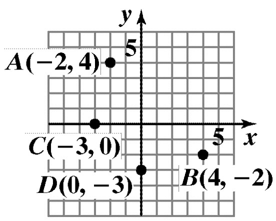
Chapter 1
Equations and Inequalities

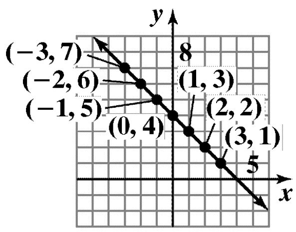
Section 1.1

Check Point Exercises

1.



2.



$y = 4 - x$

$x = -3,\ y = 7$

$x = -2,\ y = 6$

$x = -1,\ y = 5$

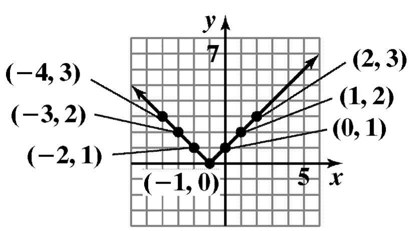
$x = 0,\ y = 4$

$x = 1,\ y = 3$

$x = 2,\ y = 2$

$x = 3,\ y = 1$

3.



$y = |x + 1|$

$x = -4,\ y = 3$

$x = -3,\ y = 2$

$x = -2,\ y = 1$

$x = -1,\ y = 0$

$x = 0,\ y = 1$

$x = 1,\ y = 2$

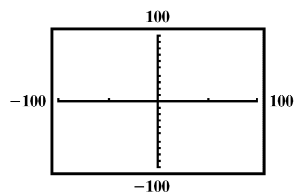
$x = 2,\ y = 3$

4. The meaning of a $[-100,100,50]$ by $[-100,100,10]$ viewing rectangle is as follows:

$$[\overbrace{-100}^{\text{minimum } x\text{-value}},\ \overbrace{100}^{\text{maximum } x\text{-value}},\ \overbrace{50}^{\text{distance between } x\text{-axis tick marks}}]$$

by

$$[\overbrace{-100}^{\text{minimum } y\text{-value}},\ \overbrace{100}^{\text{maximum } y\text{-value}},\ \overbrace{10}^{\text{distance between } y\text{-axis tick marks}}]$$



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.

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

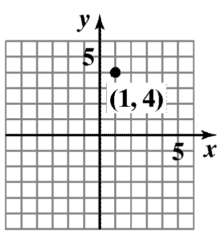
6. solution; satisfies

7. *x*-intercept; zero

8. *y*-intercept; zero

Exercise Set 1.1

1.



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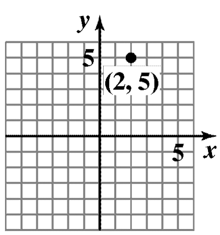

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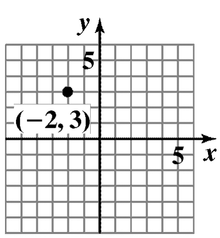

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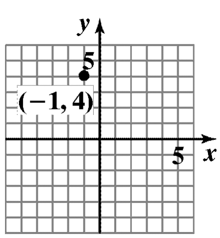

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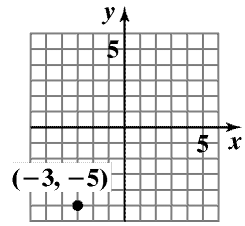
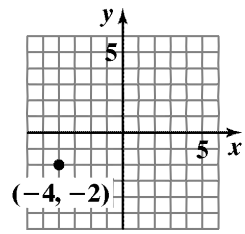


6.



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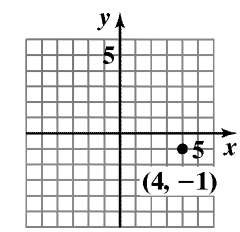

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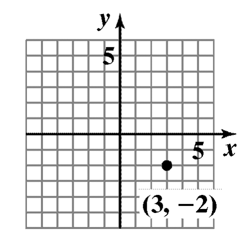
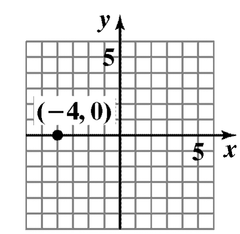
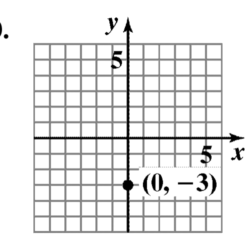


9.



10.



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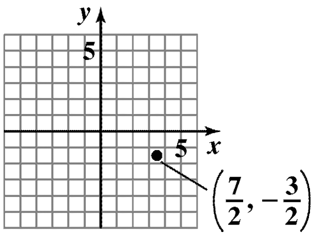
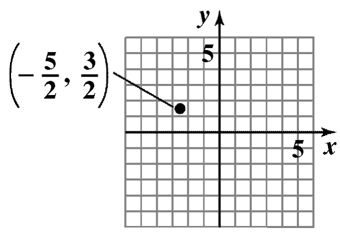
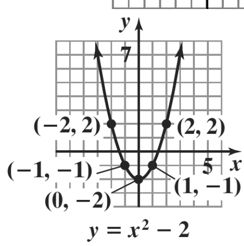


12.



13.



$x = -3, y = 7$

$x = -2, y = 2$

$x = -1, y = -1$

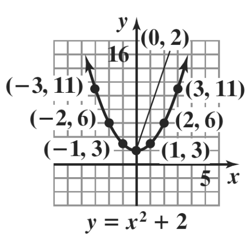
$x = 0, y = -2$

$x = 1, y = -1$

$x = 2, y = 2$

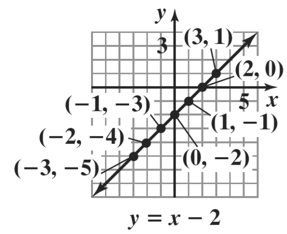
$x = 3, y = 7$

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.



$x = -3, y = -5$

$x = -2, y = -4$

$x = -1, y = -3$

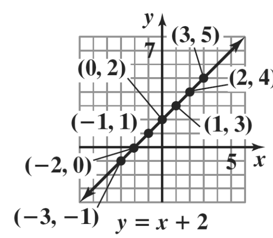
$x = 0, y = -2$

$x = 1, y = -1$

$x = 2, y = 0$

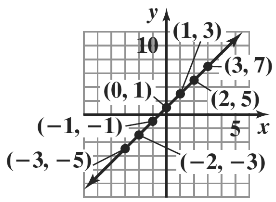
$x = 3, y = 1$

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.



$y = 2x + 1$

$x = -3,\ y = -5$

$x = -2,\ y = -3$

$x = -1,\ y = -1$

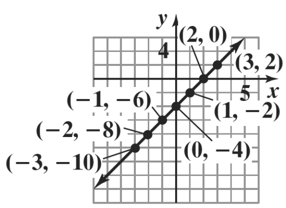
$x = 0,\ y = 1$

$x = 1,\ y = 3$

$x = 2,\ y = 5$

$x = 3,\ y = 7$

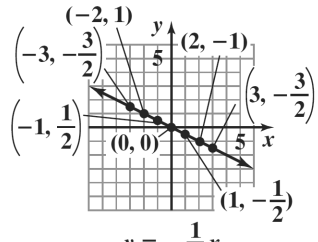
18.



$y = 2x - 4$

$x = -3,\ y = -10$
$x = -2,\ y = -8$
$x = -1,\ y = -6$
$x = 0,\ y = -4$
$x = 1,\ y = -2$
$x = 2,\ y = 0$
$x = 3,\ y = 2$

19.



$y = -\frac{1}{2}x$

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

$x = -2,\ y = 1$

$x = -1,\ y = \frac{1}{2}$

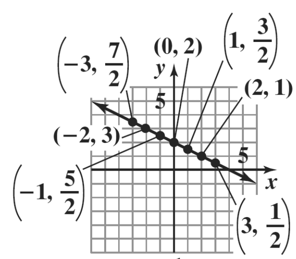
$x = 0,\ y = 0$

$x = 1,\ y = -\frac{1}{2}$

$x = 2,\ y = -1$

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

20.



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

$x = -3,\ y = \frac{7}{2}$

$x = -2,\ y = 3$

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

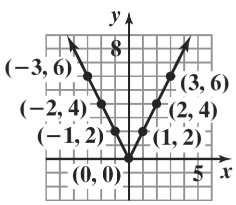
$x = 0,\ y = 2$

$x = 1,\ y = \frac{3}{2}$

$x = 2,\ y = 1$

$x = 3,\ y = \frac{1}{2}$

21.



$y = 2|x|$

$x = -3, y = 6$

$x = -2, y = 4$

$x = -1, y = 2$

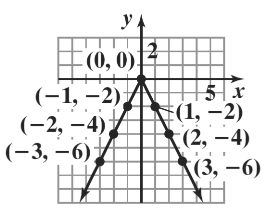
$x = 0, y = 0$

$x = 1, y = 2$

$x = 2, y = 4$

$x = 3, y = 6$

22.



$y = -2|x|$

$x = -3,\ y = -6$

$x = -2,\ y = -4$

$x = -1,\ y = -2$

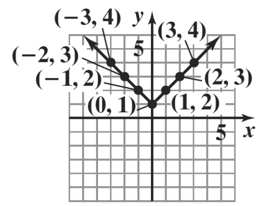
$x = 0,\ y = 0$

$x = 1,\ y = -2$

$x = 2,\ y = -4$

$x = 3,\ y = -6$

23.



$y = |x| + 1$

$x = -3,\ y = 4$

$x = -2,\ y = 3$

$x = -1,\ y = 2$

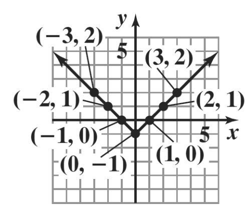
$x = 0,\ y = 1$

$x = 1,\ y = 2$

$x = 2,\ y = 3$

$x = 3,\ y = 4$

24.



$y = |x| - 1$

$x = -3, y = 2$

$x = -2, y = 1$

$x = -1, y = 0$

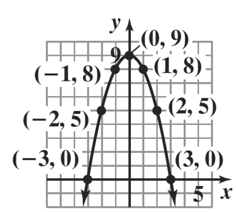
$x = 0, y = -1$

$x = 1, y = 0$

$x = 2, y = 1$

$x = 3, y = 2$

25.



$y = 9 - x^2$

$x = -3, y = 0$

$x = -2, y = 5$

$x = -1, y = 8$

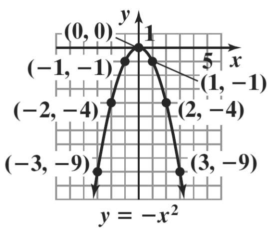
$x = 0, y = 9$

$x = 1, y = 8$

$x = 2, y = 5$

$x = 3, y = 0$

26.



$x = -3, y = -9$

$x = -2, y = -4$

$x = -1, y = -1$

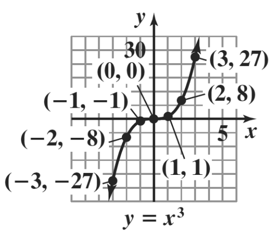
$x = 0, y = 0$

$x = 1, y = -1$

$x = 2, y = -4$

$x = 3, y = -9$

27.



$x = -3, y = -27$

$x = -2, y = -8$

$x = -1, y = 1$

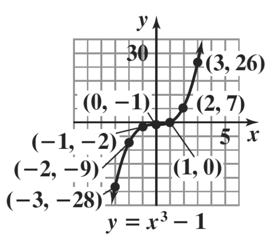
$x = 0, y = 0$

$x = 1, y = 1$

$x = 2, y = 8$

$x = 3, y = 27$

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).

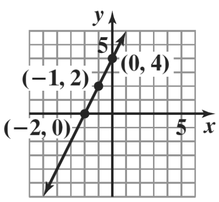
45. **a.** –1; The graph intersects the x-axis at (–1, 0).

b. none; The graph does not intersect the y-axis.

46. **a.** none; The graph does not intersect the x-axis.

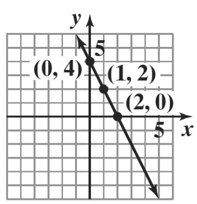
b. 2; The graph intersects the y-axis at (0, 2).

47.



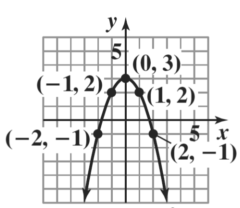
$y = 2x + 4$

48.



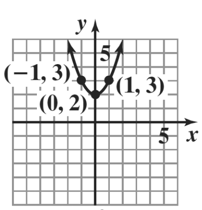
$y = 4 - 2x$

49.



$y = 3 - x^2$

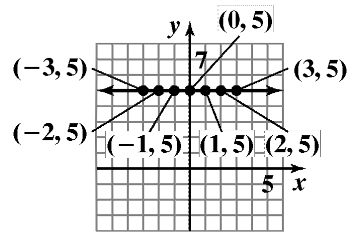
50.



$y = x^2 + 2$

51.

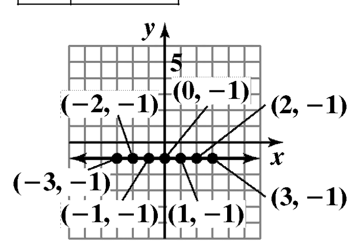
x	(x, y)
–3	(–3, 5)
–2	(–2, 5)
–1	(–1, 5)
0	(0, 5)
1	(1, 5)
2	(2, 5)
3	(3, 5)



$y = 5$

52.

