$$5(x+3)+3(x+4) = 12x+19$$
$$5x+15+3x+12 = 12x+19$$
$$8x+27 = 12x+19$$
$$-4x = -8$$
$$x = 2$$

The solution set is $\{2\}$.

56. Set $y_1 + y_2 = y_3$.

$$\frac{2x-1}{x^2+2x-8}+\frac{2}{x+4}=\frac{1}{x-2}$$
$$\frac{2x-1}{(x+4)(x-2)}+\frac{2}{x+4}=\frac{1}{x-2}$$
$$(x+4)(x-2)\left(\frac{2x-1}{(x+4)(x-2)}+\frac{2}{x+4}\right)=(x+4)(x-2)\frac{1}{x-2}$$
$$2x-1+2(x-2)=x+4$$
$$2x-1+2x-4=x+4$$
$$4x-5=x+4$$
$$3x=9$$
$$x=3$$

The solution set is $\{3\}$.

57.
$$0=4[x-(3-x)]-7(x+1)$$
$$0=4[x-3+x]-7x-7$$
$$0=4[2x-3]-7x-7$$
$$0=8x-12-7x-7$$
$$0=x-19$$
$$-x=-19$$
$$x=19$$

The solution set is $\{19\}$.

58.
$$0=2[3x-(4x-6)]-5(x-6)$$
$$0=2[3x-4x+6]-5x+30$$
$$0=2[-x+6]-5x+30$$
$$0=-2x+12-5x+30$$
$$0=-7x+42$$
$$7x=42$$
$$x=6$$

The solution set is $\{6\}$.

59.
$$0=\frac{x+6}{3x-12}-\frac{5}{x-4}-\frac{2}{3}$$
$$0=\frac{x+6}{3(x-4)}-\frac{5}{x-4}-\frac{2}{3}$$
$$3(x-4)\cdot 0=3(x-4)\left(\frac{x+6}{3(x-4)}-\frac{5}{x-4}-\frac{2}{3}\right)$$
$$0=\frac{3(x-4)(x+6)}{3(x-4)}-\frac{5\cdot 3(x-4)}{x-4}-\frac{2\cdot 3(x-4)}{3}$$
$$0=(x+6)-15-2(x-4)$$
$$0=x+6-15-2x+8$$
$$0=-x-1$$
$$x=-1$$

The solution set is $\{-1\}$.

60. $0 = \frac{1}{5x+5} - \frac{3}{x+1} + \frac{7}{5}$

$$0 = \frac{1}{5(x+1)} - \frac{3}{x+1} + \frac{7}{5}$$

$$5(x+1)\cdot 0 = 5(x+1)\left(\frac{1}{5(x+1)} - \frac{3}{x+1} + \frac{7}{5}\right)$$

$$0 = \frac{1\cdot 5(x+1)}{5(x+1)} - \frac{3\cdot 5(x+1)}{x+1} + \frac{7\cdot 5(x+1)}{5}$$

$$0 = 1 - 15 + 7(x+1)$$

$$0 = 1 - 15 + 7x + 7$$

$$0 = -7 + 7x$$

$$-7x = -7$$

$$x = 1$$

The solution set is $\{1\}$.

61. $5x + 9 = 9(x+1) - 4x$

$5x + 9 = 9x + 9 - 4x$

$5x + 9 = 5x + 9$

$9 = 9$

The solution set $\{x \mid x \text{ is a real number}\}$.

The given equation is an identity.

62. $4x + 7 = 7(x+1) - 3x$

$4x + 7 = 7x + 7 - 3x$

$4x + 7 = 4x + 7$

$7 = 7$

The solution set $\{x \mid x \text{ is a real number}\}$.

The given equation is an identity.

63. $3(x+2) = 7 + 3x$

$3x + 6 = 7 + 3x$

$6 = 7$

The solution set $\varnothing$.

The given equation is an inconsistent equation.

64. $4(x+5) = 21 + 4x$

$4x + 20 = 21 + 4x$

$20 = 21$

The solution set $\varnothing$.

The given equation is an inconsistent equation.

65. $10x + 3 = 8x + 3$

$2x + 3 = 3$

$2x = 0$

$x = 0$

The solution set $\{0\}$.

The given equation is a conditional equation.

66. $5x + 7 = 2x + 7$

$3x + 7 = 7$

$3x = 0$

$x = 0$

The solution set $\{0\}$.

The given equation is a conditional equation.

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

$2x = 6 + 4(x-3)$

$2x = 6 + 4x - 12$

$-2x = -6$

$x = 3 \Rightarrow$ no solution

The given equation is an inconsistent equation.

68. $\frac{3}{x-3} = \frac{x}{x-3} + 3$

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

$3 = x + 3x - 9$

$-4x = -12$

$x = 3 \Rightarrow$ no solution

The given equation is an inconsistent equation.

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

$3(x+5) - 24 = 2(2x-1)$

$3x + 15 - 24 = 4x - 2$

$-x = 7$

$x = -7$

The solution set is $\{-7\}$.

The given equation is a conditional equation.

70. $\frac{x+2}{7} = 5 - \frac{x+1}{3}$

$3(x+2) = 105 - 7(x+1)$

$3x + 6 = 105 - 7x - 7$

$10x = 92$

$x = \frac{92}{10}$

$x = \frac{46}{5}$

The solution set is $\left\{\frac{46}{5}\right\}$.

The given equation is a conditional equation.

71. $\dfrac{2}{x-2}=3+\dfrac{x}{x-2}$

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

$2=3x-6+x$

$-4x=-8$

$x=2 \Rightarrow$ no solution

The solution set is the empty set, $\varnothing$.

The given equation is an inconsistent equation.

72. $\dfrac{6}{x+3}+2=\dfrac{-2x}{x+3}$

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

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

$4x=-12$

$x=-3 \Rightarrow$ no solution

This equation is not true for any real numbers.

The given equation is an inconsistent equation.

73. $8x-(3x+2)+10=3x$

$8x-3x-2+10=3x$

$2x=-8$

$x=-4$

The solution set is $\{-4\}$.

The given equation is a conditional equation.

74. $2(x+2)+2x=4(x+1)$

$2x+4+2x=4x+4$

$0=0$

This equation is true for all real numbers.

The given equation is an identity.

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

$8+2x=3x$

$-x=-8$

$x=8$

The solution set is $\{8\}$.

The given equation is a conditional equation.

76. $\dfrac{3}{x}-\dfrac{1}{6}=\dfrac{1}{3}$

$18-x=2x$

$-3x=-18$

$x=6$

The solution set is $\{6\}$.

The given equation is a conditional equation.

77. $\dfrac{4}{x-2}+\dfrac{3}{x+5}=\dfrac{7}{(x+5)(x-2)}$

$4(x+5)+3(x-2)=7$

$4x+20+3x-6=7$

$7x=-7$

$x=-1$

The solution set is $\{-1\}$.

The given equation is a conditional equation.

78. $\dfrac{1}{x-1}=\dfrac{1}{(2x+3)(x-1)}+\dfrac{4}{2x+3}$

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

$2x+3=1+4x-4$

$-2x=-6$

$x=3$

The solution set is $\{3\}$.

The given equation is a conditional equation.

79. $\dfrac{4x}{x+3}-\dfrac{12}{x-3}=\dfrac{4x^2+36}{x^2-9}; x\neq 3,-3$

$4x(x-3)-12(x+3)=4x^2+36$

$4x^2-12x-12x-36=4x^2+36$

$4x^2-24x-36=4x^2+36$

$-24x-36=36$

$-24x=72$

$x=-3$ No solution

The solution set is $\{\ \}$.

The given equation is an inconsistent equation.

80. $\dfrac{4}{x^2+3x-10}-\dfrac{1}{x^2+x-6}=\dfrac{3}{x^2-x-12}$

$\dfrac{4}{(x+5)(x-2)}-\dfrac{1}{(x+3)(x-2)}=\dfrac{3}{(x+3)(x-4)}, x\neq -5,2,-3,4$

$4(x+3)(x-4)-1(x+5)(x-4)=3(x+5)(x-2)$

$4x^2-4x-48-x^2-x+20=3x^2+9x-30$

$3x^2-5x-28=3x^2+9x-30$

$2=14x$

$\dfrac{1}{7}=x$

The solution set is $\left\{\dfrac{1}{7}\right\}$.

The given equation is a conditional equation.

81. The equation is $3(x-4)=3(2-2x)$, and the solution is $x=2$.

82. The equation is $3(2x-5)=5x+2$, and the solution is $x=17$.

83. The equation is $-3(x-3)=5(2-x)$, and the solution is $x=0.5$.

84. The equation is $2x-5=4(3x+1)-2$, and the solution is $x=-0.7$.

85. Solve: $4(x-2)+2=4x-2(2-x)$

$4x-8+2=4x-4+2x$

$4x-6=6x-4$

$-2x-6=-4$

$-2x=2$

$x=-1$

Now, evaluate x^2-x for $x=-1$:

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

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

86. Solve: $2(x-6)=3x+2(2x-1)$

$2x-12=3x+4x-2$

$2x-12=7x-2$

$-5x-12=-2$

$-5x=10$

$x=-2$

Now, evaluate x^2-x for $x=-2$:

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

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

87. Solve for x: $\dfrac{3(x+3)}{5} = 2x+6$

$$3(x+3) = 5(2x+6)$$
$$3x+9 = 10x+30$$
$$-7x+9 = 30$$
$$-7x = 21$$
$$x = -3$$

Solve for y: $-2y-10 = 5y+18$

$$-7y-10 = 18$$
$$-7y = 28$$
$$y = -4$$

Now, evaluate $x^2-(xy-y)$ for $x=-3$ and $y=-4$:

$$x^2-(xy-y)$$
$$=(-3)^2-\left[-3(-4)-(-4)\right]$$
$$=(-3)^2-\left[12-(-4)\right]$$
$$=9-(12+4)=9-16=-7$$

88. Solve for x: $\dfrac{13x-6}{4} = 5x+2$

$$13x-6 = 4(5x+2)$$
$$13x-6 = 20x+8$$
$$-7x-6 = 8$$
$$-7x = 14$$
$$x = -2$$

Solve for y: $5-y = 7(y+4)+1$

$$5-y = 7y+28+1$$
$$5-y = 7y+29$$
$$5-8y = 29$$
$$-8y = 24$$
$$y = -3$$

Now, evaluate $x^2-(xy-y)$ for $x=-2$ and $y=-3$:

$$x^2-(xy-y)$$
$$=(-2)^2-\left[-2(-3)-(-3)\right]$$
$$=(-2)^2-\left[6-(-3)\right]$$
$$=4-(6+3)=4-9=-5$$

89. $\left[(3+6)^2\div 3\right]\cdot 4 = -54x$

$$\left(9^2\div 3\right)\cdot 4 = -54x$$
$$\left(81\div 3\right)\cdot 4 = -54x$$
$$27\cdot 4 = -54x$$
$$108 = -54x$$
$$-2 = x$$

The solution set is $\{-2\}$.

90. $2^3-\left[4(5-3)^3\right] = -8x$

$$8-\left[4(2)^3\right] = -8x$$
$$8-4\cdot 8 = -8x$$
$$8-32 = -8x$$
$$-24 = -8x$$
$$3 = x$$

The solution set is $\{3\}$.

91. $5-12x = 8-7x-\left[6\div 3\left(2+5^3\right)+5x\right]$

$$5-12x = 8-7x-\left[6\div 3(2+125)+5x\right]$$
$$5-12x = 8-7x-\left[6\div 3\cdot 127+5x\right]$$
$$5-12x = 8-7x-\left[2\cdot 127+5x\right]$$
$$5-12x = 8-7x-\left[254+5x\right]$$
$$5-12x = 8-7x-254-5x$$
$$5-12x = -12x-246$$
$$5 = -246$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

92. $2(5x+58) = 10x+4(21\div 3.5-11)$

$$10x+116 = 10x+4(6-11)$$
$$10x+116 = 10x+4(-5)$$
$$10x+116 = 10x-20$$
$$116 = -20$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

93. $0.7x+0.4(20) = 0.5(x+20)$

$$0.7x+8 = 0.5x+10$$
$$0.2x+8 = 10$$
$$0.2x = 2$$
$$x = 10$$

The solution set is $\{10\}$.

94. $0.5(x+2) = 0.1+3(0.1x+0.3)$

$0.5x+1 = 0.1+0.3x+0.9$

$0.5x+1 = 0.3x+1$

$0.2x+1 = 1$

$0.2x = 0$

$x = 0$

The solution set is $\{0\}$.

95. $4x+13-\{2x-[4(x-3)-5]\} = 2(x-6)$

$4x+13-\{2x-[4x-12-5]\} = 2x-12$

$4x+13-\{2x-[4x-17]\} = 2x-12$

$4x+13-\{2x-4x+17\} = 2x-12$

$4x+13-\{-2x+17\} = 2x-12$

$4x+13+2x-17 = 2x-12$

$6x-4 = 2x-12$

$4x-4 = -12$

$4x = -8$

$x = -2$

The solution set is $\{-2\}$.

96. $-2\{7-[4-2(1-x)+3]\} = 10-[4x-2(x-3)]$

$-2\{7-[4-2+2x+3]\} = 10-[4x-2x+6]$

$-2\{7-[2x+5]\} = 10-[2x+6]$

$-2\{7-2x-5\} = 10-2x-6$

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

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

$6x-4 = 4$

$6x = 8$

$x = \frac{8}{6} = \frac{4}{3}$

The solution set is $\left\{\frac{4}{3}\right\}$.

97. a. $p = \frac{4x}{5}+25$

$p = \frac{4(30)}{5}+25$

$p = 24+25$

$p = 49$

According to the model, 49% of U.S. college freshman had an average grade of A in high school in 2010. This overestimates the value shown in the bar graph by 1%.

b. $p = \frac{4x}{5}+25$

$57 = \frac{4x}{5}+25$

$32 = \frac{4x}{5}$

$160 = 4x$

$40 = x$

According to the model, 57% of U.S. college freshman will have an average grade of A in high school 40 years after 1980, or 2020.

98. a. $p = \frac{4x}{5}+25$

$p = \frac{4(20)}{5}+25$

$p = 16+25$

$p = 41$

According to the model, 41% of U.S. college freshman had an average grade of A in high school in 2000. This underestimates the value shown in the bar graph by 2%.

b. $p = \frac{4x}{5}+25$

$65 = \frac{4x}{5}+25$

$40 = \frac{4x}{5}$

$200 = 4x$

$50 = x$

According to the model, 65% of U.S. college freshman will have an average grade of A in high school 50 years after 1980, or 2030.

99. a. What cost \$10,000 in 1984 would cost about \$22,000 in 2010.

b. $C = 442x+12,969$

$= 442(20)+12,969$

$= \$21,809$

It describes the estimate from part (a) reasonably well.

c. $C = 2x^2+390x+13,126$

$= 2(20)^2+390(20)+13,126$

$= \$21,726$

It describes the estimate from part (a) reasonably well.

100. a. What cost \$10,000 in 1984 would cost about \$17,000 in 2000.

b. $C = 442x + 12,969$
$= 442(10) + 12,969$
$= \$17,389$
It describes the estimate from part (a) reasonably well.

c. $C = 2x^2 + 390x + 13,126$
$= 2(10)^2 + 390(10) + 13,126$
$= \$17,226$
It describes the estimate from part (a) reasonably well.

101. $C = 442x + 12,969$
$26,229 = 442x + 12,969$
$13,260 = 442x$
$\frac{13,260}{442} = \frac{442x}{442}$
$30 = x$
Model 1 predicts the cost will be \$26,229 30 years after 1990, or 2020.

102. $C = 442x + 12,969$
$25,345 = 442x + 12,969$
$12,376 = 442x$
$\frac{12,376}{442} = \frac{442x}{442}$
$28 = x$
Model 1 predicts the cost will be \$25,345 28 years after 1990, or 2018.

103. 11 learning trials; represented by the point $(11, 0.95)$ on the graph.

104. 1 learning trial; represented by the point $(1, 0.5)$ on the graph.

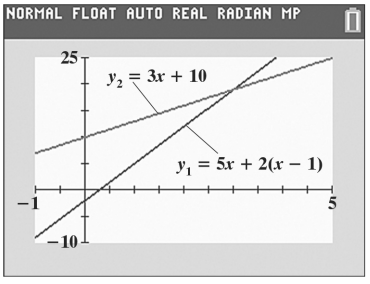
105. $C = \frac{x + 0.1(500)}{x + 500}$
$0.28 = \frac{x + 0.1(500)}{x + 500}$
$0.28(x + 500) = x + 0.1(500)$
$0.28x + 140 = x + 50$
$-0.72x = -90$
$\frac{-0.72x}{-0.72} = \frac{-90}{-0.72}$
$x = 125$
125 liters of pure peroxide must be added.

106. a. $C = \frac{x + 0.35(200)}{x + 200}$

b. $0.74 = \frac{x + 0.35(200)}{x + 200}$
$0.74(x + 200) = x + 0.35(200)$
$0.74x + 148 = x + 70$
$-0.26x = -78$
$\frac{-0.26x}{-0.26} = \frac{-78}{-0.26}$
$x = 300$
300 liters of pure acid must be added.

107. – 115. Answers will vary.

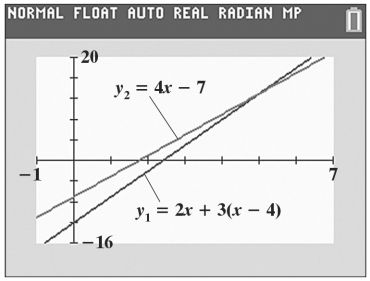
116. $5x + 2(x - 1) = 3x + 10$
Let $y_1 = 5x + 2(x - 1)$ and let $y_2 = 3x + 10$.



The solution set is $\{3\}$.

117. $2x+3(x-4)=4x-7$

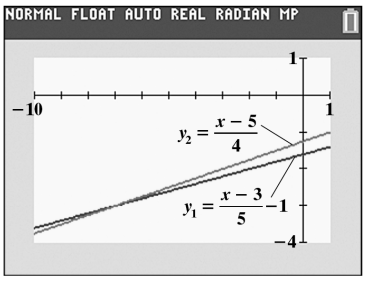
Let $y_1=2x+3(x-4)$ and let $y_2=4x-7$.



The solution set is $\{5\}$.

118. $\dfrac{x-3}{5}-1=\dfrac{x-5}{4}$

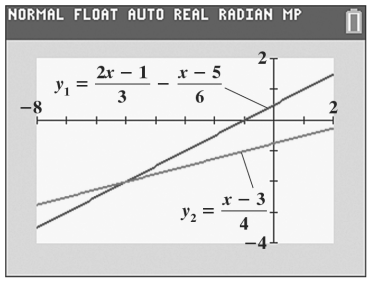
Let $y_1=\dfrac{x-3}{5}-1$ and let $y_2=\dfrac{x-5}{4}$.



The solution set is $\{-7\}$.

119. $\dfrac{2x-1}{3}-\dfrac{x-5}{6}=\dfrac{x-3}{4}$

Let $y_1=\dfrac{2x-1}{3}-\dfrac{x-5}{6}$ and let $y_2=\dfrac{x-3}{4}$.



The solution set is $\{-5\}$.

120. does not make sense; Explanations will vary. Sample explanation: Substitute $n=6$ into the equation to find P.

121. makes sense

122. makes sense

123. makes sense

124. false; Changes to make the statement true will vary. A sample change is: $x=0$ is a solution.

125. false; Changes to make the statement true will vary. A sample change is: In the first equation, $x\neq 4$.

126. true

127. false; Changes to make the statement true will vary. A sample change is: If $a = 0$, then $ax + b = 0$ is equivalent to $b = 0$, which either has no solution ($b \neq 0$) or infinitely many solutions ($b = 0$).

128. Answers will vary.

129.
$$\frac{7x+4}{b}+13=x$$
$$\frac{7(-6)+4}{b}+13=-6$$
$$\frac{-42+4}{b}+13=-6$$
$$\frac{-38}{b}+13=-6$$
$$\frac{-38}{b}=-19$$
$$-38=-19b$$
$$b=2$$

130. $\dfrac{4x-b}{x-5}=3$

$4x-b=3(x-5)$

The solution set will be $\varnothing$ if $x = 5$.

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

$20-b=0$

$20=b$

$b=20$

131. $x+150$

132. $20+0.05x$

133. $4x+400$

Section 1.3

Check Point Exercises

1. Let x = the average yearly salary, in thousands, of women with an associate's degree
Let $x + 14$ = the average yearly salary, in thousands, of women with a bachelor's degree
Let $x + 26$ = the average yearly salary, in thousands, of women with a master's degree

$$x+(x+14)+(x+26)=139$$
$$x+x+14+x+26=139$$
$$3x+40=139$$
$$3x=99$$
$$x=33$$

$x = 33$, associate's degree: \$33,000
$x+14 = 47$, bachelor's degree: \$47,000
$x + 26 = 59$, master's degree: \$59,000

2. Let x = the number of years after 1969.

$$85-0.9x=25$$
$$-0.9x=25-85$$
$$-0.9x=-60$$
$$x=\frac{-60}{-0.9}$$
$$x\approx 67$$

25% of freshmen will respond this way 67 years after 1969, or 2036.

3. Let x = the number of bridge crossings at which the costs of the two plans are the same.

$$\overbrace{5x}^{\text{No Pass}} = \overbrace{40+3x}^{\text{Discount Pass}}$$
$$5x-3x=40$$
$$2x=40$$
$$x=20$$

The two plans cost the same for 20 bridge crossings.

4. Let x = the computer's price before the reduction.

$$x-0.30x=840$$
$$0.70x=840$$
$$x=\frac{840}{0.70}$$
$$x=1200$$

Before the reduction the computer's price was \$1200.

5. Let x = the amount invested at 9%.
Let $5000 - x$ = the amount invested at 11%.

$$0.09x+0.11(5000-x)=487$$
$$0.09x+550-0.11x=487$$
$$-0.02x+550=487$$
$$-0.02x=-63$$
$$x=\frac{-63}{-0.02}$$
$$x=3150$$
$$5000-x=1850$$

\$3150 was invested at 9% and \$1850 was invested at 11%.

6. Let x = the width of the court.
Let $x + 44$ = the length of the court.

$$2l+2w=P$$
$$2(x+44)+2x=288$$
$$2x+88+2x=288$$
$$4x+88=288$$
$$4x=200$$
$$x=\frac{200}{4}$$
$$x=50$$
$$x+44=94$$

The dimensions of the court are 50 feet by 94 feet.

7.

$$2l+2w=P$$
$$2l+2w-2l=P-2l$$
$$2w=P-2l$$
$$\frac{2w}{2}=\frac{P-2l}{2}$$
$$w=\frac{P-2l}{2}$$

8.

$$P=C+MC$$
$$P=C(1+M)$$
$$\frac{P}{1+M}=\frac{C(1+M)}{1+M}$$
$$\frac{P}{1+M}=C$$
$$C=\frac{P}{1+M}$$

Concept and Vocabulary Check 1.3

1. $x + 658.6$

2. $31 + 2.4x$

3. $4 + 0.15x$

4. $x - 0.15x$ or $0.85x$

5. $0.12x + 0.09(30,000 - x)$

6. isolated on one side

7. factoring

Exercise Set 1.3

1. Let $x =$ the number of years spent watching TV.
Let $x + 19 =$ the number of years spent sleeping.

$$x + (x + 19) = 37$$
$$x + x + 19 = 37$$
$$2x + 19 = 37$$
$$2x = 18$$
$$x = 9$$
$$x + 19 = 28$$

Americans will spend 9 years watching TV and 28 years sleeping.

2. Let $x =$ the number of years spent eating.
Let $x + 24 =$ the number of years spent sleeping.

$$x + (x + 24) = 32$$
$$x + x + 24 = 32$$
$$2x + 24 = 32$$
$$2x = 8$$
$$x = 4$$
$$x + 24 = 28$$

Americans will spend 4 years eating and 28 years sleeping.

3. Let $x =$ the average salary, in thousands, for an American whose final degree is a bachelor's.
Let $2x - 70 =$ the average salary, in thousands, for an American whose final degree is a master's.

$$x + (2x - 70) = 173$$
$$x + 2x - 70 = 173$$
$$3x - 70 = 173$$
$$3x = 243$$
$$x = 81$$
$$2x - 70 = 92$$

The average salary for an American whose final degree is a bachelor's is \$81 thousand and for an American whose final degree is a master's is \$92 thousand.

4. Let $x =$ the average salary, in thousands, for an American whose final degree is a bachelor's.
Let $2x - 45 =$ the average salary, in thousands, for an American whose final degree is a doctorate.

$$x + (2x - 45) = 198$$
$$x + 2x - 45 = 198$$
$$3x - 45 = 198$$
$$3x = 243$$
$$x = 81$$
$$2x - 45 = 117$$

The average salary for an American whose final degree is a bachelor's is \$81 thousand and for an American whose final degree is a doctorate is \$117 thousand.

5. Let $x =$ the number of years after 2014.

$$37,600 + 1250x = 46,350$$
$$1250x = 8750$$
$$\frac{1250x}{1250} = \frac{8750}{1250}$$
$$x = 7$$

7 years after 2014, or in 2021, the average price of a new car will be \$46,350.

6. Let $x =$ the number of years after 2014.

$$11.3 + 0.2x = 12.3$$
$$0.2x = 1$$
$$\frac{0.2x}{0.2} = \frac{1}{0.2}$$
$$x = 5$$

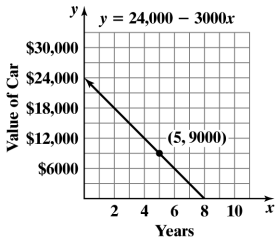
5 years after 2014, or in 2019, the average age of vehicles on U.S. roads will be 12.3 years.

7. **a.** $y = 24,000 - 3000x$

b.
$$y = 24,000 - 3000x$$
$$9000 = 24,000 - 3000x$$
$$9000 - 24,000 = -3000x$$
$$-15,000 = -3000x$$
$$x = \frac{-15,000}{-3000}$$
$$x = 5$$

The car's value will drop to \$9000 after 5 years.

c. Graph:

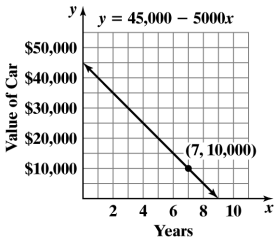


8. **a.** $y = 45,000 - 5000x$

b.
$$y = 45,000 - 5000x$$
$$10,000 = 45,000 - 5000x$$
$$10,000 - 45,000 = -5000x$$
$$-35,000 = -5000x$$
$$x = \frac{-35,000}{-5000}$$
$$x = 7$$

The car's value will drop to \$10,000 after 7 years.

c. Graph:



9. Let x = the number of months.
The cost for Club A: $25x + 40$
The cost for Club B: $30x + 15$
$$25x + 40 = 30x + 15$$
$$-5x + 40 = 15$$
$$-5x = -25$$
$$x = 5$$

The total cost for the clubs will be the same at 5 months. The cost will be
$25(5) + 40 = 30(5) + 15 = \$165$

10. Let g = the number of video games rented
$$9g = 4g + 50$$
$$5g = 50$$
$$g = 10$$

The total amount spent at each store will be the same after 10 rentals.
$9g = 9(10) = 90$
The total amount spent will be \$90.

11. Let x = the number of uses.
Cost without discount pass: $1.25x$
Cost with discount pass: $15 + 0.75x$
$$1.25x = 15 + 0.75x$$
$$0.50x = 15$$
$$x = 30$$

The bus must be used 30 times in a month for the costs to be equal.

12. Cost per crossing: $\$5x$
Cost with discount pass: $\$30 + \$3.50x$
$$5x = 30 + 3.50x$$
$$1.50x = 30$$
$$x = 20$$

The bridge must be used 20 times in a month for the costs to be equal.

13. **a.** Let x = the number of years (after 2010).
College A's enrollment: $13,300 + 1000x$

College B's enrollment: $26,800 - 500x$
$$13,300 + 1000x = 26,800 - 500x$$
$$13,300 + 1500x = 26,800$$
$$1500x = 13,500$$
$$x = 9$$

The two colleges will have the same enrollment 9 years after 2010, or 2019. That year the enrollment will be
$13,300 + 1000(9)$
$= 26,800 - 500(9)$
$= 22,300$ students

b. Check points to determine that $y_1 = 13,300 + 1000x$ and $y_2 = 26,800 - 500x$.

14. Let x = the number of years after 2000

$$10,600,000 - 28,000x = 10,200,000 - 12,000x$$
$$-16,000x = -400,000$$
$$x = 25$$

The countries will have the same population 25 years after the year 2000, or the year 2025.

$$10,200,000 - 12,000x = 10,200,000 - 12,000(25)$$
$$= 10,200,000 - 300,000$$
$$= 9,900,000$$

The population in the year 2025 will be 9,900,000.

15. Let x = the cost of the television set.

$$x - 0.20x = 336$$
$$0.80x = 336$$
$$x = 420$$

The television set's price is \$420.

16. Let x = the cost of the dictionary

$$x - 0.30x = 30.80$$
$$0.70x = 30.80$$
$$x = 44$$

The dictionary's price before the reduction was \$44.

17. Let x = the nightly cost

$$x + 0.08x = 162$$
$$1.08x = 162$$
$$x = 150$$

The nightly cost is \$150.

18. Let x = the nightly cost

$$x + 0.05x = 252$$
$$1.05x = 252$$
$$x = 240$$

The nightly cost is \$240.

19. Let c = the dealer's cost

$$584 = c + 0.25c$$
$$584 = 1.25c$$
$$467.20 = c$$

The dealer's cost is \$467.20.

20. Let c = the dealer's cost

$$15 = c + 0.25c$$
$$15 = 1.25c$$
$$12 = c$$

The dealer's cost is \$12.

21. Let x = the amount invested at 6%.
Let $7000 - x$ = the amount invested at 8%.

$$0.06x + 0.08(7000 - x) = 520$$
$$0.06x + 560 - 0.08x = 520$$
$$-0.02x + 560 = 520$$
$$-0.02x = -40$$
$$x = \frac{-40}{-0.02}$$
$$x = 2000$$
$$7000 - x = 5000$$

\$2000 was invested at 6% and \$5000 was invested at 8%.

22. Let x = the amount invested at 5%.
Let $11,000 - x$ = the amount invested at 8%.

$$0.05x + 0.08(11,000 - x) = 730$$
$$0.05x + 880 - 0.08x = 730$$
$$-0.03x + 880 = 730$$
$$-0.03x = -150$$
$$x = \frac{-150}{-0.03}$$
$$x = 5000$$
$$11,000 - x = 6000$$

\$5000 was invested at 5% and \$6000 was invested at 8%.

23. Let x = amount invested at 12%
$8000 - x$ = amount invested at 5% loss

$$.12x - .05(8000 - x) = 620$$
$$.12x - 400 + .05x = 620$$
$$.17x = 1020$$
$$x = 6000$$
$$8000\text{-}x = 2000$$

\$6000 at 12%, \$2000 at 5% loss

24. Let x = amount at 14%
$12000 - x$ = amount at 6%

$$.14x - 0.6(12000 - x) = 680$$
$$.14x - 720 + .06x = 680$$
$$.2x = 1400$$
$$x = 7000$$
$$12000 - 7000 = 5000$$

\$7000 at 14%, \$5000 at 6% loss

25. Let w = the width of the field
Let $2w$ = the length of the field
$P = 2(\text{length}) + 2(\text{width})$
$300 = 2(2w) + 2(w)$
$300 = 4w + 2w$
$300 = 6w$
$50 = w$
If $w = 50$, then $2w = 100$. Thus, the dimensions are 50 yards by 100 yards.

26. Let w = the width of the swimming pool,
Let $3w$ = the length of the swimming pool
$P = 2(\text{length}) + 2(\text{width})$
$320 = 2(3w) + 2(w)$
$320 = 6w + 2w$
$320 = 8w$
$40 = w$
If $w = 40$, $3w = 3(40) = 120$.
The dimensions are 40 feet by 120 feet.

27. Let w = the width of the field
Let $2w + 6$ = the length of the field
$228 = 6w + 12$
$216 = 6w$
$36 = w$
If $w = 36$, then $2w + 6 = 2(36) + 6 = 78$. Thus, the dimensions are 36 feet by 78 feet.

28. Let w = the width of the pool,
Let $2w - 6$ = the length of the pool
$P = 2(\text{length}) + 2(\text{width})$
$126 = 2(2w - 6) + 2(w)$
$126 = 4w - 12 + 2w$
$126 = 6w - 12$
$138 = 6w$
$23 = w$
Find the length.
$2w - 6 = 2(23) - 6 = 46 - 6 = 40$
The dimensions are 23 meters by 40 meters.

29. Let x = the width of the frame.
Total length: $16 + 2x$
Total width: $12 + 2x$
$P = 2(\text{length}) + 2(\text{width})$
$72 = 2(16 + 2x) + 2(12 + 2x)$
$72 = 32 + 4x + 24 + 4x$
$72 = 8x + 56$
$16 = 8x$
$2 = x$
The width of the frame is 2 inches.

30. Let w = the width of the path
Let $40 + 2w$ = the width of the pool and path
Let $60 + 2w$ = the length of the pool and path
$2(40 + 2w) + 2(60 + 2w) = 248$
$80 + 4w + 120 + 4w = 248$
$200 + 8w = 248$
$8w = 48$
$w = 6$
The width of the path is 6 feet.

31. Let x = number of hours
$35x$ = labor cost
$35x + 63 = 448$
$35x = 385$
$x = 11$
It took 11 hours.

32. Let x = number of hours
$63x$ = labor cost
$63x + 532 = 1603$
$63x = 1071$
$x = 17$
17 hours were required to repair the yacht.

33. Let x = inches over 5 feet
$100 + 5x = 135$
$5x = 35$
$x = 7$
A height of 5 feet 7 inches corresponds to 135 pounds.

34. Let g = the gross amount of the paycheck
Yearly Salary $= 2(12)g + 750$
$33150 = 24g + 750$
$32400 = 24g$
$1350 = g$
The gross amount of each paycheck is \$1350.

35. Let x = the weight of unpeeled bananas.

$\frac{7}{8}x =$ weight of peeled bananas

$$x = \frac{7}{8}x + \frac{7}{8}$$
$$\frac{1}{8}x = \frac{7}{8}$$
$$x = 7$$

The banana with peel weighs 7 ounces.

36. Let x = the length of the call.

$$0.43 + 0.32(x-1) + 2.10 = 5.73$$
$$0.43 + 0.32x - 0.32 + 2.10 = 5.73$$
$$0.32x + 2.21 = 5.73$$
$$0.32x = 3.52$$
$$x = 11$$

The person talked for 11 minutes.

37. $A = lw$

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

area of rectangle

38. $D = RT$

$$R = \frac{D}{T}$$

distance, rate, time equation

39. $A = \frac{1}{2}bh$

$$2A = bh$$
$$b = \frac{2A}{h};$$

area of triangle

40. $V = \frac{1}{3}Bh$

$$3V = Bh$$
$$B = \frac{3V}{h}$$

volume of a cone

41. $I = Prt$

$$P = \frac{I}{rt};$$

interest

42. $C = 2\pi r$

$$r = \frac{C}{2\pi};$$

circumference of a circle

43. $E = mc^2$

$$m = \frac{E}{c^2};$$

Einstein's equation

44. $V = \pi r^2 h$

$$h = \frac{V}{\pi r^2};$$

volume of a cylinder

45. $T = D + pm$

$$T - D = pm$$
$$\frac{T-D}{m} = \frac{pm}{m}$$
$$\frac{T-D}{m} = p$$

total of payment

46. $P = C + MC$

$$P - C = MC$$
$$\frac{P-C}{C} = M$$

markup based on cost

47. $A = \frac{1}{2}h(a+b)$

$$2A = h(a+b)$$
$$\frac{2A}{h} = a+b$$
$$\frac{2A}{h} - b = a$$

area of trapezoid

48. $A = \frac{1}{2}h(a+b)$

$$2A = h(a+b)$$
$$\frac{2A}{h} = a+b$$
$$\frac{2A}{h} - a = b$$

area of trapezoid

49. $S = P + Prt$
$S - P = Prt$
$\frac{S-P}{Pt} = r;$
interest

50. $S = P + Prt$
$S - P = Prt$
$\frac{S-P}{Pr} = t;$
interest

51. $B = \frac{F}{S-V}$
$B(S-V) = F$
$S - V = \frac{F}{B}$
$S = \frac{F}{B} + V$

52. $S = \frac{C}{1-r}$
$S(1-r) = C$
$1 - r = \frac{C}{S}$
$-r = \frac{C}{S} - 1$
$r = -\frac{C}{S} + 1$
markup based on selling price

53. $IR + Ir = E$
$I(R+r) = E$
$I = \frac{E}{R+r}$
electric current

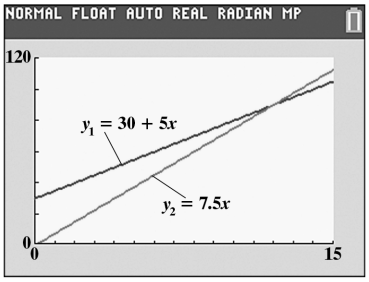
54. $A = 2lw + 2lh + 2wh$
$A - 2lw = h(2l + 2w)$
$\frac{A-2lw}{2l+2w} = h$
surface area

55. $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$
$qf + pf = pq$
$f(q+p) = pq$
$f = \frac{pq}{p+q}$
thin lens equation

56. $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
$R_1R_2 = RR_2 + RR_1$
$R_1R_2 - RR_1 = RR_2$
$R_1(R_2 - R) = RR_2$
$R_1 = \frac{RR_2}{R_2 - R}$
resistance

57. – 61. Answers will vary.

62. **a.** $F = 30 + 5x$
$F = 7.5x$

b.


c. Calculator shows the graphs to intersect at (12, 90); the two options both cost \$90 when 12 hours court time is used per month.

d. $30 + 5x = 7.5x$
$30 = 2.5x$
$x = 12$
Rent the court 12 hours per month.

63. does not make sense; Explanations will vary. Sample explanation: Though mathematical models can often provide excellent estimates about future attitudes, they cannot guaranty perfect precision.

64. makes sense

65. does not make sense; Explanations will vary. Sample explanation: Solving a formula for one of its variables does not produce a numerical value for the variable.

66. does not make sense; Explanations will vary. Sample explanation: The correct equation is $x - 0.35x = 780$.

67. $0.1x + .9(1000 - x) = 420$

$0.1 + 900 - 0.9x = 420$

$-0.8x = -480$

$x = 600$

600 students at the north campus, 400 students at south campus.

68. Let x = original price

$x - 0.4x = 0.6x$ = price after first reduction

$0.6x - 0.4(0.6x)$ = price after second reduction

$0.6x - 0.24x = 72$

$0.36x = 72$

$x = 200$

The original price was \$200.

69. Let x = woman's age

$3x$ = Coburn's age

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

$3x + 20 = 2x + 40$

$x + 20 = 40$

$x = 20$

Coburn is 60 years old the woman is 20 years old.