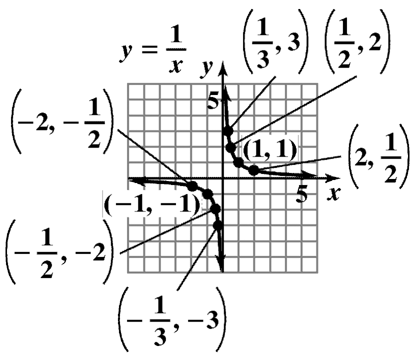
x	(x, y)
–3	(–3, –1)
–2	(–2, –1)
–1	(–1, –1)
0	(0, –1)
1	(1, –1)
2	(2, –1)
3	(3, –1)



$y = -1$

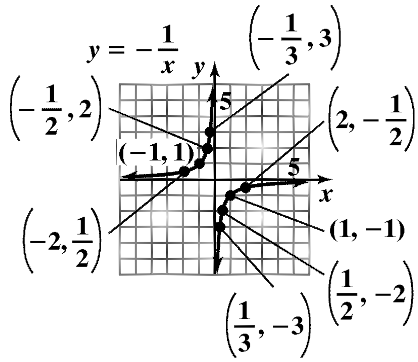
53.

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, 20% of seniors used marijuana in 2005.

b. 2005 is 25 years after 1980.
$M = -0.3n + 27$
$M = -0.3(25) + 27 = 19.5$
According to formula, 19.5% of seniors used marijuana in 2005. This underestimates the value in the graph by 0.5%.

c. According to the line graph, about 47% of seniors used alcohol in 2005.

d. 2005 is 25 years after 1980.
$A = -0.9n + 69$
$A = -0.9(25) + 69 = 46.5$
According to formula, 46.5% of seniors used alcohol in 2005. It is less than the estimate, although answers may vary.

e. The minimum for marijuana was reached in 1990.
According to the line graph, about 14% of seniors used marijuana in 1990.

56. **a.** According to the line graph, 50% of seniors used alcohol in 2000.

b. 2000 is 20 years after 1980.
$A = -0.9n + 69$
$A = -0.9(20) + 69 = 51$
According to formula, 51% of seniors used alcohol in 2000. This overestimates the value in the graph by 1%.

c. According to the line graph, about 22% of seniors used marijuana in 2000.

d. 2000 is 20 years after 1980.
$M = -0.3n + 27$
$M = -0.3(20) + 27 = 21$
According to formula, 21% of seniors used marijuana in 2000. It is less than the estimate, although answers may vary.

e. The maximum for alcohol was reached in 1980. According to the line graph, about 72% of seniors used alcohol in 1980.

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.
$$\begin{aligned} 4x+5&=29 \\ 4x+5-5&=29-5 \\ 4x&=24 \\ \frac{4x}{4}&=\frac{24}{4} \\ x&=6 \end{aligned}$$

Check:
$$\begin{aligned} 4x+5&=29 \\ 4(6)+5&=29 \\ 24+5&=29 \\ 29&=29 \text{ true} \end{aligned}$$

The solution set is $\{6\}$.

2.
$$\begin{aligned} 4(2x+1)-29&=3(2x-5) \\ 8x+4-29&=6x-15 \\ 8x-25&=6x-15 \\ 8x-25-6x&=6x-15-6x \\ 2x-25&=-15 \\ 2x-25+25&=-15+25 \\ 2x&=10 \\ \frac{2x}{2}&=\frac{10}{2} \\ x&=5 \end{aligned}$$

Check:
$$\begin{aligned} 4(2x+1)-29&=3(2x-5) \\ 4[2(5)+1]-29&=3[2(5)-5] \\ 4[10+1]-29&=3[10-5] \\ 4[11]-29&=3[5] \\ 44-29&=15 \\ 15&=15 \text{ true} \end{aligned}$$

The solution set is $\{5\}$.

3.
$$\begin{aligned} \frac{x-3}{4}&=\frac{5}{14}-\frac{x+5}{7} \\ 28\cdot\frac{x-3}{4}&=28\left(\frac{5}{14}-\frac{x+5}{7}\right) \\ 7(x-3)&=2(5)-4(x+5) \\ 7x-21&=10-4x-20 \\ 7x-21&=-4x-10 \\ 7x+4x&=-10+21 \\ 11x&=11 \\ \frac{11x}{11}&=\frac{11}{11} \\ x&=1 \end{aligned}$$

Check:
$$\begin{aligned} \frac{x-3}{4}&=\frac{5}{14}-\frac{x+5}{7} \\ \frac{1-3}{4}&=\frac{5}{14}-\frac{1+5}{7} \\ \frac{-2}{4}&=\frac{5}{14}-\frac{6}{7} \\ -\frac{1}{2}&=-\frac{1}{2} \end{aligned}$$

The solution set is $\{1\}$.

4.
$$\begin{aligned} \frac{5}{2x}&=\frac{17}{18}-\frac{1}{3x},\ x\neq 0 \\ 18x\cdot\frac{5}{2x}&=18x\left(\frac{17}{18}-\frac{1}{3x}\right) \\ 18\cdot\frac{5}{2x}&=18x\cdot\frac{17}{18}-18x\cdot\frac{1}{3x} \\ 45&=17x-6 \\ 45+6&=17x-6+6 \\ 51&=17x \\ \frac{51}{17}&=\frac{17x}{17} \\ 3&=x \end{aligned}$$

The solution set is $\{3\}$.

5.
$$\frac{x}{x-2}=\frac{2}{x-2}-\frac{2}{3}, \quad x\neq 2$$
$$3(x-2)\cdot\frac{x}{x-2}=3(x-2)\left[\frac{2}{x-2}-\frac{2}{3}\right]$$
$$3(x-2)\cdot\frac{x}{x-2}=(3x-2)\cdot\frac{2}{x-2}-3(x-2)\cdot\frac{2}{3}$$
$$3x=6-(x-2)\cdot 2$$
$$3x=6-2(x-2)$$
$$3x=6-2x+4$$
$$3x=10-2x$$
$$3x+2x=10-2x+2x$$
$$5x=10$$
$$\frac{5x}{5}=\frac{10}{5}$$
$$x=2$$
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.
$$4x-7=4(x-1)+3$$
$$7x+9=9(x+1)-2x$$
$$7x+9=9x+9-2x$$
$$7x+9=7x+9$$
$$9=9$$
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 $\{x|x \text{ is a real number}\}$.

9.
$$D=\frac{10}{9}x+\frac{53}{9}$$
$$10=\frac{10}{9}x+\frac{53}{9}$$
$$9\cdot 10=9\left(\frac{10}{9}x+\frac{53}{9}\right)$$
$$90=10x+53$$
$$90-53=10x+53-53$$
$$37=10x$$
$$\frac{37}{10}=\frac{10x}{10}$$
$$3.7=x$$
$$x=3.7$$
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. $$\begin{aligned} 25-[2+5y-3(y+2)) &= -3(2y-5)-[5(y-1)-3y+3] \\ 25-[2+5y-3y-6] &= -6y+15-[5y-5-3y+3] \\ 25-[2y-4] &= -6y+15-[2y-2] \\ 25-2y+4 &= -6y+15-2y+2 \\ -2y+29 &= -8y+17 \\ 6y &= -12 \\ y &= -2 \end{aligned}$$

The solution set is {–2}.

Check:

$$\begin{aligned} 25-[2+5y-3(y+2)) &= -3(2y-5)-[5(y-1)-3y+3] \\ 25-[2+5(-2)-3(-2+2)) &= -3[2(-2)-5]-[5(-2-1)-3(-2)+3] \\ 25-[2-10-3(0)] &= -3[-4-5]-[5(-3)+6+3] \\ 25-[-8] &= -3(-9)-[-15+9] \\ 25+8 &= 27-(-6) \\ 33 &= 27+6 \\ 33 &= 33 \end{aligned}$$

16. $$\begin{aligned} 45-[4-2y-4(y+7)] &= -4(1+3y)-[4-3(y+2)-2(2y-5)] \\ 45-[4-2y-4y-28] &= -4-12y-[4-3y-6-4y+10] \\ 45-[-6y-24] &= -4-12y-[-7y+8] \\ 45+6y+24 &= -4-12y+7y-8 \\ 6y+69 &= -5y-12 \\ 11y &= -81 \\ y &= -\frac{81}{11} \end{aligned}$$

The solution set is $\left\{-\frac{81}{11}\right\}$.

17. $$\begin{aligned} \frac{x}{3} &= \frac{x}{2}-2 \\ 6\left[\frac{x}{3} \right.&=\left. \frac{x}{2}-2\right] \\ 2x &= 3x-12 \\ 12 &= 3x-2x \\ x &= 12 \end{aligned}$$

The solution set is {12}.

18. $$\begin{aligned} \frac{x}{5} &= \frac{x}{6}+1 \\ 30\left[\frac{x}{5} \right.&=\left. \frac{x}{6}+1\right] \\ 6x &= 5x+30 \\ 6x-5x &= 30 \\ x &= 30 \end{aligned}$$

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

$12\left[\frac{x}{4}=2+\frac{x-3}{3}\right]$

$3x = 24 + 4x - 12$

$3x - 4x = 12$

$-x = 12$

$x = -12$

The solution set is $\{-12\}$.

28. $5+\frac{x-2}{3}=\frac{x+3}{8}$

$24\left[5+\frac{x-2}{3}=\frac{x+3}{8}\right]$

$120+8x-16=3x+9$

$8x-3x=9-104$

$5x=-95$

$x=-19$

The solution set is $\{-19\}$.

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

$21\left[\frac{x+1}{3}=5-\frac{x+2}{7}\right]$

$7x + 7 = 105 - 3x - 6$

$7x + 3x = 99 - 7$

$10x = 92$

$x=\frac{92}{10}$

$x=\frac{46}{5}$

The solution set is $\left\{\frac{46}{5}\right\}$.

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

$30\left[\frac{3x}{5}-\frac{x-3}{2}=\frac{x+2}{3}\right]$

$18x-15x+45=10x+20$

$3x-10x=20-45$

$-7x=-25$

$x=\frac{25}{7}$

The solution set is $\left\{\frac{25}{7}\right\}$.

31. a. $\frac{4}{x}=\frac{5}{2x}+3\,(x\neq 0)$

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

$8=5+6x$

$3=6x$

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

The solution set is $\left\{\frac{1}{2}\right\}$.

32. a. $\frac{5}{x}=\frac{10}{3x}+4\,(x\neq 0)$

b. $\frac{5}{x}=\frac{10}{3x}+4$

$15=10+12x$

$5=12x$

$x=\frac{5}{12}$

The solution set is $\left\{\frac{5}{12}\right\}$.

33. a. $\frac{2}{x}+3=\frac{5}{2x}+\frac{13}{4}\,(x\neq 0)$

b. $\frac{2}{x}+3=\frac{5}{2x}+\frac{13}{4}$

$8+12x=10+13x$

$-x=2$

$x=-2$

The solution set is $\{-2\}$.

34. a. $\frac{7}{2x}-\frac{5}{3x}=\frac{22}{3}\,(x\neq 0)$

b. $\frac{7}{2x}-\frac{5}{3x}=\frac{22}{3}$

$21-10=44x$

$11=44x$

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

The solution set is $\left\{\frac{1}{4}\right\}$.

35. a. $\frac{2}{3x}+\frac{1}{4}=\frac{11}{6x}-\frac{1}{3}\,(x\neq 0)$

b.
$$\begin{aligned}\frac{2}{3x}+\frac{1}{4}&=\frac{11}{6x}-\frac{1}{3}\\ 8+3x&=22-4x\\ 7x&=14\\ x&=2\end{aligned}$$
The solution set is $\{2\}$.

36. a. $\frac{5}{2x}-\frac{8}{9}=\frac{1}{18}-\frac{1}{3x}\,(x\neq 0)$

b.
$$\begin{aligned}\frac{5}{2x}-\frac{8}{9}&=\frac{1}{18}-\frac{1}{3x}\\ 45-16x&=x-6\\ -17x&=-51\\ x&=3\end{aligned}$$
The solution set is $\{3\}$.

37. a. $\frac{x-2}{2x}+1=\frac{x+1}{x}\quad(x\neq 0)$

b.
$$\begin{aligned}\frac{x-2}{2x}+1&=\frac{x+1}{x}\\ x-2+2x&=2x+2\\ x-2&=2\\ x&=4\end{aligned}$$
The solution set is $\{4\}$.

38. a. $\frac{4}{x}=\frac{9}{5}-\frac{7x-4}{5x}\quad(x\neq 0)$

b.
$$\begin{aligned}\frac{4}{x}&=\frac{9}{5}-\frac{7x-4}{5x}\\ 20&=9x-7x+4\\ 16&=2x\\ 8&=x\end{aligned}$$
The solution set is $\{8\}$.

39. a. $\frac{1}{x-1}+5=\frac{11}{x-1}\,(x\neq 1)$

b.
$$\begin{aligned}\frac{1}{x-1}+5&=\frac{11}{x-1}\\ 1+5(x-1)&=11\\ 1+5x-5&=11\\ 5x-4&=11\\ 5x&=15\\ x&=3\end{aligned}$$
The solution set is $\{3\}$.

40. a. $\frac{3}{x+4}-7=\frac{-4}{x+4}\,(x\neq -4)$

b.
$$\begin{aligned}\frac{3}{x+4}-7&=\frac{-4}{x+4}\\ 3-7(x+4)&=-4\\ 3-7x-28&=-4\\ -7x&=21\\ x&=-3\end{aligned}$$
The solution set is $\{-3\}$.

41. a. $\frac{8x}{x+1}=4-\frac{8}{x+1}\,(x\neq -1)$

b.
$$\begin{aligned}\frac{8x}{x+1}&=4-\frac{8}{x+1}\\ 8x&=4(x+1)-8\\ 8x&=4x+4-8\\ 4x&=-4\\ x&=-1\Rightarrow \text{ no solution}\end{aligned}$$
The solution set is the empty set, $\varnothing$.

42. a. $\frac{2}{x-2}=\frac{x}{x-2}-2\,(x\neq 2)$

b.
$$\begin{aligned}\frac{2}{x-2}&=\frac{x}{x-2}-2\\ 2&=x-2(x-2)\\ 2&=x-2x+4\\ x&=2\Rightarrow \text{ no solution}\end{aligned}$$
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.
$$\begin{aligned}\frac{3}{2x-2}+\frac{1}{2}&=\frac{2}{x-1}\\ \frac{3}{2(x-1)}+\frac{1}{2}&=\frac{2}{x-1}\\ 3+1(x-1)&=4\\ 3+x-1&=4\\ x&=2\end{aligned}$$
The solution set is $\{2\}$.

44. **a.** $\frac{3}{x+3}=\frac{5}{2x+6}+\frac{1}{x-2}\ (x\neq -3,\ x\neq 2)$

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.** $\frac{3}{x+2}+\frac{2}{x-2}=\frac{8}{(x+2)(x-2)};(x\neq -2,2)$

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.** $\frac{5}{x+2}+\frac{3}{x-2}=\frac{12}{(x+2)(x-2)}$
$$(x\neq 2,\ x\neq -2)$$

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.** $\frac{2}{x+1}-\frac{1}{x-1}=\frac{2x}{x^2-1}\ (x\neq 1,\ x\neq -1)$

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.** $\frac{4}{x+5}+\frac{2}{x-5}=\frac{32}{x^2-25};\ x\neq 5,-5$

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.** $\frac{1}{x-4}-\frac{5}{x+2}=\frac{6}{(x-4)(x+2)};(x\neq -2,4)$

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.** $\frac{6}{x+3}-\frac{5}{x-2}=\frac{-20}{x^2+x-6};\ x\neq -3,2$

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 $y_1 = y_2$.

$$\begin{aligned} 7(3x-2)+5 &= 6(2x-1)+24 \\ 21x-14+5 &= 12x-6+24 \\ 21x-9 &= 12x+18 \\ 21x-12x &= 18+9 \\ 9x &= 27 \\ x &= 3 \end{aligned}$$

The solution set is {3}.

53. Set $y_1 - y_2 = 1$.

$$\begin{aligned} \frac{x-3}{5}-\frac{x-5}{4} &= 1 \\ 20\cdot\frac{x-3}{5}-20\cdot\frac{x-5}{4} &= 20\cdot 1 \\ 4(x-3)-5(x-5) &= 20 \\ 4x-12-5x+25 &= 20 \\ -x+13 &= 20 \\ -x &= 7 \\ x &= -7 \end{aligned}$$

The solution set is {–7}.

54. Set $y_1 - y_2 = -4$.

$$\begin{aligned} \frac{x+1}{4}-\frac{x-2}{3} &= -4 \\ 12\cdot\frac{x+1}{4}-12\cdot\frac{x-2}{3} &= 12(-4) \\ 3(x+1)-4(x-2) &= -48 \\ 3x+3-4x+8 &= -48 \\ -x+11 &= -48 \\ -x &= -59 \\ x &= 59 \end{aligned}$$

The solution set is {59}.

55. Set $y_1 + y_2 = y_3$.

$$\begin{aligned} \frac{5}{x+4}+\frac{3}{x+3} &= \frac{12x+19}{x^2+7x+12} \\ \frac{5}{x+4}+\frac{3}{x+3} &= \frac{12x+19}{(x+4)(x+3)} \\ (x+4)(x+3)\left(\frac{5}{x+4}+\frac{3}{x+3}\right) &= (x+4)(x+3)\frac{12x+19}{(x+4)(x+3)} \\ 5(x+3)+3(x+4) &= 12x+19 \\ 5x+15+3x+12 &= 12x+19 \\ 8x+27 &= 12x+19 \\ -4x &= -8 \\ x &= 2 \end{aligned}$$

The solution set is {2}.

56. Set $y_1 + y_2 = y_3$.

$$\begin{aligned} \frac{2x-1}{x^2+2x-8}+\frac{2}{x+4} &= \frac{1}{x-2} \\ \frac{2x-1}{(x+4)(x-2)}+\frac{2}{x+4} &= \frac{1}{x-2} \\ (x+4)(x-2)\left(\frac{2x-1}{(x+4)(x-2)}+\frac{2}{x+4}\right) &= (x+4)(x-2)\frac{1}{x-2} \\ 2x-1+2(x-2) &= x+4 \\ 2x-1+2x-4 &= x+4 \\ 4x-5 &= x+4 \\ 3x &= 9 \\ x &= 3 \end{aligned}$$

The solution set is {3}.

57.

$$\begin{aligned} 0 &= 4[x-(3-x)]-7(x+1) \\ 0 &= 4[x-3+x]-7x-7 \\ 0 &= 4[2x-3]-7x-7 \\ 0 &= 8x-12-7x-7 \\ 0 &= x-19 \\ -x &= -19 \\ x &= 19 \end{aligned}$$

The solution set is {19}.

58.

$$\begin{aligned} 0 &= 2[3x-(4x-6)]-5(x-6) \\ 0 &= 2[3x-4x+6]-5x+30 \\ 0 &= 2[-x+6]-5x+30 \\ 0 &= -2x+12-5x+30 \\ 0 &= -7x+42 \\ 7x &= 42 \\ x &= 6 \end{aligned}$$

The solution set is {6}.

59.

$$\begin{aligned} 0 &= \frac{x+6}{3x-12}-\frac{5}{x-4}-\frac{2}{3} \\ 0 &= \frac{x+6}{3(x-4)}-\frac{5}{x-4}-\frac{2}{3} \\ 3(x-4)\cdot 0 &= 3(x-4)\left(\frac{x+6}{3(x-4)}-\frac{5}{x-4}-\frac{2}{3}\right) \\ 0 &= \frac{3(x-4)(x+6)}{3(x-4)}-\frac{5\cdot 3(x-4)}{x-4}-\frac{2\cdot 3(x-4)}{3} \\ 0 &= (x+6)-15-2(x-4) \\ 0 &= x+6-15-2x+8 \\ 0 &= -x-1 \\ x &= -1 \end{aligned}$$

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 $\{x | x \text{ is a real number}\}$.

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 $\{x | x \text{ is a real number}\}$.

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

$$2x = 6 + 4(x-3)$$
$$2x = 6 + 4x - 12$$
$$-2x = -6$$
$$x = 3 \Rightarrow \text{ no solution}$$

The given equation is an inconsistent equation.

68. $\frac{3}{x-3} = \frac{x}{x-3} + 3$

$$3 = x + 3(x-3)$$
$$3 = x + 3x - 9$$
$$-4x = -12$$
$$x = 3 \Rightarrow \text{ no solution}$$

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. $\frac{2}{x-2}=3+\frac{x}{x-2}$
$2=3(x-2)+x$
$2=3x-6+x$
$-4x=-8$
$x=2 \Rightarrow$ no solution
The solution set is the empty set, $\varnothing$.
The given equation is an inconsistent equation.

72. $\frac{6}{x+3}+2=\frac{-2x}{x+3}$
$6+2(x+3)=-2x$
$6+2x+6=-2x$
$4x=-12$
$x=-3 \Rightarrow$ 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. $\frac{2}{x}+\frac{1}{2}=\frac{3}{4}$
$8+2x=3x$
$-x=-8$
$x=8$
The solution set is $\{8\}$.
The given equation is a conditional equation.

76. $\frac{3}{x}-\frac{1}{6}=\frac{1}{3}$
$18-x=2x$
$-3x=-18$
$x=6$
The solution set is $\{6\}$.
The given equation is a conditional equation.

77. $\frac{4}{x-2}+\frac{3}{x+5}=\frac{7}{(x+5)(x-2)}$
$4(x+5)+3(x-2)=7$
$4x+20+3x-6=7$
$7x=-7$
$x=-1$
The solution set is $\{-1\}$.
The given equation is a conditional equation.

78. $\frac{1}{x-1}=\frac{1}{(2x+3)(x-1)}+\frac{4}{2x+3}$
$1(2x+3)=1+4(x-1)$
$2x+3=1+4x-4$
$-2x=-6$
$x=3$
The solution set is $\{3\}$.
The given equation is a conditional equation.

79. $\frac{4x}{x+3}-\frac{12}{x-3}=\frac{4x^2+36}{x^2-9}; x\neq 3,-3$
$4x(x-3)-12(x+3)=4x^2+36$
$4x^2-12x-12x-36=4x^2+36$
$4x^2-24x-36=4x^2+36$
$-24x-36=36$
$-24x=72$
$x=-3$ 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: $4(x-2)+2=4x-2(2-x)$

$$\begin{aligned} 4x-8+2&=4x-4+2x \\ 4x-6&=6x-4 \\ -2x-6&=-4 \\ -2x&=2 \\ x&=-1 \end{aligned}$$

Now, evaluate x^2-x for $x=-1$:

$$\begin{aligned} x^2-x&=(-1)^2-(-1) \\ &=1-(-1)=1+1=2 \end{aligned}$$

86. Solve: $2(x-6)=3x+2(2x-1)$

$$\begin{aligned} 2x-12&=3x+4x-2 \\ 2x-12&=7x-2 \\ -5x-12&=-2 \\ -5x&=10 \\ x&=-2 \end{aligned}$$

Now, evaluate x^2-x for $x=-2$:

$$\begin{aligned} x^2-x&=(-2)^2-(-2) \\ &=4-(-2)=4+2=6 \end{aligned}$$

87. Solve for x: $\dfrac{3(x+3)}{5}=2x+6$

$$\begin{aligned}3(x+3)&=5(2x+6)\\3x+9&=10x+30\\-7x+9&=30\\-7x&=21\\x&=-3\end{aligned}$$

Solve for y: $-2y-10=5y+18$

$$\begin{aligned}-7y-10&=18\\-7y&=28\\y&=-4\end{aligned}$$

Now, evaluate $x^2-(xy-y)$ for $x=-3$ and $y=-4$:

$$\begin{aligned}&x^2-(xy-y)\\&=(-3)^2-[-3(-4)-(-4)]\\&=(-3)^2-[12-(-4)]\\&=9-(12+4)=9-16=-7\end{aligned}$$

88. Solve for x: $\dfrac{13x-6}{4}=5x+2$

$$\begin{aligned}13x-6&=4(5x+2)\\13x-6&=20x+8\\-7x-6&=8\\-7x&=14\\x&=-2\end{aligned}$$

Solve for y: $5-y=7(y+4)+1$

$$\begin{aligned}5-y&=7y+28+1\\5-y&=7y+29\\5-8y&=29\\-8y&=24\\y&=-3\end{aligned}$$

Now, evaluate $x^2-(xy-y)$ for $x=-2$ and $y=-3$:

$$\begin{aligned}&x^2-(xy-y)\\&=(-2)^2-[-2(-3)-(-3)]\\&=(-2)^2-[6-(-3)]\\&=4-(6+3)=4-9=-5\end{aligned}$$

89. $\left[(3+6)^2\div 3\right]\cdot 4=-54x$

$$\begin{aligned}\left(9^2\div 3\right)\cdot 4&=-54x\\(81\div 3)\cdot 4&=-54x\\27\cdot 4&=-54x\\108&=-54x\\-2&=x\end{aligned}$$

The solution set is $\{-2\}$.

90. $2^3-\left[4(5-3)^3\right]=-8x$

$$\begin{aligned}8-\left[4(2)^3\right]&=-8x\\8-4\cdot 8&=-8x\\8-32&=-8x\\-24&=-8x\\3&=x\end{aligned}$$

The solution set is $\{3\}$.

91. $5-12x=8-7x-\left[6\div 3\left(2+5^3\right)+5x\right]$

$$\begin{aligned}5-12x&=8-7x-\left[6\div 3(2+125)+5x\right]\\5-12x&=8-7x-[6\div 3\cdot 127+5x]\\5-12x&=8-7x-[2\cdot 127+5x]\\5-12x&=8-7x-[254+5x]\\5-12x&=8-7x-254-5x\\5-12x&=-12x-246\\5&=-246\end{aligned}$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

92. $2(5x+58)=10x+4(21\div 3.5-11)$

$$\begin{aligned}10x+116&=10x+4(6-11)\\10x+116&=10x+4(-5)\\10x+116&=10x-20\\116&=-20\end{aligned}$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

93. $0.7x+0.4(20)=0.5(x+20)$

$$\begin{aligned}0.7x+8&=0.5x+10\\0.2x+8&=10\\0.2x&=2\\x&=10\end{aligned}$$

The solution set is $\{10\}$.