70. Let x = correct answers

$26 - x$ = incorrect answers

$8x - 5(26 - x) = 0$

$8x - 130 + 5x = 0$

$13x - 130 = 0$

$13x = 130$

$x = 10$

10 problems were solved correctly.

71. Let x = mother's amount

$2x$ = boy's amount

$\frac{x}{2}$ = girl's amount

$x + 2x + \frac{x}{2} = 14,000$

$\frac{7}{2}x = 14,000$

$x = \$4,000$

The mother received \$4000, the boy received \$8000, and the girl received \$2000.

72. Let x = the number of plants originally stolen

After passing the first security guard, the thief has:

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

After passing the second security guard, the thief has:

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

After passing the third security guard, the thief has:

$$\frac{1}{4}x - 3 - \left(\frac{\frac{1}{4}x - 3}{2} + 2\right) = \frac{1}{8}x - \frac{7}{2}$$

Thus, $\frac{1}{8}x - \frac{7}{2} = 1$

$x - 28 = 8$

$x = 36$

The thief stole 36 plants.

73. $V = C - \frac{C - S}{L}N$

$VL = CL - CN + SN$

$VL - SN = CL - CN$

$VL - SN = C(L - N)$

$\frac{VL - SN}{L - N} = C$

$C = \frac{VL - SN}{L - N}$

74. Answers will vary

75. $(7 - 3x)(-2 - 5x) = -14 - 35x + 6x + 15x^2$

$= -14 - 29x + 15x^2$

or

$= 15x^2 - 29x - 14$

76. $\sqrt{18} - \sqrt{8} = \sqrt{9 \cdot 2} - \sqrt{4 \cdot 2}$

$= 3\sqrt{2} - 2\sqrt{2}$

$= \sqrt{2}$

77. $\frac{7 + 4\sqrt{2}}{2 - 5\sqrt{2}} \cdot \frac{2 + 5\sqrt{2}}{2 + 5\sqrt{2}} = \frac{14 + 35\sqrt{2} + 8\sqrt{2} + 40}{4 + 10\sqrt{2} - 10\sqrt{2} - 50}$

$= \frac{54 + 43\sqrt{2}}{-46}$

$= -\frac{54 + 43\sqrt{2}}{46}$

Section 1.4

Check Point Exercises

1. **a.** $(5-2i)+(3+3i)$
$=5-2i+3+3i$
$=(5+3)+(-2+3)i$
$=8+i$

b. $(2+6i)-(12-i)$
$=2+6i-12+i$
$=(2-12)+(6+1)i$
$=-10+7i$

2. **a.** $7i(2-9i)=7i(2)-7i(9i)$
$=14i-63i^2$
$=14i-63(-1)$
$=63+14i$

b. $(5+4i)(6-7i)=30-35i+24i-28i^2$
$=30-35i+24i-28(-1)$
$=30+28-35i+24i$
$=58-11i$

3. $\dfrac{5i}{7+i}=\dfrac{5i}{7+i}\cdot\dfrac{7-i}{7-i}$
$=\dfrac{35i-5i^2}{49+7i-7i-i^2}$
$=\dfrac{35i+5}{49+1}$
$=\dfrac{35i+5}{50}$
$=\dfrac{5}{50}+\dfrac{35}{50}i$
$=\dfrac{1}{10}+\dfrac{7}{10}i$

4. $\dfrac{5+4i}{4-i}=\dfrac{5+4i}{4-i}\cdot\dfrac{4+i}{4+i}$
$=\dfrac{20+5i+16i+4i^2}{16+4i-4i-i^2}$
$=\dfrac{20+21i-4}{16+1}$
$=\dfrac{16+21i}{17}$
$=\dfrac{16}{17}+\dfrac{21}{17}i$

5. **a.** $\sqrt{-27}+\sqrt{-48}=i\sqrt{27}+i\sqrt{48}$
$=i\sqrt{9\cdot3}+i\sqrt{16\cdot3}$
$=3i\sqrt{3}+4i\sqrt{3}$
$=7i\sqrt{3}$

b. $(-2+\sqrt{-3})^2=(-2+i\sqrt{3})^2$
$=(-2)^2+2(-2)(i\sqrt{3})+(i\sqrt{3})^2$
$=4-4i\sqrt{3}+3i^2$
$=4-4i\sqrt{3}+3(-1)$
$=1-4i\sqrt{3}$

c. $\dfrac{-14+\sqrt{-12}}{2}=\dfrac{-14+i\sqrt{12}}{2}$
$=\dfrac{-14+2i\sqrt{3}}{2}$
$=\dfrac{-14}{2}+\dfrac{2i\sqrt{3}}{2}$
$=-7+i\sqrt{3}$

Concept and Vocabulary Check 1.4

1. $\sqrt{-1}$; -1

2. complex; imaginary; real

3. $-6i$

4. $14i$

5. 18; $-15i$; $12i$; $-10i^2$; 10

6. $2+9i$

7. $2+5i$

8. i; $2i\sqrt{5}$

Exercise Set 1.4

1. $(7+2i)+(1-4i)=7+2i+1-4i$
$=7+1+2i-4i$
$=8-2i$

2. $(-2+6i)+(4-i)$
$=-2+6i+4-i$
$=-2+4+6i-i$
$=2+5i$

3. $(3 + 2i) - (5 - 7i) = 3 - 5 + 2i + 7i$
$= 3 + 2i - 5 + 7i$
$= -2 + 9i$

4. $(-7 + 5i) - (-9 - 11i) = -7 + 5i + 9 + 11i$
$= -7 + 9 + 5i + 11i$
$= 2 + 16i$

5. $6 - (-5 + 4i) - (-13 - i) = 6 + 5 - 4i + 13 + i$
$= 24 - 3i$

6. $7 - (-9 + 2i) - (-17 - i) = 7 + 9 - 2i + 17 + i$
$= 33 - i$

7. $8i - (14 - 9i) = 8i - 14 + 9i$
$= -14 + 8i + 9i$
$= -14 + 17i$

8. $15i - (12 - 11i) = 15i - 12 + 11i$
$= -12 + 15i + 11i$
$= -12 + 26i$

9. $-3i(7i - 5) = -21i^2 + 15i$
$= -21(-1) + 15i$
$= 21 + 15i$

10. $-8i\,(2i - 7) = -16i^2 + 56i = -16(-1) + 56i$
$= 9 - 25i^2 = 9 + 25 = 34 = 16 + 56i$

11. $(-5 + 4i)(3 + i) = -15 - 5i + 12i + 4i^2$
$= -15 + 7i - 4$
$= -19 + 7i$

12. $(-4 - 8i)(3 + i) = -12 - 4i - 24i - 8i^2$
$= -12 - 28i + 8$
$= -4 - 28i$

13. $(7 - 5i)(-2 - 3i) = -14 - 21i + 10i + 15i^2$
$= -14 - 15 - 11i$
$= -29 - 11i$

14. $(8 - 4i)(-3 + 9i) = -24 + 72i + 12i - 36i^2$
$= -24 + 36 + 84i$
$= 12 + 84i$

15. $(3 + 5i)(3 - 5i) = 9 - 15i + 15i - 25i^2$
$= 9 + 25$
$= 34$

16. $(2 + 7i)(2 - 7i) = 4 - 49i^2 = 4 + 49 = 53$

17. $(-5 + i)(-5 - i) = 25 + 5i - 5i - i^2$
$= 25 + 1$
$= 26$

18. $(-7 + i)(-7 - i) = 49 + 7i - 7i - i^2$
$= 49 + 1$
$= 50$

19. $(2 + 3i)^2 = 4 + 12i + 9i^2$
$= 4 + 12i - 9$
$= -5 + 12i$

20. $(5 - 2i)^2 = 25 - 20i + 4i^2$
$= 25 - 20i - 4$
$= 21 - 20i$

21. $\dfrac{2}{3 - i} = \dfrac{2}{3 - i} \cdot \dfrac{3 + i}{3 + i}$
$= \dfrac{2(3 + i)}{9 + 1}$
$= \dfrac{2(3 + i)}{10}$
$= \dfrac{3 + i}{5}$
$= \dfrac{3}{5} + \dfrac{1}{5}i$

22. $\dfrac{3}{4 + i} = \dfrac{3}{4 + i} \cdot \dfrac{4 - i}{4 - i}$
$= \dfrac{3(4 - i)}{16 - i^2}$
$= \dfrac{3(4 - i)}{17}$
$= \dfrac{12}{17} - \dfrac{3}{17}i$

23. $\dfrac{2i}{1 + i} = \dfrac{2i}{1 + i} \cdot \dfrac{1 - i}{1 - i} = \dfrac{2i - 2i^2}{1 + 1} = \dfrac{2 + 2i}{2} = 1 + i$

24. $\dfrac{5i}{2 - i} = \dfrac{5i}{2 - i} \cdot \dfrac{2 + i}{2 + i}$
$= \dfrac{10i + 5i^2}{4 + 1}$
$= \dfrac{-5 + 10i}{5}$
$= -1 + 2i$

25. $\dfrac{8i}{4-3i} = \dfrac{8i}{4-3i}\cdot\dfrac{4+3i}{4+3i}$

$= \dfrac{32i+24i^2}{16+9}$

$= \dfrac{-24+32i}{25}$

$= -\dfrac{24}{25}+\dfrac{32}{25}i$

26. $\dfrac{-6i}{3+2i} = \dfrac{-6i}{3+2i}\cdot\dfrac{3-2i}{3-2i} = \dfrac{-18i+12i^2}{9+4}$

$= \dfrac{-12-18i}{13} = -\dfrac{12}{13}-\dfrac{18}{13}i$

27. $\dfrac{2+3i}{2+i} = \dfrac{2+3i}{2+i}\cdot\dfrac{2-i}{2-i}$

$= \dfrac{4+4i-3i^2}{4+1}$

$= \dfrac{7+4i}{5}$

$= \dfrac{7}{5}+\dfrac{4}{5}i$

28. $\dfrac{3-4i}{4+3i} = \dfrac{3-4i}{4+3i}\cdot\dfrac{4-3i}{4-3i}$

$= \dfrac{12-25i+12i^2}{16+9}$

$= \dfrac{-25i}{25}$

$= -i$

29. $\sqrt{-64}-\sqrt{-25} = i\sqrt{64}-i\sqrt{25}$

$= 8i-5i = 3i$

30. $\sqrt{-81}-\sqrt{-144} = i\sqrt{81}-i\sqrt{144} = 9i-12i$

$= -3i$

31. $5\sqrt{-16}+3\sqrt{-81} = 5(4i)+3(9i)$

$= 20i+27i = 47i$

32. $5\sqrt{-8}+3\sqrt{-18}$

$= 5i\sqrt{8}+3i\sqrt{18} = 5i\sqrt{4\cdot 2}+3i\sqrt{9\cdot 2}$

$= 10i\sqrt{2}+9i\sqrt{2}$

$= 19i\sqrt{2}$

33. $\left(-2+\sqrt{-4}\right)^2 = (-2+2i)^2$

$= 4-8i+4i^2$

$= 4-8i-4$

$= -8i$

34. $\left(-5-\sqrt{-9}\right)^2 = (-5-i\sqrt{9})^2 = (-5-3i)^2$

$= 25+30i+9i^2$

$= 25+30i-9$

$= 16+30i$

35. $\left(-3-\sqrt{-7}\right)^2 = \left(-3-i\sqrt{7}\right)^2$

$= 9+6i\sqrt{7}+i^2(7)$

$= 9-7+6i\sqrt{7}$

$= 2+6i\sqrt{7}$

36. $\left(-2+\sqrt{-11}\right)^2 = \left(-2+i\sqrt{11}\right)^2$

$= 4-4i\sqrt{11}+i^2(11)$

$= 4-11-4i\sqrt{11}$

$= -7-4i\sqrt{11}$

37. $\dfrac{-8+\sqrt{-32}}{24} = \dfrac{-8+i\sqrt{32}}{24}$

$= \dfrac{-8+i\sqrt{16\cdot 2}}{24}$

$= \dfrac{-8+4i\sqrt{2}}{24}$

$= -\dfrac{1}{3}+\dfrac{\sqrt{2}}{6}i$

38. $\dfrac{-12+\sqrt{-28}}{32} = \dfrac{-12+i\sqrt{28}}{32} = \dfrac{-12+i\sqrt{4\cdot 7}}{32}$

$= \dfrac{-12+2i\sqrt{7}}{32} = -\dfrac{3}{8}+\dfrac{\sqrt{7}}{16}i$

39. $\dfrac{-6-\sqrt{-12}}{48} = \dfrac{-6-i\sqrt{12}}{48}$

$= \dfrac{-6-i\sqrt{4\cdot 3}}{48}$

$= \dfrac{-6-2i\sqrt{3}}{48}$

$= -\dfrac{1}{8}-\dfrac{\sqrt{3}}{24}i$

40. $\dfrac{-15-\sqrt{-18}}{33}=\dfrac{-15-i\sqrt{18}}{33}=\dfrac{-15-i\sqrt{9\cdot 2}}{33}$
$=\dfrac{-15-3i\sqrt{2}}{33}=-\dfrac{5}{11}-\dfrac{\sqrt{2}}{11}i$

41. $\sqrt{-8}\left(\sqrt{-3}-\sqrt{5}\right)=i\sqrt{8}(i\sqrt{3}-\sqrt{5})$
$=2i\sqrt{2}\left(i\sqrt{3}-\sqrt{5}\right)$
$=-2\sqrt{6}-2i\sqrt{10}$

42. $\sqrt{-12}\left(\sqrt{-4}-\sqrt{2}\right)=i\sqrt{12}(i\sqrt{4}-\sqrt{2})$
$=2i\sqrt{3}\left(2i-\sqrt{2}\right)$
$=4i^2\sqrt{3}-2i\sqrt{6}$
$=-4\sqrt{3}-2i\sqrt{6}$

43. $\left(3\sqrt{-5}\right)\left(-4\sqrt{-12}\right)=\left(3i\sqrt{5}\right)\left(-8i\sqrt{3}\right)$
$=-24i^2\sqrt{15}$
$=24\sqrt{15}$

44. $\left(3\sqrt{-7}\right)\left(2\sqrt{-8}\right)$
$=(3i\sqrt{7})(2i\sqrt{8})=(3i\sqrt{7})(2i\sqrt{4\cdot 2})$
$=\left(3i\sqrt{7}\right)\left(4i\sqrt{2}\right)=12i^2\sqrt{14}=-12\sqrt{14}$

45. $(2-3i)(1-i)-(3-i)(3+i)$
$=\left(2-2i-3i+3i^2\right)-\left(3^2-i^2\right)$
$=2-5i+3i^2-9+i^2$
$=-7-5i+4i^2$
$=-7-5i+4(-1)$
$=-11-5i$

46. $(8+9i)(2-i)-(1-i)(1+i)$
$=\left(16-8i+18i-9i^2\right)-\left(1^2-i^2\right)$
$=16+10i-9i^2-1+i^2$
$=15+10i-8i^2$
$=15+10i-8(-1)$
$=23+10i$

47. $(2+i)^2-(3-i)^2$
$=\left(4+4i+i^2\right)-\left(9-6i+i^2\right)$
$=4+4i+i^2-9+6i-i^2$
$=-5+10i$

48. $(4-i)^2-(1+2i)^2$
$=\left(16-8i+i^2\right)-\left(1+4i+4i^2\right)$
$=16-8i+i^2-1-4i-4i^2$
$=15-12i-3i^2$
$=15-12i-3(-1)$
$=18-12i$

49. $5\sqrt{-16}+3\sqrt{-81}$
$=5\sqrt{16}\sqrt{-1}+3\sqrt{81}\sqrt{-1}$
$=5\cdot 4i+3\cdot 9i$
$=20i+27i$
$=47i \quad \text{or} \quad 0+47i$

50. $5\sqrt{-8}+3\sqrt{-18}$
$=5\sqrt{4}\sqrt{2}\sqrt{-1}+3\sqrt{9}\sqrt{2}\sqrt{-1}$
$=5\cdot 2\sqrt{2}\,i+3\cdot 3\sqrt{2}\,i$
$=10i\sqrt{2}+9i\sqrt{2}$
$=(10+9)i\sqrt{2}$
$=19i\sqrt{2} \quad \text{or} \quad 0+19i\sqrt{2}$

51. $f(x)=x^2-2x+2$
$f(1+i)=(1+i)^2-2(1+i)+2$
$=1+2i+i^2-2-2i+2$
$=1+i^2$
$=1-1$
$=0$

52. $f(x)=x^2-2x+5$
$f(1-2i)=(1-2i)^2-2(1-2i)+5$
$=1-4i+4i^2-2+4i+5$
$=4+4i^2$
$=4-4$
$=0$

53. $f(x)=\dfrac{x^2+19}{2-x}$

$$f(3i)=\frac{(3i)^2+19}{2-3i}$$
$$=\frac{9i^2+19}{2-3i}$$
$$=\frac{-9+19}{2-3i}$$
$$=\frac{10}{2-3i}$$
$$=\frac{10}{2-3i}\cdot\frac{2+3i}{2+3i}$$
$$=\frac{20+30i}{4-9i^2}$$
$$=\frac{20+30i}{4+9}$$
$$=\frac{20+30i}{13}$$
$$=\frac{20}{13}+\frac{30}{13}i$$

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

$$f(4i)=\frac{(4i)^2+11}{3-4i}=\frac{16i^2+11}{3-4i}$$
$$=\frac{-16+11}{3-4i}$$
$$=\frac{-5}{3-4i}$$
$$=\frac{-5}{3-4i}\cdot\frac{3+4i}{3+4i}$$
$$=\frac{-15-20i}{9-16i^2}$$
$$=\frac{-15-20i}{9+16}$$
$$=\frac{-15-20i}{25}$$
$$=\frac{-15}{25}-\frac{20}{25}i$$
$$=-\frac{3}{5}-\frac{4}{5}i$$

55. $E=IR=(4-5i)(3+7i)$

$$=12+28i-15i-35i^2$$
$$=12+13i-35(-1)$$
$$=12+35+13i=47+13i$$

The voltage of the circuit is $(47 + 13i)$ volts.

56. $E=IR=(2-3i)(3+5i)$

$$=6+10i-9i-15i^2=6+i-15(-1)$$
$$=6+i+15=21+i$$

The voltage of the circuit is $(21+i)$ volts.

57. Sum:

$$(5+i\sqrt{15}\,)+(5-i\sqrt{15}\,)$$
$$=5+i\sqrt{15}\;+5-i\sqrt{15}$$
$$=5+5$$
$$=10$$

Product:

$$(5+i\sqrt{15}\,)(5-i\sqrt{15})$$
$$=25-5i\sqrt{15}+5i\sqrt{15}-15i^2$$
$$=25+15$$
$$=40$$

58. – 66. Answers will vary.

67. makes sense

68. does not make sense; Explanations will vary. Sample explanation: Imaginary numbers are not undefined.

69. does not make sense; Explanations will vary. Sample explanation: $i=\sqrt{-1}$; It is not a variable in this context.

70. makes sense

71. false; Changes to make the statement true will vary. A sample change is: All irrational numbers are complex numbers.

72. false; Changes to make the statement true will vary. A sample change is: $(3 + 7i)(3 – 7i) = 9 + 49 = 58$ which is a real number.

73. false; Changes to make the statement true will vary. A sample change is:

$$\frac{7+3i}{5+3i}=\frac{7+3i}{5+3i}\cdot\frac{5-3i}{5-3i}=\frac{44-6i}{34}=\frac{22}{17}-\frac{3}{17}i$$

74. true

75.
$$\begin{aligned}\frac{4}{(2+i)(3-i)} &= \frac{4}{6-2i+3i-i^2}\\ &= \frac{4}{6+i+1}\\ &= \frac{4}{7+i}\\ &= \frac{4}{7+i}\cdot\frac{7-i}{7-i}\\ &= \frac{28-4i}{49-i^2}\\ &= \frac{28-4i}{49+1}\\ &= \frac{28-4i}{50}\\ &= \frac{28}{50}-\frac{4}{50}i\\ &= \frac{14}{25}-\frac{2}{25}i\end{aligned}$$

76.
$$\begin{aligned}&\frac{1+i}{1+2i}+\frac{1-i}{1-2i}\\ &= \frac{(1+i)(1-2i)}{(1+2i)(1-2i)}+\frac{(1-i)(1+2i)}{(1+2i)(1-2i)}\\ &= \frac{(1+i)(1-2i)+(1-i)(1+2i)}{(1+2i)(1-2i)}\\ &= \frac{1-2i+i-2i^2+1+2i-i-2i^2}{1-4i^2}\\ &= \frac{1-2i+i+2+1+2i-i+2}{1+4}\\ &= \frac{6}{5}\\ &= \frac{6}{5}+0i\end{aligned}$$

77.
$$\begin{aligned}\frac{8}{1+\frac{2}{i}} &= \frac{8}{\frac{i}{i}+\frac{2}{i}}\\ &= \frac{8}{\frac{2+i}{i}}\\ &= \frac{8i}{2+i}\\ &= \frac{8i}{2+i}\cdot\frac{2-i}{2-i}\\ &= \frac{16i-8i^2}{4-i^2}\\ &= \frac{16i+8}{4+1}\\ &= \frac{8+16i}{5}\\ &= \frac{8}{5}+\frac{16}{5}i\end{aligned}$$

78. $2x^2+7x-4=(2x-1)(x+4)$

79. $x^2-6x+9=(x-3)(x-3)=(x-3)^2$

80.
$$\begin{aligned}\frac{-b-\sqrt{b^2-4ac}}{2a} &= \frac{-(9)-\sqrt{(9)^2-4(2)(-5)}}{2(2)}\\ &= \frac{-9-\sqrt{81+40}}{4}\\ &= \frac{-9-\sqrt{121}}{4}\\ &= \frac{-9-11}{4}\\ &= -5\end{aligned}$$

Section 1.5

Check Point Exercises

1. **a.** $3x^2 - 9x = 0$

$3x(x-3) = 0$

$3x = 0 \quad \text{or} \quad x - 3 = 0$

$x = 0 \qquad x = 3$

The solution set is $\{0, 3\}$.

b. $2x^2 + x = 1$

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

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

$2x - 1 = 0 \quad \text{or} \quad x + 1 = 0$

$2x = 1 \qquad x = -1$

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

The solution set is $\left\{-1, \frac{1}{2}\right\}$.

2. **a.** $3x^2 - 21 = 0$

$3x^2 = 21$

$\frac{3x^2}{3} = \frac{21}{3}$

$x^2 = 7$

$x = \pm\sqrt{7}$

The solution set is $\left\{-\sqrt{7}, \sqrt{7}\right\}$.

b. $5x^2 + 45 = 0$

$5x^2 = -45$

$x^2 = -9$

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

$x = \pm 3i$

The solution set is $\{-3i, 3i\}$.

c. $(x+5)^2 = 11$

$x + 5 = \pm\sqrt{11}$

$x = -5 \pm \sqrt{11}$

The solution set is $\left\{-5 + \sqrt{11}, -5 - \sqrt{11}\right\}$.

3. **a.** The coefficient of the x-term is 6. Half of 6 is 3, and 3^2 is 9.

9 should be added to the binomial.

$x^2 + 6x + 9 = (x+3)^2$

b. The coefficient of the x-term is –5.

Half of –5 is $-\frac{5}{2}$, and $\left(-\frac{5}{2}\right)^2$ is $\frac{25}{4}$.

$\frac{25}{4}$ should be added to the binomial.

$x^2 - 5x + \frac{25}{4} = \left(x - \frac{5}{2}\right)^2$

c. The coefficient of the x-term is $\frac{2}{3}$.

Half of $\frac{2}{3}$ is $\frac{1}{3}$, and $\left(\frac{1}{3}\right)^2$ is $\frac{1}{9}$.

$\frac{1}{9}$ should be added to the binomial.

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

4. $x^2 + 4x - 1 = 0$

$x^2 + 4x \quad = 1$

$x^2 + 4x + 4 = 1 + 4$

$(x+2)^2 = 5$

$x + 2 = \pm\sqrt{5}$

$x = -2 \pm \sqrt{5}$

The solution set is $\left\{-2 \pm \sqrt{5}\right\}$.

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

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

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

$x^2 + \frac{3}{2}x + \frac{9}{16} = 2 + \frac{9}{16}$

$\left(x + \frac{3}{4}\right)^2 = \frac{41}{16}$

$x + \frac{3}{4} = \pm\sqrt{\frac{41}{16}}$

$x + \frac{3}{4} = \pm\frac{\sqrt{41}}{4}$

$x = -\frac{3}{4} \pm \frac{\sqrt{41}}{4}$

$x = \frac{-3 \pm \sqrt{41}}{4}$

The solution set is $\left\{\frac{-3 \pm \sqrt{41}}{4}\right\}$.

6. $2x^2+9x-5=0$

$a=2, b=9, c=-5$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-9\pm\sqrt{9^2-4(2)(-5)}}{2(2)}$$
$$=\frac{-9\pm\sqrt{81+40}}{4}$$
$$=\frac{-9\pm\sqrt{121}}{4}$$
$$=\frac{-9\pm 11}{4}$$

$x=\frac{-9+11}{4}$ or $x=\frac{-9-11}{4}$

$x=\frac{2}{4}=\frac{1}{2}$ $\qquad x=\frac{-20}{4}=-5$

The solution set is $\left\{-5,\frac{1}{2}\right\}$.

7. $2x^2+2x-1=0$

$a=2, b=2, c=-1$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-2\pm\sqrt{2^2-4(2)(-1)}}{2(2)}$$
$$=\frac{-2\pm\sqrt{4+8}}{4}$$
$$=\frac{-2\pm\sqrt{12}}{4}$$
$$=\frac{-2\pm 2\sqrt{3}}{4}$$
$$=\frac{2(-1\pm\sqrt{3})}{4}$$
$$=\frac{-1\pm\sqrt{3}}{2}$$

The solution set is $\left\{\frac{-1\pm\sqrt{3}}{2}\right\}$.

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

$a=1, b=-2, c=2$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(2)}}{2(1)}$$
$$x=\frac{2\pm\sqrt{4-8}}{2}$$
$$x=\frac{2\pm\sqrt{-4}}{2}$$
$$x=\frac{2\pm 2i}{2}$$
$$x=1\pm i$$

The solution set is $\{1+i, 1-i\}$.

9. **a.** $a=1, \quad b=6, \quad c=9$

$$b^2-4ac=(6)^2-4(1)(9)$$
$$=36-36$$
$$=0$$

Since $b^2-4ac=0$, the equation has one real solution that is rational.

b. $a=2, \quad b=-7, \quad c=-4$

$$b^2-4ac=(-7)^2-4(2)(-4)$$
$$=49+32$$
$$=81$$

Since $b^2-4ac>0$, the equation has two real solutions. Since 81 is a perfect square, the two solutions are rational.

c. $a=3, \quad b=-2, \quad c=4$

$$b^2-4ac=(-2)^2-4(3)(4)$$
$$=4-48$$
$$=-44$$

Since $b^2-4ac<0$, the equation has two imaginary solutions that are complex conjugates.

10. $P = 0.01A^2 + 0.05A + 107$

$115 = 0.01A^2 + 0.05A + 107$

$0 = 0.01A^2 + 0.05A - 8$

$a = 0.01, \quad b = 0.05, \quad c = -8$

$$A = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$A = \frac{-(0.05) \pm \sqrt{(0.05)^2 - 4(0.01)(-8)}}{2(0.01)}$$

$$A = \frac{-0.05 \pm \sqrt{0.3225}}{0.02}$$

$$A \approx \frac{-0.05 + \sqrt{0.3225}}{0.02} \qquad A \approx \frac{-0.05 - \sqrt{0.3225}}{0.02}$$

$A \approx 26$ $\qquad$ $A \approx -31$

Age cannot be negative, reject the negative answer. Thus, a woman whose normal systolic blood pressure is 115 mm Hg is approximately 26 years old.

11. Let c = the screen's diagonal.

$a^2 + b^2 = c^2$

$19.2^2 + 25.6^2 = c^2$

$368.64 + 655.36 = c^2$

$1024 = c^2$

$c = \sqrt{1024}$ or $c = -\sqrt{1024}$

$c = 32$ $\qquad$ $c = -32$

The dimension must be positive. Reject –32. The size of the screen is 32 inches.

Concept and Vocabulary Check 1.5

1. quadratic

2. $A = 0$ or $B = 0$

3. x-intercepts

4. $\pm\sqrt{d}$

5. $\pm\sqrt{7}$

6. $\frac{9}{4}$

7. $\frac{4}{25}$

8. 9

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

10. $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

11. 2; 9; –5

12. 1; –4; –1

13. $2 \pm \sqrt{2}$

14. $-1 \pm i\frac{\sqrt{6}}{2}$

15. $b^2 - 4ac$

16. no

17. two

18. the square root property

19. the quadratic formula

20. factoring and the zero-product principle

21. right; hypotenuse; legs

22. right; legs; the square of the length of the hypotenuse

Exercise Set 1.5

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

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

$x + 2 = 0$ or $x - 5 = 0$

$x = -2$ or $x = 5$

The solution set is {–2, 5}.

2. $x^2 - 13x + 36 = 0$

$(x - 4)(x - 9) = 0$

$x - 4 = 0$ or $x - 9 = 0$

$x = 4$ or $x = 9$

The solution set is {4, 9}.

3. $x^2 = 8x - 15$

$x^2 - 8x + 15 = 0$

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

$x - 3 = 0$ or $x - 5 = 0$

$x = 3$ or $x = 5$

The solution set is {3, 5}.

4. $x^2 = -11x - 10$

$x^2 + 11x + 10 = 0$

$(x + 10)(x + 1) = 0$

$x + 10 = 0$ or $x + 1 = 0$

$x = -10$ or $x = -1$

The solution set is $\{-10, -1\}$.

5. $6x^2 + 11x - 10 = 0$

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

$2x + 5 = 0$ or $3x - 2 = 0$

$2x = -5$ $\quad 3x = 2$

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

The solution set is $\left\{-\frac{5}{2}, \frac{2}{3}\right\}$.

6. $9x^2 + 9x + 2 = 0$

$(3x + 2)(3x + 1) = 0$

$3x + 2 = 0$ or $3x + 1 = 0$

$x = -\frac{2}{3}$ or $x = -\frac{1}{3}$

The solution set is $\left\{-\frac{2}{3}, -\frac{1}{3}\right\}$.

7. $3x^2 - 2x = 8$

$3x^2 - 2x - 8 = 0$

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

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

$3x = -4$

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

The solution set is $\left\{-\frac{4}{3}, 2\right\}$.

8. $4x^2 - 13x = -3$

$4x^2 - 13x + 3 = 0$

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

$4x - 1 = 0$ or $x - 3 = 0$

$4x = 1$

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

The solution set is $\left\{\frac{1}{4}, 3\right\}$.

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

$3x(x + 4) = 0$

$3x = 0$ or $x + 4 = 0$

$x = 0$ or $x = -4$

The solution set is $\{-4, 0\}$.

10. $5x^2 - 20x = 0$

$5x(x - 4) = 0$

$5x = 0$ or $x - 4 = 0$

$x = 0$ or $x = 4$

The solution set is $\{0, 4\}$.

11. $2x(x - 3) = 5x^2 - 7x$

$2x^2 - 6x - 5x^2 + 7x = 0$

$-3x^2 + x = 0$

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

$x = 0$ or $-3x + 1 = 0$

$-3x = -1$

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

The solution set is $\left\{0, \frac{1}{3}\right\}$.

12. $16x(x - 2) = 8x - 25$

$16x^2 - 32x - 8x + 25 = 0$

$16x^2 - 40x + 25 = 0$

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

$4x - 5 = 0$

$4x = 5$

$x = \frac{5}{4}$

The solution set is $\left\{\frac{5}{4}\right\}$.

13. $7 - 7x = (3x + 2)(x - 1)$

$7 - 7x = 3x^2 - x - 2$

$7 - 7x - 3x^2 + x + 2 = 0$

$-3x^2 - 6x + 9 = 0$

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

$x + 3 = 0$ or $x - 1 = 0$

$x = -3$ or $x = 1$

The solution set is $\{-3, 1\}$.

14. $10x-1=(2x+1)^2$

$10x-1=4x^2+4x+1$

$10x-1-4x^2-4x-1=0$

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

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

$2x-1=0 \quad \text{or} \quad x-1=0$

$2x=1$

$x=\frac{1}{2} \quad \text{or} \quad x=1$

The solution set is $\left\{\frac{1}{2},1\right\}$.

15. $3x^2=27$

$x^2=9$

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

The solution set is $\{-3, 3\}$.

16. $5x^2=45$

$x^2=9$

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

The solution set is $\{-3, 3\}$.

17. $5x^2+1=51$

$5x^2=50$

$x^2=10$

$x=\pm\sqrt{10}$

The solution set is $\left\{-\sqrt{10},\sqrt{10}\right\}$.

18. $3x^2-1=47$

$3x^2=48$

$x^2=16$

$x=\pm\sqrt{16}=\pm 4$

The solution set is $\{-4, 4\}$.

19. $2x^2-5=-55$

$2x^2=-50$

$x^2=-25$

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

The solution set is $\{5i,-5i\}$.

20. $2x^2-7=-15$

$2x^2=-8$

$x^2=-4$

$x=\pm\sqrt{-4}=\pm 2i$

The solution set is $\{2i,-2i\}$.

21. $(x+2)^2=25$

$x+2=\pm\sqrt{25}$

$x+2=\pm 5$

$x=-2\pm 5$

$x=-2+5 \quad \text{or} \quad x=-2-5$

$x=3 \qquad\qquad x=-7$

The solution set is $\{-7,3\}$.

22. $(x-3)^2=36$

$x-3=\pm\sqrt{36}$

$x-3=\pm 6$

$x=3\pm 6$

$x=3+6 \quad \text{or} \quad x=3-6$

$x=9 \qquad\qquad x=-3$

The solution set is $\{-3,9\}$.

23. $3(x-4)^2=15$

$(x-4)^2=5$

$x-4=\pm\sqrt{5}$

$x=4\pm\sqrt{5}$

The solution set is $\left\{4+\sqrt{5},4-\sqrt{5}\right\}$.

24. $3(x+4)^2=21$

$(x+4)^2=7$

$x+4=\pm\sqrt{7}$

$x=-4\pm\sqrt{7}$

The solution set is $\left\{-4+\sqrt{7},-4-\sqrt{7}\right\}$.

25. $(x+3)^2=-16$

$x+3=\pm\sqrt{-16}$

$x+3=\pm 4i$

$x=-3\pm 4i$

The solution set is $\{-3+4i,-3-4i\}$.

26. $(x-1)^2=-9$

$x-1=\pm\sqrt{-9}$

$x-1=\pm 3i$

$x=1\pm 3i$

The solution set is $\{1+3i,1-3i\}$.

27. $(x-3)^2=-5$

$x-3=\pm\sqrt{-5}$

$x-3=\pm i\sqrt{5}$

$x=3\pm i\sqrt{5}$

The solution set is $\{3+i\sqrt{5},3-i\sqrt{5}\}$.

28. $(x+2)^2=-7$

$x+2=\pm\sqrt{-7}$

$x+2=\pm i\sqrt{7}$

$x=-2\pm i\sqrt{7}$

The solution set is $\{-2+i\sqrt{7},-2-i\sqrt{7}\}$.

29. $(3x+2)^2=9$

$3x+2=\pm\sqrt{9}=\pm 3$

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

$3x=-5$ $\quad$ $3x=1$

$x=-\frac{5}{3}$ or $x=\frac{1}{3}$

The solution set is $\left\{-\frac{5}{3},\frac{1}{3}\right\}$.

30. $(4x-1)^2=16$

$4x-1=\pm\sqrt{16}=\pm 4$

$4x-1=-4$ or $4x-1=4$

$4x=-3$ $\quad$ $4x=5$

$x=\frac{-3}{4}$ or $x=\frac{5}{4}$

The solution set is $\left\{-\frac{3}{4},\frac{5}{4}\right\}$.

31. $(5x-1)^2=7$

$5x-1=\pm\sqrt{7}$

$5x=1\pm\sqrt{7}$

$x=\frac{1\pm\sqrt{7}}{5}$

The solution set is $\left\{\frac{1-\sqrt{7}}{5},\frac{1+\sqrt{7}}{5}\right\}$.

32. $(8x-3)^2=5$

$8x-3=\pm\sqrt{5}$

$8x=3\pm\sqrt{5}$

$x=\frac{3\pm\sqrt{5}}{8}$

The solution set is $\left\{\frac{3-\sqrt{5}}{8},\frac{3+\sqrt{5}}{8}\right\}$.

33. $(3x-4)^2=8$

$3x-4=\pm\sqrt{8}=\pm 2\sqrt{2}$

$3x=4\pm 2\sqrt{2}$

$x=\frac{4\pm 2\sqrt{2}}{3}$

The solution set is $\left\{\frac{4-2\sqrt{2}}{3},\frac{4+2\sqrt{2}}{3}\right\}$.

34. $(2x+8)^2=27$

$2x+8=\pm\sqrt{27}=\pm 3\sqrt{3}$

$2x=-8+3\sqrt{3}$

$x=\frac{-8\pm 3\sqrt{3}}{2}$

The solution set is $\left\{\frac{-8-3\sqrt{3}}{2},\frac{-8+3\sqrt{3}}{2}\right\}$.

35. x^2+12x

$\left(\frac{12}{2}\right)^2=6^2=36$

$x^2+12x+36=(x+6)^2$

36. x^2+16x

$\left(\frac{16}{2}\right)^2=8^2=64;$

$x^2+16x+64=(x+8)^2$

37. x^2-10x

$\left(\frac{10}{2}\right)^2=5^2=25$

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

38. $x^2 - 14x$

$\left(\frac{-14}{2}\right)^2 = (-7)^2 = 49;$

$x^2 - 14x + 49 = (x-7)^2$

39. $x^2 + 3x$

$\left(\frac{3}{2}\right)^2 = \frac{9}{4}$

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

40. $x^2 + 5x$

$\left(\frac{5}{2}\right)^2 = \frac{25}{4};$

$x^2 + 5x + \frac{25}{4} = \left(x + \frac{5}{2}\right)^2$

41. $x^2 - 7x$

$\left(\frac{7}{2}\right)^2 = \frac{49}{4}$

$x^2 - 7x + \frac{49}{4} = \left(x - \frac{7}{2}\right)^2$

42. $x^2 - 9x$

$\left(\frac{-9}{2}\right)^2 = \frac{81}{4};$

$x^2 - 9x + \frac{81}{4} = \left(x - \frac{9}{2}\right)^2$

43. $x^2 - \frac{2}{3}x$

$\left(\frac{\frac{2}{3}}{2}\right)^2 = \left(\frac{1}{3}\right)^2 = \frac{1}{9}$

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

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

$\left(\frac{\frac{4}{5}}{2}\right)^2 = \left(\frac{2}{5}\right)^2 = \frac{4}{25};$

$x^2 + \frac{4}{5}x + \frac{4}{25} = \left(x + \frac{2}{5}\right)^2$

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

$\left(\frac{\frac{1}{3}}{2}\right)^2 = \left(\frac{1}{6}\right)^2 = \frac{1}{36}$

$x^2 - \frac{1}{3}x + \frac{1}{36} = \left(x - \frac{1}{6}\right)^2$

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

$\left(\frac{\frac{-1}{4}}{2}\right)^2 = \left(\frac{-1}{8}\right)^2 = \frac{1}{64};$

$x^2 - \frac{1}{4}x + \frac{1}{64} = \left(x - \frac{1}{8}\right)^2$

47. $x^2 + 6x = 7$

$x^2 + 6x + 9 = 7 + 9$

$(x+3)^2 = 16$

$x + 3 = \pm 4$

$x = -3 \pm 4$

The solution set is $\{-7, 1\}$.