94. $0.5(x+2)=0.1+3(0.1x+0.3)$
$$\begin{aligned} 0.5x+1&=0.1+0.3x+0.9\\ 0.5x+1&=0.3x+1\\ 0.2x+1&=1\\ 0.2x&=0\\ x&=0 \end{aligned}$$
The solution set is $\{0\}$.

95. $4x+13-\{2x-[4(x-3)-5]\}=2(x-6)$
$$\begin{aligned} 4x+13-\{2x-[4x-12-5]\}&=2x-12\\ 4x+13-\{2x-[4x-17]\}&=2x-12\\ 4x+13-\{2x-4x+17\}&=2x-12\\ 4x+13-\{-2x+17\}&=2x-12\\ 4x+13+2x-17&=2x-12\\ 6x-4&=2x-12\\ 4x-4&=-12\\ 4x&=-8\\ x&=-2 \end{aligned}$$
The solution set is $\{-2\}$.

96. $-2\{7-[4-2(1-x)+3]\}=10-[4x-2(x-3)]$
$$\begin{aligned} -2\{7-[4-2+2x+3]\}&=10-[4x-2x+6]\\ -2\{7-[2x+5]\}&=10-[2x+6]\\ -2\{7-2x-5\}&=10-2x-6\\ -2\{-2x+2\}&=-2x+4\\ 4x-4&=-2x+4\\ 6x-4&=4\\ 6x&=8\\ x&=\frac{8}{6}=\frac{4}{3} \end{aligned}$$
The solution set is $\left\{\frac{4}{3}\right\}$.

97. a.
$$\begin{aligned} p+\frac{x}{2}&=37\\ p+\frac{40}{2}&=37\\ p+20&=37\\ p&=17 \end{aligned}$$
According to the model, 17% of American adults smoked cigarettes in 2010. This underestimates the value shown in the bar graph by 2%.

b.
$$\begin{aligned} p+\frac{x}{2}&=37\\ 7+\frac{x}{2}&=37\\ \frac{x}{2}&=30\\ x&=60 \end{aligned}$$
According to the model, only 7% of American adults will smoke cigarettes 60 years after 1970, or 2030.

98. a.
$$\begin{aligned} p+\frac{x}{2}&=37\\ p+\frac{30}{2}&=37\\ p+15&=37\\ p&=22 \end{aligned}$$
According to the model, 22% of American adults smoked cigarettes in 2000. This underestimates the value shown in the bar graph by 1%.

b.
$$\begin{aligned} p+\frac{x}{2}&=37\\ 2+\frac{x}{2}&=37\\ \frac{x}{2}&=35\\ x&=70 \end{aligned}$$
According to the model, only 2% of American adults will smoke cigarettes 70 years after 1970, or 2040.

99. a. What cost \$10,000 in 1967 would cost about \$52,000 in 2000.

b.
$$\begin{aligned} C&=1388x+24,963\\ &=1388(20)+24,963\\ &=52,723 \end{aligned}$$
According to Model 1, what cost \$10,000 in 1967 would cost about \$52,723 in 2000. This describes the estimate from part (a) reasonably well.

c.
$$\begin{aligned} C&=3x^2+1308x+25,268\\ &=3(20)^2+1308(20)+25,268\\ &=52,628 \end{aligned}$$
According to Model 2, what cost \$10,000 in 1967 would cost about \$52,628 in 2000. This describes the estimate from part (a) reasonably well.

100. **a.** What cost \$10,000 in 1967 would cost about \$52,000 in 1990.

b.
$$\begin{aligned} C &= 1388x + 24{,}963 \\ &= 1388(10) + 24{,}963 \\ &= 38{,}843 \end{aligned}$$

According to Model 1, what cost \$10,000 in 1967 would cost about \$38,843 in 1990. This describes the estimate from part (a) reasonably well.

c.
$$\begin{aligned} C &= 3x^2 + 1308x + 25{,}268 \\ &= 3(10)^2 + 1308(10) + 25{,}268 \\ &= 38{,}648 \end{aligned}$$

According to Model 2, what cost \$10,000 in 1967 would cost about \$38,648 in 1990. This describes the estimate from part (a) reasonably well.

101.
$$\begin{aligned} C &= 1388x + 24{,}963 \\ 77{,}707 &= 1388x + 24{,}963 \\ 52{,}744 &= 1388x \\ 38 &= x \end{aligned}$$

Model 1 predicts the cost will be \$77,707 38 years after 1980, or 2018.

102.
$$\begin{aligned} C &= 1388x + 24{,}963 \\ 80{,}483 &= 1388x + 24{,}963 \\ 55{,}520 &= 1388x \\ 40 &= x \end{aligned}$$

Model 1 predicts the cost will be \$80,483 40 years after 1980, or 2020.

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.
$$\begin{aligned} C &= \frac{x + 0.1(500)}{x + 500} \\ 0.28 &= \frac{x + 0.1(500)}{x + 500} \\ 0.28(x + 500) &= x + 0.1(500) \\ 0.28x + 140 &= x + 50 \\ -0.72x &= -90 \\ \frac{-0.72x}{-0.72} &= \frac{-90}{-0.72} \\ x &= 125 \end{aligned}$$

125 liters of pure peroxide must be added.

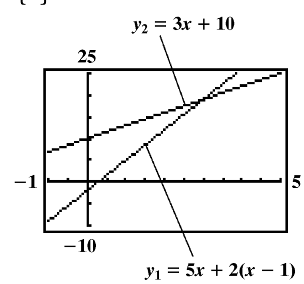
106. **a.** $C = \dfrac{x + 0.35(200)}{x + 200}$

b.
$$\begin{aligned} 0.74 &= \frac{x + 0.35(200)}{x + 200} \\ 0.74(x + 200) &= x + 0.35(200) \\ 0.74x + 148 &= x + 70 \\ -0.26x &= -78 \\ \frac{-0.26x}{-0.26} &= \frac{-78}{-0.26} \\ x &= 300 \end{aligned}$$

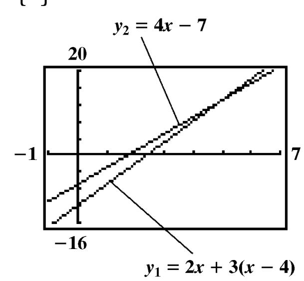
300 liters of pure acid must be added.

107. – 115. Answers will vary.

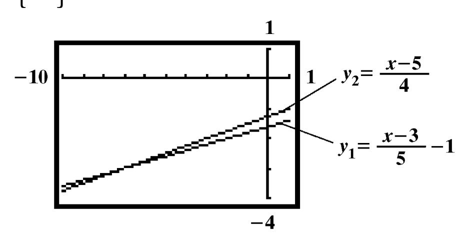
116. $\{3\}$



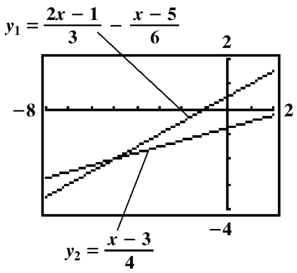
117. $\{5\}$



118. $\{-7\}$



119. $\{-5\}$



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.
$$\frac{4x-b}{x-5} = 3$$
$$4x - b = 3(x-5)$$
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 median starting salary, in thousands of dollars, of education majors.
Let $x + 21 =$ the median starting salary, in thousands of dollars, of computer science majors.
Let $x + 14 =$ the median starting salary, in thousands of dollars, of economics majors.
$$x + (x+21) + (x+14) = 140$$
$$x + x + 21 + x + 14 = 140$$
$$3x + 35 = 140$$
$$3x = 105$$
$$x = 35$$
$$x + 21 = 56$$
$$x + 14 = 49$$
The median starting salary of education majors is \$35 thousand, of computer science majors is \$56 thousand, and of economics majors is \$49 thousand.

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 text messages at which the costs of the two plans are the same.

$$\underbrace{15+0.08x}_{\text{Plan A}} = \underbrace{3+0.12x}_{\text{Plan B}}$$
$$15+0.08x-15 = 3+0.12x-15$$
$$0.08x = 0.12x-12$$
$$0.08x-0.12x = 0.12x-12-0.12x$$
$$-0.04x = -12$$
$$\frac{-0.04x}{-0.04} = \frac{-12}{-0.04}$$
$$x = 300$$

The two plans are the same at 300 text messages.

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

$$5x-4 = 26$$
$$5x = 30$$
$$x = 6$$

The number is 6.

2. Let x = the number

$$2x-3 = 11$$
$$2x = 14$$
$$x = 7$$

The number is 7.

3. Let x = the number
$$x - 0.20x = 20$$
$$0.80x = 20$$
$$x = 25$$
The number is 25.

4. Let x = the number
$$x - 0.30x = 28$$
$$0.70x = 28$$
$$x = 40$$
The number is 40.

5. Let x = the number
$$0.60x + x = 192$$
$$1.6x = 192$$
$$x = 120$$
The number is 120.

6. Let x = the number
$$0.80x + x = 252$$
$$1.8x = 252$$
$$x = 140$$
The number is 140.

7. Let x = the number
$$0.70x = 224$$
$$x = 320$$
The number is 320.

8. Let x = the number
$$0.70x = 252$$
$$x = 360$$
The number is 360.

9. Let x = the number
$x + 26$ = the other number
$$x + (x + 26) = 64$$
$$x + x + 26 = 64$$
$$2x + 26 = 64$$
$$2x = 38$$
$$x = 19$$
If x = 19, then $x + 26 = 45$.
The numbers are 19 and 45.

10. Let x = the number,
Let x +24 = the other number.
$$x + (x + 24) = 58$$
$$x + x + 24 = 58$$
$$2x + 24 = 58$$
$$2x = 34$$
$$x = 17$$
If x = 17, then x +24 = 41.
The numbers are 17 and 41.

11.
$$y_1 - y_2 = 2$$
$$(13x - 4) - (5x + 10) = 2$$
$$13x - 4 - 5x - 10 = 2$$
$$8x - 14 = 2$$
$$8x = 16$$
$$\frac{8x}{8} = \frac{16}{8}$$
$$x = 2$$

12.
$$y_1 - y_2 = 3$$
$$(10x + 6) - (12x - 7) = 3$$
$$10x + 6 - 12x + 7 = 3$$
$$-2x + 13 = 3$$
$$-2x = -10$$
$$\frac{-2x}{-2} = \frac{-10}{-2}$$
$$x = 5$$

13.
$$y_1 = 8y_2 + 14$$
$$10(2x - 1) = 8(2x + 1) + 14$$
$$20x - 10 = 16x + 8 + 14$$
$$20x - 10 = 16x + 22$$
$$4x = 32$$
$$\frac{4x}{4} = \frac{32}{4}$$
$$x = 8$$

14.
$$y_1 = 12y_2 - 51$$
$$9(3x - 5) = 12(3x - 1) - 51$$
$$27x - 45 = 36x - 12 - 51$$
$$27x - 45 = 36x - 63$$
$$-9x = -18$$
$$\frac{-9x}{-9} = \frac{-18}{-9}$$
$$x = 2$$

15.
$$3y_1 - 5y_2 = y_3 - 22$$
$$3(2x + 6) - 5(x + 8) = (x) - 22$$
$$6x + 18 - 5x - 40 = x - 22$$
$$x - 22 = x - 22$$
$$x - x = -22 + 22$$
$$0 = 0$$
The solution set is the set of all real numbers.

16.
$$\begin{aligned} 2y_1 - 3y_2 &= 4y_3 - 8 \\ 2(2.5) - 3(2x+1) &= 4(x) - 8 \\ 5 - 6x - 3 &= 4x - 8 \\ -6x + 2 &= 4x - 8 \\ -10x &= -10 \\ \frac{-10x}{-10} &= \frac{-10}{-10} \\ x &= 1 \end{aligned}$$

17.
$$\begin{aligned} 3y_1 + 4y_2 &= 4y_3 \\ 3\left(\frac{1}{x}\right) + 4\left(\frac{1}{2x}\right) &= 4\left(\frac{1}{x-1}\right) \\ \frac{3}{x} + \frac{2}{x} &= \frac{4}{x-1} \\ \frac{5}{x} &= \frac{4}{x-1} \\ \frac{5x(x-1)}{x} &= \frac{4x(x-1)}{x-1} \\ 5(x-1) &= 4x \\ 5x - 5 &= 4x \\ x &= 5 \end{aligned}$$

18.
$$\begin{aligned} 6y_1 - 3y_2 &= 7y_3 \\ 6\left(\frac{1}{x}\right) - 3\left(\frac{1}{x^2-x}\right) &= 7\left(\frac{1}{x-1}\right) \\ \frac{6}{x} - \frac{3}{x^2-x} &= \frac{7}{x-1} \\ \frac{6}{x} - \frac{3}{x(x-1)} &= \frac{7}{x-1} \\ x(x-1)\left(\frac{6}{x} - \frac{3}{x(x-1)}\right) &= x(x-1)\frac{7}{x-1} \\ \frac{6x(x-1)}{x} - \frac{3x(x-1)}{x(x-1)} &= \frac{7x(x-1)}{x-1} \\ 6(x-1) - 3 &= 7x \\ 6x - 6 - 3 &= 7x \\ 6x - 9 &= 7x \\ 6x - 7x &= 9 \\ -x &= 9 \\ \frac{-x}{-1} &= \frac{9}{-1} \\ x &= -9 \end{aligned}$$

19. Let $x =$ the number of years spent watching TV.
Let $x + 19 =$ the number of years spent sleeping.
$$\begin{aligned} x + (x+19) &= 37 \\ x + x + 19 &= 37 \\ 2x + 19 &= 37 \\ 2x &= 18 \\ x &= 9 \\ x + 19 &= 28 \end{aligned}$$
Americans will spend 9 years watching TV and 28 years sleeping.

20. Let $x =$ the number of years spent eating.
Let $x + 24 =$ the number of years spent sleeping.
$$\begin{aligned} x + (x+24) &= 32 \\ x + x + 24 &= 32 \\ 2x + 24 &= 32 \\ 2x &= 8 \\ x &= 4 \\ x + 24 &= 28 \end{aligned}$$
Americans will spend 4 years eating and 28 years sleeping.

21. Let $x =$ the average salary, in thousands, for an American whose final degree is a bachelor's.
Let $2x - 49 =$ the average salary, in thousands, for an American whose final degree is a master's.
$$\begin{aligned} x + (2x-49) &= 116 \\ x + 2x - 49 &= 116 \\ 3x - 49 &= 116 \\ 3x &= 165 \\ x &= 55 \\ 2x - 49 &= 61 \end{aligned}$$
The average salary for an American whose final degree is a bachelor's is \$55 thousand and for an American whose final degree is a master's is \$61 thousand.

22. Let $x =$ the average salary, in thousands, for an American whose final degree is a bachelor's.
Let $2x - 39 =$ the average salary, in thousands, for an American whose final degree is a doctorate.
$$\begin{aligned} x + (2x-39) &= 126 \\ x + 2x - 39 &= 126 \\ 3x - 39 &= 126 \\ 3x &= 165 \\ x &= 55 \\ 2x - 39 &= 71 \end{aligned}$$
The average salary for an American whose final degree is a bachelor's is \$55 thousand and for an American whose final degree is a doctorate is \$71 thousand.

23. Let x = the number of years since 2000.

$$31+2.4x=67$$
$$2.4x=67-31$$
$$2.4x=36$$
$$x=\frac{36}{2.4}$$
$$x=15$$

67% of American adults will view college education as essential 15 years after 2000, or 2015.

24. Let x = the number of years since 2000.

$$45-1.7x=11$$
$$-1.7x=11-45$$
$$-1.7x=-34$$
$$x=\frac{-34}{-1.7}$$
$$x=20$$

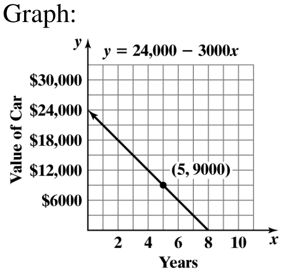
11% of American adults will believe that most qualified students get to attend college 20 years after 2000, or 2020.

25. **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:

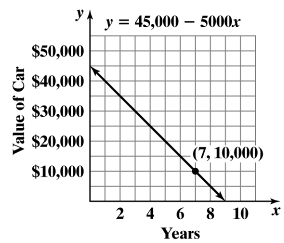


26. **a.** $y=45,000-5000x$

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:



27. 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

$$25(5)+40=30(5)+15=\$165$$

28. 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.

29. 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.

30. 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.

31. **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

$$13,300 + 1000(9)$$
$$= 26,800 - 500(9)$$
$$= 22,300 \text{ students}$$

b. Check points to determine that $y_1 = 13,300 + 1000x$ and $y_2 = 26,800 - 500x$.

32. 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.

33. Let x = the cost of the television set.

$$x - 0.20x = 336$$
$$0.80x = 336$$
$$x = 420$$

The television set's price is $420.

34. 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.

35. Let x = the nightly cost

$$x + 0.08x = 162$$
$$1.08x = 162$$
$$x = 150$$

The nightly cost is $150.

36. Let x = the nightly cost

$$x + 0.05x = 252$$
$$1.05x = 252$$
$$x = 240$$

The nightly cost is $240.

37. Let c = the dealer's cost

$$584 = c + 0.25c$$
$$584 = 1.25c$$
$$467.20 = c$$

The dealer's cost is $467.20.

38. Let c = the dealer's cost

$$15 = c + 0.25c$$
$$15 = 1.25c$$
$$12 = c$$

The dealer's cost is $12.

39. 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%.

40. 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%.

41. 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

42. 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

43. 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.

44. 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.

45. 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.

46. 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.

47. 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.

48. 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.

49. Let x = number of hours
$35x$ = labor cost
$35x + 63 = 448$
$35x = 385$
$x = 11$
It took 11 hours.

50. Let x = number of hours
$63x$ = labor cost
$63x + 532 = 1603$
$63x = 1071$
$x = 17$
17 hours were required to repair the yacht.

51. Let x = inches over 5 feet
$100 + 5x = 135$
$5x = 35$
$x = 7$
A height of 5 feet 7 inches corresponds to 135 pounds.

52. Let g = the gross amount of the paycheck
$\text{Yearly Salary} = 2(12)g + 750$
$33150 = 24g + 750$
$32400 = 24g$
$1350 = g$
The gross amount of each paycheck is $1350.

53. 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.

54. 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.

55. $A = lw$
$w = \frac{A}{l}$
area of rectangle

56. $D = RT$
$R = \frac{D}{T}$
distance, rate, time equation

57. $A = \frac{1}{2}bh$
$2A = bh$
$b = \frac{2A}{h};$
area of triangle

58. $V = \frac{1}{3}Bh$
$3V = Bh$
$B = \frac{3V}{h}$
volume of a cone

59. $I = Prt$
$P = \frac{I}{rt};$
interest

60. $C = 2\pi r$
$r = \frac{C}{2\pi};$
circumference of a circle

61. $E = mc^2$
$m = \frac{E}{c^2};$
Einstein's equation

62. $V = \pi r^2 h$
$h = \frac{V}{\pi r^2};$
volume of a cylinder

63. $T = D + pm$
$T - D = pm$
$\frac{T-D}{m} = \frac{pm}{m}$
$\frac{T-D}{m} = p$
total of payment

64. $P = C + MC$
$P - C = MC$
$\frac{P-C}{C} = M$
markup based on cost

65. $A = \frac{1}{2}h(a+b)$
$2A = h(a+b)$
$\frac{2A}{h} = a + b$
$\frac{2A}{h} - b = a$
area of trapezoid

66.
$$A=\frac{1}{2}h(a+b)$$
$$2A=h(a+b)$$
$$\frac{2A}{h}=a+b$$
$$\frac{2A}{h}-a=b$$
area of trapezoid

67.
$$S=P+Prt$$
$$S-P=Prt$$
$$\frac{S-P}{Pt}=r;$$
interest

68.
$$S=P+Prt$$
$$S-P=Prt$$
$$\frac{S-P}{Pr}=t;$$
interest

69.
$$B=\frac{F}{S-V}$$
$$B(S-V)=F$$
$$S-V=\frac{F}{B}$$
$$S=\frac{F}{B}+V$$

70.
$$S=\frac{C}{1-r}$$
$$S(1-r)=C$$
$$1-r=\frac{C}{S}$$
$$-r=\frac{C}{S}-1$$
$$r=-\frac{C}{S}+1$$
markup based on selling price

71.
$$IR+Ir=E$$
$$I(R+r)=E$$
$$I=\frac{E}{R+r}$$
electric current

72.
$$A=2lw+2lh+2wh$$
$$A-2lw=h\left(2l+2w\right)$$
$$\frac{A-2lw}{2l+2w}=h$$
surface area

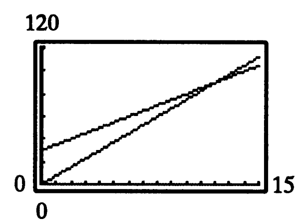
73.
$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$$
$$qf+pf=pq$$
$$f(q+p)=pq$$
$$f=\frac{pq}{p+q}$$
thin lens equation

74.
$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$$
$$R_1R_2=RR_2+RR_1$$
$$R_1R_2-RR_1=RR_2$$
$$R_1\left(R_2-R\right)=RR_2$$
$$R_1=\frac{RR_2}{R_2-R}$$
resistance

75. – 79. Answers will vary.

80. **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.

81. 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.

82. makes sense

83. 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.

84. does not make sense; Explanations will vary. Sample explanation: The correct equation is $x - 0.35x = 780$.

85.
$$\begin{aligned} 0.1x + .9(1000 - x) &= 420 \\ 0.1 + 900 - 0.9x &= 420 \\ -0.8x &= -480 \\ x &= 600 \end{aligned}$$
600 students at the north campus, 400 students at south campus.

86. Let x = original price
$x - 0.4x = 0.6x$ = price after first reduction
$0.6x - 0.4(0.6x)$ = price after second reduction
$$\begin{aligned} 0.6x - 0.24x &= 72 \\ 0.36x &= 72 \\ x &= 200 \end{aligned}$$
The original price was \$200.

87. 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.

88. Let x = correct answers
$26 - x$ = incorrect answers
$$\begin{aligned} 8x - 5(26 - x) &= 0 \\ 8x - 130 + 5x &= 0 \\ 13x - 130 &= 0 \\ 13x &= 130 \\ x &= 10 \end{aligned}$$
10 problems were solved correctly.

89. Let x = mother's amount
$2x$ = boy's amount
$\frac{x}{2}$ = girl's amount
$$\begin{aligned} x + 2x + \frac{x}{2} &= 14,000 \\ \frac{7}{2}x &= 14,000 \\ x &= \$4,000 \end{aligned}$$
The mother received \$4000, the boy received \$8000, and the girl received \$2000.

90. 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, $\frac{1}{8}x - \frac{7}{2} = 1$
$$\begin{aligned} x - 28 &= 8 \\ x &= 36 \end{aligned}$$
The thief stole 36 plants.

91.
$$\begin{aligned} V &= C - \frac{C - S}{L}N \\ VL &= CL - CN + SN \\ VL - SN &= CL - CN \\ VL - SN &= C(L - N) \\ \frac{VL - SN}{L - N} &= C \\ C &= \frac{VL - SN}{L - N} \end{aligned}$$

92. Answers will vary

93.
$$\begin{aligned} (7 - 3x)(-2 - 5x) &= -14 - 35x + 6x + 15x^2 \\ &= -14 - 29x + 15x^2 \\ &\text{or} \\ &= 15x^2 - 29x - 14 \end{aligned}$$

94. $\sqrt{18}-\sqrt{8}=\sqrt{9\cdot 2}-\sqrt{4\cdot 2}$
$=3\sqrt{2}-2\sqrt{2}$
$=\sqrt{2}$

95. $\dfrac{7+4\sqrt{2}}{2-5\sqrt{2}}\cdot\dfrac{2+5\sqrt{2}}{2+5\sqrt{2}}=\dfrac{14+35\sqrt{2}+8\sqrt{2}+40}{4+10\sqrt{2}-10\sqrt{2}-50}$
$=\dfrac{54+43\sqrt{2}}{-46}$
$=-\dfrac{54+43\sqrt{2}}{46}$

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. $\dfrac{5+4i}{4-i}=\dfrac{5+4i}{4-i}\cdot\dfrac{4+i}{4+i}$
$=\dfrac{20+5i+16i+4i^2}{16+4i-4i-i^2}$
$=\dfrac{20+21i-4}{16+1}$
$=\dfrac{16+21i}{17}$
$=\dfrac{16}{17}+\dfrac{21}{17}i$

4. **a.** $\sqrt{-27}+\sqrt{-48}=i\sqrt{27}+i\sqrt{48}$
$=i\sqrt{9\cdot 3}+i\sqrt{16\cdot 3}$
$=3i\sqrt{3}+4i\sqrt{3}$
$=7i\sqrt{3}$

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. $\left(2+7i\right)\left(2-7i\right) = 4-49i^2 = 4+49 = 53$

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. $\left(2+3i\right)^2 = 4+12i+9i^2$
$= 4+12i-9$
$= -5+12i$

20. $\left(5-2i\right)^2 = 25-20i+4i^2$
$= 25-20i-4$
$= 21-20i$

21. $\frac{2}{3-i} = \frac{2}{3-i}\cdot\frac{3+i}{3+i}$
$= \frac{2(3+i)}{9+1}$
$= \frac{2\left(3+i\right)}{10}$
$= \frac{3+i}{5}$
$= \frac{3}{5}+\frac{1}{5}i$

22. $\frac{3}{4+i} = \frac{3}{4+i}\cdot\frac{4-i}{4-i}$
$= \frac{3\left(4-i\right)}{16-i^2}$
$= \frac{3\left(4-i\right)}{17}$
$= \frac{12}{17}-\frac{3}{17}i$

23. $\frac{2i}{1+i} = \frac{2i}{1+i}\cdot\frac{1-i}{1-i} = \frac{2i-2i^2}{1+1} = \frac{2+2i}{2} = 1+i$

24. $\frac{5i}{2-i} = \frac{5i}{2-i}\cdot\frac{2+i}{2+i}$
$= \frac{10i+5i^2}{4+1}$
$= \frac{-5+10i}{5}$
$= -1+2i$

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. $\left(-2+\sqrt{-4}\right)^2=\left(-2+2i\right)^2$
$=4-8i+4i^2$
$=4-8i-4$
$=-8i$