48. $x^2 + 6x = -8$

$x^2 + 6x + 9 = -8 + 9$

$(x+3)^2 = 1$

$x + 3 = \pm 1$

$x = -3 \pm 1$

The solution set is $\{-4, -2\}$.

49. $x^2 - 2x = 2$

$x^2 - 2x + 1 = 2 + 1$

$(x-1)^2 = 3$

$x - 1 = \pm\sqrt{3}$

$x = 1 \pm \sqrt{3}$

The solution set is $\left\{1+\sqrt{3}, 1-\sqrt{3}\right\}$.

50. $x^2 + 4x = 12$

$x^2 + 4x + 4 = 12 + 4$

$(x+2)^2 = 16$

$x + 2 = \pm 4$

$x = -2 \pm 4$

The solution set is $\{-6, 2\}$.

51. $x^2 - 6x - 11 = 0$

$x^2 - 6x = 11$

$x^2 - 6x + 9 = 11 + 9$

$(x-3)^2 = 20$

$x - 3 = \pm\sqrt{20}$

$x = 3 \pm 2\sqrt{5}$

The solution set is $\left\{3 + 2\sqrt{5}, 3 - 2\sqrt{5}\right\}$.

52. $x^2 - 2x - 5 = 0$

$x^2 - 2x = 5$

$x^2 - 2x + 1 = 5 + 1$

$(x-1)^2 = 6$

$x - 1 = \pm\sqrt{6}$

$x = 1 \pm \sqrt{6}$

The solution set is $\left\{1 + \sqrt{6}, 1 - \sqrt{6}\right\}$.

53. $x^2 + 4x + 1 = 0$

$x^2 + 4x = -1$

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

$(x+2)^2 = 3$

$x + 2 = \pm\sqrt{3}$

$x = -2 \pm \sqrt{3}$

The solution set is $\left\{-2 + \sqrt{3}, -2 - \sqrt{3}\right\}$.

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

$x^2 + 6x = 5$

$x^2 + 6x + 9 = 5 + 9$

$(x+3)^2 = 14$

$x + 3 = \pm\sqrt{14}$

$x = -3 \pm \sqrt{14}$

The solution set is $\left\{-3 + \sqrt{14}, -3 - \sqrt{14}\right\}$.

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

$x^2 - 5x = -6$

$x^2 - 5x + \frac{25}{4} = -6 + \frac{25}{4}$

$\left(x - \frac{5}{2}\right)^2 = \frac{1}{4}$

$x - \frac{5}{2} = \pm\sqrt{\frac{1}{4}}$

$x - \frac{5}{2} = \pm\frac{1}{2}$

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

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

$x = 3$ $\quad$ $x = 2$

The solution set is {2, 3}.

56. $x^2 + 7x - 8 = 0$

$x^2 + 7x = 8$

$x^2 + 7x + \frac{49}{4} = 8 + \frac{49}{4}$

$\left(x + \frac{7}{2}\right)^2 = \frac{81}{4}$

$x + \frac{7}{2} = \pm\sqrt{\frac{81}{4}}$

$x + \frac{7}{2} = \pm\frac{9}{2}$

$x = -\frac{7}{2} \pm \frac{9}{2}$

$x = -\frac{7}{2} + \frac{9}{2}$ or $x = -\frac{7}{2} - \frac{9}{2}$

$x = 1$ $\quad$ $x = -8$

The solution set is {–8, 1}.

57. $x^2 + 3x - 1 = 0$

$x^2 + 3x = 1$

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

$\left(x + \frac{3}{2}\right)^2 = \frac{13}{4}$

$x + \frac{3}{2} = \pm\frac{\sqrt{13}}{2}$

$x = \frac{-3 \pm \sqrt{13}}{2}$

The solution set is $\left\{\frac{-3 + \sqrt{13}}{2}, \frac{-3 - \sqrt{13}}{2}\right\}$.

58. $x^2 - 3x - 5 = 0$

$$x^2 - 3x = 5$$

$$x^2 - 3x + \frac{9}{4} = 5 + \frac{9}{4}$$

$$\left(x - \frac{3}{2}\right)^2 = \frac{29}{4}$$

$$x - \frac{3}{2} = \frac{\pm\sqrt{29}}{2}$$

$$x = \frac{3 \pm \sqrt{29}}{2}$$

The solution set is $\left\{\frac{3+\sqrt{29}}{2}, \frac{3-\sqrt{29}}{2}\right\}$.

59. $2x^2 - 7x + 3 = 0$

$$x^2 - \frac{7}{2}x + \frac{3}{2} = 0$$

$$x^2 - \frac{7}{2}x = \frac{-3}{2}$$

$$x^2 - \frac{7}{2}x + \frac{49}{16} = -\frac{3}{2} + \frac{49}{16}$$

$$\left(x - \frac{7}{4}\right)^2 = \frac{25}{16}$$

$$x - \frac{7}{4} = \pm\frac{5}{4}$$

$$x = \frac{7}{4} \pm \frac{5}{4}$$

The solution set is $\left\{\frac{1}{2}, 3\right\}$.

60. $2x^2 + 5x - 3 = 0$

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

$$x^2 + \frac{5}{2}x = \frac{3}{2}$$

$$x^2 + \frac{5}{2}x + \frac{25}{16} = \frac{3}{2} + \frac{25}{16}$$

$$\left(x + \frac{5}{4}\right)^2 = \frac{49}{16}$$

$$x + \frac{5}{4} = \pm\frac{7}{4}$$

$$x = -\frac{5}{4} \pm \frac{7}{4}$$

$$x = \frac{1}{2}; -3$$

The solution set is $\left\{-3, \frac{1}{2}\right\}$.

61. $4x^2 - 4x - 1 = 0$

$$4x^2 - 4x - 1 = 0$$

$$x^2 - x - \frac{1}{4} = 0$$

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

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

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

$$x - \frac{1}{2} = \frac{\pm\sqrt{2}}{2}$$

$$x = \frac{1 \pm \sqrt{2}}{2}$$

The solution set is $\left\{\frac{1+\sqrt{2}}{2}, \frac{1-\sqrt{2}}{2}\right\}$.

62. $2x^2 - 4x - 1 = 0$

$$x^2 - 2x - \frac{1}{2} = 0$$

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

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

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

$$x - 1 = \pm\sqrt{\frac{3}{2}}$$

$$x = 1 \pm \frac{\sqrt{6}}{2}$$

$$x = \frac{2 \pm \sqrt{6}}{2}$$

The solution set is $\left\{\frac{2+\sqrt{6}}{2}, \frac{2-\sqrt{6}}{2}\right\}$.

63. $3x^2 - 2x - 2 = 0$

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

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

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

$$\left(x - \frac{1}{3}\right)^2 = \frac{7}{9}$$

$$x - \frac{1}{3} = \frac{\pm\sqrt{7}}{3}$$

$$x = \frac{1 \pm \sqrt{7}}{3}$$

The solution set is $\left\{\frac{1+\sqrt{7}}{3}, \frac{1-\sqrt{7}}{3}\right\}$.

64. $3x^2 - 5x - 10 = 0$

$$x^2 - \frac{5}{3}x - \frac{10}{3} = 0$$

$$x^2 - \frac{5}{3}x = \frac{10}{3}$$

$$x^2 - \frac{5}{3}x + \frac{25}{36} = \frac{10}{3} + \frac{25}{36}$$

$$\left(x - \frac{5}{6}\right)^2 = \frac{145}{36}$$

$$x - \frac{5}{6} = \frac{\pm\sqrt{145}}{6}$$

$$x = \frac{5 \pm \sqrt{145}}{6}$$

The solution set is $\left\{\frac{5+\sqrt{145}}{6}, \frac{5-\sqrt{145}}{6}\right\}$.

65. $x^2 + 8x + 15 = 0$

$$x = \frac{-8 \pm \sqrt{8^2 - 4(1)(15)}}{2(1)}$$

$$x = \frac{-8 \pm \sqrt{64 - 60}}{2}$$

$$x = \frac{-8 \pm \sqrt{4}}{2}$$

$$x = \frac{-8 \pm 2}{2}$$

The solution set is $\{-5, -3\}$.

66. $x^2 + 8x + 12 = 0$

$$x = \frac{-8 \pm \sqrt{8^2 - 4(1)(12)}}{2(1)}$$

$$x = \frac{-8 \pm \sqrt{64 - 48}}{2}$$

$$x = \frac{-8 \pm \sqrt{16}}{2}$$

$$x = \frac{-8 \pm 4}{2}$$

The solution set is $\{-6, -2\}$.

67. $x^2+5x+3=0$

$$x=\frac{-5\pm\sqrt{5^2-4(1)(3)}}{2(1)}$$

$$x=\frac{-5\pm\sqrt{25-12}}{2}$$

$$x=\frac{-5\pm\sqrt{13}}{2}$$

The solution set is $\left\{\frac{-5+\sqrt{13}}{2},\frac{-5-\sqrt{13}}{2}\right\}$.

68. $x^2+5x+2=0$

$$x=\frac{-5\pm\sqrt{5^2-4(1)(2)}}{2(1)}$$

$$x=\frac{-5\pm\sqrt{25-8}}{2}$$

$$x=\frac{-5\pm\sqrt{17}}{2}$$

The solution set is $\left\{\frac{-5+\sqrt{17}}{2},\frac{-5-\sqrt{17}}{2}\right\}$.

69. $3x^2-3x-4=0$

$$x=\frac{3\pm\sqrt{(-3)^2-4(3)(-4)}}{2(3)}$$

$$x=\frac{3\pm\sqrt{9+48}}{6}$$

$$x=\frac{3\pm\sqrt{57}}{6}$$

The solution set is $\left\{\frac{3+\sqrt{57}}{6},\frac{3-\sqrt{57}}{6}\right\}$.

70. $5x^2+x-2=0$

$$x=\frac{-1\pm\sqrt{1^2-4(5)(-2)}}{2(5)}$$

$$x=\frac{-1\pm\sqrt{1+40}}{10}$$

$$x=\frac{-1\pm\sqrt{41}}{10}$$

The solution set is $\left\{\frac{-1+\sqrt{41}}{10},\frac{-1-\sqrt{41}}{10}\right\}$.

71. $4x^2=2x+7$

$$4x^2-2x-7=0$$

$$x=\frac{2\pm\sqrt{(-2)^2-4(4)(-7)}}{2(4)}$$

$$x=\frac{2\pm\sqrt{4+112}}{8}$$

$$x=\frac{2\pm\sqrt{116}}{8}$$

$$x=\frac{2\pm2\sqrt{29}}{8}$$

$$x=\frac{1\pm\sqrt{29}}{4}$$

The solution set is $\left\{\frac{1+\sqrt{29}}{4},\frac{1-\sqrt{29}}{4}\right\}$.

72. $3x^2=6x-1$

$$3x^2-6x+1=0$$

$$x=\frac{6\pm\sqrt{(-6)^2-4(3)(1)}}{2(3)}$$

$$x=\frac{6\pm\sqrt{36-12}}{6}$$

$$x=\frac{6\pm\sqrt{24}}{6}$$

$$x=\frac{6\pm2\sqrt{6}}{6}$$

$$x=\frac{3\pm\sqrt{6}}{3}$$

The solution set is $\left\{\frac{3+\sqrt{6}}{3},\frac{3-\sqrt{6}}{3}\right\}$.

73. $x^2-6x+10=0$

$$x=\frac{6\pm\sqrt{(-6)^2-4(1)(10)}}{2(1)}$$

$$x=\frac{6\pm\sqrt{36-40}}{2}$$

$$x=\frac{6\pm\sqrt{-4}}{2}$$

$$x=\frac{6\pm2i}{2}$$

$$x=3\pm i$$

The solution set is $\{3+i,3-i\}$.

74. $x^2 - 2x + 17 = 0$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(1)(17)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{4 - 68}}{2}$$

$$x = \frac{2 \pm \sqrt{-64}}{2}$$

$$x = \frac{2 \pm 8i}{2}$$

$$x = 1 \pm 4i$$

The solution set is $\{1 + 4i, 1 - 4i\}$.

75. $x^2 - 4x - 5 = 0$

$(-4)^2 - 4(1)(-5)$

= 16 + 20

= 36; 2 unequal real solutions

76. $4x^2 - 2x + 3 = 0$

$(-2)^2 - 4(4)(3)$

= 4 – 48

= –44; 2 complex imaginary solutions

77. $2x^2 - 11x + 3 = 0$

$(-11)^2 - 4(2)(3)$

= 121 – 24

= 97; 2 unequal real solutions

78. $2x^2 + 11x - 6 = 0$

$11^2 - 4(2)(-6)$

= 121 + 48

= 169; 2 unequal real solutions

79. $x^2 - 2x + 1 = 0$

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

= 4 – 4

= 0; 1 real solution

80. $3x^2 = 2x - 1$

$3x^2 - 2x + 1 = 0$

$(-2)^2 - 4(3)(1)$

= 4 – 12

= –8; 2 complex imaginary solutions

81. $x^2 - 3x - 7 = 0$

$(-3)^2 - 4(1)(-7)$

= 9 + 28

= 37; 2 unequal real solutions

82. $3x^2 + 4x - 2 = 0$

$4^2 - 4(3)(-2)$

= 16 + 24

= 40; 2 unequal real solutions

83. $2x^2 - x = 1$

$2x^2 - x - 1 = 0$

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

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

$2x = -1$

$x = -\frac{1}{2}$ or $x = 1$

The solution set is $\left\{-\frac{1}{2}, 1\right\}$.

84. $3x^2 - 4x = 4$

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

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

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

$3x = -2$

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

The solution set is $\left\{-\frac{2}{3}, 2\right\}$.

85. $5x^2 + 2 = 11x$

$5x^2 - 11x + 2 = 0$

$(5x - 1)(x - 2) = 0$

$5x - 1 = 0$ or $x - 2 = 0$

$5x = 1$

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

The solution set is $\left\{\frac{1}{5}, 2\right\}$.

86. $5x^2 = 6 - 13x$

$5x^2 + 13x - 6 = 0$

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

$5x - 2 = 0$ or $x + 3$

$5x = 2$

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

The solution set is $\left\{-3, \frac{2}{5}\right\}$.

87. $3x^2 = 60$

$x^2 = 20$

$x = \pm\sqrt{20}$

$x = \pm 2\sqrt{5}$

The solution set is $\{-2\sqrt{5}, 2\sqrt{5}\}$.

88. $2x^2 = 250$

$x^2 = 125$

$x = \pm\sqrt{125}$

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

The solution set is $\{-5\sqrt{5}, 5\sqrt{5}\}$.

89. $x^2 - 2x = 1$

$x^2 - 2x + 1 = 1 + 1$

$(x-1)^2 = 2$

$x - 1 = \pm\sqrt{2}$

$x = 1 \pm \sqrt{2}$

The solution set is $\{1+\sqrt{2}, 1-\sqrt{2}\}$.

90. $2x^2 + 3x = 1$

$2x^2 + 3x - 1 = 0$

$x = \dfrac{-3 \pm \sqrt{3^2 - 4(2)(-1)}}{2(2)}$

$x = \dfrac{-3 \pm \sqrt{9+8}}{4}$

$x = \dfrac{-3 \pm \sqrt{17}}{4}$

The solution set is $\left\{\dfrac{-3+\sqrt{17}}{4}, \dfrac{-3-\sqrt{17}}{4}\right\}$.

91. $(2x+3)(x+4) = 1$

$2x^2 + 8x + 3x + 12 = 1$

$2x^2 + 11x + 11 = 0$

$x = \dfrac{-11 \pm \sqrt{11^2 - 4(2)(11)}}{2(2)}$

$x = \dfrac{-11 \pm \sqrt{121 - 88}}{4}$

$x = \dfrac{-11 \pm \sqrt{33}}{4}$

The solution set is $\left\{\dfrac{-11+\sqrt{33}}{4}, \dfrac{-11-\sqrt{33}}{4}\right\}$.

92. $(2x-5)(x+1) = 2$

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

$2x^2 - 3x - 7 = 0$

$x = \dfrac{3 \pm \sqrt{(-3)^2 - 4(2)(-7)}}{2(2)}$

$x = \dfrac{3 \pm \sqrt{9+56}}{4}$

$x = \dfrac{3 \pm \sqrt{65}}{4}$

The solution set is $\left\{\dfrac{3+\sqrt{65}}{4}, \dfrac{3-\sqrt{65}}{4}\right\}$.

93. $(3x-4)^2 = 16$

$3x - 4 = \pm\sqrt{16}$

$3x - 4 = \pm 4$

$3x = 4 \pm 4$

$3x = 8$ or $3x = 0$

$x = \dfrac{8}{3}$ or $x = 0$

The solution set is $\left\{0, \dfrac{8}{3}\right\}$.

94. $(2x+7)^2 = 25$

$2x + 7 = \pm 5$

$2x = -7 \pm 5$

$2x = -12$ or $2x = -2$

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

The solution set is $\{-6, -1\}$.

95. $3x^2 - 12x + 12 = 0$

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

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

$x - 2 = 0$

$x = 2$

The solution set is $\{2\}$.

96. $9 - 6x + x^2 = 0$

$x^2 - 6x + 9 = 0$

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

$x - 3 = 0$

$x = 3$

The solution set is $\{3\}$.

97. $4x^2 - 16 = 0$

$4x^2 = 16$

$x^2 = 4$

$x = \pm 2$

The solution set is $\{-2, 2\}$.

98. $3x^2 - 27 = 0$

$3x^2 = 27$

$x^2 = 9$

$x = \pm 3$

The solution set is $\{-3, 3\}$.

99. $x^2 - 6x + 13 = 0$

$x^2 - 6x = -13$

$x^2 - 6x + 9 = -13 + 9$

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

$x - 3 = \pm 2i$

$x = 3 \pm 2i$

The solution set is $\{3 + 2i, 3 - 2i\}$.

100. $x^2 - 4x + 29 = 0$

$x^2 - 4x = -29$

$x^2 - 4x + 4 = -29 + 4$

$(x-2)^2 = -25$

$x - 2 = \pm 5i$

$x = 2 \pm 5i$

The solution set is $\{2 + 5i, 2 - 5i\}$.

101. $x^2 = 4x - 7$

$x^2 - 4x = -7$

$x^2 - 4x + 4 = -7 + 4$

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

$x - 2 = \pm i\sqrt{3}$

$x = 2 \pm i\sqrt{3}$

The solution set is $\{2 + i\sqrt{3}, 2 - i\sqrt{3}\}$.

102. $5x^2 = 2x - 3$

$5x^2 - 2x + 3 = 0$

$$x = \frac{2 \pm \sqrt{(-2)^2 - 4(5)(3)}}{2(5)}$$

$$x = \frac{2 \pm \sqrt{4 - 60}}{10}$$

$$x = \frac{2 \pm \sqrt{-56}}{10}$$

$$x = \frac{2 \pm 2i\sqrt{14}}{10}$$

$$x = \frac{1 \pm i\sqrt{14}}{5}$$

The solution set is $\left\{\frac{1 + i\sqrt{14}}{5}, \frac{1 - i\sqrt{14}}{5}\right\}$.

103. $2x^2 - 7x = 0$

$x(2x - 7) = 0$

$x = 0$ or $2x - 7 = 0$

$2x = 7$

$x = 0$ or $x = \frac{7}{2}$

The solution set is $\left\{0, \frac{7}{2}\right\}$.

104. $2x^2 + 5x = 3$

$2x^2 + 5x - 3 = 0$

$$x = \frac{-5 \pm \sqrt{5^2 - 4(2)(-3)}}{2(2)}$$

$$x = \frac{-5 \pm \sqrt{25 + 24}}{4}$$

$$x = \frac{-5 \pm \sqrt{49}}{4}$$

$$x = \frac{-5 \pm 7}{4}$$

$x = -3, \frac{1}{2}$

The solution set is $\left\{-3, \frac{1}{2}\right\}$.

105. $\frac{1}{x}+\frac{1}{x+2}=\frac{1}{3}; x\neq 0,-2$

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

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

$x=\frac{-(-4)\pm\sqrt{(-4)^2-4(1)(-6)}}{2(1)}$

$x=\frac{4\pm\sqrt{16+24}}{2}$

$x=\frac{4\pm\sqrt{40}}{2}$

$x=\frac{4\pm 2\sqrt{10}}{2}$

$x=2\pm\sqrt{10}$

The solution set is $\{2+\sqrt{10},\ 2-\sqrt{10}\}$.

106. $\frac{1}{x}+\frac{1}{x+3}=\frac{1}{4}; x\neq 0,-3$

$4x+12+4x=x^2+3x$

$0=x^2-5x-12$

$x=\frac{-(-5)\pm\sqrt{(-5)^2-4(1)(-12)}}{2(1)}$

$x=\frac{5\pm\sqrt{25+48}}{2}$

$x=\frac{5\pm\sqrt{73}}{2}$

The solution set is $\left\{\frac{5+\sqrt{73}}{2},\frac{5-\sqrt{73}}{2}\right\}$.

107. $\frac{2x}{x-3}+\frac{6}{x+3}=\frac{-28}{x^2-9}; x\neq 3,-3$

$2x(x+3)+6(x-3)=-28$

$2x^2+6x+6x-18=-28$

$2x^2+12x+10=0$

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

$(x+1)(x+5)=0$

The solution set is $\{-5,\ -1\}$.

108. $\frac{3}{x-3}+\frac{5}{x-4}=\frac{x^2-20}{x^2-7x+12}; x\neq 3,4$

$3x-12+5x-15=x^2-20$

$0=x^2-8x+7$

$0=(x-7)(x-1)$

$x=7 \qquad x=1$

The solution set is $\{1, 7\}$.

109. $x^2-4x-5=0$

$(x+1)(x-5)=0$

$x+1=0$ or $x-5=0$

$x=-1 \qquad x=5$

This equation matches graph (d).

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

$a=1, \quad b=-6, \quad c=7$

$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$x=\frac{-(-6)\pm\sqrt{(-6)^2-4(1)(7)}}{2(1)}$

$x=\frac{6\pm\sqrt{8}}{2}$

$x=3\pm\sqrt{2}$

$x\approx 1.6, \quad x\approx 4.4$

This equation matches graph (a).

111. $0=-(x+1)^2+4$

$(x+1)^2=4$

$x+1=\pm 2$

$x=-1\pm 2$

$x=-3, \quad x=1$

This equation matches graph (f).

112. $0=-(x+3)^2+1$

$(x+3)^2=1$

$x+3=\pm 1$

$x=-3\pm 1$

$x=-4, \quad x=-2$

This equation matches graph (e).

113. $x^2 - 2x + 2 = 0$

$a = 1, \quad b = -2, \quad c = 2$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(2)}}{2(1)}$$

$$x = \frac{2 \pm \sqrt{-4}}{2}$$

$$x = \frac{2 \pm 2i}{2}$$

$$x = 1 \pm i$$

This equation has no real roots. Thus, its equation has no x-intercepts. This equation matches graph (b).

114. $x^2 + 6x + 9 = 0$

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

$x + 3 = 0$

$x = -3$

This equation matches graph (c).

115. $y = 2x^2 - 3x$

$2 = 2x^2 - 3x$

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

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

$$x = -\frac{1}{2}, \quad x = 2$$

116. $y = 5x^2 + 3x$

$2 = 5x^2 + 3x$

$0 = 5x^2 + 3x - 2$

$0 = (x+1)(5x-2)$

$$x = -1, \quad x = \frac{2}{5}$$

117. $y_1 y_2 = 14$

$(x-1)(x+4) = 14$

$x^2 + 3x - 4 = 14$

$x^2 + 3x - 18 = 0$

$(x+6)(x-3) = 0$

$x = -6, \quad x = 3$

118. $y_1 y_2 = -30$

$(x-3)(x+8) = -30$

$x^2 + 5x - 24 = -30$

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

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

$x = -3, \quad x = -2$

119. $y_1 + y_2 = 1$

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

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

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

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

$$2x^2 + 8x + 3x + 6 = x^2 + 6x + 8$$

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

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(5) \pm \sqrt{(5)^2 - 4(1)(-2)}}{2(1)}$$

$$x = \frac{-5 \pm \sqrt{33}}{2}$$

The solution set is $\left\{\frac{-5+\sqrt{33}}{2}, \frac{-5-\sqrt{33}}{2}\right\}$.

120. $y_1 + y_2 = 3$

$$\frac{3}{x-1} + \frac{8}{x} = 3$$

$$x(x-1)\left(\frac{3}{x-1} + \frac{8}{x}\right) = 3(x)(x-1)$$

$$\frac{3x(x-1)}{x-1} + \frac{8x(x-1)}{x} = 3x(x-1)$$

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

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

$$11x - 8 = 3x^2 - 3x$$

$$0 = 3x^2 - 14x + 8$$

$$0 = (3x-2)(x-4)$$

$$x = \frac{2}{3}, \quad x = 4$$

The solution set is $\left\{\frac{2}{3}, 4\right\}$.

121. $y_1 - y_2 = 0$

$$\left(2x^2+5x-4\right)-\left(-x^2+15x-10\right)=0$$

$$2x^2+5x-4+x^2-15x+10=0$$

$$3x^2-10x+6=0$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(-10)\pm\sqrt{(-10)^2-4(3)(6)}}{2(3)}$$

$$x=\frac{10\pm\sqrt{28}}{6}$$

$$x=\frac{10\pm2\sqrt{7}}{6}$$

$$x=\frac{5\pm\sqrt{7}}{3}$$

The solution set is $\left\{\frac{5+\sqrt{7}}{3},\frac{5-\sqrt{7}}{3}\right\}$.

122. $y_1 - y_2 = 0$

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

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

$$2x^2+3x-1=0$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(3)\pm\sqrt{(3)^2-4(2)(-1)}}{2(2)}$$

$$x=\frac{-3\pm\sqrt{17}}{4}$$

The solution set is $\left\{\frac{-3+\sqrt{17}}{4},\frac{-3-\sqrt{17}}{4}\right\}$.

123. Values that make the denominator zero must be excluded**.**

$$2x^2+4x-9=0$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(4)\pm\sqrt{(4)^2-4(2)(-9)}}{2(2)}$$

$$x=\frac{-4\pm\sqrt{88}}{4}$$

$$x=\frac{-4\pm2\sqrt{22}}{4}$$

$$x=\frac{-2\pm\sqrt{22}}{2}$$

124. Values that make the denominator zero must be excluded**.**

$$2x^2-8x+5=0$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(-8)\pm\sqrt{(-8)^2-4(2)(5)}}{2(2)}$$

$$x=\frac{8\pm\sqrt{24}}{4}$$

$$x=\frac{8\pm2\sqrt{6}}{4}$$

$$x=\frac{4\pm\sqrt{6}}{2}$$

125. $x^2-(6+2x)=0$

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

Apply the quadratic formula.

$a=1 \quad b=-2 \quad c=-6$

$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(-6)}}{2(1)}$$

$$=\frac{2\pm\sqrt{4-(-24)}}{2}$$

$$=\frac{2\pm\sqrt{28}}{2}$$

$$=\frac{2\pm\sqrt{4\cdot7}}{2}=\frac{2\pm2\sqrt{7}}{2}=1\pm\sqrt{7}$$

We disregard $1-\sqrt{7}$ because it is negative, and we are looking for a positive number.

Thus, the number is $1+\sqrt{7}$.

126. Let x = the number.

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

Apply the quadratic formula.

$a=2 \quad b=-2 \quad c=-1$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(2)(-1)}}{2(2)}$$
$$=\frac{2\pm\sqrt{4-(-8)}}{4}$$
$$=\frac{2\pm\sqrt{12}}{4}=\frac{2\pm\sqrt{4\cdot3}}{4}=\frac{2\pm2\sqrt{3}}{4}=\frac{1\pm\sqrt{3}}{2}$$

We disregard $\frac{1+\sqrt{3}}{2}$ because it is positive, and we are looking for a negative number. The number is $\frac{1-\sqrt{3}}{2}$.

127.

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

Multiply both sides of the equation by the least common denominator, $(x-1)(x-2)(x+2)$. This results in the following:

$$x+2=(x-1)(x-2)+5(x-1)$$
$$x+2=x^2-2x-x+2+5x-5$$
$$x+2=x^2+2x-3$$
$$0=x^2+x-5$$

Apply the quadratic formula:

$a=1 \quad b=1 \quad c=-5$.

$$x=\frac{-1\pm\sqrt{1^2-4(1)(-5)}}{2(1)}=\frac{-1\pm\sqrt{1-(-20)}}{2}$$
$$=\frac{-1\pm\sqrt{21}}{2}$$

The solutions are $\frac{-1\pm\sqrt{21}}{2}$, and the solution set is $\left\{\frac{-1\pm\sqrt{21}}{2}\right\}$.

128.

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

Multiply both sides of the equation by the least common denominator, $(x-2)(x-3)$. This results in the following:

$$(x-3)(x-1)+x(x-2)=1$$
$$x^2-x-3x+3+x^2-2x=1$$
$$2x^2-6x+3=1$$
$$2x^2-6x+2=0$$

Apply the quadratic formula:

$a=2 \quad b=-6 \quad c=2$.

$$x=\frac{-(-6)\pm\sqrt{(-6)^2-4(2)(2)}}{2(2)}$$
$$=\frac{6\pm\sqrt{36-16}}{4}=\frac{6\pm\sqrt{20}}{4}$$
$$=\frac{6\pm\sqrt{4\cdot5}}{4}=\frac{6\pm2\sqrt{5}}{4}$$
$$=\frac{3\pm\sqrt{5}}{2}$$

The solutions are $\frac{3\pm\sqrt{5}}{2}$, and the solution set is $\left\{\frac{3\pm\sqrt{5}}{2}\right\}$.

129. $\sqrt{2}x^2+3x-2\sqrt{2}=0$

Apply the quadratic formula:

$a=\sqrt{2} \quad b=3 \quad c=-2\sqrt{2}$

$$x=\frac{-3\pm\sqrt{3^2-4\left(\sqrt{2}\right)\left(-2\sqrt{2}\right)}}{2\left(\sqrt{2}\right)}$$

$$=\frac{-3\pm\sqrt{9-(-16)}}{2\sqrt{2}}$$

$$=\frac{-3\pm\sqrt{25}}{2\sqrt{2}}=\frac{-3\pm5}{2\sqrt{2}}$$

Evaluate the expression to obtain two solutions.

$$x=\frac{-3-5}{2\sqrt{2}} \quad \text{or} \quad x=\frac{-3+5}{2\sqrt{2}}$$

$$=\frac{-8}{2\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}} \qquad =\frac{2}{2\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}}$$

$$=\frac{-8\sqrt{2}}{4} \qquad =\frac{2\sqrt{2}}{4}$$

$$=-2\sqrt{2} \qquad =\frac{\sqrt{2}}{2}$$

The solutions are $-2\sqrt{2}$ and $\frac{\sqrt{2}}{2}$, and the solution set is $\left\{-2\sqrt{2},\ \frac{\sqrt{2}}{2}\right\}$.

130. $\sqrt{3}x^2+6x+7\sqrt{3}=0$

Apply the quadratic formula:

$a=\sqrt{3} \quad b=6 \quad c=7\sqrt{3}$

$$x=\frac{-6\pm\sqrt{6^2-4\left(\sqrt{3}\right)\left(7\sqrt{3}\right)}}{2\left(\sqrt{3}\right)}$$

$$=\frac{-6\pm\sqrt{36-84}}{2\sqrt{3}}$$

$$=\frac{-6\pm\sqrt{-48}}{2\sqrt{3}}$$

$$=\frac{-6\pm\sqrt{16\cdot3\cdot(-1)}}{2\sqrt{3}}$$

$$=\frac{-6\pm4\sqrt{3}i}{2\sqrt{3}}$$

$$=\frac{-6}{2\sqrt{3}}\pm\frac{4\sqrt{3}i}{2\sqrt{3}}=-\sqrt{3}\pm2i$$

The solutions are $-\sqrt{3}\pm2i$, and the solution set is $\left\{-\sqrt{3}\pm2i\right\}$.

131. $N=\frac{x^2-x}{2}$

$$21=\frac{x^2-x}{2}$$

$$42=x^2-x$$

$$0=x^2-x-42$$

$$0=(x+6)(x-7)$$

$x+6=0 \quad \text{or} \quad x-7=0$

$x=-6 \qquad\qquad x=7$

Reject the negative value.
There were 7 players.

132. $N=\frac{x^2-x}{2}$

$$36=\frac{x^2-x}{2}$$

$$72=x^2-x$$

$$0=x^2-x-72$$

$$0=(x+8)(x-9)$$

$x+8=0 \quad \text{or} \quad x-9=0$

$x=-8 \qquad\qquad x=9$

Reject the negative value.
There were 9 players.

133. This is represented on the graph as point (7, 21).

134. This is represented on the graph as point (9, 36).

135. $f(x)=0.013x^2-1.19x+28.24$

$$3=0.013x^2-1.19x+28.24$$

$$0=0.013x^2-1.19x+25.24$$

Apply the quadratic formula.

$a=0.013 \quad b=-1.19 \quad c=25.24$

$$x=\frac{-(-1.19)\pm\sqrt{(-1.19)^2-4(0.013)(25.24)}}{2(0.013)}$$

$$=\frac{1.19\pm\sqrt{1.4161-1.31248}}{0.026}$$

$$=\frac{1.19\pm\sqrt{0.10362}}{0.026}$$

$$\approx\frac{1.19\pm0.32190}{0.026}$$

$\approx 58.15 \text{ or } 33.39$

The solutions are approximately 33.39 and 58.15. Thus, 33 year olds and 58 year olds are expected to be in 3 fatal crashes per 100 million miles driven. The function models the actual data well.

136. $f(x) = 0.013x^2 - 1.19x + 28.24$

$10 = 0.013x^2 - 1.19x + 28.24$

$0 = 0.013x^2 - 1.19x + 18.24$

$a = 0.013 \quad b = -1.19 \quad c = 18.24$

$$x = \frac{-(-1.19) \pm \sqrt{(-1.19)^2 - 4(0.013)(18.24)}}{2(0.013)}$$

$$= \frac{1.19 \pm \sqrt{1.4161 - 0.94848}}{0.026}$$

$$= \frac{1.19 \pm \sqrt{0.46762}}{0.026} \approx \frac{1.19 \pm 0.68383}{0.026}$$

Evaluate the expression to obtain two solutions.

$$x = \frac{1.19 + 0.68383}{0.026} \quad \text{or} \quad x = \frac{1.19 - 0.68383}{0.026}$$

$$x = \frac{1.87383}{0.026} \qquad x = \frac{0.50617}{0.026}$$

$x \approx 72.1 \qquad x \approx 19$

Drivers of approximately age 19 and age 72 are expected to be involved in 10 fatal crashes per 100 million miles driven. The model doesn't seem to predict the number of accidents very well. The model overestimates the number of fatal accidents.

137. Using the TRACE feature, we find that the height of the shot put is approximately 0 feet when the distance is 77.8 feet. Graph (b) shows the shot' path.

138. Using the ZERO feature, we find that the height of the shot put is approximately 0 feet when the distance is 55.3 feet. Graph (a) shows the shot's path.

139. $x^2 = 4^2 + 2^2$

$x^2 = 16 + 4$

$x^2 = 20$

$x = \pm\sqrt{20}$

$x = \pm 2\sqrt{5}$

We disregard $-2\sqrt{5}$ because we can't have a negative measurement. The path is $2\sqrt{5}$ miles, or approximately 4.5 miles.

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

$x^2 = 36 + 9$

$x^2 = 45$

$x = \pm\sqrt{45}$

$x = \pm 3\sqrt{5}$

We disregard $-3\sqrt{5}$ because we can't have a negative measurement. The path is $3\sqrt{5}$ miles, or approximately 6.7 miles.

141. $x^2 + 10^2 = 30^2$

$x^2 + 100 = 900$

$x^2 = 800$

Apply the square root property.

$x = \pm\sqrt{800} = \pm\sqrt{400 \cdot 2} = \pm 20\sqrt{2}$

We disregard $-20\sqrt{2}$ because we can't have a negative length measurement. The solution is $20\sqrt{2}$. We conclude that the ladder reaches $20\sqrt{2}$ feet, or approximately 28.3 feet, up the house.

142. $90^2 + 90^2 = x^2$

$8100 + 8100 = x^2$

$16200 = x^2$

$x \approx \pm 127.28$

The distance is 127.28 feet.

143. **a.** $x^2 + 120^2 = 122^2$

$x^2 + 14400 = 14884$

$x^2 = 484$

$x \approx \pm 22$

The ramp's vertical distance is 22 inches.

b. This ramp does not satisfy the requirement.

144. **a.** $h^2 = a^2 + a^2$

$h^2 = 2a^2$

$h = \sqrt{2a^2}$

$h = a\sqrt{2}$

b. The length of the hypotenuse of an isosceles right triangle is the length of the leg times $\sqrt{2}$.

145. Let w = the width

Let $w + 3$ = the length

Area $= lw$

$54 = (w + 3)w$

$54 = w^2 + 3w$

$0 = w^2 + 3w - 54$

$0 = (w + 9)(w - 6)$

Apply the zero product principle.

$w + 9 = 0 \qquad w - 6 = 0$

$w = -9 \qquad w = 6$

The solution set is $\{-9, 6\}$. Disregard –9 because we can't have a negative length measurement. The width is 6 feet and the length is $6 + 3 = 9$ feet.

146. Let w = the width
Let $w + 3$ = the width
Area = lw

$$180 = (w+3)w$$
$$180 = w^2 + 3w$$
$$0 = w^2 + 3w - 180$$
$$0 = (w+15)(w-12)$$
$$w+15 = 0 \qquad w-12 = 0$$
$$\cancel{w = -15} \qquad w = 12$$

The width is 12 yards and the length is 12 yards + 3 yards = 15 yards.

147. Let x = the length of the side of the original square
Let $x + 3$ = the length of the side of the new, larger square

$$(x+3)^2 = 64$$
$$x^2 + 6x + 9 = 64$$
$$x^2 + 6x - 55 = 0$$
$$(x+11)(x-5) = 0$$

Apply the zero product principle.

$$x+11 = 0 \qquad x-5 = 0$$
$$x = -11 \qquad x = 5$$

The solution set is $\{-11, 5\}$. Disregard –11 because we can't have a negative length measurement. This means that x, the length of the side of the original square, is 5 inches.