34. $\left(-5-\sqrt{-9}\right)^2=(-5-i\sqrt{9})^2=\left(-5-3i\right)^2$
$=25+30i+9i^2$
$=25+30i-9$
$=16+30i$

35. $\left(-3-\sqrt{-7}\right)^2=\left(-3-i\sqrt{7}\right)^2$
$=9+6i\sqrt{7}+i^2\left(7\right)$
$=9-7+6i\sqrt{7}$
$=2+6i\sqrt{7}$

36. $\left(-2+\sqrt{-11}\right)^2=\left(-2+i\sqrt{11}\right)^2$
$=4-4i\sqrt{11}+i^2\left(11\right)$
$=4-11-4i\sqrt{11}$
$=-7-4i\sqrt{11}$

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. $5\sqrt{-16}+3\sqrt{-81}$
$=5\sqrt{16}\sqrt{-1}+3\sqrt{81}\sqrt{-1}$
$=5\cdot 4i+3\cdot 9i$
$=20i+27i$
$=47i$ or $0+47i$

50. $5\sqrt{-8}+3\sqrt{-18}$
$=5\sqrt{4}\sqrt{2}\sqrt{-1}+3\sqrt{9}\sqrt{2}\sqrt{-1}$
$=5\cdot 2\sqrt{2}\,i+3\cdot 3\sqrt{2}\,i$
$=10i\sqrt{2}+9i\sqrt{2}$
$=(10+9)i\sqrt{2}$
$=19i\sqrt{2}$ or $0+19i\sqrt{2}$

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:

$$\left(5+i\sqrt{15}\right)+\left(5-i\sqrt{15}\right)$$
$$=5+i\sqrt{15}+5-i\sqrt{15}$$
$$=5+5$$
$$=10$$

Product:

$$\left(5+i\sqrt{15}\right)\left(5-i\sqrt{15}\right)$$
$$=25-5i\sqrt{15}+5i\sqrt{15}-15i^2$$
$$=25+15$$
$$=40$$

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.
$$\frac{4}{(2+i)(3-i)}=\frac{4}{6-2i+3i-i^2}=\frac{4}{6+i+1}=\frac{4}{7+i}=\frac{4}{7+i}\cdot\frac{7-i}{7-i}=\frac{28-4i}{49-i^2}=\frac{28-4i}{49+1}=\frac{28-4i}{50}=\frac{28}{50}-\frac{4}{50}i=\frac{14}{25}-\frac{2}{25}i$$

76.
$$\frac{1+i}{1+2i}+\frac{1-i}{1-2i}$$
$$=\frac{(1+i)(1-2i)}{(1+2i)(1-2i)}+\frac{(1-i)(1+2i)}{(1+2i)(1-2i)}$$
$$=\frac{(1+i)(1-2i)+(1-i)(1+2i)}{(1+2i)(1-2i)}$$
$$=\frac{1-2i+i-2i^2+1+2i-i-2i^2}{1-4i^2}$$
$$=\frac{1-2i+i+2+1+2i-i+2}{1+4}$$
$$=\frac{6}{5}$$
$$=\frac{6}{5}+0i$$

77.
$$\frac{8}{1+\frac{2}{i}}=\frac{8}{\frac{i}{i}+\frac{2}{i}}=\frac{8}{\frac{2+i}{i}}=\frac{8i}{2+i}=\frac{8i}{2+i}\cdot\frac{2-i}{2-i}=\frac{16i-8i^2}{4-i^2}=\frac{16i+8}{4+1}=\frac{8+16i}{5}=\frac{8}{5}+\frac{16}{5}i$$

78. $2x^2+7x-4=(2x-1)(x+4)$

79. $x^2-6x+9=(x-3)(x-3)=(x-3)^2$

80.
$$\frac{-b-\sqrt{b^2-4ac}}{2a}=\frac{-(9)-\sqrt{(9)^2-4(2)(-5)}}{2(2)}=\frac{-9-\sqrt{81+40}}{4}=\frac{-9-\sqrt{121}}{4}=\frac{-9-11}{4}=-5$$

Section 1.5

Check Point Exercises

1. **a.** $3x^2 - 9x = 0$

$3x(x-3) = 0$

$3x = 0 \quad \text{or} \quad x - 3 = 0$

$x = 0 \qquad\qquad x = 3$

The solution set is {0, 3}.

b. $2x^2 + x = 1$

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

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

$2x - 1 = 0 \quad \text{or} \quad x + 1 = 0$

$2x = 1 \qquad\qquad x = -1$

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

The solution set is $\left\{-1, \frac{1}{2}\right\}$.

2. **a.** $3x^2 = 21$

$\frac{3x^2}{3} = \frac{21}{3}$

$x^2 = 7$

$x = \pm\sqrt{7}$

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. $2x^2+2x-1=0$

$a=2, b=2, c=-1$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-2\pm\sqrt{2^2-4(2)(-1)}}{2(2)}$$
$$=\frac{-2\pm\sqrt{4+8}}{4}$$
$$=\frac{-2\pm\sqrt{12}}{4}$$
$$=\frac{-2\pm2\sqrt{3}}{4}$$
$$=\frac{2(-1\pm\sqrt{3})}{4}$$
$$=\frac{-1\pm\sqrt{3}}{2}$$

The solution set is $\left\{\frac{-1\pm\sqrt{3}}{2}\right\}$.

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

$a=1, b=-2, c=2$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(-2)\pm\sqrt{(-2)^2-4(1)(2)}}{2(1)}$$
$$x=\frac{2\pm\sqrt{4-8}}{2}$$
$$x=\frac{2\pm\sqrt{-4}}{2}$$
$$x=\frac{2\pm2i}{2}$$
$$x=1\pm i$$

The solution set is $\{1+i, 1-i\}$.

8. **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.

9. $P=0.01A^2+0.05A+107$

$115=0.01A^2+0.05A+107$

$0=0.01A^2+0.05A-8$

$a=0.01,\quad b=0.05,\quad c=-8$

$$A=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$A=\frac{-(0.05)\pm\sqrt{(0.05)^2-4(0.01)(-8)}}{2(0.01)}$$
$$A=\frac{-0.05\pm\sqrt{0.3225}}{0.02}$$
$$A\approx\frac{-0.05+\sqrt{0.3225}}{0.02}\qquad A\approx\frac{-0.05-\sqrt{0.3225}}{0.02}$$
$$A\approx26\qquad A\approx-31$$

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.

10. Let w = the screen's width.

$$w^2+l^2=d^2$$
$$w^2+15^2=25^2$$
$$w^2+225=625$$
$$w^2=400$$
$$w=\pm\sqrt{400}$$
$$w=\pm20$$

Reject the negative value.
The width of the television is 20 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. $3x^2 - 2x = 8$

$3x^2 - 2x - 8 = 0$

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

$3x + 4 = 0 \quad \text{or} \quad x - 2 = 0$

$3x = -4$

$x = -\frac{4}{3} \quad \text{or} \quad x = 2$

The solution set is $\left\{-\frac{4}{3}, 2\right\}$.

8. $4x^2 - 13x = -3$

$4x^2 - 13x + 3 = 0$

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

$4x - 1 = 0 \quad \text{or} \quad x - 3 = 0$

$4x = 1$

$x = \frac{1}{4} \quad \text{or} \quad x = 3$

The solution set is $\left\{\frac{1}{4}, 3\right\}$.

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

$3x(x + 4) = 0$

$3x = 0 \quad \text{or} \quad x + 4 = 0$

$x = 0 \quad \text{or} \quad x = -4$

The solution set is $\{-4, 0\}$.

10. $5x^2 - 20x = 0$

$5x(x - 4) = 0$

$5x = 0 \quad \text{or} \quad x - 4 = 0$

$x = 0 \quad \text{or} \quad x = 4$

The solution set is $\{0, 4\}$.

11. $2x(x - 3) = 5x^2 - 7x$

$2x^2 - 6x - 5x^2 + 7x = 0$

$-3x^2 + x = 0$

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

$x = 0 \quad \text{or} \quad -3x + 1 = 0$

$-3x = -1$

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

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

$7 - 7x = 3x^2 - x - 2$

$7 - 7x - 3x^2 + x + 2 = 0$

$-3x^2 - 6x + 9 = 0$

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

$x + 3 = 0 \quad \text{or} \quad x - 1 = 0$

$x = -3 \quad \text{or} \quad x = 1$

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. $(x+2)^2 = 25$

$x + 2 = \pm\sqrt{25}$

$x + 2 = \pm 5$

$x = -2 \pm 5$

$x = -2 + 5$ or $x = -2 - 5$

$x = 3$ $\quad$ $x = -7$

The solution set is $\{-7, 3\}$.

22. $(x-3)^2 = 36$

$x - 3 = \pm\sqrt{36}$

$x - 3 = \pm 6$

$x = 3 \pm 6$

$x = 3 + 6$ or $x = 3 - 6$

$x = 9$ $\quad$ $x = -3$

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 $\{4 + \sqrt{5}, 4 - \sqrt{5}\}$.

24. $3(x+4)^2 = 21$

$(x+4)^2 = 7$

$x + 4 = \pm\sqrt{7}$

$x = -4 \pm \sqrt{7}$

The solution set is $\{-4 + \sqrt{7}, -4 - \sqrt{7}\}$.

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

$$4x-1 = \pm\sqrt{16} = \pm 4$$
$$4x-1 = -4 \quad \text{or} \quad 4x-1 = 4$$
$$4x = -3 \qquad 4x = 5$$
$$x = \frac{-3}{4} \quad \text{or} \quad x = \frac{5}{4}$$

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.
$$\begin{aligned} x^2 + 6x &= 7 \\ x^2 + 6x + 9 &= 7 + 9 \\ (x+3)^2 &= 16 \\ x + 3 &= \pm 4 \\ x &= -3 \pm 4 \end{aligned}$$
The solution set is {–7, 1}.

48.
$$\begin{aligned} x^2 + 6x &= -8 \\ x^2 + 6x + 9 &= -8 + 9 \\ (x+3)^2 &= 1 \\ x + 3 &= \pm 1 \\ x &= -3 \pm 1 \end{aligned}$$
The solution set is {–4, –2}.

49.
$$\begin{aligned} x^2 - 2x &= 2 \\ x^2 - 2x + 1 &= 2 + 1 \\ (x-1)^2 &= 3 \\ x - 1 &= \pm\sqrt{3} \\ x &= 1 \pm \sqrt{3} \end{aligned}$$
The solution set is $\left\{1+\sqrt{3}, 1-\sqrt{3}\right\}$.

50.
$$\begin{aligned} x^2 + 4x &= 12 \\ x^2 + 4x + 4 &= 12 + 4 \\ (x+2)^2 &= 16 \\ x + 2 &= \pm 4 \\ x &= -2 \pm 4 \end{aligned}$$
The solution set is {–6, 2}.

51.
$$\begin{aligned} x^2 - 6x - 11 &= 0 \\ x^2 - 6x &= 11 \\ x^2 - 6x + 9 &= 11 + 9 \\ (x-3)^2 &= 20 \\ x - 3 &= \pm\sqrt{20} \\ x &= 3 \pm 2\sqrt{5} \end{aligned}$$
The solution set is $\left\{3+2\sqrt{5}, 3-2\sqrt{5}\right\}$.

52.
$$\begin{aligned} x^2 - 2x - 5 &= 0 \\ x^2 - 2x &= 5 \\ x^2 - 2x + 1 &= 5 + 1 \\ (x-1)^2 &= 6 \\ x - 1 &= \pm\sqrt{6} \\ x &= 1 \pm \sqrt{6} \end{aligned}$$
The solution set is $\left\{1+\sqrt{6}, 1-\sqrt{6}\right\}$.

53.
$$\begin{aligned} x^2 + 4x + 1 &= 0 \\ x^2 + 4x &= -1 \\ x^2 + 4x + 4 &= -1 + 4 \\ (x+2)^2 &= 3 \\ x + 2 &= \pm\sqrt{3} \\ x &= -2 \pm \sqrt{3} \end{aligned}$$
The solution set is $\left\{-2+\sqrt{3}, -2-\sqrt{3}\right\}$.

54.
$$\begin{aligned}x^2+6x-5&=0\\ x^2+6x&=5\\ x^2+6x+9&=5+9\\ (x+3)^2&=14\\ x+3&=\pm\sqrt{14}\\ x&=-3\pm\sqrt{14}\end{aligned}$$
The solution set is $\left\{-3+\sqrt{14},-3-\sqrt{14}\right\}$.

55.
$$\begin{aligned}x^2-5x+6&=0\\ x^2-5x&=-6\\ x^2-5x+\frac{25}{4}&=-6+\frac{25}{4}\\ \left(x-\frac{5}{2}\right)^2&=\frac{1}{4}\\ x-\frac{5}{2}&=\pm\sqrt{\frac{1}{4}}\\ x-\frac{5}{2}&=\pm\frac{1}{2}\\ x&=\frac{5}{2}\pm\frac{1}{2}\end{aligned}$$
$x=\frac{5}{2}+\frac{1}{2}$ or $x=\frac{5}{2}-\frac{1}{2}$

$x=3$ $\quad$ $x=2$

The solution set is {2, 3}.