148. Let x = the side of the original square,
Let $x + 2$ = the side of the new, larger square

$$(x+2)^2 = 36$$
$$x^2 + 4x + 4 = 36$$
$$x^2 + 4x - 32 = 0$$
$$(x+8)(x-4) = 0$$
$$x+8 = 0 \qquad x-4 = 0$$
$$\cancel{x = -8} \qquad x = 4$$

The length of the side of the original square, is 4 inches.

149. Let x = the width of the path

$$(20+2x)(10+2x) = 600$$
$$200 + 40x + 20x + 4x^2 = 600$$
$$200 + 60x + 4x^2 = 600$$
$$4x^2 + 60x + 200 = 600$$
$$4x^2 + 60x - 400 = 0$$
$$4(x^2 + 15x - 100) = 0$$
$$4(x+20)(x-5) = 0$$

Apply the zero product principle.

$$4(x+20) = 0 \qquad x-5 = 0$$
$$x+20 = 0 \qquad x = 5$$
$$x = -20$$

The solution set is $\{-20, 5\}$. Disregard –20 because we can't have a negative width measurement. The width of the path is 5 meters.

150. Let x = the width of the path

$$(12+2x)(15+2x) = 378$$
$$180 + 24x + 30x + 4x^2 = 378$$
$$4x^2 + 54x + 180 = 378$$
$$4x^2 + 54x - 198 = 0$$
$$2(2x^2 + 27x - 99) = 0$$
$$2(2x+33)(x-3) = 0$$
$$2(2x+33) = 0 \qquad x-3 = 0$$
$$2x+33 = 0 \qquad x = 3$$
$$2x = -33$$
$$\cancel{x = -\frac{33}{2}}$$

The width of the path is 3 meters.

151. $x(x)(2) = 200$

$$2x^2 = 200$$
$$x^2 = 100$$
$$x = \pm 10$$

The length and width are 10 inches.

152. $x(x)(3) = 75$

$$3x^2 = 75$$
$$x^2 = 25$$
$$x = \pm 5$$

The length and width is 5 inches.

153. $x(20-2x)=13$

$20x-2x^2=13$

$0=2x^2-20x+13$

$x=\dfrac{-(-20)\pm\sqrt{(-20)^2-4(2)(13)}}{2(2)}$

$x=\dfrac{20\pm\sqrt{296}}{4}$

$x=\dfrac{10\pm17.2}{4}$

$x=9.3, 0.7$

9.3 in and 0.7 in

154. $\left(\dfrac{x}{4}\right)^2+\left(\dfrac{8-x}{4}\right)^2=2$

$\dfrac{x^2}{16}+\dfrac{64-16x+x^2}{16}=2$

$x^2+64-16x+x^2=32$

$2x^2-16x+32=0$

$x^2-8x+16=0$

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

$x=4$ in

Both are 4 inches.

155. – 165. Answers will vary.

166. does not make sense; Explanations will vary. Sample explanation: The factoring method would be quicker.

167. does not make sense; Explanations will vary. Sample explanation: Higher degree polynomial equations can have only one x-intercept.

168. does not make sense; Explanations will vary. Sample explanation: The solutions are not irrational.

169. makes sense

170. false; Changes to make the statement true will vary. A sample change is: $(2x-3)^2=25$

$2x-3=\pm5$

171. true

172. false; Changes to make the statement true will vary. A sample change is: The quadratic formula is developed by completing the square.

173. false; Changes to make the statement true will vary. A sample change is: The first step is to collect all the terms on one side and have 0 on the other.

174. $(x+3)(x-5)=0$

$x^2-5x+3x-15=0$

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

175. $s=-16t^2+v_0t$

$0=-16t^2+v_0t-s$

$a=-16,\ b=v_0,\ c=-s$

$t=\dfrac{-v_0\pm\sqrt{(v_0)^2-4(-16)(-s)}}{2(-16)}$

$t=\dfrac{-v_0\pm\sqrt{(v_0)^2-64s}}{-32}$

$t=\dfrac{v_0\pm\sqrt{v_0^2-64s}}{32}$

176. The dimensions of the pool are 12 meters by 8 meters. With the tile, the dimensions will be 12 + $2x$ meters by 8 + $2x$ meters. If we take the area of the pool with the tile and subtract the area of the pool without the tile, we are left with the area of the tile only.

$(12+2x)(8+2x)-12(8)=120$

$96+24x+16x+4x^2-96=120$

$4x^2+40x-120=0$

$x^2+10x-30=0$

$a=1 \quad b=10 \quad c=-30$

$x=\dfrac{-10\pm\sqrt{10^2-4(1)(-30)}}{2(1)}$

$=\dfrac{-10\pm\sqrt{100+120}}{2}$

$=\dfrac{-10\pm\sqrt{220}}{2}\approx\dfrac{-10\pm14.8}{2}$

Evaluate the expression to obtain two solutions.

$x=\dfrac{-10+14.8}{2}$ or $x=\dfrac{-10-14.8}{2}$

$x=\dfrac{4.8}{2}$ $\qquad$ $x=\dfrac{-24.8}{2}$

$x=2.4$ $\qquad$ $x=-12.4$

We disregard –12.4 because we can't have a negative width measurement. The solution is 2.4 and we conclude that the width of the uniform tile border is 2.4 meters. This is more than the 2-meter requirement, so the tile meets the zoning laws.

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

178. $(\sqrt{x+4}+1)^2 = \sqrt{x+4}^2 + 2(\sqrt{x+4})(1) + 1^2$
$= x + 4 + 2\sqrt{x+4} + 1$
$= x + 5 + 2\sqrt{x+4}$

179. $5x^{2/3} + 11x^{1/3} + 2 = 0$
$5(-8)^{2/3} + 11(-8)^{1/3} + 2 = 0$
$5(-2)^2 + 11(-2)^1 + 2 = 0$
$5(4) + 11(-2) + 2 = 0$
$20 - 22 + 2 = 0$
$0 = 0,$ true
The statement is true.

Mid-Chapter 1 Check Point

1. $-5 + 3(x+5) = 2(3x-4)$
$-5 + 3x + 15 = 6x - 8$
$3x + 10 = 6x - 8$
$-3x = -18$
$\frac{-3x}{-3} = \frac{-18}{-3}$
$x = 6$
The solution set is $\{6\}$.

2. $5x^2 - 2x = 7$
$5x^2 - 2x - 7 = 0$
$(5x-7)(x+1) = 0$
$5x - 7 = 0$ or $x + 1 = 0$
$5x = 7$ $\quad$ $x = -1$
$x = \frac{7}{5}$
The solution set is $\left\{-1, \frac{7}{5}\right\}$.

3. $\frac{x-3}{5} - 1 = \frac{x-5}{4}$
$20\left(\frac{x-3}{5} - 1\right) = 20\left(\frac{x-5}{4}\right)$
$\frac{20(x-3)}{5} - 20(1) = \frac{20(x-5)}{4}$
$4(x-3) - 20 = 5(x-5)$
$4x - 12 - 20 = 5x - 25$
$4x - 32 = 5x - 25$
$-x = 7$
$x = -7$
The solution set is $\{-7\}$.

4. $3x^2 - 6x - 2 = 0$
$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(3)(-2)}}{2(3)}$
$x = \frac{6 \pm \sqrt{60}}{6}$
$x = \frac{6 \pm 2\sqrt{15}}{6}$
$x = \frac{3 \pm \sqrt{15}}{3}$
The solution set is $\left\{\frac{3+\sqrt{15}}{3}, \frac{3-\sqrt{15}}{3}\right\}$.

5. $4x - 2(1-x) = 3(2x+1) - 5$
$4x - 2(1-x) = 3(2x+1) - 5$
$4x - 2 + 2x = 6x + 3 - 5$
$6x - 2 = 6x - 2$
$0 = 0$
The equation is an identity.
The solution set is $\{x | x \text{ is a real number}\}$.

6. $5x^2+1=37$

$5x^2=36$

$\frac{5x^2}{5}=\frac{36}{5}$

$x^2=\frac{36}{5}$

$x=\pm\sqrt{\frac{36}{5}}$

$x=\pm\frac{6}{\sqrt{5}}$

$x=\pm\frac{6}{\sqrt{5}}\cdot\frac{\sqrt{5}}{\sqrt{5}}$

$x=\pm\frac{6\sqrt{5}}{5}$

The solution set is $\left\{-\frac{6\sqrt{5}}{5},\frac{6\sqrt{5}}{5}\right\}$.

7. $x(2x-3)=-4$

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

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

$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$x=\frac{-(-3)\pm\sqrt{(-3)^2-4(2)(4)}}{2(2)}$

$x=\frac{3\pm\sqrt{-23}}{4}$

$x=\frac{3\pm i\sqrt{23}}{4}$

The solution set is $\left\{\frac{3+i\sqrt{23}}{4},\frac{3-i\sqrt{23}}{4}\right\}$.

8. $\frac{3x}{4}-\frac{x}{3}+1=\frac{4x}{5}-\frac{3}{20}$

$\frac{3x}{4}-\frac{x}{3}+1=\frac{4x}{5}-\frac{3}{20}$

$60\left(\frac{3x}{4}-\frac{x}{3}+1\right)=60\left(\frac{4x}{5}-\frac{3}{20}\right)$

$\frac{60(3x)}{4}-\frac{60x}{3}+60(1)=\frac{60(4x)}{5}-\frac{60(3)}{20}$

$45x-20x+60=48x-9$

$25x+60=48x-9$

$-23x=-69$

$\frac{-23x}{-23}=\frac{-69}{-23}$

$x=3$

The solution set is $\{3\}$.

9. $(x+3)^2=24$

$x+3=\pm\sqrt{24}$

$x=-3\pm2\sqrt{6}$

The solution set is $\left\{-3+2\sqrt{6},-3-2\sqrt{6}\right\}$.

10. $\frac{1}{x^2}-\frac{4}{x}+1=0$

$x^2\left(\frac{1}{x^2}-\frac{4}{x}+1\right)=x^2(0)$

$\frac{x^2}{x^2}-\frac{4x^2}{x}+x^2=0$

$1-4x+x^2=0$

$x^2-4x+1=0$

$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$

$x=\frac{-(-4)\pm\sqrt{(-4)^2-4(1)(1)}}{2(1)}$

$x=\frac{4\pm\sqrt{12}}{2}$

$x=\frac{4\pm2\sqrt{3}}{2}$

$x=2\pm\sqrt{3}$

The solution set is $\left\{2+\sqrt{3},2-\sqrt{3}\right\}$.

11. $3x+1-(x-5)=2x-4$

$2x+6=2x-4$

$6=-4$

The solution set is $\varnothing$.

12. $\dfrac{2x}{x^2+6x+8}=\dfrac{x}{x+4}-\dfrac{2}{x+2}, \quad x\neq -2, x\neq -4$

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

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

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

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

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

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

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

$x+2=0$ or $x-4=0$

$x=-2$ $\qquad$ $x=4$

–2 must be rejected.

The solution set is $\{4\}$.

13. Let $y=0$.

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

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(6)\pm\sqrt{(6)^2-4(1)(2)}}{2(1)}$$

$$x=\frac{-6\pm\sqrt{28}}{2}$$

$$x=\frac{-6\pm 2\sqrt{7}}{2}$$

$$x=-3\pm\sqrt{7}$$

x-intercepts: $-3+\sqrt{7}$ and $-3-\sqrt{7}$.

14. Let $y=0$.

$$0=4(x+1)-3x-(6-x)$$

$$0=4x+4-3x-6+x$$

$$0=2x-2$$

$$-2x=-2$$

$$x=1$$

x-intercept: 1.

15. Let $y=0$.

$$0=2x^2+26$$

$$-2x^2=26$$

$$x^2=-13$$

$$x=\pm\sqrt{-13}$$

$$x=\pm i\sqrt{13}$$

There are no x-intercepts.

16. Let $y=0$.

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

$$6(0)=6\left(\frac{x^2}{3}+\frac{x}{2}-\frac{2}{3}\right)$$

$$0=\frac{6\cdot x^2}{3}+\frac{6\cdot x}{2}-\frac{6\cdot 2}{3}$$

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

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(3)\pm\sqrt{(3)^2-4(2)(-4)}}{2(2)}$$

$$x=\frac{-3\pm\sqrt{41}}{4}$$

x-intercepts: $\dfrac{-3+\sqrt{41}}{4}$ and $\dfrac{-3-\sqrt{41}}{4}$.

17. Let $y=0$.

$$0=x^2-5x+8$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

$$x=\frac{-(-5)\pm\sqrt{(-5)^2-4(1)(8)}}{2(1)}$$

$$x=\frac{5\pm\sqrt{-7}}{2}$$

$$x=\frac{5\pm i\sqrt{7}}{2}$$

There are no x-intercepts.

18.

$$y_1=y_2$$

$$3(2x-5)-2(4x+1)=-5(x+3)-2$$

$$6x-15-8x-2=-5x-15-2$$

$$-2x-17=-5x-17$$

$$3x=0$$

$$x=0$$

The solution set is $\{0\}$.

19. $y_1 y_2 = 10$

$(2x+3)(x+2) = 10$

$2x^2 + 7x + 6 = 10$

$2x^2 + 7x - 4 = 0$

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

$2x - 1 = 0$ or $x + 4 = 0$

$x = \frac{1}{2}$ $\quad x = -4$

The solution set is $\left\{-4, \frac{1}{2}\right\}$.

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

$x^2 + 10x = 3$

Since $b = 10$, we add $\left(\frac{10}{2}\right)^2 = 5^2 = 25$.

$x^2 + 10x + 25 = 3 + 25$

$(x+5)^2 = 28$

Apply the square root principle:

$x + 5 = \pm\sqrt{28}$

$x + 5 = \pm\sqrt{4 \cdot 7} = \pm 2\sqrt{7}$

$x = -5 \pm 2\sqrt{7}$

The solutions are $-5 \pm 2\sqrt{7}$, and the solution set is $\left\{-5 \pm 2\sqrt{7}\right\}$.

21. $2x^2 + 5x + 4 = 0$

$a = 2 \quad b = 5 \quad c = 4$

$b^2 - 4ac = 5^2 - 4(2)(4)$

$= 25 - 32 = -7$

Since the discriminant is negative, there are no real solutions. There are two imaginary solutions that are complex conjugates.

22. $10x(x+4) = 15x - 15$

$10x^2 + 40x = 15x - 15$

$10x^2 - 25x + 15 = 0$

$a = 10 \quad b = -25 \quad c = 15$

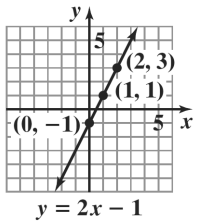
$b^2 - 4ac = (-25)^2 - 4(10)(15)$

$= 625 - 600 = 25$

Since the discriminant is positive and a perfect square, there are two rational solutions.

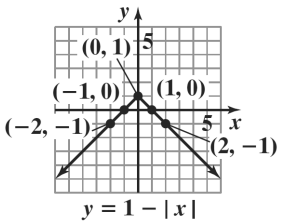
23.

x	(x, y)
-2	-5
-1	-3
0	-1
1	1
2	3



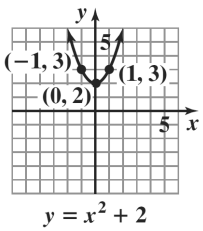
24.

x	(x, y)
-3	-2
-2	-1
-1	0
0	1
1	0
2	-1
3	-2



25.

x	(x, y)
-2	6
-1	3
0	2
1	3
2	6



26.
$$L = a + (n-1)d$$
$$L = a + dn - d$$
$$-dn = a - d - L$$
$$\frac{-dn}{-d} = \frac{a}{-d} - \frac{d}{-d} - \frac{L}{-d}$$
$$n = -\frac{a}{d} + 1 + \frac{L}{d}$$
$$n = \frac{L}{d} - \frac{a}{d} + 1$$
$$n = \frac{L-a}{d} + 1$$

27.
$$A = 2lw + 2lh + 2wh$$
$$-2lw - 2lh = 2wh - A$$
$$l(-2w - 2h) = 2wh - A$$
$$l = \frac{2wh - A}{-2w - 2h}$$
$$l = \frac{A - 2wh}{2w + 2h}$$

28.
$$f = \frac{f_1 f_2}{f_1 + f_2}$$
$$(f_1 + f_2)(f) = (f_1 + f_2)\frac{f_1 f_2}{f_1 + f_2}$$
$$f_1 f + f_2 f = f_1 f_2$$
$$f_1 f - f_1 f_2 = -f_2 f$$
$$f_1(f - f_2) = -f_2 f$$
$$f_1 = \frac{-f_2 f}{f - f_2}$$
$$f_1 = -\frac{f f_2}{f - f_2} \text{ or } f_1 = \frac{f f_2}{f_2 - f}$$

29. Let $x =$ the average yearly earnings, in thousands, of marketing majors.
Let $x + 19 =$ the average yearly earnings, in thousands, of engineering majors.
Let $x + 6 =$ the average yearly earnings, in thousands, of accounting majors.
$$x + (x + 19) + (x + 6) = 196$$
$$x + x + 19 + x + 6 = 196$$
$$3x + 25 = 196$$
$$3x = 171$$
$$x = 57$$
$$x + 19 = 76$$
$$x + 6 = 63$$
The average yearly earnings for marketing majors, engineering majors, and accounting majors were \$57 thousand, \$76 thousand, and \$63 thousand, respectively.

30. Let x = the number of years since 1960.
$$23 - 0.28x = 0$$
$$-0.28x = -23$$
$$\frac{-0.28x}{-0.28} = \frac{-23}{-0.28}$$
$$x \approx 82$$
If this trend continues, corporations will pay zero taxes 82 years after 1960, or 2042.

31. Let x = the amount invested at 8%.
Let $25{,}000 - x$ = the amount invested at 9%.
$$0.08x + 0.09(25{,}000 - x) = 2135$$
$$0.08x + 2250 - 0.09x = 2135$$
$$-0.01x + 2250 = 2135$$
$$-0.01x = -115$$
$$x = \frac{-115}{-0.01}$$
$$x = 11{,}500$$
$$25{,}000 - x = 13{,}500$$
\$11,500 was invested at 8% and \$13,500 was invested at 9%.

32. Let x = the number of bridge crossings.
Without discount pass: $8x$
With discount pass: $45 + 5x$
$$8x = 45 + 5x$$
$$3x = 45$$
$$x = 15$$
The cost will be the same for 15 bridge crossings.

33. Let x = the price before the reduction.
$$x - 0.40x = 468$$
$$0.60x = 468$$
$$\frac{0.60x}{0.60} = \frac{468}{0.60}$$
$$x = 780$$
The price before the reduction was \$780.

34. Let x = the amount invested at 4%.
Let $4000 - x$ = the amount invested that lost 3%.

$$0.04x - 0.03(4000 - x) = 55$$
$$0.04x - 120 + 0.03x = 55$$
$$0.07x - 120 = 55$$
$$0.07x = 175$$
$$x = \frac{175}{0.07}$$
$$x = 2500$$
$$4000 - x = 1500$$

$2500 was invested at 4% and $1500 lost 3%.

35. Let x = the width of the rectangle
Let $2x + 5$ = the length of the rectangle

$$2l + 2w = P$$
$$2(2x+5) + 2x = 46$$
$$4x + 10 + 2x = 46$$
$$6x + 10 = 46$$
$$6x = 36$$
$$\frac{6x}{6} = \frac{36}{6}$$
$$x = 6$$
$$2x + 5 = 17$$

The dimensions of the rectangle are 6 ft by 17 ft.

36. Let x = the width of the rectangle
Let $2x - 1$ = the length of the rectangle

$$lw = A$$
$$(2x-1)x = 28$$
$$2x^2 - x = 28$$
$$2x^2 - x - 28 = 0$$
$$(2x+7)(x-4) = 0$$
$$2x + 7 = 0 \quad \text{or} \quad x - 4 = 0$$
$$2x = -7 \qquad\qquad x = 4$$
$$x = -\frac{7}{2}$$

$-\frac{7}{2}$ must be rejected.

If $x = 4$, then $2x - 1 = 7$

The dimensions of the rectangle are 4 ft by 7 ft.

37. Let x = the height up the pole at which the wires are attached.

$$x^2 + 5^2 = 13^2$$
$$x^2 + 25 = 169$$
$$x^2 = 144$$
$$x = \pm 12$$

–12 must be rejected.
The wires are attached 12 yards up the pole.

38. **a.**

$$P = -10x^2 + 475x + 3500$$
$$5990 = -10x^2 + 475x + 3500$$
$$0 = -10x^2 + 475x - 2490$$
$$0 = 2x^2 - 95x + 498$$
$$0 = (x-6)(2x-83)$$
$$x - 6 = 0 \quad \text{or} \quad 2x - 83 = 0$$
$$x = 6 \qquad\qquad 2x = 83$$
$$x = 41.5$$

The population reached 5990 after 6 years.

b. This is represented by the point (6, 5990).

39.

$$p = 0.004x^2 - 0.35x + 13.9$$
$$19 = 0.004x^2 - 0.35x + 13.9$$
$$0 = 0.004x^2 - 0.35x - 5.1$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$x = \frac{-(-0.35) \pm \sqrt{(-0.35)^2 - 4(0.004)(-5.1)}}{2(0.004)}$$
$$x = \frac{0.35 \pm \sqrt{0.1225 + 0.0816}}{0.008}$$
$$x \approx 100, \quad x \approx -13 \text{ (rejected)}$$

The percentage of foreign born Americans will be 19% about 100 years after 1920, or 2020.

40. $(6 - 2i) - (7 - i) = 6 - 2i - 7 + i = -1 - i$

41. $3i(2 + i) = 6i + 3i^2 = -3 + 6i$

42.

$$(1+i)(4-3i) = 4 - 3i + 4i - 3i^2$$
$$= 4 + i + 3 = 7 + i$$

43.

$$\frac{1+i}{1-i} = \frac{1+i}{1-i} \cdot \frac{1+i}{1+i} = \frac{1+i+i+i^2}{1-i^2}$$
$$= \frac{1+2i-1}{1+1}$$
$$= \frac{2i}{2}$$
$$= i$$

44. $\sqrt{-75} - \sqrt{-12} = 5i\sqrt{3} - 2i\sqrt{3} = 3i\sqrt{3}$

45.

$$\left(2 - \sqrt{-3}\right)^2 = \left(2 - i\sqrt{3}\right)^2$$
$$= 4 - 4i\sqrt{3} + 3i^2$$
$$= 4 - 4i\sqrt{3} - 3$$
$$= 1 - 4i\sqrt{3}$$

Section 1.6

Check Point Exercises

1. $4x^4 = 12x^2$

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

$4x^2\left(x^2 - 3\right) = 0$

$4x^2 = 0 \quad \text{or} \quad x^2 - 3 = 0$

$x^2 = 0 \qquad x^2 = 3$

$x = \pm\sqrt{0} \qquad x = \pm\sqrt{3}$

$x = 0 \qquad x = \pm\sqrt{3}$

The solution set is $\left\{-\sqrt{3}, 0, \sqrt{3}\right\}$.

2. $2x^3 + 3x^2 = 8x + 12$

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

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

$2x + 3 = 0 \quad \text{or} \quad x^2 - 4 = 0$

$2x = -3 \qquad x^2 = 4$

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

The solution set is $\left\{-2, -\frac{3}{2}, 2\right\}$.

3. $\sqrt{x+3} + 3 = x$

$\sqrt{x+3} = x - 3$

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

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

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

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

$x - 6 = 0 \quad \text{or} \quad x - 1 = 0$

$x = 6 \qquad x = 1$

1 does not check and must be rejected.

The solution set is $\{6\}$.

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

$\sqrt{x+5} = 2 + \sqrt{x-3}$

$\left(\sqrt{x+5}\right)^2 = \left(2 + \sqrt{x-3}\right)^2$

$x + 5 = (2)^2 + 2(2)\left(\sqrt{x-3}\right) + \left(\sqrt{x-3}\right)^2$

$x + 5 = 4 + 4\sqrt{x-3} + x - 3$

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

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

$1 = \sqrt{x-3}$

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

$1 = x - 3$

$4 = x$

The check indicates that 4 is a solution.

The solution set is $\{4\}$.

5. **a.** $5x^{3/2} - 25 = 0$

$5x^{3/2} = 25$

$x^{3/2} = 5$

$\left(x^{3/2}\right)^{2/3} = (5)^{2/3}$

$x = 5^{2/3} \quad \text{or} \quad \sqrt[3]{25}$

Check:

$5\left(5^{2/3}\right)^{3/2} - 25 = 0$

$5(5) - 25 = 0$

$25 - 25 = 0$

$0 = 0$

The solution set is $\left\{5^{2/3}\right\}$ or $\left\{\sqrt[3]{25}\right\}$.

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

$x^{2/3} = 4$

$\left(x^{2/3}\right)^{3/2} = 4^{3/2}$ or

$x = \left(2^2\right)^{3/2}$

$x = 2^3 \qquad x = (-2)^3$

$x = 8 \qquad x = -8$

The solution set is $\{-8, 8\}$.

6. $x^4 - 5x^2 + 6 = 0$

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

Let $t = x^2$.

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

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

$t - 3 = 0$ or $t - 2 = 0$

$t = 3$ or $t = 2$

$x^2 = 3$ or $x^2 = 2$

$x = \pm\sqrt{3}$ or $x = \pm\sqrt{2}$

The solution set is $\left\{-\sqrt{3}, -\sqrt{2}, \sqrt{2}, \sqrt{3}\right\}$.

7. $3x^{2/3} - 11x^{1/3} - 4 = 0$

Let $t = x^{1/3}$.

$3t^2 - 11t - 4 = 0$

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

$3t + 1 = 0$ or $t - 4 = 0$

$3t = -1$

$t = -\frac{1}{3}$ $\quad t = 4$

$x^{1/3} = -\frac{1}{3}$ $\quad x^{1/3} = 4$

$x = \left(-\frac{1}{3}\right)^3$ $\quad x = 4^3$

$x = -\frac{1}{27}$ $\quad x = 64$

The solution set is $\left\{-\frac{1}{27}, 64\right\}$.

8. $\left(x^2 - 4\right)^2 + \left(x^2 - 4\right) - 6 = 0$

Let $u = x^2 - 4$.

$u^2 + u - 6 = 0$

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

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

$u = -3$ or $u = 2$

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

$x = \pm 1$ or $x = \pm\sqrt{6}$

The solution set is $\left\{-\sqrt{6}, -1, 1, \sqrt{6}\right\}$.

9. $|2x - 1| = 5$

$2x - 1 = 5$ or $2x - 1 = -5$

$2x = 6$ $\quad 2x = -4$

$x = 3$ $\quad x = -2$

The solution set is $\{-2, 3\}$.

10. $4|1 - 2x| - 20 = 0$

$4|1 - 2x| = 20$

$|1 - 2x| = 5$

$1 - 2x = 5$ or $1 - 2x = -5$

$-2x = 4$ $\quad -2x = -6$

$x = -2$ $\quad x = 3$

The solution set is $\{-2, 3\}$.

11. $H = -2.3\sqrt{I} + 67.6$

$33.1 = -2.3\sqrt{I} + 67.6$

$-34.5 = -2.3\sqrt{I}$

$\frac{-34.5}{-2.3} = \frac{-2.3\sqrt{I}}{-2.3}$

$15 = \sqrt{I}$

$15^2 = \left(\sqrt{I}\right)^2$

$225 = I$

The model indicates that an annual income of 225 thousand dollars, or \$225,000, corresponds to 33.1 hours per week watching TV.

Concept and Vocabulary Check 1.6

1. subtract $8x$ and subtract 12 from both sides

2. radical

3. extraneous

4. $2x + 1$; $x^2 + 14x + 49$

5. $x + 2$; $x + 8 - 6\sqrt{x-1}$

6. $5^{\frac{4}{3}}$

7. $\pm 5^{\frac{3}{2}}$

8. x^2; $u^2 - 13u + 36 = 0$

9. $x^{\frac{1}{3}}$; $u^2 + 2u - 3 = 0$

10. c; $-c$

11. $3x - 1 = 7$; $3x - 1 = -7$

Exercise Set 1.6

1.
$$3x^4 - 48x^2 = 0$$
$$3x^2(x^2 - 16) = 0$$
$$3x^2(x+4)(x-4) = 0$$
$$3x^2 = 0 \quad x+4=0 \quad x-4=0$$
$$x^2 = 0 \quad x = -4 \quad x = 4$$
$$x = 0$$

The solution set is $\{-4, 0, 4\}$.

2.
$$5x^4 - 20x^2 = 0$$
$$5x^2(x^2 - 4) = 0$$
$$5x^2(x+2)(x-2) = 0$$
$$5x^2 = 0 \quad x+2=0 \quad x-2=0$$
$$x^2 = 0$$
$$x = 0 \quad x = -2 \quad x = 2$$

The solution set is $\{-2, 0, 2\}$.

3.
$$3x^3 + 2x^2 = 12x + 8$$
$$3x^3 + 2x^2 - 12x - 8 = 0$$
$$x^2(3x+2) - 4(3x+2) = 0$$
$$(3x+2)(x^2 - 4) = 0$$
$$3x+2=0 \quad x^2 - 4 = 0$$
$$3x = -2 \quad x^2 = 4$$
$$x = -\frac{2}{3} \quad x = \pm 2$$

The solution set is $\left\{-2, -\frac{2}{3}, 2\right\}$.

4.
$$4x^3 - 12x^2 = 9x - 27$$
$$4x^3 - 12x^2 - 9x + 27 = 0$$
$$4x^2(x-3) - 9(x-3) = 0$$
$$(x-3)(4x^2 - 9) = 0$$
$$x - 3 = 0 \quad 4x^2 - 9 = 0$$
$$x = 3 \quad 4x^2 = 9$$
$$x^2 = \frac{9}{4}$$
$$x = \pm\frac{3}{2}$$

The solution set is $\left\{-\frac{3}{2}, \frac{3}{2}, 3\right\}$.

5.
$$2x - 3 = 8x^3 - 12x^2$$
$$8x^3 - 12x^2 - 2x + 3 = 0$$
$$4x^2(2x-3) - (2x-3) = 0$$
$$(2x-3)(4x^2 - 1) = 0$$
$$2x - 3 = 0 \quad 4x^2 - 1 = 0$$
$$2x = 3 \quad 4x^2 = 1$$
$$x^2 = \frac{1}{4}$$
$$x = \frac{3}{2} \quad x = \pm\frac{1}{2}$$

The solution set is $\left\{\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right\}$.

6.
$$x + 1 = 9x^3 + 9x^2$$
$$9x^3 + 9x^2 - x - 1 = 0$$
$$9x^2(x+1) - (x+1) = 0$$
$$(x+1)(9x^2 - 1) = 0$$
$$x + 1 = 0 \quad 9x^2 - 1 = 1$$
$$x = -1 \quad 9x^2 = 1$$
$$x^2 = \frac{1}{9}$$
$$x = \pm\frac{1}{3}$$

The solution set is $\left\{-1, -\frac{1}{3}, \frac{1}{3}\right\}$.

7. $4y^3 - 2 = y - 8y^2$

$4y^3 + 8y^2 - y - 2 = 0$

$4y^2(y+2) - (y+2) = 0$

$(y+2)(4y^2 - 1) = 0$

$y + 2 = 0 \quad 4y^2 - 1 = 0$

$4y^2 = 1$

$y^2 = \frac{1}{4}$

$y = -2 \qquad y = \pm\frac{1}{2}$

The solution set is $\left\{-2, \frac{1}{2}, -\frac{1}{2}\right\}$.

8. $9y^3 + 8 = 4y + 18y^2$

$9y^3 - 18y^2 - 4y + 8 = 0$

$9y^2(y-2) - 4(y-2) = 0$

$(y-2)(9y^2 - 4) = 0$

$y - 2 = 0 \quad 9y^2 - 4 = 0$

$y = 2 \qquad 9y^2 = 4$

$y^2 = \frac{4}{9}$

$y = \pm\frac{2}{3}$

The solution set is $\left\{-\frac{2}{3}, \frac{2}{3}, 2\right\}$.

9. $2x^4 = 16x$

$2x^4 - 16x = 0$

$2x\left(x^3 - 8\right) = 0$

$2x = 0 \qquad x^3 - 8 = 0$

$x = 0 \qquad (x-2)(x^2 + 2x + 2) = 0$

$x - 2 = 0 \quad x^2 + 2x + 4 = 0$

$x = 2 \quad x = \frac{-2 \pm \sqrt{2^2 - 4(1)(4)}}{2(1)}$

$x = \frac{-2 \pm \sqrt{-12}}{2}$

$x = \frac{-2 \pm 2i\sqrt{3}}{2}$

$x = -1 \pm i\sqrt{3}$

The solution set is $\left\{0, 2, -1 \pm i\sqrt{3}\right\}$.

10. $3x^4 = 81x$

$3x^4 - 81x = 0$

$3x(x^3 - 27) = 0$

$3x = 0 \qquad x^3 - 27 = 0$

$x = 0;$

$(x-3)(x^2 + 3x + 9) = 0$

$x - 3 = 0 \quad x^2 + 3x + 9 = 0$

$x = 3 \qquad x = \frac{-3 \pm \sqrt{3^2 - 4(1)(9)}}{2(1)}$

$x = \frac{-3 \pm \sqrt{9 - 36}}{2}$

$x = \frac{-3 \pm \sqrt{-27}}{2}$

$x = \frac{-3 \pm 3i\sqrt{3}}{2}$

The solution set is $\left\{0, 3, \frac{-3 \pm 3i\sqrt{3}}{2}\right\}$.

11. $\sqrt{3x+18} = x$

$3x + 18 = x^2$

$x^2 - 3x - 18 = 0$

$(x+3)(x-6) = 0$

$x + 3 = 0 \quad x - 6 = 0$

$x = -3 \qquad x = 6$

$\sqrt{3(-3)+18} = -3 \quad \sqrt{3(6)+18} = 6$

$\sqrt{-9+18} = -3 \qquad \sqrt{18+18} = 6$

$\sqrt{9} = -3$ False $\sqrt{36} = 6$

The solution set is $\{6\}$.

12. $\sqrt{20-8x} = x$

$20 - 8x = x^2$

$x^2 + 8x - 20 = 0$

$(x+10)(x-2) = 0$

$x + 10 = 0 \qquad x - 2 = 0$

$x = -10 \qquad x = 2$

$\sqrt{20-8(-10)} = -10 \qquad \sqrt{20-8(2)} = 2$

$\sqrt{20+80} = -10 \qquad \sqrt{20-16} = 2$

$\sqrt{100} = -10$ False $\sqrt{4} = 2$

The solution set is $\{2\}$.

13. $\sqrt{x+3} = x-3$

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

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

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

$x-1=0 \quad x-6=0$

$x=1 \qquad x=6$

$\sqrt{1+3} = 1-3 \qquad \sqrt{6+3} = 6-3$

$\sqrt{4} = -2$ False $\sqrt{9} = 3$

The solution set is $\{6\}$.

14. $\sqrt{x+10} = x-2$

$x+10 = (x-2)^2$

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

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

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

$x+1=0 \quad x-6=0$

$x=-1 \qquad x=6$

$\sqrt{-1+10} = -1-2 \qquad \sqrt{6+10} = 6-2$

$\sqrt{9} = -3$ False $\sqrt{16} = 4$

The solution set is $\{6\}$.

15. $\sqrt{2x+13} = x+7$

$2x+13 = (x+7)^2$

$2x+13 = x^2+14x+49$

$x^2+12x+36 = 0$

$(x+6)^2 = 0$

$x+6 = 0$

$x = -6$

$\sqrt{2(-6)+13} = -6+7$

$\sqrt{-12+13} = 1$

$\sqrt{1} = 1$

The solution set is $\{-6\}$.

16. $\sqrt{6x+1} = x-1$

$6x+1 = (x-1)^2$

$6x+1 = x^2-2x+1$

$x^2-8x = 0$

$x(x-8) = 0$

$x-8=0 \qquad x=0$

$x=8$

$\sqrt{6(0)+1} = 0-1 \qquad \sqrt{6(8)+1} = 8-1$

$\sqrt{0+1} = -1 \qquad \sqrt{48+1} = 7$

$\sqrt{1} = -1$ False $\sqrt{49} = 7$

The solution set is $\{8\}$.

17. $x-\sqrt{2x+5} = 5$

$x-5 = \sqrt{2x+5}$

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

$x^2-10x+25 = 2x+5$

$x^2-12x+20 = 0$

$(x-2)(x-10) = 0$

$x-2=0 \quad x-10=0$

$x=2 \qquad x=10$

$2-\sqrt{2(2)+5} = 5 \qquad 10-\sqrt{2(10)+5} = 5$

$2-\sqrt{9} = 5 \qquad 10-\sqrt{25} = 5$

$2-3 = 5$ False $10-5 = 5$

The solution set is $\{10\}$.

18. $x-\sqrt{x+11} = 1$

$x-1 = \sqrt{x+11}$

$(x-1)^2 = x+11$

$x^2-2x+1 = x+11$

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

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

$x+2=0 \qquad x-5=0$

$x=-2 \qquad x=5$

$-2-\sqrt{-2+11} = 1 \qquad 5-\sqrt{5+11} = 1$

$-2-\sqrt{9} = 1 \qquad 5-\sqrt{16} = 1$

$-2-3 = 1$ False $5-4 = 1$

The solution set is $\{5\}$.

19. $\sqrt{2x+19}-8=x$

$\sqrt{2x+19}=x+8$

$\left(\sqrt{2x+19}\right)^2=(x+8)^2$

$2x+19=x^2+16x+64$

$0=x^2+14x+45$

$0=(x+9)(x+5)$

$x+9=0$ or $x+5=0$

$x=-9$ $x=-5$

–9 does not check and must be rejected.

The solution set is $\{-5\}$.

20. $\sqrt{2x+15}-6=x$

$\sqrt{2x+15}=x+6$

$\left(\sqrt{2x+15}\right)^2=(x+6)^2$

$2x+15=x^2+12x+36$

$0=x^2+10x+21$

$0=(x+3)(x+7)$

$x+3=0$ or $x+7=0$

$x=-3$ $x=-7$

–7 does not check and must be rejected.

The solution set is $\{-3\}$.

21. $\sqrt{3x}+10=x+4$

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

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

$3x=x^2-12x+36$

$x^2-15x+36=0$

$(x-12)(x-3)=0$

$x-12=0$ $x-3=0$

$x=12$ $x=3$

$\sqrt{3(12)}+10=12+4$ $\sqrt{3(3)}+10=3+4$

$\sqrt{36}+10=16$ $\sqrt{9}+10=7$

$6+10=16$ $3+10=7$ False

The solution set is $\{12\}$.

22. $\sqrt{x}-3=x-9$

$\sqrt{x}=x-6$

$x=(x-6)^2$

$x=x^2-12x+36$

$x^2-13x+36=0$

$(x-9)(x-4)=0$

$x-9=0$ $x-4=0$

$x=9$ $x=4$

$\sqrt{9}-3=9-9$ $\sqrt{4}-3=4-9$

$3-3=9-9$ $2-3=4-9$ False

The solution set is $\{9\}$.