56.
$$\begin{aligned}x^2+7x-8&=0\\ x^2+7x&=8\\ x^2+7x+\frac{49}{4}&=8+\frac{49}{4}\\ \left(x+\frac{7}{2}\right)^2&=\frac{81}{4}\\ x+\frac{7}{2}&=\pm\sqrt{\frac{81}{4}}\\ x+\frac{7}{2}&=\pm\frac{9}{2}\\ x&=-\frac{7}{2}\pm\frac{9}{2}\end{aligned}$$
$x=-\frac{7}{2}+\frac{9}{2}$ or $x=-\frac{7}{2}-\frac{9}{2}$

$x=1$ $\quad$ $x=-8$

The solution set is {–8, 1}.

57.
$$\begin{aligned}x^2+3x-1&=0\\ x^2+3x&=1\\ x^2+3x+\frac{9}{4}&=1+\frac{9}{4}\\ \left(x+\frac{3}{2}\right)^2&=\frac{13}{4}\\ x+\frac{3}{2}&=\pm\frac{\sqrt{13}}{2}\\ x&=\frac{-3\pm\sqrt{13}}{2}\end{aligned}$$
The solution set is $\left\{\frac{-3+\sqrt{13}}{2},\frac{-3-\sqrt{13}}{2}\right\}$.

58.
$$\begin{aligned}x^2-3x-5&=0\\ x^2-3x&=5\\ x^2-3x+\frac{9}{4}&=5+\frac{9}{4}\\ \left(x-\frac{3}{2}\right)^2&=\frac{29}{4}\\ x-\frac{3}{2}&=\frac{\pm\sqrt{29}}{2}\\ x&=\frac{3\pm\sqrt{29}}{2}\end{aligned}$$
The solution set is $\left\{\frac{3+\sqrt{29}}{2},\frac{3-\sqrt{29}}{2}\right\}$.

59.
$$\begin{aligned}2x^2-7x+3&=0\\ x^2-\frac{7}{2}x+\frac{3}{2}&=0\\ x^2-\frac{7}{2}x&=\frac{-3}{2}\\ x^2-\frac{7}{2}x+\frac{49}{16}&=-\frac{3}{2}+\frac{49}{16}\\ \left(x-\frac{7}{4}\right)^2&=\frac{25}{16}\\ x-\frac{7}{4}&=\pm\frac{5}{4}\\ x&=\frac{7}{4}\pm\frac{5}{4}\end{aligned}$$
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 $\left\{\frac{5 \pm \sqrt{145}}{6}, \frac{5 - \sqrt{145}}{6}\right\}$.

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. $4x^2 = 2x + 7$

$4x^2 - 2x - 7 = 0$

$x = \dfrac{2 \pm \sqrt{(-2)^2 - 4(4)(-7)}}{2(4)}$

$x = \dfrac{2 \pm \sqrt{4 + 112}}{8}$

$x = \dfrac{2 \pm \sqrt{116}}{8}$

$x = \dfrac{2 \pm 2\sqrt{29}}{8}$

$x = \dfrac{1 \pm \sqrt{29}}{4}$

The solution set is $\left\{\dfrac{1+\sqrt{29}}{4}, \dfrac{1-\sqrt{29}}{4}\right\}$.

72. $3x^2 = 6x - 1$

$3x^2 - 6x + 1 = 0$

$x = \dfrac{6 \pm \sqrt{(-6)^2 - 4(3)(1)}}{2(3)}$

$x = \dfrac{6 \pm \sqrt{36 - 12}}{6}$

$x = \dfrac{6 \pm \sqrt{24}}{6}$

$x = \dfrac{6 \pm 2\sqrt{6}}{6}$

$x = \dfrac{3 \pm \sqrt{6}}{3}$

The solution set is $\left\{\dfrac{3+\sqrt{6}}{3}, \dfrac{3-\sqrt{6}}{3}\right\}$.

73. $x^2 - 6x + 10 = 0$

$x = \dfrac{6 \pm \sqrt{(-6)^2 - 4(1)(10)}}{2(1)}$

$x = \dfrac{6 \pm \sqrt{36 - 40}}{2}$

$x = \dfrac{6 \pm \sqrt{-4}}{2}$

$x = \dfrac{6 \pm 2i}{2}$

$x = 3 \pm i$

The solution set is $\{3+i, 3-i\}$.

74. $x^2 - 2x + 17 = 0$

$x = \dfrac{2 \pm \sqrt{(-2)^2 - 4(1)(17)}}{2(1)}$

$x = \dfrac{2 \pm \sqrt{4 - 68}}{2}$

$x = \dfrac{2 \pm \sqrt{-64}}{2}$

$x = \dfrac{2 \pm 8i}{2}$

$x = 1 \pm 4i$

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.
$$2x^2-x=1$$
$$2x^2-x-1=0$$
$$(2x+1)(x-1)=0$$
$$2x+1=0 \text{ or } x-1=0$$
$$2x=-1$$
$$x=-\frac{1}{2} \text{ or } x=1$$
The solution set is $\left\{-\frac{1}{2},1\right\}$.

84.
$$3x^2-4x=4$$
$$3x^2-4x-4=0$$
$$(3x+2)(x-2)=0$$
$$3x+2 \quad \text{or} \quad x-2=0$$
$$3x=-2$$
$$x=-\frac{2}{3} \quad \text{or} \quad x=-3$$
The solution set is $\left\{-\frac{2}{3},2\right\}$.

85.
$$5x^2+2=11x$$
$$5x^2-11x+2=0$$
$$(5x-1)(x-2)=0$$
$$5x-1=0 \text{ or } x-2=0$$
$$5x=1$$
$$x=\frac{1}{5} \text{ or } x=2$$
The solution set is $\left\{\frac{1}{5},2\right\}$.

86.
$$5x^2=6-13x$$
$$5x^2+13x-6=0$$
$$(5x-2)(x+3)=0$$
$$5x-2=0 \quad \text{or} \quad x+3$$
$$5x=2$$
$$x=\frac{2}{5} \quad \text{or} \quad x=-3$$
The solution set is $\left\{-3,\frac{2}{5}\right\}$.

87.
$$3x^2=60$$
$$x^2=20$$
$$x=\pm\sqrt{20}$$
$$x=\pm2\sqrt{5}$$
The solution set is $\left\{-2\sqrt{5},2\sqrt{5}\right\}$.

88.
$$2x^2=250$$
$$x^2=125$$
$$x=\pm\sqrt{125}$$
$$x=\pm5\sqrt{5}$$
The solution set is $\left\{-5\sqrt{5},5\sqrt{5}\right\}$.

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 $\left\{1+\sqrt{2},1-\sqrt{2}\right\}$.

90.
$$2x^2+3x=1$$
$$2x^2+3x-1=0$$
$$x=\frac{-3\pm\sqrt{3^2-4(2)(-1)}}{2(2)}$$
$$x=\frac{-3\pm\sqrt{9+8}}{4}$$
$$x=\frac{-3\pm\sqrt{17}}{4}$$
The solution set is $\left\{\frac{-3+\sqrt{17}}{4},\frac{-3-\sqrt{17}}{4}\right\}$.

91.
$$(2x+3)(x+4)=1$$
$$2x^2+8x+3x+12=1$$
$$2x^2+11x+11=0$$
$$x=\frac{-11\pm\sqrt{11^2-4(2)(11)}}{2(2)}$$
$$x=\frac{-11\pm\sqrt{121-88}}{4}$$
$$x=\frac{-11\pm\sqrt{33}}{4}$$
The solution set is $\left\{\frac{-11+\sqrt{33}}{4},\frac{-11-\sqrt{33}}{4}\right\}$.

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

$3x-4=\pm\sqrt{16}$

$3x-4=\pm4$

$3x=4\pm4$

$3x=8$ or $3x=0$

$x=\dfrac{8}{3}$ or $x=0$

The solution set is $\left\{0,\dfrac{8}{3}\right\}$.

94. $(2x+7)^2=25$

$2x+7=\pm5$

$2x=-7\pm5$

$2x=-12$ 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. $4x^2-16=0$

$4x^2=16$

$x^2=4$

$x=\pm2$

The solution set is $\{-2,2\}$.

98. $3x^2-27=0$

$3x^2=27$

$x^2=9$

$x=\pm3$

The solution set is $\{-3,3\}$.

99. $x^2-6x+13=0$

$x^2-6x=-13$

$x^2-6x+9=-13+9$

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

$x-3=\pm2i$

$x=3\pm2i$

The solution set is $\{3+2i,3-2i\}$.

100. $x^2-4x+29=0$

$x^2-4x=-29$

$x^2-4x+4=-29+4$

$(x-2)^2=-25$

$x-2=\pm5i$

$x=2\pm5i$

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 $\left\{2+i\sqrt{3},2-i\sqrt{3}\right\}$.

102. $5x^2 = 2x - 3$

$5x^2 - 2x + 3 = 0$

$x = \dfrac{2 \pm \sqrt{(-2)^2 - 4(5)(3)}}{2(5)}$

$x = \dfrac{2 \pm \sqrt{4-60}}{10}$

$x = \dfrac{2 \pm \sqrt{-56}}{10}$

$x = \dfrac{2 \pm 2i\sqrt{14}}{10}$

$x = \dfrac{1 \pm i\sqrt{14}}{5}$

The solution set is $\left\{\dfrac{1+i\sqrt{14}}{5}, \dfrac{1-i\sqrt{14}}{5}\right\}$.

103. $2x^2 - 7x = 0$

$x(2x-7) = 0$

$x = 0$ or $2x - 7 = 0$

$2x = 7$

$x = 0$ or $x = \dfrac{7}{2}$

The solution set is $\left\{0, \dfrac{7}{2}\right\}$.

104. $2x^2 + 5x = 3$

$2x^2 + 5x - 3 = 0$

$x = \dfrac{-5 \pm \sqrt{5^2 - 4(2)(-3)}}{2(2)}$

$x = \dfrac{-5 \pm \sqrt{25+24}}{4}$

$x = \dfrac{-5 \pm \sqrt{49}}{4}$

$x = \dfrac{-5 \pm 7}{4}$

$x = -3, \dfrac{1}{2}$

The solution set is $\left\{-3, \dfrac{1}{2}\right\}$.

105. $\dfrac{1}{x} + \dfrac{1}{x+2} = \dfrac{1}{3}; x \neq 0, -2$

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

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

$x = \dfrac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(-6)}}{2(1)}$

$x = \dfrac{4 \pm \sqrt{16+24}}{2}$

$x = \dfrac{4 \pm \sqrt{40}}{2}$

$x = \dfrac{4 \pm 2\sqrt{10}}{2}$

$x = 2 \pm \sqrt{10}$

The solution set is $\{2+\sqrt{10},\ 2-\sqrt{10}\}$.

106. $\dfrac{1}{x} + \dfrac{1}{x+3} = \dfrac{1}{4}; x \neq 0, -3$

$4x + 12 + 4x = x^2 + 3x$

$0 = x^2 - 5x - 12$

$x = \dfrac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(-12)}}{2(1)}$

$x = \dfrac{5 \pm \sqrt{25+48}}{2}$

$x = \dfrac{5 \pm \sqrt{73}}{2}$

The solution set is $\left\{\dfrac{5+\sqrt{73}}{2}, \dfrac{5-\sqrt{73}}{2}\right\}$.

107. $\dfrac{2x}{x-3} + \dfrac{6}{x+3} = \dfrac{-28}{x^2-9}; x \neq 3, -3$

$2x(x+3) + 6(x-3) = -28$

$2x^2 + 6x + 6x - 18 = -28$

$2x^2 + 12x + 10 = 0$

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

$(x+1)(x+5) = 0$

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. $y_1y_2=14$

$(x-1)(x+4)=14$

$x^2+3x-4=14$

$x^2+3x-18=0$

$(x+6)(x-3)=0$

$x=-6, \quad x=3$

118.
$$y_1y_2=-30$$
$$(x-3)(x+8)=-30$$
$$x^2+5x-24=-30$$
$$x^2+5x+6=0$$
$$(x+3)(x+2)=0$$
$$x=-3,\quad x=-2$$

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. $\dfrac{x-1}{x-2}+\dfrac{x}{x-3}=\dfrac{1}{x^2-5x+6}$

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

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:

$a=2 \quad b=-6 \quad c=2.$

$$x=\frac{-(-6)\pm\sqrt{(-6)^2-4(2)(2)}}{2(2)}$$
$$=\frac{6\pm\sqrt{36-16}}{4}=\frac{6\pm\sqrt{20}}{4}$$
$$=\frac{6\pm\sqrt{4\cdot 5}}{4}=\frac{6\pm 2\sqrt{5}}{4}$$
$$=\frac{3\pm\sqrt{5}}{2}$$

The solutions are $\dfrac{3\pm\sqrt{5}}{2}$, and the solution set is $\left\{\dfrac{3\pm\sqrt{5}}{2}\right\}$.