23. $\sqrt{x+8}-\sqrt{x-4}=2$

$\sqrt{x+8}=\sqrt{x-4}+2$

$x+8=(\sqrt{x-4}+2)^2$

$x+8=x-4+4\sqrt{x-4}+4$

$x+8=x+4\sqrt{x-4}$

$8=4\sqrt{x-4}$

$2=\sqrt{x-4}$

$4=x-4$

$x=8$

$\sqrt{8+8}-\sqrt{8-4}=2$

$\sqrt{16}-\sqrt{4}=2$

$4-2=2$

The solution set is $\{8\}$.

24. $\sqrt{x+5}-\sqrt{x-3}=2$

$\sqrt{x+5}=\sqrt{x-3}+2$

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

$x+5=x-3+4\sqrt{x-3}+4$

$x+5=x+1+4\sqrt{x-3}$

$5=1+4\sqrt{x-3}$

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

$1=\sqrt{x-3}$

$1=x-3$

$x=4$

$\sqrt{4+5}-\sqrt{4-3}=2$

$\sqrt{9}-\sqrt{1}=2$

$3-1=2$

The solution set is $\{4\}$.

25. $\sqrt{x-5}-\sqrt{x-8}=3$

$$\sqrt{x-5}=\sqrt{x-8}+3$$
$$x-5=(\sqrt{x-8}+3)^2$$
$$x-5=x-8+6\sqrt{x-8}+9$$
$$x-5=x+1+6\sqrt{x-8}$$
$$-6=6\sqrt{x-8}$$
$$-1=\sqrt{x-8}$$
$$1=x-8$$
$$x=9$$

$\sqrt{9-5}-\sqrt{9-8}=3$

$\sqrt{4}-\sqrt{1}=3$

$2-1=3$ False

The solution set is the empty set, $\varnothing$.

26. $\sqrt{2x-3}-\sqrt{x-2}=1$

$$\sqrt{2x-3}=\sqrt{x-2}+1$$
$$2x-3=(\sqrt{x-2}+1)^2$$
$$2x-3=x-2+2\sqrt{x-2}+1$$
$$2x-3=x-1+2\sqrt{x-2}$$
$$x-2=2\sqrt{x-2}$$
$$\frac{x}{2}-1=\sqrt{x-2}$$
$$\left(\frac{x}{2}-1\right)^2=x-2$$
$$\frac{x^2}{4}-x+1=x-2$$
$$x^2-4x+4=4x-8$$
$$x^2-8x+12=0$$
$$(x-6)(x-2)=0$$

$x-6=0 \quad x-2=0$

$x=6 \qquad x=2$

$\sqrt{2(6)-3}-\sqrt{6-2}=1$ $\quad$ $\sqrt{2(2)-3}-\sqrt{2-2}=1$

$\sqrt{12-3}-\sqrt{4}=1$ $\quad$ $\sqrt{4-3}-\sqrt{0}=1$

$\sqrt{9}-\sqrt{4}=1$ $\quad$ $\sqrt{1}-0=1$

$3-2=1$ $\quad$ $1-0=1$

The solution set is $\{2, 6\}$.

27. $\sqrt{2x+3}+\sqrt{x-2}=2$

$$\sqrt{2x+3}=2-\sqrt{x-2}$$
$$2x+3=(2-\sqrt{x-2})^2$$
$$2x+3=4-4\sqrt{x-2}+x-2$$
$$x+1=-4\sqrt{x-2}$$
$$(x+1)^2=16(x-2)$$
$$x^2+2x+1=16x-32$$
$$x^2-14x+33=0$$
$$(x-11)(x-3)=0$$

$x-11=0 \quad x-3=0$

$x=11 \qquad x=3$

$\sqrt{2(11)+3}+\sqrt{11-2}=2$

$\sqrt{22+3}+\sqrt{9}=2$

$5+3=2$ False

$\sqrt{2(3)+3}+\sqrt{3-2}=2$

$\sqrt{6+3}+\sqrt{1}=2$

$3+1=2$ False

The solution set is the empty set, $\varnothing$.

28. $\sqrt{x+2}+\sqrt{3x+7}=1$

$$\sqrt{x+2}=1-\sqrt{3x+7}$$
$$x+2=(1-\sqrt{3x+7})^2$$
$$x+2=1-2\sqrt{3x+7}+3x+7$$
$$-2x-6=-2\sqrt{3x+7}$$
$$x+3=\sqrt{3x+7}$$
$$(x+3)^2=3x+7$$
$$x^2+6x+9=3x+7$$
$$x^2+3x+2=0$$
$$(x+1)(x+2)=0$$

$x+1=0 \quad x+2=0$

$x=-1 \qquad x=-2$

$\sqrt{-1+2}+\sqrt{3(-1)+7}=1$

$\sqrt{1}+\sqrt{4}=1$

$1+2=1$ False

$\sqrt{-2+2}+\sqrt{3(-2)+7}=1$

$\sqrt{0}+\sqrt{1}=1$

$0+1=1$

The solution set is $\{-2\}$.

29. $\sqrt{3\sqrt{x+1}} = \sqrt{3x-5}$

$3\sqrt{x+1} = 3x-5$

$9(x+1) = 9x^2 - 30x + 25$

$9x^2 - 39x + 16 = 0$

$$x = \frac{39 \pm \sqrt{945}}{18} = \frac{13 \pm \sqrt{105}}{6}$$

Check proposed solutions.

The solution set is $\left\{\frac{13+\sqrt{105}}{6}\right\}$.

30. $\sqrt{1+4\sqrt{x}} = 1+\sqrt{x}$

$1+4\sqrt{x} = 1+2\sqrt{x}+x$

$2\sqrt{x} = x$

$4x = x^2$

$x^2 - 4x = 0$

$x(x-4) = 0$

$x = 0$ or $x = 4$

The solution set is $\{0, 4\}$.

31. $x^{3/2} = 8$

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

$x = \sqrt[3]{8}^2$

$x = 2^2$

$x = 4$

$4^{3/2} = 8$

$\sqrt{4}^3 = 8$

$2^3 = 8$

The solution set is $\{4\}$.

32. $x^{3/2} = 27$

$(x^{3/2})^{2/3} = 27^{2/3}$

$x = \sqrt[3]{27}^2$

$x = 3^2$

$x = 9$

$9^{3/2} = 27$

$\sqrt{9}^3 = 27$

$3^3 = 27$

The solution set is $\{9\}$.

33. $(x-4)^{3/2} = 27$

$((x-4)^{3/2})^{2/3} = 27^{2/3}$

$x - 4 = \sqrt[3]{27}^2$

$x - 4 = 3^2$

$x - 4 = 9$

$x = 13$

$(13-4)^{3/2} = 27$

$9^{3/2} = 27$

$\sqrt{9}^3 = 27$

$3^3 = 27$

The solution set is $\{13\}$.

34. $(x+5)^{3/2} = 8$

$((x+5)^{3/2})^{2/3} = 8^{2/3}$

$x + 5 = \sqrt[3]{8}^2$

$x + 5 = 2^2$

$x + 5 = 4$

$x = -1$

$(-1+5)^{3/2} = 8$

$4^{3/2} = 8$

$\sqrt{4}^3 = 8$

$2^3 = 8$

The solution set is $\{-1\}$.

35. $6x^{5/2} - 12 = 0$

$6x^{5/2} = 12$

$x^{5/2} = 2$

$(x^{5/2})^{2/5} = 2^{2/5}$

$x = \sqrt[5]{2^2}$

$x = \sqrt[5]{4}$

$6(\sqrt[5]{4})^{5/2} - 12 = 0$

$6(4^{1/5})^{5/2} - 12 = 0$

$6(4^{1/2}) - 12 = 0$

$6(2) - 12 = 0$

The solution set is $\left\{\sqrt[5]{4}\right\}$.

36. $8x^{5/3} - 24 = 0$

$8x^{5/3} = 24$

$x^{5/3} = 3$

$(x^{5/3})^{3/5} = 3^{3/5}$

$x = \sqrt[5]{3^3}$

$x = \sqrt[5]{27}$

$8(\sqrt[5]{27})^{5/3} - 24 = 0$

$8(27^{1/5})^{5/3} - 24 = 0$

$8(27^{1/3}) - 24 = 0$

$8(3) - 24 = 0$

The solution set is $\left\{\sqrt[5]{27}\right\}$.

37. $(x-4)^{2/3} = 16$

$\left[(x-4)^{2/3}\right]^{3/2} = (16)^{3/2}$

$x - 4 = \left(2^4\right)^{3/2}$

$x - 4 = 4^3 \qquad x - 4 = (-4)^3$

$x - 4 = 64 \qquad x - 4 = -64$

$x = 68 \qquad x = -60$

The solution set is $\{-60, 68\}$.

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

$\left[(x+5)^{\frac{2}{3}}\right]^{\frac{3}{2}} = (4)^{\frac{3}{2}}$

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

$x + 5 = 2^3 \quad \text{or} \quad x + 5 = (-2)^3$

$x + 5 = 8 \qquad x + 5 = -8$

$x = 3 \qquad x = -13$

The solution set is $\{-13, 3\}$.

39. $(x^2 - x - 4)^{3/4} - 2 = 6$

$(x^2 - x - 4)^{3/4} = 8$

$((x^2 - x - 4)^{3/4})^{4/3} = 8^{4/3}$

$x^2 - x - 4 = \sqrt[3]{8}^4$

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

$x^2 - x - 4 = 16$

$x^2 - x - 20 = 0$

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

$x - 5 = 0 \quad x + 4 = 0$

$x = 5 \qquad x = -4$

$(5^2 - 5 - 4)^{3/4} - 2 = 6$

$(25-9)^{3/4} - 2 = 6$

$16^{3/4} - 2 = 6$

$\sqrt[4]{16}^3 - 2 = 6$

$2^3 - 2 = 6$

$8 - 2 = 6$

$((-4)^2 - (-4) - 4)^{3/4} - 2 = 6$

$(16 + 4 - 4)^{3/4} - 2 = 6$

$16^{3/4} - 2 = 6$

$\sqrt[4]{16}^3 - 2 = 6$

$2^3 - 2 = 6$

$8 - 2 = 6$

The solution set is $\{5, -4\}$.

40. $(x^2 - 3x + 3)^{3/2} - 1 = 0$

$(x^2 - 3x + 3)^{3/2} = 1$

$x^2 - 3x + 3 = 1^{2/3}$

$x^2 - 3x + 3 = 1$

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

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

$x - 1 = 0 \quad x - 2 = 0$

$x = 1 \qquad x = 2$

$(1^2 - 3(1) + 3)^{3/2} - 1 = 0$

$(1 - 3 + 3)^{3/2} - 1 = 0$

$1^{3/2} - 1 = 0$

$1 - 1 = 0$

$(2^2 - 3(2) + 3)^{3/2} - 1 = 0$

$(4 - 6 + 3)^{3/2} - 1 = 0$

$1^{3/2} - 1 = 0$

$1 - 1 = 0$

The solution set is $\{1, 2\}$.

41. $x^4 - 5x^2 + 4 = 0$ let $t = x^2$

$t^2 - 5t + 4 = 0$

$(t-1)(t-4) = 0$

$t - 1 = 0 \quad t - 4 = 0$

$t = 1 \quad t = 4$

$x^2 = 1 \quad x^2 = 4$

$x = \pm 1 \quad x = \pm 2$

The solution set is {1, –1, 2, –2}.

42. $x^4 - 13x^2 + 36 = 0$ let $t = x^2$

$t^2 - 13t + 36 = 0$

$(t-4)(t-9) = 0$

$t - 4 = 0 \quad t - 9 = 0$

$t = 4 \quad t = 9$

$x^2 = 4 \quad x^2 = 9$

$x = \pm 2 \quad x = \pm 3$

The solution set is {–3, –2, 2, 3}.

43. $9x^4 = 25x^2 - 16$

$9x^4 - 25x^2 + 16 = 0$ let $t = x^2$

$9t^2 - 25t + 16 = 0$

$(9t-16)(t-1) = 0$

$9t - 16 = 0 \quad t - 1 = 0$

$9t = 16 \quad t = 1$

$t = \frac{16}{9} \quad x^2 = 1$

$x = \pm 1$

$x^2 = \frac{16}{9}$

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

The solution set is $\left\{1, -1, \frac{4}{3}, -\frac{4}{3}\right\}$.

44. $4x^4 = 13x^2 - 9$

$4x^4 - 13x^2 + 9 = 0$ let $t = x^2$

$4t^2 - 13t + 9 = 0$

$(4t-9)(t-1) = 0$

$4t - 9 = 0 \quad t - 1 = 0$

$4t = 9 \quad t = 1$

$t = \frac{9}{4} \quad x^2 = 1$

$x^2 = \frac{9}{4} \quad x = \pm 1$

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

The solution set is $\left\{-\frac{3}{2}, -1, 1, \frac{3}{2}\right\}$.

45. $x - 13\sqrt{x} + 40 = 0$ Let $t = \sqrt{x}$.

$t^2 - 13t + 40 = 0$

$(t-8)(t-5) = 0$

$t - 8 = 0 \quad t - 5 = 0$

$t = 8 \quad t = 5$

$\sqrt{x} = 8 \quad \sqrt{x} = 5$

$x = 64 \quad x = 25$

The solution set is {25, 64}.

46. $2x - 7\sqrt{x} - 30 = 0$ Let $t = \sqrt{x}$.

$2t^2 - 7t - 30 = 0$

$(2t+5)(t-6) = 0$

$2t + 5 = 0$

$t = \frac{5}{2} \quad t - 6 = 0$

$t = 6$

$\sqrt{x} = \frac{5}{2} \quad \sqrt{x} = 6$

$x = 36$

$x = \frac{25}{4}$

The solution set is {36} since 25/4 does not check in the original equation.

47. $x^{-2} - x^{-1} - 20 = 0$ Let $t = x^{-1}$

$t^2 - t - 20 = 0$

$(t-5)(t+4) = 0$

$t-5=0 \quad t+4=0$

$t=5 \qquad t=-4$

$x^{-1}=5 \quad x^{-1}=-4$

$\frac{1}{x}=5 \qquad \frac{1}{x}=-4$

$1=5x \qquad 1=-4x$

$\frac{1}{5}=x \qquad -\frac{1}{4}=x$

The solution set is $\left\{-\frac{1}{4},\frac{1}{5}\right\}$.

48. $x^{-2} - x^{-1} - 6 = 0$ Let t = x^{-1}.

$t^2 - t - 6 = 0$

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

$t-3=0 \qquad t+2=0$

$t=3 \qquad t=-2$

$x^{-1}=3 \qquad x^{-1}=-2$

$\frac{1}{x}=3 \qquad \frac{1}{x}=-2$

$1=3x \qquad 1=-2x$

$\frac{1}{3}=x \qquad -\frac{1}{2}=x$

The solution set is $\left\{-\frac{1}{2},\frac{1}{3}\right\}$.

49. $x^{2/3} - x^{1/3} - 6 = 0$ let $t = x^{1/3}$

$t^2 - t - 6 = 0$

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

$t-3=0 \qquad t+2=0$

$t=3 \qquad t=-2$

$x^{1/3}=3 \qquad x^{1/3}=-2$

$x=3^3 \qquad x=(-2)^3$

$x=27 \qquad x=-8$

The solution set is {27, –8}.

50. $2x^{2/3} + 7x^{1/3} - 15 = 0$ let $t = x^{1/3}$

$2t^2 + 7t - 15 = 0$

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

$2t-3=0 \qquad t+5=0$

$2t=3 \qquad t=-5$

$t=\frac{3}{2} \qquad x^{1/3}=-5$

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

$x=\left(\frac{3}{2}\right)^3 \qquad x=-125$

$x=\frac{27}{8}$

The solution set is $\left\{-125,\frac{27}{8}\right\}$.

51. $x^{3/2} - 2x^{3/4} + 1 = 0$ let $t = x^{3/4}$

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

$(t-1)(t-1) = 0$

$t-1=0$

$t=1$

$x^{3/4}=1$

$x=1^{4/3}$

$x=1$

The solution set is {1}.

52. $x^{2/5} + x^{1/5} - 6 = 0$ let $t = x^{1/5}$

$t^2 + t - 6 = 0$

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

$t+3=0 \qquad t-2=0$

$t=-3 \qquad t=2$

$x^{1/5}=-3 \qquad x^{1/5}=2$

$x=(-3)^5 \qquad x=2^5$

$x=-243 \qquad x=32$

The solution set is {–243, 32}.

53. $2x - 3x^{1/2} + 1 = 0$ let $t = x^{1/2}$

$2t^2 - 3t + 1 = 0$

$(2t - 1)(t - 1) = 0$

$2t - 1 = 0 \qquad t - 1 = 0$

$2t = 1$

$t = \frac{1}{2} \qquad t = 1$

$x^{1/2} = \frac{1}{2} \qquad x^{1/2} = 1$

$x = \left(\frac{1}{2}\right)^2 \qquad x = 1^2$

$x = \frac{1}{4} \qquad x = 1$

The solution set is $\left\{\frac{1}{4}, 1\right\}$.

54. $x + 3x^{1/2} - 4 = 0$ let $t = x^{1/2}$

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

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

$t - 1 = 0 \qquad t + 4 = 0$

$t = 1 \qquad t = -4$

$x^{1/2} = 1 \qquad x^{1/2} = -4$

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

$x = 1 \qquad x = 16$

The solution set is $\{1\}$.

55. $(x - 5)^2 - 4(x - 5) - 21 = 0$ let $t = x - 5$

$t^2 - 4t - 21 = 0$

$(t + 3)(t - 7) = 0$

$t + 3 = 0 \qquad t - 7 = 0$

$t = -3 \qquad t = 7$

$x - 5 = -3 \qquad x - 5 = 7$

$x = 2 \qquad x = 12$

The solution set is $\{2, 12\}$.

56. $(x + 3)^2 + 7(x + 3) - 18 = 0$ let $t = x + 3$

$t^2 + 7t - 18 = 0$

$(t + 9)(t - 2) = 0$

$t + 9 = 0 \qquad t - 2 = 0$

$t = -9 \qquad t = 2$

$x + 3 = -9 \qquad x + 3 = 2$

$x = -12 \qquad x = -1$

The solution set is $\{-12, -1\}$.

57. $\left(x^2 - x\right)^2 - 14\left(x^2 - x\right) + 24 = 0$

Let $t = x^2 - x$.

$t^2 - 14t + 24 = 0$

$(t - 2)(t - 12) = 0$

$t = 2$ or $t = 12$

$x^2 - x = 2 \qquad$ or $\qquad x^2 - x = 12$

$x^2 - x - 2 = 0 \qquad x^2 - x - 12 = 0$

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

The solution set is $\{-3, -1, 2, 4\}$.

58. $\left(x^2 - 2x\right)^2 - 11\left(x^2 - 2x\right) + 24 = 0$

Let $t = x^2 - 2x$

$t^2 - 11t + 24 = 0$

$(t - 3)(t - 8) = 0$

$t = 3$ or $t = 8$

$x^2 - 2x = 3 \qquad$ or $\qquad x^2 - 2x = 8$

$x^2 - 2x - 3 = 0 \qquad x^2 - 2x - 8 = 0$

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

The solution set is $\{-2, -1, 3, 4\}$.

59. $\left(y - \frac{8}{y}\right)^2 + 5\left(y - \frac{8}{y}\right) - 14 = 0$

Let $t = y - \frac{8}{y}$.

$t^2 + 5t - 14 = 0$

$(t + 7)(t - 2) = 0$

$t = -7$ or $t = 2$

$y - \frac{8}{y} = -7 \qquad$ or $\qquad y - \frac{8}{y} = 2$

$y^2 + 7y - 8 = 0 \qquad y^2 - 2y - 8 = 0$

$(y + 8)(y - 1) = 0 \qquad (y - 4)(y + 2) = 0$

The solution set is $\{-8, -2, 1, 4\}$.

60. $\left(y-\frac{10}{y}\right)^2+6\left(y-\frac{10}{y}\right)-27=0$

Let $t=y-\frac{10}{y}$.

$t^2+6t-27=0$

$(t+9)(t-3)=0$

$t=-9$ or $t=3$

$y-\frac{10}{y}=-9$ or $y-\frac{10}{y}=3$

$y^2+9y-10=0$ $\quad y^2-3y-10=0$

$(y+10)(y-1)=0$ $\quad (y-5)(y+2)=0$

The solution set is $\{-10, -2, 1, 5\}$.

61. $|x|=8$

$x=8, x=-8$

The solution set is $\{8, -8\}$.

62. $|x|=6$

$x=6, x=-6$

The solution set is $\{-6, 6\}$.

63. $|x-2|=7$

$x-2=7 \quad x-2=-7$

$x=9 \quad x=-5$

The solution set is $\{9, -5\}$.

64. $|x+1|=5$

$x+1=5 \quad x+1=-5$

$x=4 \quad x=-6$

The solution set is $\{-6, 4\}$.

65. $|2x-1|=5$

$2x-1=5 \quad 2x-1=-5$

$2x=6 \quad 2x=-4$

$x=3 \quad x=-2$

The solution set is $\{3, -2\}$.

66. $|2x-3|=11$

$2x-3=11 \quad 2x-3=-11$

$2x=14 \quad 2x=-8$

$x=7 \quad x=-4$

The solution set is $\{-4, 7\}$.

67. $2|3x-2|=14$

$|3x-2|=7$

$3x-2=7 \quad 3x-2=-7$

$3x=9 \quad 3x=-5$

$x=3 \quad x=-5/3$

The solution set is $\{3, -5/3\}$.

68. $3|2x-1|=21$

$|2x-1|=7$

$2x-1=7$ or $2x-1=-7$

$2x=8 \quad 2x=-6$

$x=4 \quad x=-3$

The solution set is $\{4, -3\}$.

69. $7|5x|+2=16$

$7|5x|=14$

$|5x|=2$

$5x=2 \quad 5x=-2$

$x=2/5 \quad x=-2/5$

The solution set is $\left\{\frac{2}{5}, -\frac{2}{5}\right\}$.

70. $7|3x|+2=16$

$7|3x|=14$

$|3x|=2$

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

$x=2/3 \quad x=-2/3$

The solution set is $\{-2/3, 2/3\}$.

71. $2\left|4-\frac{5}{2}x\right|+6=18$

$2\left|4-\frac{5}{2}x\right|=12$

$\left|4-\frac{5}{2}x\right|=6$

$4-\frac{5}{2}x=6$ or $4-\frac{5}{2}x=-6$

$-\frac{5}{2}x=2 \quad -\frac{5}{2}x=-10$

$-\frac{2}{5}\left(-\frac{5}{2}\right)x=-\frac{2}{5}(2) \quad -\frac{2}{5}\left(-\frac{5}{2}\right)x=-\frac{2}{5}(-10)$

$x=-\frac{4}{5} \quad x=4$

The solution set is $\left\{-\frac{4}{5}, 4\right\}$.

72. $4\left|1-\frac{3}{4}x\right|+7=10$

$4\left|1-\frac{3}{4}x\right|=3$

$\left|1-\frac{3}{4}x\right|=\frac{3}{4}$

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

$-\frac{3}{4}x=-\frac{1}{4}$ $\quad -\frac{3}{4}x=-\frac{7}{4}$

$-\frac{4}{3}\left(-\frac{3}{4}\right)x=-\frac{4}{3}\left(-\frac{1}{4}\right)$ $\quad -\frac{4}{3}\left(-\frac{3}{4}\right)x=-\frac{4}{3}\left(-\frac{7}{4}\right)$

$x=\frac{1}{3}$ $\quad x=\frac{7}{3}$

The solution set is $\left\{\frac{1}{3},\frac{7}{3}\right\}$.

73. $|x+1|+5=3$

$|x+1|=-2$

No solution

The solution set is $\{\ \}$.

74. $|x+1|+6=2$

$|x+1|=-4$

No solution

The solution set is $\{\ \}$.

75. $|2x-1|+3=3$

$|2x-1|=0$

$2x-1=0$

$2x=1$

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

The solution set is $\left\{\frac{1}{2}\right\}$.

76. $|3x-2|+4=4$

$|3x-2|=0$

$3x-2=0$

$3x=2$

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

The solution set is $\left\{\frac{2}{3}\right\}$.

77. $|3x-1|=|x+5|$

$3x-1=x+5$ $\quad 3x-1=-x-5$

$2x-1=5$ $\quad 4x-1=-5$

$2x=6$ $\quad 4x=-4$

$x=3$ $\quad x=-1$

The solution set is $\{3,-1\}$.

78. $|2x-7|=|x+3|$

$2x-7=x+3$ or $2x-7=-(x+3)$

$x=10$ $\quad 2x-7=-x-3$

$3x=4$

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

The solution set is $\left\{10,\frac{4}{3}\right\}$.

79. Set $y=0$ to find the x–intercept(s).

$0=\sqrt{x+2}+\sqrt{x-1}-3$

$-\sqrt{x+2}=\sqrt{x-1}-3$

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

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

$x+2=x-1-6\sqrt{x-1}+9$

$x+2=x-1-6\sqrt{x-1}+9$

$2=8-6\sqrt{x-1}$

$-6=-6\sqrt{x-1}$

$\frac{-6}{-6}=\frac{-6\sqrt{x-1}}{-6}$

$1=\sqrt{x-1}$

$(1)^2=\left(\sqrt{x-1}\right)^2$

$1=x-1$

$2=x$

The x-intercept is 2.

The corresponding graph is graph (c).

80. Set $y = 0$ to find the x–intercept(s).

$$0 = \sqrt{x-4} + \sqrt{x+4} - 4$$
$$-\sqrt{x-4} = \sqrt{x+4} - 4$$
$$\left(-\sqrt{x-4}\right)^2 = \left(\sqrt{x+4} - 4\right)^2$$
$$x - 4 = \left(\sqrt{x+4}\right)^2 - 2\left(\sqrt{x+4}\right)(4) + (4)^2$$
$$x - 4 = x + 4 - 8\sqrt{x+4} + 16$$
$$-4 = 20 - 8\sqrt{x+4}$$
$$-24 = -8\sqrt{x+4}$$
$$\frac{-24}{-8} = \frac{-8\sqrt{x+4}}{-8}$$
$$3 = \sqrt{x+4}$$
$$(3)^2 = \left(\sqrt{x+4}\right)^2$$
$$9 = x + 4$$
$$5 = x$$

The x-intercept is 5.
The corresponding graph is graph (a).

81. Set $y = 0$ to find the x–intercept(s).

$$0 = x^{\frac{1}{3}} + 2x^{\frac{1}{6}} - 3$$

Let $t = x^{\frac{1}{6}}$.

$$x^{\frac{1}{3}} + 2x^{\frac{1}{6}} - 3 = 0$$
$$\left(x^{\frac{1}{6}}\right)^2 + 2x^{\frac{1}{6}} - 3 = 0$$
$$t^2 + 2t - 3 = 0$$
$$(t+3)(t-1) = 0$$
$$t + 3 = 0 \quad \text{or} \quad t - 1 = 0$$
$$t = -3 \qquad t = 1$$

Substitute $x^{\frac{1}{6}}$ for t.

$$x^{\frac{1}{6}} = -3 \qquad \text{or} \qquad x^{\frac{1}{6}} = 1$$
$$\left(x^{\frac{1}{6}}\right)^6 = (-3)^6 \qquad \left(x^{\frac{1}{6}}\right)^6 = (1)^6$$
$$x = 729 \qquad x = 1$$

729 does not check and must be rejected.
The x-intercept is 1.
The corresponding graph is graph (e).

82. Set $y = 0$ to find the x–intercept(s).

$$0 = x^{-2} - x^{-1} - 6$$

Let $t = x^{-1}$.

$$x^{-2} - x^{-1} - 6 = 0$$
$$\left(x^{-1}\right)^2 - x^{-1} - 6 = 0$$
$$t^2 - t - 6 = 0$$
$$(t+2)(t-3) = 0$$
$$t + 2 = 0 \quad \text{or} \quad t - 3 = 0$$
$$t = -2 \qquad t = 3$$

Substitute x^{-1} for t.

$$x^{-1} = -2 \quad \text{or} \quad x^{-1} = 3$$
$$x = -\frac{1}{2} \qquad x = \frac{1}{3}$$

The x-intercepts are $-\frac{1}{2}$ and $\frac{1}{3}$.
The corresponding graph is graph (b).

83. Set $y = 0$ to find the x–intercept(s).

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

Let $t = x + 2$.

$$(x+2)^2 - 9(x+2) + 20 = 0$$
$$t^2 - 9t + 20 = 0$$
$$(t-5)(t-4) = 0$$
$$t - 5 = 0 \quad \text{or} \quad t - 4 = 0$$
$$t = 5 \qquad t = 4$$

Substitute $x + 2$ for t.

$$x + 2 = 5 \quad \text{or} \quad x + 2 = 4$$
$$x = 3 \qquad x = 2$$

The x-intercepts are 2 and 3.
The corresponding graph is graph (f).

84. Set $y = 0$ to find the x–intercept(s).

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

Let $t = x + 2$.

$$2(x+2)^2 + 5(x+2) - 3 = 0$$
$$2t^2 + 5t - 3 = 0$$
$$(2t-1)(t+3) = 0$$
$$2t - 1 = 0 \quad \text{or} \quad t + 3 = 0$$
$$2t = 1 \qquad\qquad t = -3$$
$$t = \frac{1}{2}$$

Substitute $x + 2$ for t.

$$x + 2 = \frac{1}{2} \quad \text{or} \quad x + 2 = -3$$
$$x = -5$$
$$x = \frac{1}{2} - 2$$
$$x = -\frac{3}{2}$$

The x-intercepts are -5 and $-\frac{3}{2}$.

The corresponding graph is graph (d).

85. $|5 - 4x| = 11$

$$5 - 4x = 11 \qquad 5 - 4x = -11$$
$$-4x = 6 \quad \text{or} \quad -4x = -16$$
$$x = -\frac{3}{2} \qquad x = 4$$

The solution set is $\left\{-\frac{3}{2}, 4\right\}$.

86. $|2 - 3x| = 13$

$$2 - 3x = 13 \qquad 2 - 3x = -13$$
$$-3x = 11 \quad \text{or} \quad -3x = -15$$
$$x = -\frac{11}{3} \qquad x = 5$$

The solution set is $\left\{-\frac{11}{3}, 5\right\}$.

87. $x + \sqrt{x+5} = 7$

$$\sqrt{x+5} = 7 - x$$
$$\left(\sqrt{x+5}\right)^2 = (7-x)^2$$
$$x + 5 = 49 - 14x + x^2$$
$$0 = x^2 - 15x + 44$$
$$0 = (x-4)(x-11)$$
$$x - 4 = 0 \quad \text{or} \quad x - 11 = 0$$
$$x = 4 \qquad\qquad x = 11$$

11 does not check and must be rejected.

The solution set is $\{4\}$.

88. $x - \sqrt{x-2} = 4$

$$-\sqrt{x-2} = 4 - x$$
$$\left(-\sqrt{x-2}\right)^2 = (4-x)^2$$
$$x - 2 = 16 - 8x + x^2$$
$$0 = x^2 - 9x + 18$$
$$0 = (x-6)(x-3)$$
$$x - 6 = 0 \quad \text{or} \quad x - 3 = 0$$
$$x = 6 \qquad\qquad x = 3$$

3 does not check and must be rejected.

The solution set is $\{6\}$.

89. $2x^3 + x^2 - 8x + 2 = 6$

$$2x^3 + x^2 - 8x - 4 = 0$$
$$x^2(2x+1) - 4(2x+1) = 0$$
$$(2x+1)(x^2 - 4) = 0$$
$$(2x+1)(x+2)(x-2) = 0$$
$$2x + 1 = 0 \quad \text{or} \quad x + 2 = 0 \quad \text{or} \quad x - 2 = 0$$
$$x = -\frac{1}{2} \qquad x = -2 \qquad x = 2$$

The solution set is $\left\{-\frac{1}{2}, -2, 2\right\}$.

90. $x^3 + 4x^2 - x + 6 = 10$

$$x^3 + 4x^2 - x - 4 = 0$$
$$x^2(x+4) - 1(x+4) = 0$$
$$(x+4)(x^2 - 1) = 0$$
$$(x+4)(x+1)(x-1) = 0$$
$$x + 4 = 0 \quad \text{or} \quad x + 1 = 0 \quad \text{or} \quad x - 1 = 0$$
$$x = -4 \qquad x = -1 \qquad x = 1$$

The solution set is $\{-4, -1, 1\}$.

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

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

$$x+4 = \left(\sqrt[3]{8}\right)^2$$

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

$$x+4 = 4$$

$$x = 0$$

The solution set is $\{0\}$.

92. $(x-5)^{\frac{3}{2}} = 125$

$$\left((x-5)^{\frac{3}{2}}\right)^{\frac{2}{3}} = (125)^{\frac{2}{3}}$$

$$x-5 = \left(\sqrt[3]{125}\right)^2$$

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

$$x-5 = 25$$

$$x = 30$$

The solution set is $\{30\}$.

93. $y_1 = y_2 + 3$

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

$$\left(x^2-1\right)^2 - 2\left(x^2-1\right) - 3 = 0$$

Let $t = x^2 - 1$ and substitute.

$$t^2 - 2t - 3 = 0$$

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

$t+1=0$ or $t-3=0$

$t=-1$ $\qquad$ $t=3$

Substitute x^2-1 for t.

$x^2-1=-1$ or $x^2-1=3$

$x^2=0$ $\qquad$ $x^2=4$

$x=0$ $\qquad$ $x=\pm 2$

The solution set is $\{-2,0,2\}$.

94. $y_1 = y_2 + 6$

$$6\left(\frac{2x}{x-3}\right)^2 = 5\left(\frac{2x}{x-3}\right)+6$$

$$6\left(\frac{2x}{x-3}\right)^2 - 5\left(\frac{2x}{x-3}\right) - 6 = 0$$

Let $t = \dfrac{2x}{x-3}$ and substitute.

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

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

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

$t=-\dfrac{2}{3}$ $\qquad$ $t=\dfrac{3}{2}$

Substitute $\dfrac{2x}{x-3}$ for t.

$\dfrac{2x}{x-3} = -\dfrac{2}{3}$ or $\dfrac{2x}{x-3} = \dfrac{3}{2}$

First solve $\dfrac{2x}{x-3} = -\dfrac{2}{3}$

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

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

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

$$8x = 6$$

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

Next solve $\dfrac{2x}{x-3} = \dfrac{3}{2}$

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

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

$$4x = 3x-9$$

$$x = -9$$

The solution set is $\left\{-9, \dfrac{3}{4}\right\}$.

95. $\left|x^2+2x-36\right| = 12$

$x^2+2x-36=12$ $\qquad$ $x^2+2x-36=-12$

$x^2+2x-48=0$ or $x^2+2x-24=0$

$(x+8)(x-6)=0$ $\qquad$ $(x+6)(x-4)=0$

Setting each of the factors above equal to zero gives $x=-8,\ x=6,\ x=-6,$ and $x=4$.

The solution set is $\{-8,-6,4,6\}$.

96. $\left|x^2+6x+1\right|=8$

$x^2+6x+1=8$ or $x^2+6x+1=-8$

$x^2+6x-7=0$ $\quad$ $x^2+6x+9=0$

$(x+7)(x-1)=0$ $\quad$ $(x+3)(x+3)=0$

Setting each of the factors above equal to zero gives $x=-7,\quad x=-3,\quad$ and $x=1$.

The solution set is $\{-7,-3,1\}$.

97. $x(x+1)^3-42(x+1)^2=0$

$(x+1)^2\left(x(x+1)-42\right)=0$

$(x+1)^2\left(x^2+x-42\right)=0$

$(x+1)^2(x+7)(x-6)=0$

Setting each of the factors above equal to zero gives $x=-7,\quad x=-1,\quad$ and $x=6$.

The solution set is $\{-7,-1,6\}$.

98. $x(x-2)^3-35(x-2)^2=0$

$x(x-2)^3-35(x-2)^2=0$

$(x-2)^2\left(x(x-2)-35\right)=0$

$(x-2)^2\left(x^2-2x-35\right)=0$

$(x-2)^2(x+5)(x-7)=0$

Setting each of the factors above equal to zero gives $x=-5,\quad x=2,\quad$ and $x=7$.

The solution set is $\{-5,2,7\}$.

99. Let x = the number.

$\sqrt{5x-4}=x-2$

$\left(\sqrt{5x-4}\right)^2=(x-2)^2$

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

$0=x^2-9x+8$

$0=(x-8)(x-1)$

$x-8=0$ or $x-1=0$

$x=8$ $\quad$ $x=1$

Check $x=8$: $\sqrt{5(8)-4}=8-2$

$\sqrt{40-4}=6$

$\sqrt{36}=6$

$6=6$

Check $x=1$: $\sqrt{5(1)-4}=1-2$

$\sqrt{5-4}=-1$

$\sqrt{-1}\neq -1$

Discard $x=1$. The number is 8.

100. Let x = the number.

$\sqrt{x-3}=x-5$

$\left(\sqrt{x-3}\right)^2=(x-5)^2$

$x-3=x^2-10x+25$

$0=x^2-11x+28$

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

$x-7=0$ or $x-4=0$

$x=7$ $\quad$ $x=4$

Check $x=7$: $\sqrt{7-3}=7-5$

$\sqrt{4}=2$

$2=2$

Check $x=4$: $\sqrt{4-3}=4-5$

$\sqrt{1}=-1$

$1\neq -1$

Discard 4. The number is 7.

101. $r=\sqrt{\dfrac{3V}{\pi h}}$

$r^2=\left(\sqrt{\dfrac{3V}{\pi h}}\right)^2$

$r^2=\dfrac{3V}{\pi h}$

$\pi r^2 h=3V$

$\dfrac{\pi r^2 h}{3}=V$

$V=\dfrac{\pi r^2 h}{3}$ or $V=\dfrac{1}{3}\pi r^2 h$

102. $r=\sqrt{\dfrac{A}{4\pi}}$

$r^2=\left(\sqrt{\dfrac{A}{4\pi}}\right)^2$

$r^2=\dfrac{A}{4\pi}$

$4\pi r^2=A$ or $A=4\pi r^2$

103. Exclude any value that causes the denominator to equal zero.

$$|x+2|-14=0$$
$$|x+2|=14$$
$$x+2=14 \quad \text{or} \quad x+2=-14$$
$$x=12 \qquad\qquad x=-16$$

–16 and 12 must be excluded from the domain.

104. Exclude any value that causes the denominator to equal zero.

$$x^3+3x^2-x-3=0$$
$$x^2(x+3)-1(x+3)=0$$
$$(x+3)\left(x^2-1\right)=0$$
$$(x+3)(x+1)(x-1)=0$$

Setting each of the factors above equal to zero gives $x=-3, \quad x=-1, \quad$ and $x=1$.

–3, –1, and 1 must be excluded from the domain.

105.
$$t=\frac{\sqrt{d}}{2}$$
$$1.16=\frac{\sqrt{d}}{2}$$
$$2.32=\sqrt{d}$$
$$2.32^2=\left(\sqrt{d}\right)^2$$
$$d\approx 5.4$$

The vertical distance was about 5.4 feet.

106.
$$t=\frac{\sqrt{d}}{2}$$
$$0.85=\frac{\sqrt{d}}{2}$$
$$1.7=\sqrt{d}$$
$$1.7^2=\left(\sqrt{d}\right)^2$$
$$d\approx 2.9$$

The vertical distance was about 2.9 feet.

107. It is represented by the point $(5.4, 1.16)$.

108. It is represented by the point $(2.9, 0.85)$.

109. a. According to the line graph, about 47% ±1% of U.S. women participated in the labor force in 2010.

b. $p=1.6\sqrt{t}+38$

$p=1.6\sqrt{40}+38\approx 48.1$

According to the formula, about 48.1% of U.S. women participated in the labor force in 2010.

c.
$$p=1.6\sqrt{t}+38$$
$$51=1.6\sqrt{t}+38$$
$$13=1.6\sqrt{t}$$
$$\frac{13}{1.6}=\frac{1.6\sqrt{t}}{1.6}$$
$$\frac{13}{1.6}=\sqrt{t}$$
$$\left(\frac{13}{1.6}\right)^2=\left(\sqrt{t}\right)^2$$
$$66\approx t$$

According to the formula, 51% of U.S. women will participate in the labor force 66 years after 1970, or 2036.

110. a. According to the line graph, about 53% ±1% of U.S. men participated in the labor force in 2010.

b. $p=-1.6\sqrt{t}+62$

$p=-1.6\sqrt{40}+62\approx 51.9$

According to the formula, about 51.9% of U.S. men participated in the labor force in 2010.

c.
$$p=-1.6\sqrt{t}+62$$
$$49=-1.6\sqrt{t}+62$$
$$-13=-1.6\sqrt{t}$$
$$\frac{-13}{-1.6}=\frac{-1.6\sqrt{t}}{-1.6}$$
$$\frac{-13}{-1.6}=\sqrt{t}$$
$$\left(\frac{-13}{-1.6}\right)^2=\left(\sqrt{t}\right)^2$$
$$66\approx t$$

According to the formula, 49% of U.S. men will participate in the labor force 66 years after 1970, or 2036.

111.
$$365 = 0.2x^{3/2}$$
$$\frac{365}{0.2} = \frac{0.2x^{3/2}}{0.2}$$
$$1825 = x^{3/2}$$
$$1825^2 = \left(x^{3/2}\right)^2$$
$$3{,}330{,}625 = x^3$$
$$\sqrt[3]{3{,}330{,}625} = \sqrt[3]{x^3}$$
$$149.34 \approx x$$

The average distance of the Earth from the sun is approximately 149 million kilometers.

112.
$$f(x) = 0.2x^{3/2}$$
$$88 = 0.2x^{3/2}$$
$$\frac{88}{0.2} = \frac{0.2x^{3/2}}{0.2}$$
$$440 = x^{3/2}$$
$$440^2 = \left(x^{3/2}\right)^2$$
$$193{,}600 = x^3$$
$$\sqrt[3]{193{,}600} = \sqrt[3]{x^3}$$
$$58 \approx x$$

The average distance of Mercury from the sun is approximately 58 million kilometers.

113.
$$\sqrt{6^2 + x^2} + \sqrt{8^2 + (10 - x)^2} = 18$$
$$\sqrt{36 + x^2} = 18 - \sqrt{64 + 100 - 20x + x^2}$$
$$36 + x^2 = 324 - 36\sqrt{x^2 - 20x + 164} + x^2 - 20x + 164$$
$$36\sqrt{x^2 - 20x + 164} = -20x + 452$$
$$9\sqrt{x^2 - 20x + 164} = -5x + 113$$
$$81(x^2 - 20x + 164) = 25x^2 - 1130x + 12769$$
$$81x^2 - 1620x + 13284 = 25x^2 - 1130x + 12769$$
$$56x^2 - 490x + 515 = 0$$
$$x = \frac{490 \pm \sqrt{(-490)^2 - 4(56)(515)}}{2(56)}$$
$$x = \frac{490 \pm 353.19}{112}$$
$$x \approx 1.2 \qquad x \approx 7.5$$

The point should be located approximately either 1.2 feet or 7.5 feet from the base of the 6-foot pole.

114. a. Distance from point $A = \sqrt{6^2 + x^2} + \sqrt{3^2 + (12 - x)^2}$ or $A = \sqrt{x^2 + 36} + \sqrt{(12 - x)^2 + 9}$.

b. Let the distance = 15.

$$\sqrt{6^2 + x^2} + \sqrt{3^2 + (12 - x)^2} = 15$$
$$\sqrt{36 + x^2} = 15 - \sqrt{9 + 144 - 24x + x^2}$$
$$36 + x^2 = 225 - 30\sqrt{153 - 24x + x^2} + x^2 - 24x + 153$$
$$30\sqrt{x^2 - 24x + 153} = -24x + 342$$
$$5\sqrt{x^2 - 24x + 153} = -4x + 157$$
$$25(x^2 - 24x + 153) = 16x^2 - 456x + 3249$$
$$25x^2 - 600x + 3825 = 16x^2 - 456x + 3249$$
$$9x^2 - 144x + 576 = 0$$
$$x^2 - 16x + 64 = 0$$
$$(x - 8)(x - 8) = 0$$
$$x = 8$$

The distance is 8 miles.

115. – 121. Answers will vary.

122. $x^3 + 3x^2 - x - 3 = 0$

The solution set is $\{-3, -1, 1\}$.

$$(-3)^3 + 3(-3)^2 - (-3) - 3 = 0$$
$$-27 + 27 + 3 - 3 = 0$$
$$(-1)^3 + 3(-1)^2 - (-1) - 3 = 0$$
$$-1 + 3 + 1 - 3 = 0$$
$$1^3 + 3(1)^2 - (1) - 3 = 0$$
$$1 + 3 - 1 - 3 = 0$$

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

The solution set is $\{0, 2\}$.

$$-(0)^4 + 4(0)^3 - 4(0)^2 = 0$$
$$0 = 0$$
$$-(2)^4 + 4(2)^3 - 4(2)^2 = 0$$
$$-16 + 32 - 16 = 0$$
$$0 = 0$$

124. $\sqrt{2x + 13} - x - 5 = 0$

The solution set is $\{-2\}$.

$$\sqrt{2(-2) + 13} - (-2) - 5 = 0$$
$$\sqrt{-4 + 13} + 2 - 5 = 0$$
$$\sqrt{9} - 3 = 0$$
$$3 - 3 = 0$$

125. does not make sense; Explanations will vary. Sample explanation: You should substitute into the original equation.

126. makes sense

127. does not make sense; Explanations will vary. Sample explanation: Changing the order of the terms does not change the fact that this equation is quadratic in form.

128. makes sense

129. false; Changes to make the statement true will vary. A sample change is: Squaring $x+2$ results in x^2+4x+4.

130. false; Changes to make the statement true will vary. A sample change is: 21 satisfies the linear equation but not the radical equation.

131. false; Changes to make the statement true will vary. A sample change is: To solve the equation, let $u^2 = x$.

132. false; Changes to make the statement true will vary. A sample change is: Neither 6 nor –6 satisfies the absolute value equation.

133. $\sqrt{6x-2} = \sqrt{2x+3} - \sqrt{4x-1}$

$$6x-2 = 2x+3-2\sqrt{(2x+3)(4x-1)}+4x-1$$
$$-4 = -2\sqrt{(2x+3)(4x-1)}$$
$$2 = \sqrt{8x^2+10x-3}$$
$$4 = 8x^2+10x-3$$
$$8x^2+10x-7=0$$
$$x = \frac{-10\pm\sqrt{10^2-4(8)(-7)}}{2(8)}$$
$$x = \frac{-10\pm\sqrt{100+224}}{16}$$
$$x = \frac{-10\pm\sqrt{324}}{16}$$
$$x = \frac{-10\pm 18}{16}$$
$$x = \frac{-28}{26}, \frac{8}{16}$$
$$x = \frac{1}{2}$$

The solution set is $\left\{\frac{1}{2}\right\}$.

134. $5-\frac{2}{x} = \sqrt{5-\frac{2}{x}}$

or

$$5-\frac{2}{x}=0 \qquad 5-\frac{2}{x}=1$$
$$5=\frac{2}{x} \qquad -\frac{2}{x}=-4$$
$$5x=2 \qquad -4x=-2$$
$$x=\frac{2}{5} \qquad x=\frac{1}{2}$$

The solution set is $\left\{\frac{2}{5},\frac{1}{2}\right\}$.

135. $\sqrt[3]{x\sqrt{x}} = 9$

$$\sqrt[3]{x\sqrt{x}} = 9$$
$$\sqrt[3]{x^1 x^{\frac{1}{2}}} = 9$$
$$\left(x^1 x^{\frac{1}{2}}\right)^{\frac{1}{3}} = 9$$
$$\left(x^{\frac{3}{2}}\right)^{\frac{1}{3}} = 9$$
$$x^{\frac{1}{2}} = 9$$
$$\left(x^{\frac{1}{2}}\right)^2 = (9)^2$$
$$x = 81$$

The solution set is {81}.

136. $x^{5/6} + x^{2/3} - 2x^{1/2} = 0$

$$x^{1/2}(x^{2/6} + x^{1/6} - 2) = 0 \text{ let } t = x^{1/6}$$
$$x^{1/2}(t^2+t-2)=0$$
$$x^{1/2}=0 \quad t^2+t-2=0$$
$$(t-1)(t+2)=0$$
$$t-1=0 \qquad t+2=0$$
$$t=1 \qquad t=-2$$
$$x^{1/6}=1 \qquad x^{1/6}=-2$$
$$x=1^6 \qquad x=(-2)^6$$
$$x=0 \qquad x=1 \qquad x=64$$

64 does not check and must be rejected.
The solution set is {0, 1}.

137. $3-2x \le 11$

$3-2(-1) \le 11$

$3+2 \le 11$

$5 \le 11$, true

Yes, –1 is a solution.

138. $-2x-4 = x+5$

$-2x-x = 5+4$

$-3x = 9$

$x = \dfrac{9}{-3}$

$x = -3$

The solution set is $\{-3\}$.

139. $\dfrac{x+3}{4} = \dfrac{x-2}{3} + \dfrac{1}{4}$

$12\left(\dfrac{x+3}{4}\right) = 12\left(\dfrac{x-2}{3} + \dfrac{1}{4}\right)$

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

$3x+9 = 4x-8+3$

$3x+9 = 4x-5$

$3x-4x = -5-9$

$-x = -14$

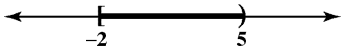
$x = 14$

The solution set is $\{14\}$.

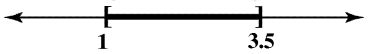
Section 1.7

Check Point Exercises

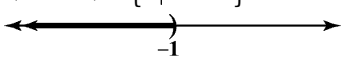
1. **a.** $[-2,5) = \{x \mid -2 \le x < 5\}$



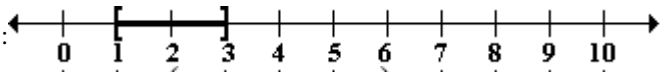
b. $[1,3.5] = \{x \mid 1 \le x \le 3.5\}$



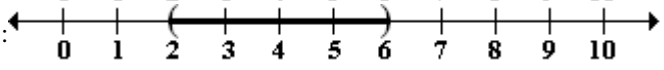
c. $(-\infty,-1) = \{x \mid x < -1\}$



2. a. Graph $[1,3]$:

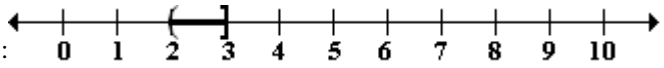


Graph $(2,6)$:



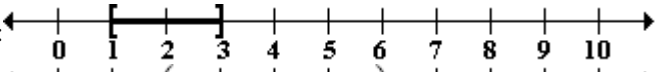
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $[1,3]$ and $(2,6)$:

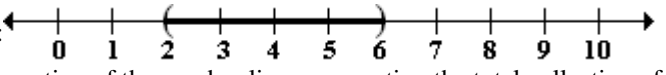


Thus, $[1,3] \cap (2,6) = (2,3]$.

b. Graph $[1,3]$:

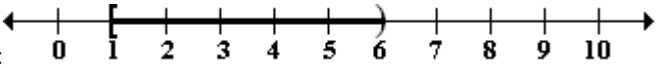


Graph $(2,6)$:



To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $[1,3]$ or $(2,6)$ or both:



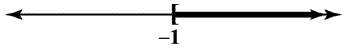
Thus, $[1,3] \cup (2,6) = [1,6)$.

3. $2 - 3x \le 5$

$-3x \le 3$

$x \ge -1$

The solution set is $\{x \mid x \ge -1\}$ or $[-1, \infty)$.



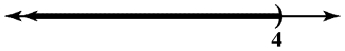
4. $3x + 1 > 7x - 15$

$-4x > -16$

$\frac{-4x}{-4} < \frac{-16}{-4}$

$x < 4$

The solution set is $\{x \mid x < 4\}$ or $(-\infty, 4)$.



5. $\frac{x-4}{2} \ge \frac{x-2}{3} + \frac{5}{6}$

$6\left(\frac{x-4}{2}\right) \ge 6\left(\frac{x-2}{3} + \frac{5}{6}\right)$

$3(x-4) \ge 2(x-2) + 5$

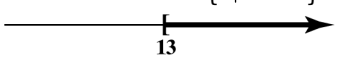
$3x - 12 \ge 2x - 4 + 5$

$3x - 12 \ge 2x + 1$

$3x - 2x \ge 1 + 12$

$x \ge 13$

The solution set is $\{x \mid x \ge 13\}$ or $[13, \infty)$.



6. **a.** $3(x+1) > 3x+2$

$3x+3 > 3x+2$

$3 > 2$

$3 > 2$ is true for all values of x.

The solution set is $\{x \mid x \text{ is a real number}\}$ or $\Re$ or $(-\infty.\infty)$.

b. $x+1 \le x-1$

$1 \le -1$

$1 \le -1$ is false for all values of x.

The solution set is $\varnothing$.

7. $1 \le 2x+3 < 11$

$-2 \le 2x < 8$

$-1 \le x < 4$

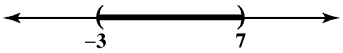
The solution set is $\{x \mid -1 \le x < 4\}$ or $[-1, 4)$.

8. $|x-2| < 5$

$-5 < x-2 < 5$

$-3 < x < 7$

The solution set is $\{x \mid -3 < x < 7\}$ or $(-3, 7)$.



9. $-3|5x-2|+20 \ge -19$

$-3|5x-2| \ge -39$

$\dfrac{-3|5x-2|}{-3} \le \dfrac{-39}{-3}$

$|5x-2| \le 13$

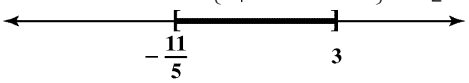
$-13 \le 5x-2 \le 13$

$-11 \le 5x \le 15$

$\dfrac{-11}{5} \le \dfrac{5x}{5} \le \dfrac{15}{5}$

$-\dfrac{11}{5} \le x \le 3$

The solution set is $\left\{x \mid -\dfrac{11}{5} \le x \le 3\right\}$ or $\left[-\dfrac{11}{5}, 3\right]$.



10. $18 < |6-3x|$

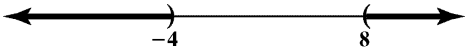
$6-3x < -18$ or $6-3x > 18$

$-3x < -24$ or $-3x > 12$

$\dfrac{-3x}{-3} > \dfrac{-24}{-3}$ or $\dfrac{-3x}{-3} < \dfrac{12}{-3}$

$x > 8$ or $x < -4$

The solution set is $\{x \mid x < -4 \text{ or } x > 8\}$ or $(-\infty, -4) \cup (8, \infty)$.



11. Let x = the number of miles driven in a week.

$260 < 80 + 0.25x$

$180 < 0.25x$

$720 < x$

Driving more than 720 miles in a week makes Basic the better deal.

Concept and Vocabulary Check 1.7

1. 2; 5; 2; 5

2. greater than

3. less than or equal to

4. $(-\infty, 9)$; intersection

5. $(-\infty, 12)$; union

6. adding 4; dividing; -3; direction; $>$; $<$

7. $\varnothing$

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

9. middle

10. $-c$; c

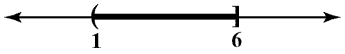
11. $-c$; c

12. $-2 < x-7 < 2$

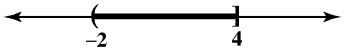
13. $x-7 < -2$ or $-7 > 2$

Exercise Set 1.7

1. $1 < x \le 6$



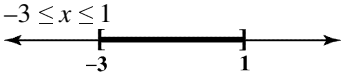
2. $-2 < x \le 4$



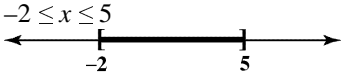
3. $-5 \le x < 2$

4. $-4 \le x < 3$

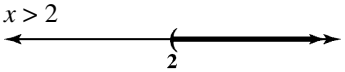
5. $-3 \le x \le 1$



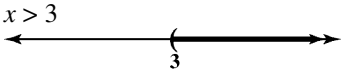
6. $-2 \le x \le 5$



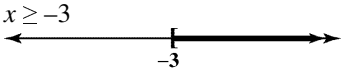
7. $x > 2$



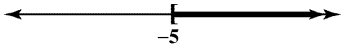
8. $x > 3$



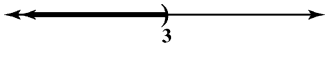
9. $x \ge -3$



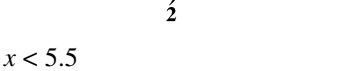
10. $x \ge -5$



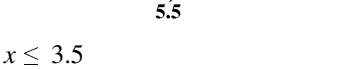
11. $x < 3$



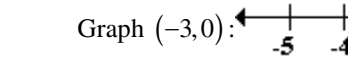
12. $x < 2$



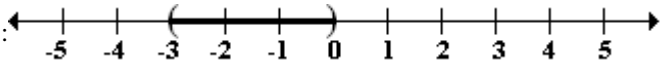
13. $x < 5.5$



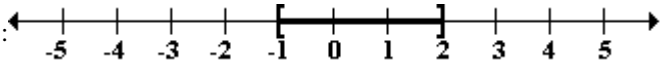
14. $x \le 3.5$



15. Graph $(-3,0)$:

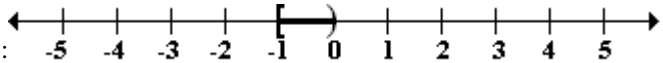


Graph $[-1,2]$:



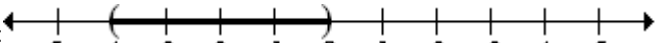
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $(-3,0)$ and $[-1,2]$:

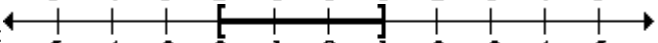


Thus, $(-3,0) \cap [-1,2] = [-1,0)$.

16. Graph $(-4,0)$:

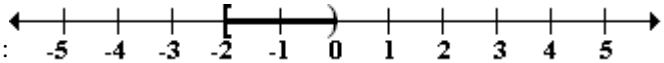


Graph $[-2,1]$:



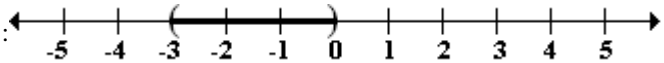
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $(-4,0)$ and $[-2,1]$:

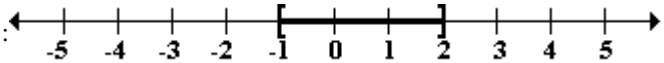


Thus, $(-4,0) \cap [-2,1] = [-2,0)$.

17. Graph $(-3,0)$:

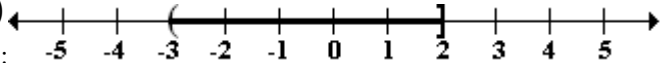


Graph $[-1,2]$:



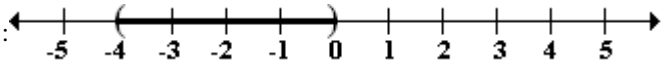
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $(-3,0)$ or $[-1,2]$ or both:

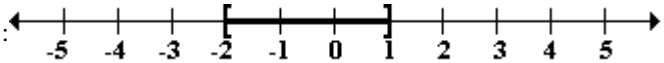


Thus, $(-3,0) \cup [-1,2] = (-3,2]$.

18. Graph $(-4,0)$:

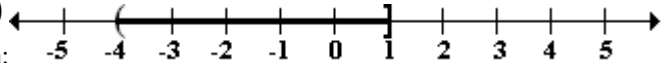


Graph $[-2,1]$:



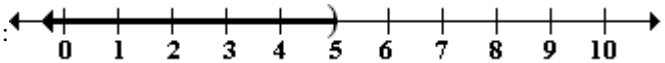
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $(-4,0)$ or $[-2,1]$ or both:

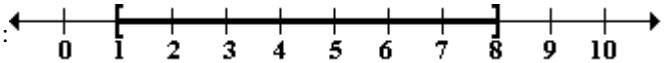


Thus, $(-4,0) \cup [-2,1] = (-4,1]$.

19. Graph $(-\infty,5)$:

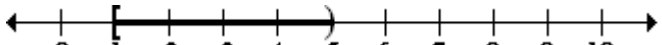


Graph $[1,8]$:



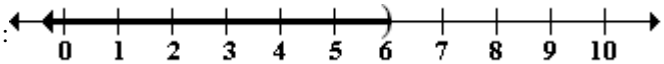
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $(-\infty,5)$ and $[1,8]$:

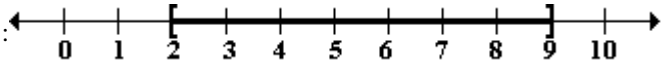


Thus, $(-\infty,5) \cap [1,8] = [1,5)$.

20. Graph $(-\infty,6)$:

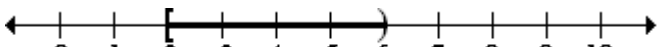


Graph $[2,9]$:



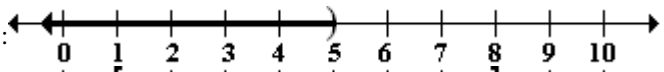
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $(-\infty,6)$ and $[2,9]$:

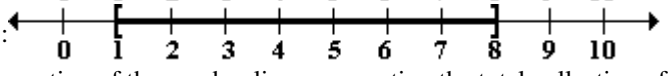


Thus, $(-\infty,6) \cap [2,9] = [2,6)$.

21. Graph $(-\infty, 5)$:

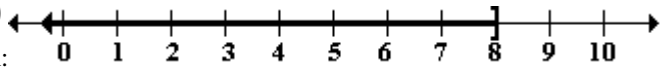


Graph $[1, 8]$:



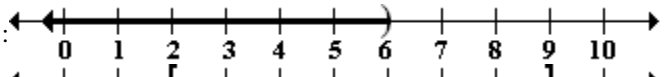
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $(-\infty, 5)$ or $[1, 8]$ or both:

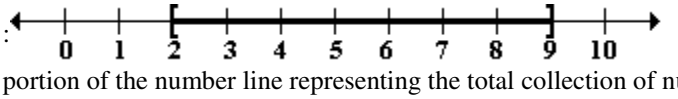


Thus, $(-\infty, 5) \cup [1, 8] = (-\infty, 8]$.

22. Graph $(-\infty, 6)$:

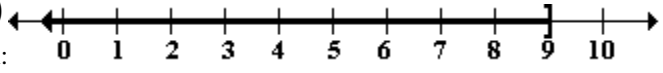


Graph $[2, 9]$:



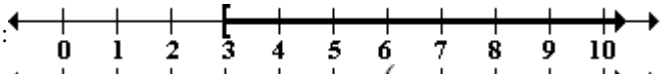
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $(-\infty, 6)$ or $[2, 9]$ or both:

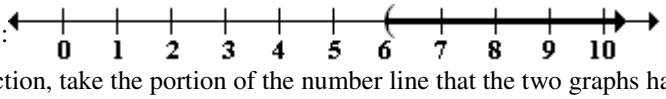


Thus, $(-\infty, 6) \cup [2, 9] = (-\infty, 9]$.

23. Graph $[3, \infty)$:

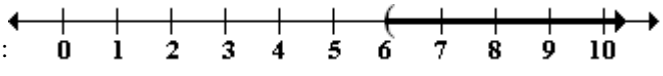


Graph $(6, \infty)$:



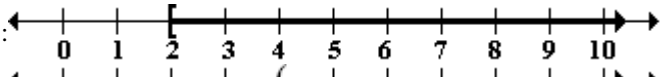
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $[3, \infty)$ and $(6, \infty)$:

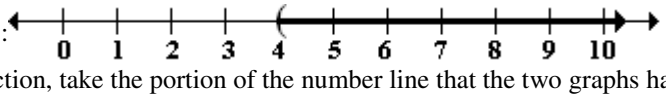


Thus, $[3, \infty) \cap (6, \infty) = (6, \infty)$.

24. Graph $[2, \infty)$:

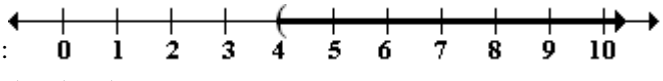


Graph $(4, \infty)$:



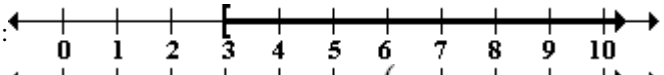
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $[2, \infty)$ and $(4, \infty)$:

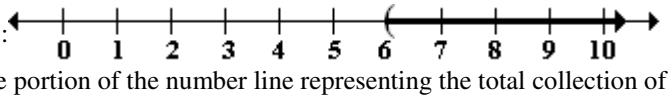


Thus, $[2, \infty) \cap (4, \infty) = (4, \infty)$.

25. Graph $[3, \infty)$:

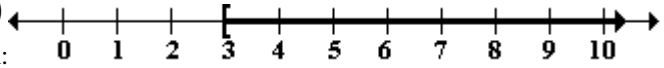


Graph $(6, \infty)$:



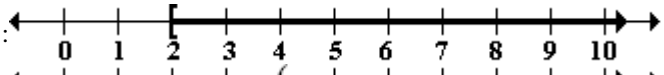
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $[3, \infty)$ or $(6, \infty)$ or both:

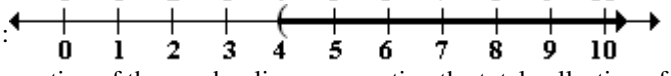


Thus, $[3, \infty) \cup (6, \infty) = [3, \infty)$.

26. Graph $[2,\infty)$:

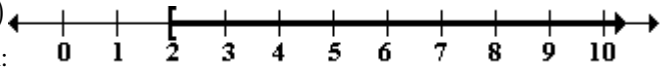


Graph $(4,\infty)$:



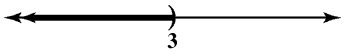
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $[2,\infty)$ or $(4,\infty)$ or both:

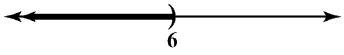


Thus, $[2,\infty) \cup (4,\infty) = [2,\infty)$.

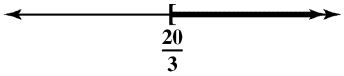
27. $5x + 11 < 26$
$5x < 15$
$x < 3$
The solution set is $\{x \mid x < 3\}$, or $(-\infty, 3)$.



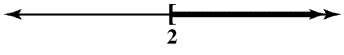
28. $2x + 5 < 17$
$2x < 12$
$x < 6$
The solution set is $\{x \mid x < 6\}$ or $(-\infty, 6)$.



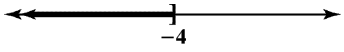
29. $3x - 7 \geq 13$
$3x \geq 20$
$x \geq \frac{20}{3}$
The solution set is $\left\{x \mid x > \frac{20}{3}\right\}$, or $\left[\frac{20}{3}, \infty\right)$.



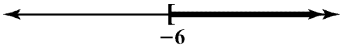
30. $8x - 2 \geq 14$
$8x \geq 16$
$x \geq 2$
The solution set is $\{x \mid x > 2\}$ or $[2,\infty)$.



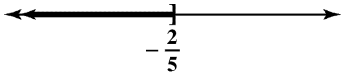
31. $-9x \geq 36$
$x \leq -4$
The solution set is $\{x \mid x \leq -4\}$, or $(-\infty, -4]$.



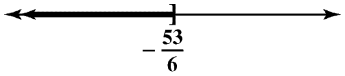
32. $-5x \le 30$
$x \ge -6$
The solution set is $\{x \mid x \ge -6\}$ or $[-6, \infty)$.



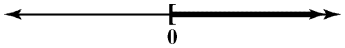
33. $8x - 11 \le 3x - 13$
$8x - 3x \le -13 + 11$
$5x \le -2$
$x \le -\frac{2}{5}$
The solution set is $\left\{x \mid x \le -\frac{2}{5}\right\}$, or $\left(-\infty, -\frac{2}{5}\right]$.



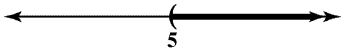
34. $18x + 45 \le 12x - 8$
$18x - 12x \le -8 - 45$
$6x \le -53$
$x \le -\frac{53}{6}$
The solution set is $\left\{x \mid x \le -\frac{53}{6}\right\}$ or $\left(-\infty, -\frac{53}{6}\right]$.



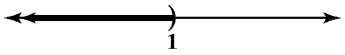
35. $4(x + 1) + 2 \ge 3x + 6$
$4x + 4 + 2 \ge 3x + 6$
$4x + 6 \ge 3x + 6$
$4x - 3x \ge 6 - 6$
$x \ge 0$
The solution set is $\{x \mid x > 0\}$, or $[0, \infty)$.



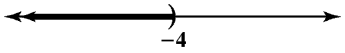
36. $8x + 3 > 3(2x + 1) + x + 5$
$8x + 3 > 6x + 3 + x + 5$
$8x + 3 > 7x + 8$
$8x - 7x > 8 - 3$
$x > 5$
The solution set is $\{x \mid x > 5\}$ or $(5, \infty)$.



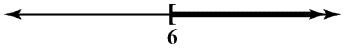
37. $2x - 11 < -3(x + 2)$
$2x - 11 < -3x - 6$
$5x < 5$
$x < 1$
The solution set is $\{x \mid x < 1\}$, or $(-\infty, 1)$.



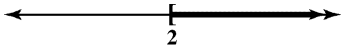
38. $-4(x + 2) > 3x + 20$
$-4x - 8 > 3x + 20$
$-7x > 28$
$x < -4$
The solution set is $\{x \mid x < -4\}$ or $(-\infty, -4)$.



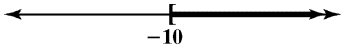
39. $1 - (x + 3) \ge 4 - 2x$
$1 - x - 3 \ge 4 - 2x$
$-x - 2 \ge 4 - 2x$
$x \ge 6$
The solution set is $\{x \mid x \ge 6\}$, or $[6, \infty)$.



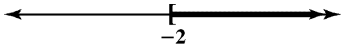
40. $5(3 - x) \le 3x - 1$
$15 - 5x \le 3x - 1$
$-8x \le -16$
$x \ge 2$
The solution set is $\{x \mid x \ge 2\}$ or $[2, \infty)$.



41. $\frac{x}{4} - \frac{3}{2} \le \frac{x}{2} + 1$
$\frac{4x}{4} - \frac{4 \cdot 3}{2} \le \frac{4 \cdot x}{2} + 4 \cdot 1$
$x - 6 \le 2x + 4$
$-x \le 10$
$x \ge -10$
The solution set is $\{x \mid x \ge -10\}$, or $[-10, \infty)$.



42. $\frac{3x}{10} + 1 \ge \frac{1}{5} - \frac{x}{10}$
$10\left(\frac{3x}{10} + 1\right) \ge 10\left(\frac{1}{5} - \frac{x}{10}\right)$
$3x + 10 \ge 2 - x$
$4x \ge -8$
$x \ge -2$
The solution set is $\{x \mid x \ge -2\}$ or $[-2, \infty)$.

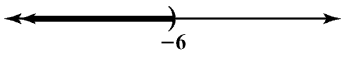


43. $1-\frac{x}{2}>4$

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

$x<-6$

The solution set is $\{x \mid x,-6\}$, or $(-\infty,-6)$.

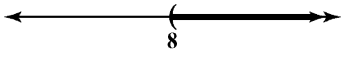


44. $7-\frac{4}{5}x<\frac{3}{5}$

$-\frac{4}{5}x<-\frac{32}{5}$

$x>8$

The solution set is $\{x \mid x>8\}$ or (8, ∞).



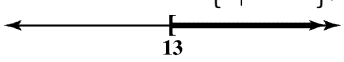
45. $\frac{x-4}{6}\geq\frac{x-2}{9}+\frac{5}{18}$

$3(x-4)\geq 2(x-2)+5$

$3x-12\geq 2x-4+5$

$x\geq 13$

The solution set is $\{x \mid x\geq 13\}$, or $[13,\infty)$.



46.

$\frac{4x-3}{6}+2\geq\frac{2x-1}{12}$

$2(4x-3)+24\geq 2x-1$

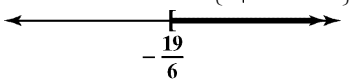
$8x-6+24\geq 2x-1$

$6x+18\geq -1$

$6x\geq -19$

$x\geq -\frac{19}{6}$

The solution set is $\left\{x \mid x\geq \frac{-19}{6}\right\}$ or $\left[\frac{-19}{6},\infty\right)$.



47. $4(3x-2)-3x<3(1+3x)-7$

$12x-8-3x<3+9x-7$

$9x-8<-4+9x$

$-8<-4$

True for all x

The solution set is $\{x \mid x \text{ is any real number}\}$, or $(-\infty,\infty)$.

48. $3(x-8)-2(10-x)>5(x-1)$

$3x-24-20+2x>5x-5$

$5x-44>5x-5$

$-44>-5$

Not true for any x.

The solution set is the empty set, ∅.

49. $5(x-2)-3(x+4)\geq 2x-20$

$5x-10-3x-12\geq 2x-20$

$2x-22\geq 2x-20$

$-22\geq -20$

Not true for any x.

The solution set is the empty set, ∅.

50. $6(x-1)-(4-x)\geq 7x-8$

$6x-6-4+x\geq 7x-8$

$7x-10\geq 7x-8$

$-10\geq -8$

Not true for any x.

The solution set is the empty set, ∅.

51. $6<x+3<8$

$6-3<x+3-3<8-3$

$3<x<5$

The solution set is $\{x \mid 3<x<5\}$, or (3, 5).

52. $7<x+5<11$

$7-5<x+5-5<11-5$

$2<x<6$

The solution set is $\{x \mid 2<x<6\}$ or (2, 6).

53. $-3\leq x-2<1$

$-1\leq x<3$

The solution set is $\{x \mid -1\leq x<3\}$, or [–1, 3).

54. $-6<x-4\leq 1$

$-2<x\leq 5$

The solution set is $\{x \mid -2<x\leq 5\}$ or (–2, 5].

55. $-11<2x-1\leq -5$

$-10<2x\leq -4$

$-5<x\leq -2$

The solution set is $\{x \mid -5<x\leq -2\}$, or (–5, –2].

56. $3 \le 4x - 3 < 19$
$6 \le 4x < 22$
$\frac{6}{4} \le x < \frac{22}{4}$
$\frac{3}{2} \le x < \frac{11}{2}$
The solution set is $\left\{x \middle| \frac{3}{2} \le x < \frac{11}{2}\right\}$ or $\left[\frac{3}{2}, \frac{11}{2}\right)$.

57. $-3 \le \frac{2}{3}x - 5 < -1$
$2 \le \frac{2}{3}x < 4$
$3 \le x < 6$
The solution set is $\{x \mid 3 \le x < 6\}$, or $[3, 6)$.

58. $-6 \le \frac{1}{2}x - 4 < -3$
$-2 \le \frac{1}{2}x < 1$
$-4 \le x < 2$
The solution set is $\{x \mid -4 \ge x < 2\}$ or $[-4, 2)$.

59. $|x| < 3$
$-3 < x < 3$
The solution set is $\{x \mid -3 < x < 3\}$, or $(-3, 3)$.

60. $|x| < 5$
$-5 < x < 5$
The solution set is $\{x \mid -5 < x < 5\}$ or $(-5, 5)$.

61. $|x - 1| \le 2$
$-2 \le x - 1 \le 2$
$-1 \le x \le 3$
The solution set is $\{x \mid -1 \le x \le 3\}$, or $[-1, 3]$.

62. $|x + 3| \le 4$
$-4 \le x + 3 \le 4$
$-7 \le x \le 1$
The solution set is $\{x \mid -7 \le x \le 1\}$ or $[-7, 1]$.

63. $|2x - 6| < 8$
$-8 < 2x - 6 < 8$
$-2 < 2x < 14$
$-1 < x < 7$
The solution set is $\{x \mid -1 < x < 7\}$, or $(-1, 7)$.

64. $|3x + 5| < 17$
$-17 < 3x + 5 < 17$
$-22 < 3x < 12$
The solution set is $\left\{x \middle| -\frac{22}{3} < x < 4\right\}$ or $\left(-\frac{22}{3}, 4\right)$.

65. $|2(x - 1) + 4| \le 8$
$-8 \le 2(x - 1) + 4 \le 8$
$-8 \le 2x - 2 + 4 \le 8$
$-8 \le 2x + 2 \le 8$
$-10 \le 2x \le 6$
$-5 \le x \le 3$
The solution set is $\{x \mid -5 \le x \le 3\}$, or $[-5, 3]$.

66. $|3(x - 1) + 2| \le 20$
$-20 \le 3(x - 1) + 2 \le 20$
$-20 \le 3x - 1 \le 20$
$-19 \le 3x \le 21$
$-\frac{19}{3} \le x \le 7$
The solution set is $\left\{x \middle| -\frac{19}{3} \le x \le 7\right\}$ or $\left[-\frac{19}{3}, 7\right]$.

67. $\left|\frac{2y + 6}{3}\right| < 2$
$-2 < \frac{2y + 6}{3} < 2$
$-6 < 2y + 6 < 6$
$-12 < 2y < 0$
$-6 < y < 0$
The solution set is $\{x \mid -6 < y < 0\}$, or $(-6, 0)$.

68. $\left|\frac{3(x - 1)}{4}\right| < 6$
$-6 < \frac{3(x - 1)}{4} < 6$
$-24 < 3x - 3 < 24$
$-21 < 3x < 27$
$-7 < x < 9$
The solution set is $\{x \mid -7 < x < 9\}$ or $(-7, 9)$.

69. $|x| > 3$
$x > 3$ or $x < -3$
The solution set is $\{x \mid x > 3 \text{ or } x < -3\}$, that is,
$(-\infty, -3)$ or $(3, \infty)$.

70. $|x| > 5$

$x > 5$ or $x < -5$

The solution set is $\{x \mid x < -5 \text{ or } x > 5\}$, that is,

all x in $(-\infty, -5)$ or $(5, \infty)$.

71. $|x - 1| \geq 2$

$x - 1 \geq 2$ or $x - 1 \leq -2$

$x \geq 3$ $\quad$ $x \leq -1$

The solution set is $\{x \mid x \leq -1 \text{ or } x \geq 3\}$, that is,

$(-\infty, -1]$ or $[3, \infty)$.

72. $|x + 3| \geq 4$

$x + 3 \geq 4$ or $x + 3 \leq -4$

$x \geq 1$ $\quad$ $x \leq -7$

The solution set is $\{x \mid x \leq -7 \text{ or } x \geq 1\}$ that is,

$(-\infty, -7)$ or $(1, \infty)$.

73. $|3x - 8| > 7$

$3x - 8 > 7$ or $3x - 8 < -7$

$3x > 15$ $\quad$ $3x < 1$

$x > 5$ $\quad$ $x < \frac{1}{3}$

The solution set is $\left\{x \mid x < \frac{1}{3} \text{ or } x > 5\right\}$, that is,

$\left(-\infty, \frac{1}{3}\right)$ or $(5, \infty)$.

74. $|5x - 2| > 13$

$5x - 2 > 13$ or $5x - 2 < -13$

$5x > 15$ $\quad$ $5x < -11$

$x > 3$ $\quad$ $x < -\frac{11}{5}$

The solution set is $\left\{x \mid x < \frac{-11}{5} \text{ or } x > 3\right\}$,

that is, all x in $\left(-\infty, \frac{-11}{5}\right)$ or $(3, \infty)$

75. $\left|\frac{2x+2}{4}\right| \geq 2$

$\frac{2x+2}{4} \geq 2$ or $\frac{2x+2}{4} \leq -2$

$2x + 2 \geq 8$ $\quad$ $2x + 2 \leq -8$

$2x \geq 6$ $\quad$ $2x \leq -10$

$x \geq 3$ $\quad$ $x \leq -5$

The solution set is $\{x \mid x \leq -5 \text{ or } x \geq 3\}$, that is,

$(-\infty, -5]$ or $[3, \infty)$.

76. $\left|\frac{3x-3}{9}\right| \geq 1$

$\frac{3x-3}{9} \geq 1$ or $\frac{3x-3}{9} \leq -1$

$3x - 3 \geq 9$ $\quad$ $3x - 3 \leq -9$

$3x \geq 12$ $\quad$ $3x \leq -6$

$x \geq 4$ $\quad$ $x \leq -2$

The solution set is $\{x \mid x \leq -2 \text{ or } x \geq 4\}$,

or $(-\infty, -2]$ or $[4, \infty)$.

77. $\left|3 - \frac{2}{3}x\right| > 5$

$3 - \frac{2}{3}x > 5$ or $3 - \frac{2}{3}x < -5$

$-\frac{2}{3}x > 2$ $\quad$ $-\frac{2}{3}x < -8$

$x < -3$ $\quad$ $x > 12$

The solution set is $\{x \mid x < -3 \text{ or } x > 12\}$, that is,

$(-\infty, -3)$ or $(12, \infty)$.

78. $\left|3 - \frac{3}{4}x\right| > 9$

$3 - \frac{3}{4}x > 9$ or $3 - \frac{3}{4}x < -9$

$-\frac{3}{4}x > 6$ $\quad$ $-\frac{3}{4}x < -12$

$x < -8$ $\quad$ $x > 16$

$\{x \mid x < -8 \text{ or } x > 16\}$, that is all x in

$(-\infty, -8)$ or $(16, \infty)$.

79. $3|x - 1| + 2 \geq 8$

$3|x - 1| \geq 6$

$|x - 1| \geq 2$

$x - 1 \geq 2$ or $x - 1 \leq -2$

$x \geq 3$ $\quad$ $x \leq -1$

The solution set is $\{x \mid x \leq 1 \text{ or } x \geq 3\}$, that is,

$(-\infty, -1]$ or $[3, \infty)$.

80. $5|2x+1|-3 \geq 9$

$5|2x+1| \geq 12$

$|2x+1| \geq \frac{12}{5}$

$2x+1 \geq \frac{12}{5}$ $\quad$ $2x+1 \leq -\frac{12}{5}$

$2x \geq \frac{7}{5}$ or $2x \leq -\frac{17}{5}$

$x \geq \frac{7}{10}$ $\quad$ $x \leq -\frac{17}{10}$

The solution set is $\left\{x \middle| x \leq -\frac{17}{10} \text{ or } x \geq \frac{7}{10}\right\}$.

81. $-2|x-4| \geq -4$

$\frac{-2|x-4|}{-2} \leq \frac{-4}{-2}$

$|x-4| \leq 2$

$-2 \leq x-4 \leq 2$

$2 \leq x \leq 6$

The solution set is $\{x|2 \leq x \leq 6\}$.

82. $-3|x+7| \geq -27$

$\frac{-3|x+7|}{-3} \leq \frac{-27}{-3}$

$|x+7| \leq 9$

$-9 \leq x+7 \leq 9$

$-16 \leq x \leq 2$

The solution set is $\{x|-16 \leq x \leq 2\}$.

83. $-4|1-x| < -16$

$\frac{-4|1-x|}{-4} > \frac{-16}{-4}$

$|1-x| > 4$

$1-x > 4$ $\quad$ $1-x < -4$

$-x > 3$ or $-x < -5$

$x < -3$ $\quad$ $x > 5$

The solution set is $\{x| x < -3 \text{ or } x > 5\}$.

84. $-2|5-x| < -6$

$-2|5-x| < -6$

$\frac{-2|5-x|}{-2} > \frac{-6}{-2}$

$|5-x| > 3$

$5-x > 3$ $\quad$ $5-x < -3$

$-x > -2$ or $-x < -8$

$x < 2$ $\quad$ $x > 8$

The solution set is $\{x| x < 2 \text{ or } x > 8\}$.

85. $3 \leq |2x-1|$

$2x-1 \geq 3$ $\quad$ $2x-1 \leq -3$

$2x \geq 4$ or $2x \leq -2$

$x \geq 2$ $\quad$ $x \leq -1$

The solution set is $\{x| x \leq -1 \text{ or } x \geq 2\}$.

86. $9 \leq |4x+7|$

$4x+7 \geq 9$ or $4x+7 \leq -9$

$4x \geq 2$ $\quad$ $4x \leq -16$

$x \geq \frac{2}{4}$ $\quad$ $x \leq -4$

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

The solution set is $\left\{x \middle| x \leq -4 \text{ or } x \geq \frac{1}{2}\right\}$.

87. $5 > |4-x|$ is equivalent to $|4-x| < 5$.

$-5 < 4-x < 5$

$-9 < -x < 1$

$\frac{-9}{-1} > \frac{-x}{-1} > \frac{1}{-1}$

$9 > x > -1$

$-1 < x < 9$

The solution set is $\{x|-1 < x < 9\}$.

88. $2 > |11-x|$ is equivalent to $|11-x| < 2$.

$-2 < 11-x < 2$

$-13 < -x < -9$

$\frac{-13}{-1} > \frac{-x}{-1} > \frac{-9}{-1}$

$13 > x > 9$

$9 < x < 13$

The solution set is $\{x| 9 < x < 13\}$.

89. $1 < |2 - 3x|$ is equivalent to $|2 - 3x| > 1$.

$$\begin{array}{ll} 2 - 3x > 1 & \\ -3x > -1 & 2 - 3x < -1 \\ \dfrac{-3x}{-3} < \dfrac{-1}{-3} \quad \text{or} & -3x < -3 \\ & \dfrac{-3x}{-3} > \dfrac{-3}{-3} \\ x < \dfrac{1}{3} & x > 1 \end{array}$$

The solution set is $\left\{x \,\middle|\, x < \frac{1}{3} \text{ or } x > 1\right\}$.

90. $4 < |2 - x|$ is equivalent to $|2 - x| > 4$.

$$\begin{array}{ll} 2 - x > 4 \quad \text{or} & 2 - x < -4 \\ -x > 2 & -x < -6 \\ \dfrac{-x}{-1} < \dfrac{2}{-1} & \dfrac{-x}{-1} > \dfrac{-6}{-1} \\ x < -2 & x > 6 \end{array}$$

The solution set is $\{x \mid x < -2 \text{ or } x > 6\}$.

91. $12 < \left|-2x + \frac{6}{7}\right| + \frac{3}{7}$

$$\frac{81}{7} < \left|-2x + \frac{6}{7}\right|$$

$$-2x + \frac{6}{7} > \frac{81}{7} \quad \text{or} \quad -2x + \frac{6}{7} < -\frac{81}{7}$$

$$-2x > \frac{75}{7} \qquad -2x < -\frac{87}{7}$$

$$x < -\frac{75}{14} \qquad x > \frac{87}{14}$$

The solution set is $\left\{x \,\middle|\, x < -\frac{75}{14} \text{ or } x > \frac{87}{14}\right\}$, that is, $\left(-\infty, -\frac{75}{14}\right)$ or $\left(\frac{87}{14}, \infty\right)$.

92. $1 < \left|x - \frac{11}{3}\right| + \frac{7}{3}$

$$-\frac{4}{3} < \left|x - \frac{11}{3}\right|$$

Since $\left|x - \frac{11}{3}\right| > -\frac{4}{3}$ is true for all x,

the solution set is $\{x \mid x \text{ is any real number}\}$

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

93. $4 + \left|3 - \frac{x}{3}\right| \geq 9$

$$\left|3 - \frac{x}{3}\right| \geq 5$$

$$3 - \frac{x}{3} \geq 5 \quad \text{or} \quad 3 - \frac{x}{3} \leq -5$$

$$-\frac{x}{3} \geq 2 \qquad -\frac{x}{3} \leq -8$$

$$x \leq -6 \qquad x \geq 24$$

The solution set is $\{x \mid x \leq -6 \text{ or } x \geq 24\}$, that is, $(-\infty, -6]$ or $[24, \infty)$.

94. $\left|2 - \frac{x}{2}\right| - 1 \leq 1$

$$\left|2 - \frac{x}{2}\right| \leq 2$$

$$-2 \leq 2 - \frac{x}{2} \leq 2$$

$$-4 \leq -\frac{x}{2} \leq 0$$

$$8 \geq x \geq 0$$

The solution set is $\{x \mid 0 \leq x \leq 8\}$ or $[0, 8]$.

95. $y_1 \leq y_2$

$$\frac{x}{2} + 3 \leq \frac{x}{3} + \frac{5}{2}$$

$$6\left(\frac{x}{2} + 3\right) \leq 6\left(\frac{x}{3} + \frac{5}{2}\right)$$

$$\frac{6x}{2} + 6(3) \leq \frac{6x}{3} + \frac{6(5)}{2}$$

$$3x + 18 \leq 2x + 15$$

$$x \leq -3$$

The solution set is $(-\infty, -3]$.

96.
$$y_1 > y_2$$
$$\frac{2}{3}(6x-9)+4 > 5x+1$$
$$3\left(\frac{2}{3}(6x-9)+4\right) > 3(5x+1)$$
$$2(6x-9)+12 > 15x+3$$
$$12x-18+12 > 15x+3$$
$$12x-6 > 15x+3$$
$$-3x > 9$$
$$\frac{-3x}{-3} < \frac{9}{-3}$$
$$x < -3$$
The solution set is $(-\infty,-3)$.

97.
$$y \geq 4$$
$$1-(x+3)+2x \geq 4$$
$$1-x-3+2x \geq 4$$
$$x-2 \geq 4$$
$$x \geq 6$$
The solution set is $[6,\infty)$.

98.
$$y \leq 0$$
$$2x-11+3(x+2) \leq 0$$
$$2x-11+3x+6 \leq 0$$
$$5x-5 \leq 0$$
$$5x \leq 5$$
$$x \leq 1$$
The solution set is $(-\infty,1]$.

99.
$$y < 8$$
$$|3x-4|+2 < 8$$
$$|3x-4| < 6$$
$$-6 < 3x-4 < 6$$
$$-2 < 3x < 10$$
$$\frac{-2}{3} < \frac{3x}{3} < \frac{10}{3}$$
$$\frac{-2}{3} < x < \frac{10}{3}$$
The solution set is $\left(\frac{-2}{3},\frac{10}{3}\right)$.

100.
$$y > 9$$
$$|2x-5|+1 > 9$$
$$|2x-5| > 8$$
$$2x-5 < -8 \quad \text{or} \quad 2x-5 > 8$$
$$2x < -3 \qquad\qquad 2x > 13$$
$$x < -\frac{3}{2} \qquad\qquad x > \frac{13}{2}$$
The solution set is $\left(-\infty,-\frac{3}{2}\right)\cup\left(\frac{13}{2},\infty\right)$.

101.
$$y \leq 4$$
$$7-\left|\frac{x}{2}+2\right| \leq 4$$
$$-\left|\frac{x}{2}+2\right| \leq -3$$
$$\left|\frac{x}{2}+2\right| \geq 3$$
$$\frac{x}{2}+2 \geq 3 \quad \text{or} \quad \frac{x}{2}+2 \leq -3$$
$$x+4 \geq 6 \qquad x+4 \leq -6$$
$$x \geq 2 \qquad\qquad x \leq -10$$
The solution set is $(-\infty,-10]\cup[2,\infty)$.

102.
$$y \geq 6$$
$$8-|5x+3| \geq 6$$
$$-|5x+3| \geq -2$$
$$-(-|5x+3|) \leq -(-2)$$
$$|5x+3| \leq 2$$
$$-2 \leq 5x+3 \leq 2$$
$$-5 \leq 5x \leq -1$$
$$\frac{-5}{5} \leq \frac{5x}{5} \leq \frac{-1}{5}$$
$$-1 \leq x \leq -\frac{1}{5}$$
The solution set is $\left[-1,-\frac{1}{5}\right]$.

103. The graph's height is below 5 on the interval $(-1,9)$.

104. The graph's height is at or above 5 on the interval $(-\infty,-1]\cup[9,\infty)$.

105. The solution set is $\{x \mid -1 \leq x < 2\}$ or $[-1,2)$.

106. The solution set is $\{x \mid 1 < x \le 4\}$ or $(1,4]$.

107. Let x be the number.

$|4-3x| \ge 5$ or $|3x-4| \ge 5$

$3x-4 \ge 5$ $\quad$ $3x-4 \le -5$

$3x \ge 9$ or $3x \le -1$

$x \ge 3$ $\quad$ $x \le -\frac{1}{3}$

The solution set is $\left\{x \mid x \le -\frac{1}{3} \text{ or } x \ge 3\right\}$ or $\left(-\infty, -\frac{1}{3}\right] \cup [3,\infty)$.

108. Let x be the number.

$|5-4x| \le 13$ or $|4x-5| \le 13$

$-13 \le 4x-5 \le 13$

$-8 \le 4x \le 18$

$-2 \le x \le \frac{9}{2}$

The solution set is $\left\{x \mid -2 \le x \le \frac{9}{2}\right\}$ or $\left[-2, -\frac{2}{9}\right]$.

109. $(0,4)$

110. $[0,5]$

111. passion $\le$ intimacy or intimacy $\ge$ passion

112. commitment $\ge$ intimacy or intimacy $\le$ commitment

113. passion<commitment or commitment > passion

114. commitment > passion or passion < commitment

115. 9, after 3 years

116. after approximately $5\frac{1}{2}$ years

117. a. $I = \frac{1}{4}x + 26$

$\frac{1}{4}x + 26 > 33$

$\frac{1}{4}x > 7$

$x > 28$

More than 33% of U.S. households will have an interfaith marriage in years after 2016 (i.e. $1988 + 28$).

b. $N = \frac{1}{4}x + 6$

$\frac{1}{4}x + 6 > 14$

$\frac{1}{4}x > 8$

$x > 32$

More than 14% of U.S. households will have a person of faith married to someone with no religion in years after 2020 (i.e. $1988 + 32$).

c. More than 33% of U.S. households will have an interfaith marriage *and* more than 14% of U.S. households will have a person of faith married to someone with no religion in years after 2020.

d. More than 33% of U.S. households will have an interfaith marriage *or* more than 14% of U.S. households will have a person of faith married to someone with no religion in years after 2016.

118. a. $I = \frac{1}{4}x + 26$

$\frac{1}{4}x + 26 > 34$

$\frac{1}{4}x > 8$

$x > 32$

More than 34% of U.S. households will have an interfaith marriage in years after 2020 (i.e. $1988 + 32$).

b. $N = \frac{1}{4}x + 6$

$\frac{1}{4}x + 6 > 15$

$\frac{1}{4}x > 9$

$x > 36$

More than 15% of U.S. households will have a person of faith married to someone with no religion in years after 2024 (i.e. $1988 + 36$).

c. More than 34% of U.S. households will have an interfaith marriage *and* more than 15% of U.S. households will have a person of faith married to someone with no religion in years after 2024.

d. More than 34% of U.S. households will have an interfaith marriage *or* more than 15% of U.S. households will have a person of faith married to someone with no religion in years after 2020.

119. $15 \le \frac{5}{9}(F-32) \le 35$

$\frac{9}{5}(15) \le \frac{9}{5}\left(\frac{5}{9}(F-32)\right) \le \frac{9}{5}(35)$

$9(3) \le F-32 \le 9(7)$

$27 \le F-32 \le 63$

$59 \le F \le 95$

The range for Fahrenheit temperatures is $59°\text{F}$ to $95°\text{F}$, inclusive or $[59°\text{F}, 95°\text{F}]$.

120. $41 \le \frac{9}{5}C + 32 \le 50$

$41-32 \le \frac{9}{5}C + 32 - 32 \le 50 - 32$

$9 \le \frac{9}{5}C \le 18$

$\frac{5}{9}(9) \le \frac{5}{9}\left(\frac{9}{5}C\right) \le \frac{5}{9}(18)$

$5 \le C \le 10$

The range for Celsius temperatures is $5°\text{C}$ to $10°\text{C}$, inclusive or $[5°\text{C}, 10°\text{C}]$.

121. $\left|\frac{h-50}{5}\right| \ge 1.645$

$\frac{h-50}{5} \ge 1.645$ or $\frac{h-50}{5} \le -1.645$

$h-50 \ge 8.225$ $\qquad$ $h-50 \le -8.225$

$h \ge 58.225$ $\qquad$ $h \le 41.775$

The number of outcomes would be 59 or more, or 41 or less.

122. $50 + 0.20x < 20 + 0.50x$

$30 < 0.3x$

$100 < x$

Basic Rental is a better deal when driving more than 100 miles per day.

123. $15 + 0.08x < 3 + .12x$

$12 < 0.04x$

$300 < x$

Plan A is a better deal when texting more than 300 times per month.

124. $1800 + 0.03x < 200 + 0.08x$

$1600 < 0.05x$

$32000 < x$

A home assessment of greater than $32,000 would make the first bill a better deal.

125. $2 + 0.08x < 8 + 0.05x$

$0.03x < 6$

$x < 200$

The credit union is a better deal when writing less than 200 checks.

126. $2x > 10{,}000 + 0.40x$

$1.6x > 10{,}000$

$\frac{1.6x}{1.6} > \frac{10{,}000}{1.6}$

$x > 6250$

More than 6250 tapes need to be sold a week to make a profit.

127. $3000 + 3x < 5.5x$

$3000 < 2.5x$

$1200 < x$

More then 1200 packets of stationary need to be sold each week to make a profit.

128. $265 + 65x \le 2800$

$65x \le 2535$

$x \le 39$

39 bags or fewer can be lifted safely.

129. $245 + 95x \le 3000$

$95x \le 2755$

$x \le 29$

29 bags or less can be lifted safely.

130. Let $x =$ the grade on the final exam.

$\frac{86+88+92+84+x+x}{6} \ge 90$

$86+88+92+84+x+x \ge 540$

$2x + 350 \ge 540$

$2x \ge 190$

$x \ge 95$

You must receive at least a 95% to earn an A.

131. a. $\frac{86+88+x}{3} \ge 90$

$\frac{174+x}{3} \ge 90$

$174 + x \ge 270$

$x \ge 96$

You must get at least a 96.

b. $\dfrac{86+88+x}{3} < 80$

$\dfrac{174+x}{3} < 80$

$174 + x < 240$

$x < 66$

This will happen if you get a grade less than 66.

132. Let x = the number of hours the mechanic works on the car.

$226 \le 175 + 34x \le 294$

$51 \le 34x \le 119$

$1.5 \le x \le 3.5$

The man will be working on the job at least 1.5 and at most 3.5 hours.

133. Let x = the number of times the bridge is crossed per three month period

The cost with the 3-month pass is $C_3 = 7.50 + 0.50x$.

The cost with the 6-month pass is $C_6 = 30$.

Because we need to buy two 3-month passes per 6-month pass, we multiply the cost with the 3-month pass by 2.

$2(7.50 + 0.50x) < 30$

$15 + x < 30$

$x < 15$

We also must consider the cost without purchasing a pass. We need this cost to be less than the cost with a 3-month pass.

$3x > 7.50 + 0.50x$

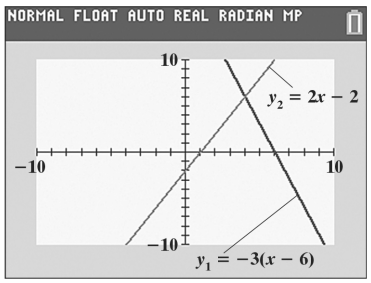
$2.50x > 7.50$

$x > 3$

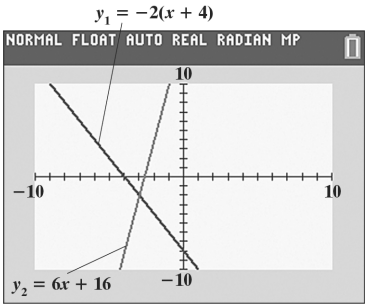
The 3-month pass is the best deal when making more than 3 but less than 15 crossings per 3-month period.

134. – 141. Answers will vary.

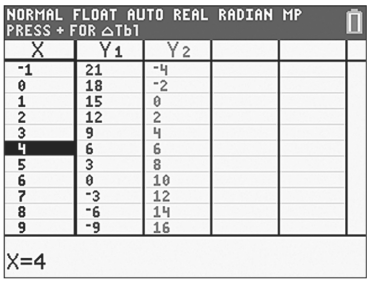
142. $x < 4$



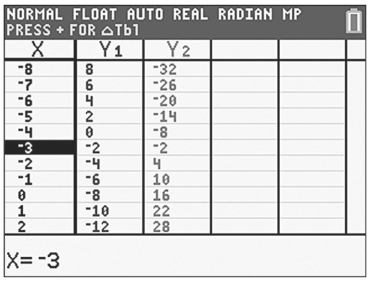
143. $x < -3$



144. Verify exercise 142.

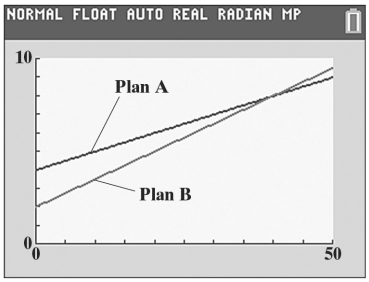


Verify exercise 143.



145. a. The cost of Plan A is $4 + 0.10x$;
The cost of Plan B is $2 + 0.15x$.

b. Graph:



c. 41 or more checks make Plan A better.

d. $4 + 0.10x < 2 + 0.15x$

$2 < 0.05x$

$x > 40$

The solution set is $\{x \mid x > 40\}$ or (40, ∞).

146. makes sense

147. makes sense

148. makes sense

149. makes sense

150. true

151. false; Changes to make the statement true will vary. A sample change is: $(-\infty, 3) \cup (-\infty, -2) = (-\infty, 3)$

152. false; Changes to make the statement true will vary. A sample change is: $3x > 6$ is equivalent to $x > 2$.

153. true

154. Because $x > y$, $y - x$ represents a negative number. When both sides are multiplied by $(y - x)$ the inequality must be reversed.

155. a. $|x - 4| < 3$

b. $|x - 4| \geq 3$

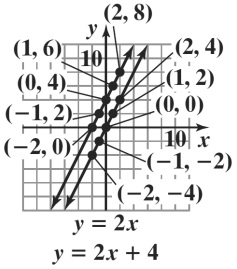
156. Answers will vary.

157. Set 1 has each x-coordinate paired with only one y-coordinate.

158.

x	$y = 2x$	(x, y)
–2	$y = 2(-2) = -4$	$(-2, -4)$
–1	$y = 2(-1) + 4 = 2$	$(-1, -2)$
0	$y = 2(0) = 0$	$(0, 0)$
1	$y = 2(1) = 2$	$(1, 2)$
2	$y = 2(2) = 4$	$(2, 4)$

x	$y = 2x + 4$	(x, y)
–2	$y = 2(-2) + 4 = 0$	$(-2, 0)$
–1	$y = 2(-1) + 4 = 2$	$(-1, 2)$
0	$y = 2(0) + 4 = 4$	$(0, 4)$
1	$y = 2(1) + 4 = 6$	$(1, 6)$
2	$y = 2(2) + 4 = 8$	$(2, 8)$



159. a. When the x-coordinate is 2, the y-coordinate is 3.

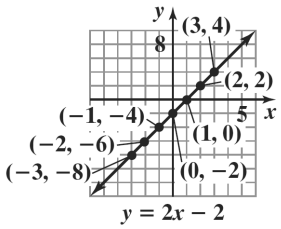
b. When the y-coordinate is 4, the x-coordinates are –3 and 3.

c. The x-coordinates are all real numbers.

d. The y-coordinates are all real numbers greater than or equal to 1.

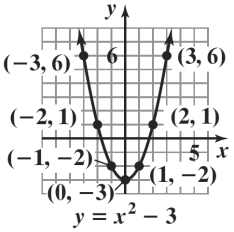
Chapter 1 Review Exercises

1.



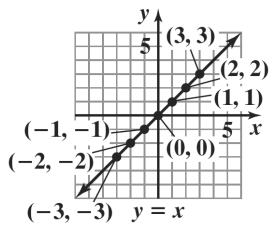
$x = -3$, $y = -8$
$x = -2$, $y = -6$
$x = -1$, $y = -4$
$x = 0$, $y = -2$
$x = 1$, $y = 0$
$x = 2$, $y = 2$
$x = 3$, $y = 4$

2.



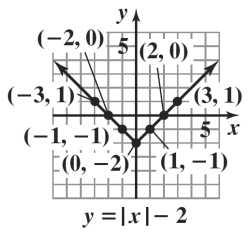
$x = -3$, $y = 6$
$x = -2$, $y = 1$
$x = -1$, $y = -2$
$x = 0$, $y = -3$
$x = 1$, $y = -2$
$x = 2$, $y = 1$
$x = 3$, $y = 6$

3.



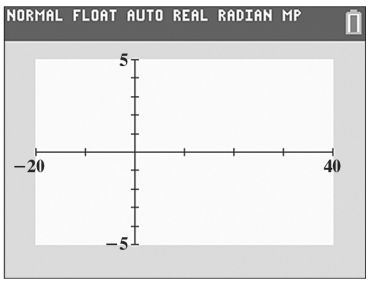
$x = -3, y = -3$
$x = -2, y = -2$
$x = -1, y = -1$
$x = 0, y = 0$
$x = 1, y = 1$
$x = 2, y = 2$
$x = 3, y = 3$

4.



$x = -3, y = 1$
$x = -2, y = 0$
$x = -1, y = -1$
$x = 0, y = -2$
$x = 1, y = -1$
$x = 2, y = 0$
$x = 3, y = 1$

5. A portion of Cartesian coordinate plane with minimum x-value equal to –20, maximum x-value equal to 40, x-scale equal to 10 and with minimum y-value equal to –5, maximum y-value equal to 5, and y-scale equal to 1.



6. x-intercept: –2; The graph intersects the x-axis at $(-2,\ 0)$.

y-intercept: 2; The graph intersects the y-axis at $(0,\ 2)$.

7. x-intercepts: 2, –2; The graph intersects the x-axis at $(-2,\ 0)$ and $(2,\ 0)$.

y-intercept: –4; The graph intercepts the y-axis at $(0,\ -4)$.

8. x-intercept: 5; The graph intersects the x-axis at $(5,\ 0)$.

y-intercept: None; The graph does not intersect the y-axis.

9. The coordinates are (20, 8). This means that 8% of college students anticipated a starting salary of $20 thousand.

10. The starting salary that was anticipated by the greatest percentage of college students was $30 thousand. 22% of students anticipated this salary.

11. The starting salary that was anticipated by the least percentage of college students was $70 thousand. 2% of students anticipated this salary.

12. Starting salaries of $25 thousand and $30 thousand were anticipated by more than 20% of college students

13. 14% of students anticipated a starting salary of $40 thousand.

14. $p = -0.01s^2 + 0.8s + 3.7$

$p = -0.01(40)^2 + 0.8(40) + 3.7$

$p = 19.7$

This is greater than the estimate of the previous question.

15. $2x - 5 = 7$

$2x = 12$

$x = 6$

The solution set is $\{6\}$.
This is a conditional equation.

16. $5x + 20 = 3x$

$2x = -20$

$x = -10$

The solution set is $\{-10\}$.
This is a conditional equation.

17. $7(x - 4) = x + 2$

$7x - 28 = x + 2$

$6x = 30$

$x = 5$

The solution set is $\{5\}$.
This is a conditional equation.

18. $1 - 2(6 - x) = 3x + 2$
$1 - 12 + 2x = 3x + 2$
$-11 - x = 2$
$-x = 13$
$x = -13$
The solution set is $\{-13\}$.
This is a conditional equation.

19. $2(x - 4) + 3(x + 5) = 2x - 2$
$2x - 8 + 3x + 15 = 2x - 2$
$5x + 7 = 2x - 2$
$3x = -9$
$x = -3$
The solution set is $\{-3\}$.
This is a conditional equation.

20. $2x - 4(5x + 1) = 3x + 17$
$2x - 20x - 4 = 3x + 17$
$-18x - 4 = 3x + 17$
$-21x = 21$
$x = -1$
The solution set is $\{-1\}$.
This is a conditional equation.

21. $7x + 5 = 5(x + 3) + 2x$
$7x + 5 = 5x + 15 + 2x$
$7x + 5 = 7x + 15$
$5 = 15$
The solution set is $\varnothing$.
This is an inconsistent equation.

22. $7x + 13 = 2(2x - 5) + 3x + 23$
$7x + 13 = 2(2x - 5) + 3x + 23$
$7x + 13 = 4x - 10 + 3x + 23$
$7x + 13 = 7x + 13$
$13 = 13$
The solution set is all real numbers.
This is an identity.

23. $\dfrac{2x}{3} = \dfrac{x}{6} + 1$
$2(2x) = x + 6$
$4x = x + 6$
$3x = 6$
$x = 2$
The solution set is $\{2\}$.
This is a conditional equation.

24. $\dfrac{x}{2} - \dfrac{1}{10} = \dfrac{x}{5} + \dfrac{1}{2}$
$5x - 1 = 2x + 5$
$3x = 6$
$x = 2$
The solution set is $\{2\}$.
This is a conditional equation.

25. $\dfrac{2x}{3} = 6 - \dfrac{x}{4}$
$4(2x) = 12(6) - 3x$
$8x = 72 - 3x$
$11x = 72$
$x = \dfrac{72}{11}$
The solution set is $\left\{\dfrac{72}{11}\right\}$.
This is a conditional equation.

26. $\dfrac{x}{4} = 2 - \dfrac{x - 3}{3}$
$\dfrac{12 \cdot x}{4} = 12(2) - \dfrac{12(x - 3)}{3}$
$3x = 24 - 4x + 12$
$7x = 36$
$x = \dfrac{36}{7}$
The solution set is $\left\{\dfrac{36}{7}\right\}$.
This is a conditional equation.

27. $\dfrac{3x + 1}{3} - \dfrac{13}{2} = \dfrac{1 - x}{4}$
$4(3x + 1) - 6(13) = 3(1 - x)$
$12x + 4 - 78 = 3 - 3x$
$12x - 74 = 3 - 3x$
$15x = 77$
$x = \dfrac{77}{15}$
The solution set is $\left\{\dfrac{77}{15}\right\}$.
This is a conditional equation.

28. $\frac{9}{4}-\frac{1}{2x}=\frac{4}{x}$

$9x-2=16$

$9x=18$

$x=2$

The solution set is $\{2\}$.

This is a conditional equation.

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

$7+2(x-5)=x+2$

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

$2x-3=x+2$

$x=5$

5 does not check and must be rejected.

The solution set is the empty set, $\varnothing$.

This is an inconsistent equation.

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

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

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

$x+1-x+1=2$

$2=2$

The solution set is all real numbers except –1 and 1.

This is a conditional equation.

31. $\frac{5}{x+3}+\frac{1}{x-2}=\frac{8}{x^2+x-6}$

$\frac{5}{x+3}+\frac{1}{x-2}=\frac{8}{(x+3)(x-2)}$

$\frac{5(x+3)(x-2)}{x+3}+\frac{(x+3)(x-2)}{x-2}=\frac{8(x+3)(x-2)}{(x+3)(x-2)}$

$5(x-2)+1(x+3)=8$

$5x-10+x+3=8$

$6x-7=8$

$6x=15$

$x=\frac{15}{6}$

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

The solution set is $\left\{\frac{5}{2}\right\}$.

This is a conditional equation.

32. $\frac{1}{x+5}=0$

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

$1=0$

The solution set is the empty set, $\varnothing$.

This is an inconsistent equation.

33. $\frac{4}{x+2}+\frac{3}{x}=\frac{10}{x^2+2x}$

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

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

$4x+3(x+2)=10$

$4x+3x+6=10$

$7x+6=10$

$7x=4$

$x=\frac{4}{7}$

The solution set is $\left\{\frac{4}{7}\right\}$.

This is a conditional equation.

34. $3-5(2x+1)-2(x-4)=0$

$3-5(2x+1)-2(x-4)=0$

$3-10x-5-2x+8=0$

$-12x+6=0$

$-12x=-6$

$x=\frac{-6}{-12}$

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

The solution set is $\left\{\frac{1}{2}\right\}$.

This is a conditional equation.

35. $\dfrac{x+2}{x+3}+\dfrac{1}{x^2+2x-3}-1=0$

$\dfrac{x+2}{x+3}+\dfrac{1}{(x+3)(x-1)}-1=0$

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

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

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

$x^2+x-2+1=x^2+2x-3$

$x-1=2x-3$

$-x=-2$

$x=2$

The solution set is $\{2\}$.

This is a conditional equation.

36. Let $x=$ the number involving oversleeping.
Let $x+10=$ the number involving computer problems.
Let $x+80=$ the number involving illness.

$x+(x+10)+(x+80)=270$

$x+x+10+x+80=270$

$3x+90=270$

$3x=180$

$x=60$

$x+10=70$

$x+80=140$

The number involving oversleeping, computer problems, and illness, respectively, is 60, 70, and 140.

37. Let x = the number of years after 1980.

$2.69+0.17x=9.49$

$0.17x=6.8$

$x=40$

The average price of a movie ticket will be \$9.49 40 years after 1980, or 2020.

38. Let x = the number of GB used.
Plan A: $C=52+18x$
Plan B: $C=32+22x$
Set the costs equal to each other.

$52+18x=32+22x$

$52=32+4x$

$20=4x$

$5=x$

The cost will be the same for 5 GB.

39. Let x = the original price of the phone

$48=x-0.20x$

$48=0.80x$

$60=x$

The original price is \$60.

40. Let x = the amount sold to earn \$800 in one week

$800=300+0.05x$

$500=0.05x$

$10{,}000=x$

Sales must be \$10,000 in one week to earn \$800.

41. Let x = the amount invested at 4%
Let y = the amount invested at 7%

$x+y=9000$

$0.04x+0.07y=555$

Multiply the first equation by –0.04 and add.

$-0.04x-0.04y=-360$

$0.04x+0.07y=555$

$0.03y=195$

$y=6500$

Back-substitute 6500 for y in one of the original equations to find x.

$x+y=9000$

$x+6500=9000$

$x=2500$

There was \$2500 invested at 4% and \$6500 invested at 7%.

42. Let $x=$ the amount invested at 2%
Let $8000-x=$ the amount invested at 5%.

$0.05(8000-x)=0.02x+85$

$400-0.05x=0.02x+85$

$-0.05x-0.02x=85-400$

$-0.07x=-315$

$\dfrac{-0.07x}{-0.07}=\dfrac{-315}{-0.07}$

$x=4500$

$8000-x=3500$

\$4500 was invested at 2% and \$3500 was invested at 5%.

43. Let w = the width of the playing field,
Let $3w - 6$ = the length of the playing field

$$P = 2(\text{length}) + 2(\text{width})$$
$$340 = 2(3w - 6) + 2w$$
$$340 = 6w - 12 + 2w$$
$$340 = 8w - 12$$
$$352 = 8w$$
$$44 = w$$

The dimensions are 44 yards by 126 yards.

44. **a.** Let x = the number of years (after 2015).
College A's enrollment: $14{,}100 + 1500x$
College B's enrollment: $41{,}700 - 800x$
$14{,}100 + 1500x = 41{,}700 - 800x$

b. Check points to determine that $y_1 = 14{,}100 + 1500x$ and $y_2 = 41{,}700 - 800x$. Since $y_1 = y_2 = 32{,}100$ when $x = 12$, the two colleges will have the same enrollment in the year $2015 + 12 = 2027$. That year the enrollments will be 32,100 students.

45.
$$vt + gt^2 = s$$
$$gt^2 = s - vt$$
$$\frac{gt^2}{t^2} = \frac{s - vt}{t^2}$$
$$g = \frac{s - vt}{t^2}$$

46.
$$T = gr + gvt$$
$$T = g(r + vt)$$
$$\frac{T}{r + vt} = \frac{g(r + vt)}{r + vt}$$
$$\frac{T}{r + vt} = g$$
$$g = \frac{T}{r + vt}$$

47.
$$T = \frac{A - P}{\text{Pr}}$$
$$Pr(T) = Pr\frac{A - P}{\text{Pr}}$$
$$PrT = A - P$$
$$PrT + P = A$$
$$P(rT + 1) = A$$
$$P = \frac{A}{1 + rT}$$

48.
$$(8 - 3i) - (17 - 7i) = 8 - 3i - 17 + 7i$$
$$= -9 + 4i$$

49.
$$4i(3i - 2) = (4i)(3i) + (4i)(-2)$$
$$= 12i^2 - 8i$$
$$= -12 - 8i$$

50.
$$(7 - i)(2 + 3i)$$
$$= 7 \cdot 2 + 7(3i) + (-i)(2) + (-i)(3i)$$
$$= 14 + 21i - 2i + 3$$
$$= 17 + 19i$$

51.
$$(3 - 4i)^2 = 3^2 + 2 \cdot 3(-4i) + (-4i)^2$$
$$= 9 - 24i - 16$$
$$= -7 - 24i$$

52. $(7 + 8i)(7 - 8i) = 7^2 + 8^2 = 49 + 64 = 113$

53.
$$\frac{6}{5 + i} = \frac{6}{5 + i} \cdot \frac{5 - i}{5 - i}$$
$$= \frac{30 - 6i}{25 + 1}$$
$$= \frac{30 - 6i}{26}$$
$$= \frac{15 - 3i}{13}$$
$$= \frac{15}{13} - \frac{3}{13}i$$

54.
$$\frac{3 + 4i}{4 - 2i} = \frac{3 + 4i}{4 - 2i} \cdot \frac{4 + 2i}{4 + 2i}$$
$$= \frac{12 + 6i + 16i + 8i^2}{16 - 4i^2}$$
$$= \frac{12 + 22i - 8}{16 + 4}$$
$$= \frac{4 + 22i}{20}$$
$$= \frac{1}{5} + \frac{11}{10}i$$

55.
$$\sqrt{-32} - \sqrt{-18} = i\sqrt{32} - i\sqrt{18}$$
$$= i\sqrt{16 \cdot 2} - i\sqrt{9 \cdot 2}$$
$$= 4i\sqrt{2} - 3i\sqrt{2}$$
$$= (4i - 3i)\sqrt{2}$$
$$= i\sqrt{2}$$

56. $(-2+\sqrt{-100})^2 = (-2+i\sqrt{100})^2$
$= (-2+10i)^2$
$= 4-40i+(10i)^2$
$= 4-40i-100$
$= -96-40i$

57. $\dfrac{4+\sqrt{-8}}{2} = \dfrac{4+i\sqrt{8}}{2} = \dfrac{4+2i\sqrt{2}}{2} = 2+i\sqrt{2}$

58. $2x^2+15x = 8$
$2x^2+15x-8 = 0$
$(2x-1)(x+8) = 0$
$2x-1 = 0 \quad x+8 = 0$
$x = \dfrac{1}{2}$ or $x = -8$
The solution set is $\left\{\dfrac{1}{2}, -8\right\}$.

59. $5x^2+20x = 0$
$5x(x+4) = 0$
$5x = 0 \quad x+4 = 0$
$x = 0$ or $x = -4$
The solution set is $\{0, -4\}$.

60. $2x^2-3 = 125$
$2x^2 = 128$
$x^2 = 64$
$x = \pm 8$
The solution set is $\{8, -8\}$.

61. $\dfrac{x^2}{2}+5 = -3$
$\dfrac{x^2}{2} = -8$
$x^2 = -16$
$\sqrt{x^2} = \pm\sqrt{-16}$
$x = \pm 4i$

62. $(x+3)^2 = -10$
$\sqrt{(x+3)^2} = \pm\sqrt{-10}$
$x+3 = \pm i\sqrt{10}$
$x = -3 \pm i\sqrt{10}$

63. $(3x-4)^2 = 18$
$\sqrt{(3x-4)^2} = \pm\sqrt{18}$
$3x-4 = \pm 3\sqrt{2}$
$3x = 4 \pm 3\sqrt{2}$
$\dfrac{3x}{3} = \dfrac{4 \pm 3\sqrt{2}}{3}$
$x = \dfrac{4 \pm 3\sqrt{2}}{3}$

64. x^2+20x
$\left(\dfrac{20}{2}\right)^2 = 10^2 = 100$
$x^2+20x+100 = (x+10)^2$

65. x^2-3x
$\left(\dfrac{3}{2}\right)^2 = \dfrac{9}{4}$
$x^2-3x+\dfrac{9}{4} = \left(x-\dfrac{3}{2}\right)^2$

66. $x^2-12x = -27$
$x^2-12x+36 = -27+36$
$(x-6)^2 = 9$
$x-6 = \pm 3$
$x = 6 \pm 3$
$x = 9, 3$
The solution set is $\{9, 3\}$.

67. $3x^2-12x+11 = 0$
$x^2-4x = -\dfrac{11}{3}$
$x^2-4x+4 = -\dfrac{11}{3}+4$
$(x-2)^2 = \dfrac{1}{3}$
$x-2 = \pm\sqrt{\dfrac{1}{3}}$
$x = 2 \pm \dfrac{\sqrt{3}}{3}$
The solution set is $\left\{2+\dfrac{\sqrt{3}}{3}, 2-\dfrac{\sqrt{3}}{3}\right\}$.

68. $x^2 = 2x + 4$

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

$x = \dfrac{2 \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2(1)}$

$x = \dfrac{2 \pm \sqrt{4 + 16}}{2}$

$x = \dfrac{2 \pm \sqrt{20}}{2}$

$x = \dfrac{2 \pm 2\sqrt{5}}{2}$

$x = 1 \pm \sqrt{5}$

The solution set is $\left\{1 + \sqrt{5}, 1 - \sqrt{5}\right\}$.

69. $x^2 - 2x + 19 = 0$

$x = \dfrac{2 \pm \sqrt{(-2)^2 - 4(1)(19)}}{2(1)}$

$x = \dfrac{2 \pm \sqrt{4 - 76}}{2}$

$x = \dfrac{2 \pm \sqrt{-72}}{2}$

$x = \dfrac{2 \pm 6i\sqrt{2}}{2}$

$x = 1 \pm 3i\sqrt{2}$

The solution set is $\left\{1 + 3i\sqrt{2}, 1 - 3i\sqrt{2}\right\}$.

70. $2x^2 = 3 - 4x$

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

$x = \dfrac{-4 \pm \sqrt{4^2 - 4(2)(-3)}}{2(2)}$

$x = \dfrac{-4 \pm \sqrt{16 + 24}}{4}$

$x = \dfrac{-4 \pm \sqrt{40}}{4}$

$x = \dfrac{-4 \pm 2\sqrt{10}}{4}$

$x = \dfrac{-2 \pm \sqrt{10}}{2}$

The solution set is $\left\{\dfrac{-2 + \sqrt{10}}{2}, \dfrac{-2 - \sqrt{10}}{2}\right\}$.

71. $x^2 - 4x + 13 = 0$

$(-4)^2 - 4(1)(13)$

$= 16 - 52$

$= -36$; 2 complex imaginary solutions

72. $9x^2 = 2 - 3x$

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

$3^2 - 4(9)(-2)$

$= 9 + 72$

$= 81$; 2 unequal real solutions

73. $2x^2 - 11x + 5 = 0$

$(2x - 1)(x - 5) = 0$

$2x - 1 = 0 \quad x - 5 = 0$

$x = \dfrac{1}{2}$ or $x = 5$

The solution set is $\left\{5, \dfrac{1}{2}\right\}$.

74. $(3x + 5)(x - 3) = 5$

$3x^2 + 5x - 9x - 15 = 5$

$3x^2 - 4x - 20 = 0$

$x = \dfrac{4 \pm \sqrt{(-4)^2 - 4(3)(-20)}}{2(3)}$

$x = \dfrac{4 \pm \sqrt{16 + 240}}{6}$

$x = \dfrac{4 \pm \sqrt{256}}{6}$

$x = \dfrac{4 \pm 16}{6}$

$x = \dfrac{20}{6}, \dfrac{-12}{6}$

$x = \dfrac{10}{3}, -2$

The solution set is $\left\{-2, \dfrac{10}{3}\right\}$.

75. $3x^2 - 7x + 1 = 0$

$$x = \frac{7 \pm \sqrt{(-7)^2 - 4(3)(1)}}{2(3)}$$

$$x = \frac{7 \pm \sqrt{49 - 12}}{6}$$

$$x = \frac{7 \pm \sqrt{37}}{6}$$

The solution set is $\left\{\frac{7+\sqrt{37}}{6}, \frac{7-\sqrt{37}}{6}\right\}$.

76. $x^2 - 9 = 0$

$$x^2 = 9$$

$$x = \pm 3$$

The solution set is $\{-3, 3\}$.

77. $(x-3)^2 - 25 = 0$

$$(x-3)^2 = 25$$

$$x - 3 = \pm 5$$

$$x = 3 \pm 5$$

$$x = 8, -2$$

The solution set is $\{8, -2\}$.

78. $3x^2 - x + 2 = 0$

$$x = \frac{1 \pm \sqrt{(-1)^2 - 4(3)(2)}}{2(3)}$$

$$x = \frac{1 \pm \sqrt{1 - 24}}{6}$$

$$x = \frac{1 \pm \sqrt{-23}}{6}$$

$$x = \frac{1 \pm i\sqrt{23}}{6}$$

The solution set is $\left\{\frac{1+i\sqrt{23}}{6}, \frac{1-i\sqrt{23}}{6}\right\}$.

79. $3x^2 - 10x = 8$

$$3x^2 - 10x - 8 = 0$$

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

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

$3x = -2$ or $x = 4$

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

The solution set is $\left\{-\frac{2}{3}, 4\right\}$.

80. $(x+2)^2 + 4 = 0$

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

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

$$x + 2 = \pm 2i$$

$$x = -2 \pm 2i$$

The solution set is $\{-2 + 2i, -2 - 2i\}$.

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

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

$$20 + (x-1)(x+1) = 8(x+1)$$

$$20 + x^2 - 1 = 8x + 8$$

$$x^2 - 8x - 11 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(1)(11)}}{2(1)}$$

$$x = \frac{8 \pm \sqrt{20}}{2}$$

$$x = \frac{8 \pm 2\sqrt{5}}{2}$$

$$x = 4 \pm \sqrt{5}$$

The solution set is $\left\{4 + \sqrt{5}, 4 - \sqrt{5}\right\}$.

82. $W(t) = 3t^2$

$$588 = 3t^2$$

$$196 = t^2$$

Apply the square root property.

$$t^2 = 196$$

$$t = \pm\sqrt{196}$$

$$t = \pm 14$$

The solutions are –14 and 14. We disregard –14, because we cannot have a negative time measurement. The fetus will weigh 588 grams after 14 weeks.

83. **a.** $G = -82x^2 + 410x + 7079$

$$G = -82(6)^2 + 410(6) + 7079$$

$$= 6587$$

The model estimates the aid per student in 2011 was \$6587. This underestimates the actual number shown in the bar graph by \$13.

b. $G = -82x^2 + 410x + 7079$

$4127 = -82x^2 + 410x + 7079$

$82x^2 - 410x - 2952 = 0$

$x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$x = \dfrac{-(-410) \pm \sqrt{(-410)^2 - 4(82)(-2952)}}{2(82)}$

$x = \dfrac{410 \pm \sqrt{1136356}}{164}$

$x = \dfrac{410 \pm 1066}{164}$

$x = 9$ or -4

The model projects the government aid per student will be \$4127 9 years after 2005, or 2014.

84. $A = lw$

$15 = l(2l - 7)$

$15 = 2l^2 - 7l$

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

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

$l = 5$

$2l - 7 = 3$

The length is 5 yards, the width is 3 yards.

85. Let x = height of building

$2x$ = shadow height

$x^2 + (2x)^2 = 300^2$

$x^2 + 4x^2 = 90{,}000$

$5x^2 = 90{,}000$

$x^2 = 18{,}000$

$x \approx \pm 134.164$

Discard negative height.

The building is approximately 134 meters high.

86. $2x^4 = 50x^2$

$2x^4 - 50x^2 = 0$

$2x^2(x^2 - 25) = 0$

$x = 0$

$x = \pm 5$

The solution set is $\{-5, 0, 5\}$.

87. $2x^3 - x^2 - 18x + 9 = 0$

$x^2(2x - 1) - 9(2x - 1) = 0$

$(x^2 - 9)(2x - 1) = 0$

$x = \pm 3,\ x = \dfrac{1}{2}$

The solution set is $\left\{-3, \dfrac{1}{2}, 3\right\}$.

88. $\sqrt{2x - 3} + x = 3$

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

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

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

$x^2 - 8x = -12$

$x^2 - 8x + 16 = -12 + 16$

$(x - 4)^2 = 4$

$x - 4 = \pm 2$

$x = 4 + 2$

$x = 6, 2$

The solution set is $\{2\}$.

89. $\sqrt{x - 4} + \sqrt{x + 1} = 5$

$\sqrt{x - 4} = 5 - \sqrt{x + 1}$

$x - 4 = 25 - 10\sqrt{x + 1} + (x + 1)$

$x - 4 = 26 + x - 10\sqrt{x + 1}$

$-30 = -10\sqrt{x + 1}$

$3 = \sqrt{x + 1}$

$9 = x + 1$

$x = 8$

The solution set is $\{8\}$.

90. $3x^{\frac{3}{4}} - 24 = 0$

$3x^{\frac{3}{4}} = 24$

$x^{\frac{3}{4}} = 8$

$\left(x^{\frac{3}{4}}\right)^{\frac{4}{3}} = (8)^{\frac{4}{3}}$

$x = 16$

The solution set is $\{16\}$.

91. $(x-7)^{\frac{2}{3}} = 25$

$$\left[(x-7)^{\frac{2}{3}}\right]^{\frac{3}{2}} = 25^{\frac{3}{2}}$$

$$x-7 = \left(5^2\right)^{\frac{3}{2}}$$

$$x-7 = 5^3$$

$$x-7 = 125$$

$$x = 132$$

The solution set is {132}.

92. $x^4 - 5x^2 + 4 = 0$

Let $t = x^2$

$t^2 - 5t + 4 = 0$

$t = 4$ or $t = 1$

$x^2 = 4$ $\qquad$ $x^2 = 1$

$x = \pm 2$ $\qquad$ $x = \pm 1$

The solution set is {–2, –1, 1, 2}.

93. $x^{1/2} + 3x^{1/4} - 10 = 0$

Let $t = x^{1/4}$

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

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

$t = -5$ or $t = 2$

$x^{\frac{1}{4}} = -5$ $\qquad$ $x^{\frac{1}{4}} = 2$

$\left(x^{\frac{1}{4}}\right)^4 = (-5)^4$ $\qquad$ $\left(x^{\frac{1}{4}}\right)^4 = (2)^4$

$x = 625$ $\qquad$ $x = 16$

625 does not check and must be rejected.

The solution set is {16}.

94. $|2x+1| = 7$

$2x+1 = 7$ or $2x+1 = -7$

$2x = 6$ $\qquad$ $2x = -8$

$x = 3$ $\qquad$ $x = -8$

The solution set is {–4, 3}.

95. $2|x-3| - 6 = 10$

$2|x-3| = 16$

$|x-3| = 8$

$x-3 = 8$ or $x-3 = -8$

$x = 11$ $\qquad$ $x = -5$

The solution set is {–5, 11}.

96. $3x^{4/3} - 5x^{2/3} + 2 = 0$

Let $t = x^{\frac{2}{3}}$.

$3t^2 - 5t + 2 = 0$

$(3t-2)(t-1) = 0$

$3t - 2 = 0$ or $t - 1 = 0$

$3t = 2$ $\qquad$ $t = 1$

$t = \frac{2}{3}$ $\qquad$ $x^{\frac{2}{3}} = 1$

$x^{\frac{2}{3}} = \frac{2}{3}$ $\qquad$ $\left(x^{\frac{2}{3}}\right)^{\frac{3}{2}} = \pm(1)^{\frac{3}{2}}$

$\left(x^{\frac{2}{3}}\right)^{\frac{3}{2}} = \pm\left(\frac{2}{3}\right)^{\frac{3}{2}}$ $\qquad$ $x = \pm 1$

$$x = \pm\sqrt[2]{\left(\frac{2}{3}\right)^3}$$

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

$$x = \pm\frac{2}{3}\cdot\frac{\sqrt{2}}{\sqrt{3}}\cdot\frac{\sqrt{3}}{\sqrt{3}}$$

$$x = \pm\frac{2\sqrt{6}}{9}$$

The solution set is $\left\{-\frac{2\sqrt{6}}{9}, \frac{2\sqrt{6}}{9}, -1, 1\right\}$.

97. $2\sqrt{x-1} = x$

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

$4x - 4 = x^2$

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

$(x-2)^2 = 0$

$x = 2$

The solution set is {2}.

98. $|2x-5| - 3 = 0$

$2x-5 = 3$ or $2x-5 = -3$

$2x = 8$ $\qquad$ $2x = 2$

$x = 4$ $\qquad$ $x = 1$

The solution set is {4, 1}.

99. $x^3 + 2x^2 - 9x - 18 = 0$

$x^2(x+2) - 9(x+2) = 0$

$(x+2)(x^2 - 9) = 0$

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

The solution set is $\{-3, -2, 3\}$.

100. $\sqrt{8-2x} - x = 0$

$\sqrt{8-2x} = x$

$\left(\sqrt{8-2x}\right)^2 = (x)^2$

$8 - 2x = x^2$

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

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

$x + 4 = 0$ or $x - 2 = 0$

$x = -4$ $\qquad$ $x = 2$

-4 does not check.

The solution set is $\{2\}$.

101. $x^3 + 3x^2 - 2x - 6 = 0$

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

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

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

$x = -3$ $\qquad$ $x^2 = 2$

$x = \pm\sqrt{2}$

The solution set is $\{-3, -\sqrt{2}, \sqrt{2}\}$.

102. $-4|x+1| + 12 = 0$

$-4|x+1| = -12$

$|x+1| = 3$

$x + 1 = 3$ or $x + 1 = -3$

$x = 2$ $\qquad$ $x = -4$

The solution set is $\{-4, 2\}$.

103. $p = -2.5\sqrt{t} + 17$

$7 = -2.5\sqrt{t} + 17$

$-10 = -2.5\sqrt{t}$

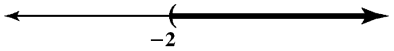
$4 = \sqrt{t}$

$16 = t$

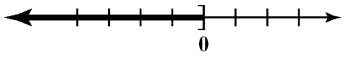
The percentage dropped to 7% 16 years after 1993, or 2009.

104. $\{x \mid -3 \le x < 5\}$

105. $\{x \mid x > -2\}$

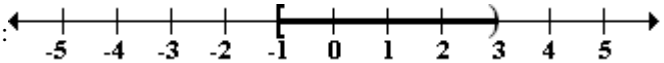


106. $\{x \mid x \le 0\}$



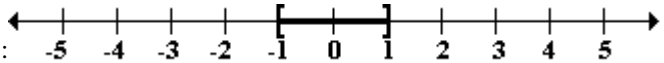
107. Graph $(-2,1]$:

Graph $[-1,3)$:



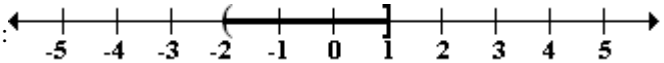
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $(-2,1]$ and $[-1,3)$:

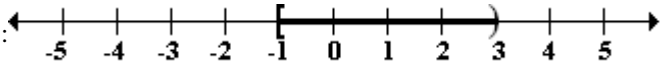


Thus, $(-2,1] \cap [-1,3) = [-1,1]$.

108. Graph $(-2,1]$:

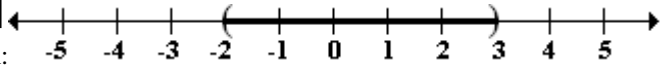


Graph $[-1,3)$:



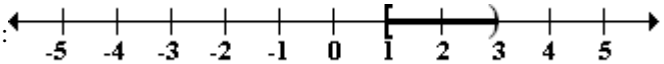
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $(-2,1]$ or $[-1,3)$ or both:

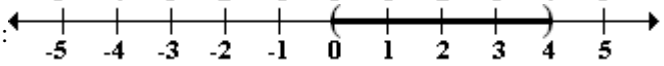


Thus, $(-2,1] \cup [-1,3) = (-2,3)$.

109. Graph $[1,3)$:

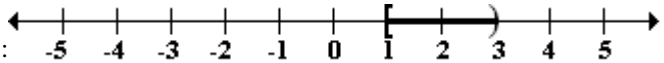


Graph $(0,4)$:



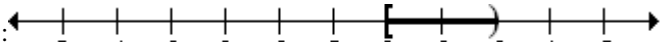
To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $[1,3)$ and $(0,4)$:

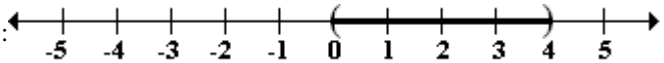


Thus, $[1,3) \cap (0,4) = [1,3)$.

110. Graph $[1,3)$:

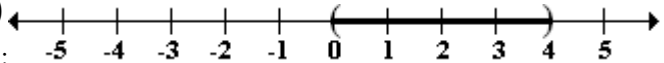


Graph $(0,4)$:



To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $[1,3)$ or $(0,4)$ or both:

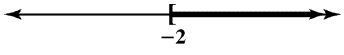


Thus, $[1,3) \cup (0,4) = (0,4)$.

111. $-6x + 3 \le 15$

$-6x \le 12$

$x \ge 2$

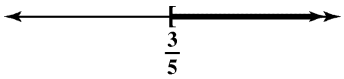


The solution set is $[-2, \infty)$.

112. $6x - 9 \ge -4x - 3$

$10x \ge 6$

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



The solution set is $\left[\frac{3}{5}, \infty\right)$.

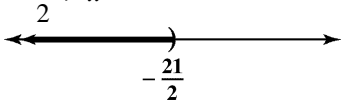
113. $\frac{x}{3} - \frac{3}{4} - 1 > \frac{x}{2}$

$12\left(\frac{x}{3} - \frac{3}{4} - 1\right) > 12\left(\frac{x}{2}\right)$

$4x - 9 - 12 > 6x$

$-21 > 2x$

$-\frac{21}{2} > x$



The solution set is $\left(-\infty, -\frac{21}{2}\right)$.

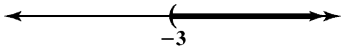
114. $6x + 5 > -2(x - 3) - 25$

$6x + 5 > -2x + 6 - 25$

$8x + 5 > -19$

$8x > -24$

$x > -3$



The solution set is $(-3, \infty)$.

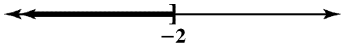
115. $3(2x - 1) - 2(x - 4) \ge 7 + 2(3 + 4x)$

$6x - 3 - 2x + 8 \ge 7 + 6 + 8x$

$4x + 5 \ge 8x + 13$

$-4x \ge 8$

$x \le -2$



The solution set is $[-\infty, -2)$.

116. $5(x - 2) - 3(x + 4) \ge 2x - 20$

$5x - 10 - 3x - 12 \ge 2x - 20$

$2x - 22 \ge 2x - 20$

$-22 \ge -20$

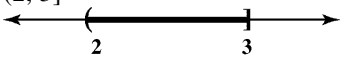
The solution set is $\varnothing$.

117. $7 < 2x + 3 \le 9$

$4 < 2x \le 6$

$2 < x \le 3$

$(2, 3]$



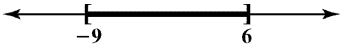
The solution set is $[2, 3)$.

118. $|2x + 3| \le 15$

$-15 \le 2x + 3 \le 15$

$-18 \le 2x \le 12$

$-9 \le x \le 6$



The solution set is $[-9, 6]$.

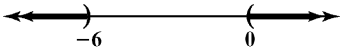
119. $\left|\frac{2x + 6}{3}\right| > 2$

$\frac{2x + 6}{3} > 2 \quad \frac{2x + 6}{3} < -2$

$2x + 6 > 6 \quad 2x + 6 < -6$

$2x > 0 \quad 2x < -12$

$x > 0 \quad x < -6$



The solution set is $(-\infty, -6)$ or $(0, \infty)$.

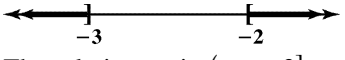
120. $|2x + 5| - 7 \ge -6$

$|2x + 5| \ge 1$

$2x + 5 \ge 1$ or $2x + 5 \le -1$

$2x \ge -4 \quad 2x \le -6$

$x \ge -2$ or $x \le -3$



The solution set is $(-\infty, -3]$ or $[-2, \infty)$.

121. $-4|x + 2| + 5 \le -7$

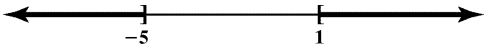
$-4|x + 2| \le -12$

$|x + 2| \ge 3$

$x + 2 \ge 3 \quad$ or $\quad x + 2 \le -3$

$x \ge 1 \quad x \le -5$

The solution set is $(-\infty, -5] \cup [1, \infty)$.



122. $y_1 > y_2$

$$-10-3(2x+1) > 8x+1$$
$$-10-6x-3 > 8x+1$$
$$-6x-13 > 8x+1$$
$$-14x > 14$$
$$\frac{-14x}{-14} < \frac{14}{-14}$$
$$x < -1$$

The solution set is $(-\infty, -1)$.

123.
$$3-|2x-5| \geq -6$$
$$-|2x-5| \geq -9$$
$$\frac{-|2x-5|}{-1} \leq \frac{-9}{-1}$$
$$|2x-5| \leq 9$$
$$-9 \leq 2x-5 \leq 9$$
$$-4 \leq 2x \leq 14$$
$$-2 \leq x \leq 7$$

The solution set is $[-2, 7]$.

124.
$$0.20x + 24 \leq 40$$
$$0.20x \leq 16$$
$$\frac{0.20x}{0.20} \leq \frac{16}{0.20}$$
$$x \leq 80$$

A customer can drive no more than 80 miles.

125.
$$80 \leq \frac{95+79+91+86+x}{5} < 90$$
$$400 \leq 95+79+91+86+x < 450$$
$$400 \leq 351 + x < 450$$
$$49 \leq x < 99$$

A grade of at least 49% but less than 99% will result in a B.

126.
$$0.075x \geq 9000$$
$$\frac{0.075x}{0.075} \geq \frac{9000}{0.075}$$
$$x \geq 120{,}000$$

The investment must be at least \$120,000.

Chapter 1 Test

1.
$$7(x-2) = 4(x+1) - 21$$
$$7x - 14 = 4x + 4 - 21$$
$$7x - 14 = 4x - 17$$
$$3x = -3$$
$$x = -1$$

The solution set is $\{-1\}$.

2.
$$-10-3(2x+1)-8x-1 = 0$$
$$-10-6x-3-8x-1 = 0$$
$$-14x-14 = 0$$
$$-14x = 14$$
$$x = -1$$

The solution set is $\{-1\}$.

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

The solution set is $\{-6\}$.

4.
$$\frac{2}{x-3} - \frac{4}{x+3} = \frac{8}{(x-3)(x+3)}$$
$$2(x+3) - 4(x-3) = 8$$
$$2x+6-4x+12 = 8$$
$$-2x+18 = 8$$
$$-2x = -10$$
$$x = 5$$

The solution set is $\{5\}$.

5.
$$2x^2 - 3x - 2 = 0$$
$$(2x+1)(x-2) = 0$$
$$2x+1 = 0 \quad \text{or} \quad x-2 = 0$$
$$x = -\frac{1}{2} \quad \text{or} \quad x = 2$$

The solution set is $\left\{-\frac{1}{2}, 2\right\}$.

6.
$$(3x-1)^2 = 75$$
$$3x-1 = \pm\sqrt{75}$$
$$3x = 1 \pm 5\sqrt{3}$$
$$x = \frac{1 \pm 5\sqrt{3}}{3}$$

The solution set is $\left\{\frac{1-5\sqrt{3}}{3}, \frac{1+5\sqrt{3}}{3}\right\}$.

7. $(x+3)^2+25=0$

$(x+3)^2=-25$

$x+3=\pm\sqrt{-25}$

$x=-3\pm 5i$

The solution set is $\{-3+5i,-3-5i\}$.

8. $x(x-2)=4$

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

$x=\dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$

$x=\dfrac{2\pm\sqrt{(-2)^2-4(1)(-4)}}{2}$

$x=\dfrac{2\pm 2\sqrt{5}}{2}$

$x=1\pm\sqrt{5}$

The solution set is $\{1-\sqrt{5},1+\sqrt{5}\}$.

9. $4x^2=8x-5$

$4x^2-8x+5=0$

$x=\dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$

$x=\dfrac{8\pm\sqrt{(-8)^2-4(4)(5)}}{2(4)}$

$x=\dfrac{8\pm\sqrt{-16}}{8}$

$x=\dfrac{8\pm 4i}{8}$

$x=1\pm\dfrac{1}{2}i$

The solution set is $\left\{1+\dfrac{1}{2}i,1-\dfrac{1}{2}i\right\}$.

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

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

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

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

$x=1$ or $x=-1$ or $x=4$

The solution set is $\{-1,1,4\}$.

11. $\sqrt{x-3}+5=x$

$\sqrt{x-3}=x-5$

$x-3=x^2-10x+25$

$x^2-11x+28=0$

$x=\dfrac{11\pm\sqrt{11^2-4(1)(28)}}{2(1)}$

$x=\dfrac{11\pm\sqrt{121-112}}{2}$

$x=\dfrac{11\pm\sqrt{9}}{2}$

$x=\dfrac{11\pm 3}{2}$

$x=7$ or $x=4$

4 does not check and must be rejected.

The solution set is $\{7\}$.

12. $\sqrt{8-2x}-x=0$

$\sqrt{8-2x}=x$

$\left(\sqrt{8-2x}\right)^2=(x)^2$

$8-2x=x^2$

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

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

$x+4=0$ or $x-2=0$

$x=-4$ $\quad$ $x=2$

-4 does not check and must be rejected.

The solution set is $\{2\}$.

13. $\sqrt{x+4}+\sqrt{x-1}=5$

$\sqrt{x+4}=5-\sqrt{x-1}$

$x+4=25-10\sqrt{x-1}+(x-1)$

$x+4=25-10\sqrt{x-1}+x-1$

$-20=-10\sqrt{x-1}$

$2=\sqrt{x-1}$

$4=x-1$

$x=5$

The solution set is $\{5\}$.

14. $5x^{3/2} - 10 = 0$

$5x^{3/2} = 10$

$x^{3/2} = 2$

$x = 2^{2/3}$

$x = \sqrt[3]{4}$

The solution set is $\left\{\sqrt[3]{4}\right\}$.

15. $x^{2/3} - 9x^{1/3} + 8 = 0$ let $t = x^{1/3}$

$t^2 - 9t + 8 = 0$

$(t-1)(t-8) = 0$

$t = 1 \qquad t = 8$

$x^{1/3} = 1 \quad x^{1/3} = 8$

$x = 1 \qquad x = 512$

The solution set is $\{1, 512\}$.

16. $\left|\frac{2}{3}x - 6\right| = 2$

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

$\frac{2}{3}x = 8 \qquad \frac{2}{3}x = 4$

$x = 12 \qquad x = 6$

The solution set is $\{6, 12\}$.

17. $-3\left|4x - 7\right| + 15 = 0$

$-3\left|4x - 7\right| = -15$

$\left|4x - 7\right| = 5$

$4x - 7 = 5 \quad$ or $\quad 4x - 7 = -5$

$4x = 12 \qquad 4x = 2$

$x = 3 \qquad x = \frac{1}{2}$

The solution set is $\left\{\frac{1}{2}, 3\right\}$

18. $\frac{1}{x^2} - \frac{4}{x} + 1 = 0$

$\frac{x^2}{x^2} - \frac{4x^2}{x} + x^2 = 0$

$1 - 4x + x^2 = 0$

$x^2 - 4x + 1 = 0$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(1)}}{2(1)}$

$x = \frac{4 \pm \sqrt{12}}{2}$

$x = \frac{4 \pm 2\sqrt{3}}{2}$

$x = 2 \pm \sqrt{3}$

The solution set is $\left\{2 + \sqrt{3}, 2 - \sqrt{3}\right\}$.

19. $\frac{2x}{x^2 + 6x + 8} + \frac{2}{x+2} = \frac{x}{x+4}$

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

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

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

$2x + 2x + 8 = x^2 + 2x$

$2x + 8 = x^2$

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

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

$x - 4 = 0 \quad$ or $\quad x + 2 = 0$

$x = 4 \qquad x = -2$ (rejected)

The solution set is $\{4\}$.

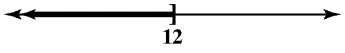
20. $3(x + 4) \geq 5x - 12$

$3x + 12 \geq 5x - 12$

$-2x \geq -24$

$x \leq 12$

The solution set is $(-\infty, 12]$.



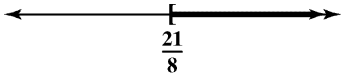
21. $\frac{x}{6}+\frac{1}{8}\le\frac{x}{2}-\frac{3}{4}$

$4x+3\le 12x-18$

$-8x\le -21$

$x\ge\frac{21}{8}$

The solution set is $\left[\frac{21}{8},\infty\right)$.



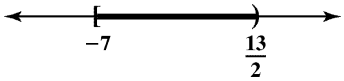
22. $-3\le\frac{2x+5}{3}<6$

$-9\le 2x+5<18$

$-14\le 2x<13$

$-7\le x<\frac{13}{2}$

The solution set is $\left[-7,\frac{13}{2}\right)$.



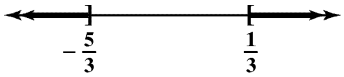
23. $|3x+2|\ge 3$

$3x+2\ge 3$ or $3x+2\le -3$

$3x\ge 1$ $\quad$ $3x\le -5$

$x\ge\frac{1}{3}$ $\quad$ $x\le -\frac{5}{3}$

The solution set is $\left(-\infty,-\frac{5}{3}\right]\cup\left[\frac{1}{3},\infty\right)$.



24. $-3\le y\le 7$

$-3\le 2x-5\le 7$

$2\le 2x\le 12$

$1\le x\le 6$

The solution set is $[1,6]$.

25. $y\ge 1$

$\left|\frac{2-x}{4}\right|\ge 1$

$\frac{2-x}{4}\ge 1$ or $\frac{2-x}{4}\le -1$

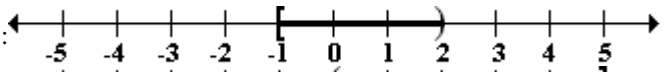
$2-x\ge 4$ $\quad$ $2-x\le -4$

$-x\ge 2$ $\quad$ $-x\le -6$

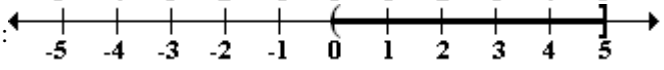
$x\le -2$ $\quad$ $x\ge 6$

The solution set is $(-\infty,-2]\cup[6,\infty)$.

26. Graph $[-1,2)$:

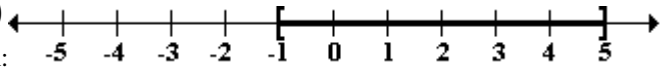


Graph $(0,5]$:



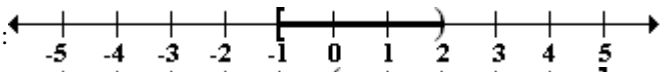
To find the union, take the portion of the number line representing the total collection of numbers in the two graphs.

Numbers in either $[-1,2)$ or $(0,5]$ or both:

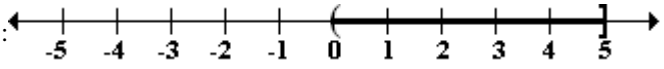


Thus,
$[-1,2) \cup (0,5] = [-1,5]$.

27. Graph $[-1,2)$:

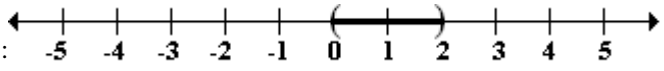


Graph $(0,5]$:



To find the intersection, take the portion of the number line that the two graphs have in common.

Numbers in both $[-1,2)$ and $(0,5]$:



Thus, $[-1,2) \cap (0,5] = (0,2)$.

28. $V = \frac{1}{3}lwh$

$3V = lwh$

$\frac{3V}{lw} = \frac{lwh}{lw}$

$\frac{3V}{lw} = h$

$h = \frac{3V}{lw}$

29. $y - y_1 = m(x - x_1)$

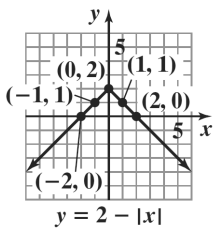
$y - y_1 = mx - mx_1$

$-mx = y_1 - mx_1 - y$

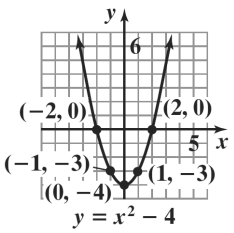
$\frac{-mx}{-m} = \frac{y_1 - mx_1 - y}{-m}$

$x = \frac{y - y_1}{m} + x_1$

30.



31.



32. $(6-7i)(2+5i) = 12+30i-14i-35i^2$
$= 12+16i+35$
$= 47+16i$

33. $\dfrac{5}{2-i} = \dfrac{5}{2-i}\cdot\dfrac{2+i}{2+i}$
$= \dfrac{5(2+i)}{4+1}$
$= \dfrac{5(2+i)}{5}$
$= 2+i$

34. $2\sqrt{-49}+3\sqrt{-64} = 2(7i)+3(8i)$
$= 14i+24i$
$= 38i$

35. $43x+575 = 1177$
$43x = 602$
$x = 14$
The system's income will be \$1177 billion 14 years after 2004, or 2018.

36. $B = 0.07x^2+47.4x+500$
$1177 = 0.07x^2+47.4x+500$
$0 = 0.07x^2+47.4x-677$
$0 = 0.07x^2+47.4x-677$
$x = \dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$
$x = \dfrac{-(47.4)\pm\sqrt{(47.4)^2-4(0.07)(-677)}}{2(0.07)}$
$x \approx 14, \quad x \approx -691$ (rejected)
The system's income will be \$1177 billion 14 years after 2004, or 2018.

37. The formulas model the data quite well.

38. Let x = the percentage of strikingly-attractive men.
Let $x+57$ = the percentage of average-looking men.
Let $x+25$ = the percentage of good-looking men.
$(x)+(x+57)+(x+25) = 88$
$x+x+57+x+25 = 88$
$3x+82 = 88$
$3x = 6$
$x = 2$
$x+57 = 59$
$x+25 = 27$
2% of men are strikingly-attractive.
59% of men are average-looking.
27% of men are good-looking.

39. $29700+150x = 5000+1100x$
$24700 = 950x$
$26 = x$
In 26 years, the cost will be \$33,600.

40. Let x = amount invested at 8%
$10000-x$ = amount invested at 10%
$0.08x+0.1(10000-x) = 940$
$0.08x+1000-0.1x = 940$
$-0.02x = -60$
$x = 3000$
$10000-x = 7000$
\$3000 at 8%, \$7000 at 10%

41. $l = 2w+4$
$A = lw$
$48 = (2w+4)w$
$48 = 2w^2+4w$
$0 = 2w^2+4w-48$
$0 = w^2+2w-24$
$0 = (w+6)(w-4)$

$w+6 = 0 \qquad w-4 = 0$
$w = -6 \qquad w = 4$
$2w+4 = 2(4)+4 = 12$
width is 4 feet, length is 12 feet

42. $24^2+x^2 = 26^2$
$576+x^2 = 676$
$x^2 = 100$
$x = \pm 10$
The wire should be attached 10 feet up the pole.

43. Let x = the original selling price

$20 = x - 0.60x$

$20 = 0.40x$

$50 = x$

The original price is \$50.

44. Let x = the number text messages.

The monthly cost using Plan A is $C_A = 25$.

The monthly cost using Plan B is $C_B = 13 + 0.06x$.

For Plan A to be better deal, it must cost less than Plan B.

$C_A < C_B$

$25 < 13 + 0.06x$

$12 < 0.06x$

$200 < x$

$x > 200$

Plan A is a better deal when more than 200 text messages per month are sent/received.