129. $\sqrt{2}x^2+3x-2\sqrt{2}=0$

Apply the quadratic formula:

$a=\sqrt{2} \quad b=3 \quad c=-2\sqrt{2}$

$$x=\frac{-3\pm\sqrt{3^2-4\left(\sqrt{2}\right)\left(-2\sqrt{2}\right)}}{2\left(\sqrt{2}\right)}$$
$$=\frac{-3\pm\sqrt{9-(-16)}}{2\sqrt{2}}$$
$$=\frac{-3\pm\sqrt{25}}{2\sqrt{2}}=\frac{-3\pm 5}{2\sqrt{2}}$$

Evaluate the expression to obtain two solutions.

$$x=\frac{-3-5}{2\sqrt{2}} \qquad \text{or} \qquad x=\frac{-3+5}{2\sqrt{2}}$$
$$=\frac{-8}{2\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}} \qquad\qquad =\frac{2}{2\sqrt{2}}\cdot\frac{\sqrt{2}}{\sqrt{2}}$$
$$=\frac{-8\sqrt{2}}{4} \qquad\qquad =\frac{2\sqrt{2}}{4}$$
$$=-2\sqrt{2} \qquad\qquad =\frac{\sqrt{2}}{2}$$

The solutions are $-2\sqrt{2}$ and $\dfrac{\sqrt{2}}{2}$, and the solution set is $\left\{-2\sqrt{2},\ \dfrac{\sqrt{2}}{2}\right\}$.

130. $\sqrt{3}x^2+6x+7\sqrt{3}=0$

Apply the quadratic formula:

$a=\sqrt{3} \quad b=6 \quad c=7\sqrt{3}$

$$x=\frac{-6\pm\sqrt{6^2-4\left(\sqrt{3}\right)\left(7\sqrt{3}\right)}}{2\left(\sqrt{3}\right)}$$
$$=\frac{-6\pm\sqrt{36-84}}{2\sqrt{3}}$$
$$=\frac{-6\pm\sqrt{-48}}{2\sqrt{3}}$$
$$=\frac{-6\pm\sqrt{16\cdot 3\cdot(-1)}}{2\sqrt{3}}$$
$$=\frac{-6\pm 4\sqrt{3}i}{2\sqrt{3}}$$
$$=\frac{-6}{2\sqrt{3}}\pm\frac{4\sqrt{3}i}{2\sqrt{3}}=-\sqrt{3}\pm 2i$$

The solutions are $-\sqrt{3}\pm 2i$, and the solution set is $\left\{-\sqrt{3}\pm 2i\right\}$.

131. $N = \dfrac{x^2 - x}{2}$

$21 = \dfrac{x^2 - x}{2}$

$42 = x^2 - x$

$0 = x^2 - x - 42$

$0 = (x+6)(x-7)$

$x + 6 = 0 \quad \text{or} \quad x - 7 = 0$

$x = -6 \qquad\qquad x = 7$

Reject the negative value.
There were 7 players.

132. $N = \dfrac{x^2 - x}{2}$

$36 = \dfrac{x^2 - x}{2}$

$72 = x^2 - x$

$0 = x^2 - x - 72$

$0 = (x+8)(x-9)$

$x + 8 = 0 \quad \text{or} \quad x - 9 = 0$

$x = -8 \qquad\qquad x = 9$

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.

$a = 0.013 \quad b = -1.19 \quad c = 25.24$

$$x = \frac{-(-1.19) \pm \sqrt{(-1.19)^2 - 4(0.013)(25.24)}}{2(0.013)}$$

$$= \frac{1.19 \pm \sqrt{1.4161 - 1.31248}}{0.026}$$

$$= \frac{1.19 \pm \sqrt{0.10362}}{0.026}$$

$$\approx \frac{1.19 \pm 0.32190}{0.026}$$

$\approx 58.15 \ \text{or} \ 33.39$

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.

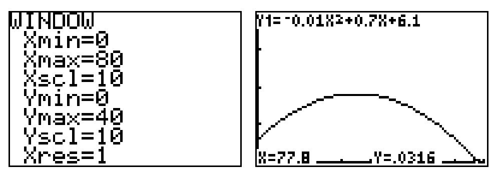
$x = \dfrac{1.19 + 0.68383}{0.026} \quad \text{or} \quad x = \dfrac{1.19 - 0.68383}{0.026}$

$x = \dfrac{1.87383}{0.026} \qquad\qquad x = \dfrac{0.50617}{0.026}$

$x \approx 72.1 \qquad\qquad x \approx 19$

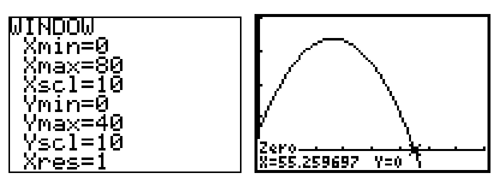
Drivers of approximately age 19 and age 72 are expected to be involved in 10 fatal crashes per 100 million miles driven. The model doesn't seem to predict the number of accidents very well. The model overestimates the number of fatal accidents.

137. Let $y_1 = -0.01x^2 + 0.7x + 6.1$



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. Let $y_1 = -0.04x^2 + 2.1x + 6.1$



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. **a.** $\dfrac{1}{\Phi - 1}$

b.
$$\frac{\Phi}{1} = \frac{1}{\Phi - 1}$$
$$(\Phi - 1)\frac{\Phi}{1} = (\Phi - 1)\frac{1}{\Phi - 1}$$
$$\Phi^2 - \Phi = 1$$
$$\Phi^2 - \Phi - 1 = 0$$
$$\Phi = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$\Phi = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-1)}}{2(1)}$$
$$\Phi = \frac{1 \pm \sqrt{1+4}}{2}$$
$$\Phi = \frac{1 \pm \sqrt{5}}{2}, \text{ reject negative}$$
$$\Phi = \frac{1 + \sqrt{5}}{2}$$

c. The golden ratio is $\dfrac{1+\sqrt{5}}{2}$ to 1.

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.
$$x^2 = 4^2 + 2^2$$
$$x^2 = 16 + 4$$
$$x^2 = 20$$
$$x = \pm\sqrt{20}$$
$$x = \pm 2\sqrt{5}$$
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.

142.
$$x^2 + 10^2 = 30^2$$
$$x^2 + 100 = 900$$
$$x^2 = 800$$
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.

143.
$$90^2 + 90^2 = x^2$$
$$8100 + 8100 = x^2$$
$$16200 = x^2$$
$$x \approx \pm 127.28$$
The distance is 127.28 feet.

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
$$\text{Area} = lw$$
$$54 = (w+3)w$$
$$54 = w^2 + 3w$$
$$0 = w^2 + 3w - 54$$
$$0 = (w+9)(w-6)$$
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. $x(20-2x)=13$

$$20x-2x^2=13$$
$$0=2x^2-20x+13$$
$$x=\frac{-(-20)\pm\sqrt{(-20)^2-4(2)(13)}}{2(2)}$$
$$x=\frac{20\pm\sqrt{296}}{4}$$
$$x=\frac{10\pm17.2}{4}$$
$$x=9.3, 0.7$$

9.3 in and 0.7 in

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

$$\frac{x^2}{16}+\frac{64-16x+x^2}{16}=2$$
$$x^2+64-16x+x^2=32$$
$$2x^2-16x+32=0$$
$$x^2-8x+16=0$$
$$(x-4)(x-4)=0$$
$$x=4 \text{ in}$$

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. $s=-16t^2+v_0t$

$$0=-16t^2+v_0t-s$$
$$a=-16,\ b=v_0,\ c=-s$$
$$t=\frac{-v_0\pm\sqrt{(v_0)^2-4(-16)(-s)}}{2(-16)}$$
$$t=\frac{-v_0\pm\sqrt{(v_0)^2-64s}}{-32}$$
$$t=\frac{v_0\pm\sqrt{v_0^{\,2}-64s}}{32}$$

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.

$$(12+2x)(8+2x)-12(8)=120$$
$$\cancel{96}+24x+16x+4x^2-\cancel{96}=120$$
$$4x^2+40x-120=0$$
$$x^2+10x-30=0$$
$$a=1 \qquad b=10 \qquad c=-30$$
$$x=\frac{-10\pm\sqrt{10^2-4(1)(-30)}}{2(1)}$$
$$=\frac{-10\pm\sqrt{100+120}}{2}$$
$$=\frac{-10\pm\sqrt{220}}{2}\approx\frac{-10\pm14.8}{2}$$

Evaluate the expression to obtain two solutions.

$$x=\frac{-10+14.8}{2} \quad \text{or} \quad x=\frac{-10-14.8}{2}$$
$$x=\frac{4.8}{2} \qquad\qquad x=\frac{-24.8}{2}$$
$$x=2.4 \qquad\qquad x=-12.4$$

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.
$$5x^{2/3} + 11x^{1/3} + 2 = 0$$
$$5(-8)^{2/3} + 11(-8)^{1/3} + 2 = 0$$
$$5(-2)^2 + 11(-2)^1 + 2 = 0$$
$$5(4) + 11(-2) + 2 = 0$$
$$20 - 22 + 2 = 0$$
$$0 = 0, \text{ true}$$
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.
$$5x^2 - 2x = 7$$
$$5x^2 - 2x - 7 = 0$$
$$(5x-7)(x+1) = 0$$
$$5x - 7 = 0 \quad \text{or} \quad x + 1 = 0$$
$$5x = 7 \qquad x = -1$$
$$x = \frac{7}{5}$$
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 $\{x \mid x \text{ is a real number}\}$.

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. $$\frac{2x}{x^2+6x+8}=\frac{x}{x+4}-\frac{2}{x+2}, \quad x\neq -2, x\neq -4$$
$$\frac{2x}{(x+4)(x+2)}=\frac{x}{x+4}-\frac{2}{x+2}$$
$$\frac{2x(x+4)(x+2)}{(x+4)(x+2)}=(x+4)(x+2)\left(\frac{x}{x+4}-\frac{2}{x+2}\right)$$
$$2x=\frac{x(x+4)(x+2)}{x+4}-\frac{2(x+4)(x+2)}{x+2}$$
$$2x=x(x+2)-2(x+4)$$
$$2x=x^2+2x-2x-8$$
$$0=x^2-2x-8$$
$$0=(x+2)(x-4)$$

$x+2=0$ or $x-4=0$

$x=-2$ $\quad$ $x=4$

–2 must be rejected.

The solution set is $\{4\}$.

13. Let $y=0$.
$$0=x^2+6x+2$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$x=\frac{-(6)\pm\sqrt{(6)^2-4(1)(2)}}{2(1)}$$
$$x=\frac{-6\pm\sqrt{28}}{2}$$
$$x=\frac{-6\pm2\sqrt{7}}{2}$$
$$x=-3\pm\sqrt{7}$$
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: $\frac{-3+\sqrt{41}}{4}$ and $\frac{-3-\sqrt{41}}{4}$.

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.
$$y_1 y_2 = 10$$
$$(2x+3)(x+2) = 10$$
$$2x^2 + 7x + 6 = 10$$
$$2x^2 + 7x - 4 = 0$$
$$(2x-1)(x+4) = 0$$
$$2x - 1 = 0 \quad \text{or} \quad x + 4 = 0$$
$$x = \frac{1}{2} \qquad x = -4$$

The solution set is $\left\{-4, \frac{1}{2}\right\}$.

20.
$$x^2 + 10x - 3 = 0$$
$$x^2 + 10x \quad = 3$$

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.
$$2x^2 + 5x + 4 = 0$$
$$a = 2 \quad b = 5 \quad c = 4$$
$$b^2 - 4ac = 5^2 - 4(2)(4)$$
$$= 25 - 32 = -7$$

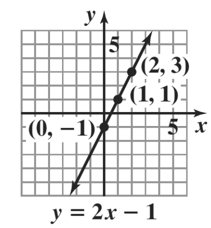
Since the discriminant is negative, there are no real solutions. There are two imaginary solutions that are complex conjugates.

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.

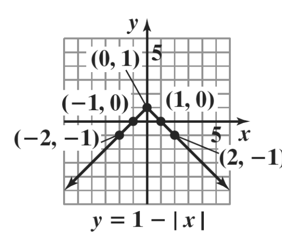
23.

x	(x, y)
−2	−5
−1	−3
0	−1
1	1
2	3



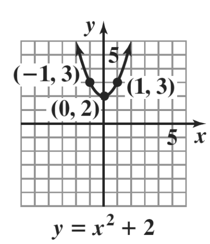
24.

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.
$$f = \frac{f_1 f_2}{f_1 + f_2}$$
$$(f_1 + f_2)(f) = (f_1 + f_2)\frac{f_1 f_2}{f_1 + f_2}$$
$$f_1 f + f_2 f = f_1 f_2$$
$$f_1 f - f_1 f_2 = -f_2 f$$
$$f_1(f - f_2) = -f_2 f$$
$$f_1 = \frac{-f_2 f}{f - f_2}$$
$$f_1 = -\frac{ff_2}{f - f_2} \text{ or } f_1 = \frac{ff_2}{f_2 - f}$$

29. Let x = the number of times "sorry" was used.
Let $x + 419 =$ the number of times "love" was used.
Let $x + 32 =$ the number of times "thanks" was used.
$$x + (x + 419) + (x + 32) = 1084$$
$$x + x + 419 + x + 32 = 1084$$
$$3x + 451 = 1084$$
$$3x = 633$$
$$x = 211$$
$$x + 419 = 630$$
$$x + 32 = 243$$
The word "sorry" was used 211 times, the word "love" was used 630 times, and the word "thanks" was used 243 times.

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 text messages.
Plan A: $C = 15 + 0.05x$
Plan B: $C = 10 + 0.075x$
Set the costs equal to each other.
$$15 + 0.05x = 10 + 0.075x$$
$$15 = 10 + 0.025x$$
$$5 = 0.025x$$
$$200 = x$$
The cost will be the same for 200 text messages.

$$C = 15 + 0.05x$$
$$C = 15 + 0.05(200)$$
$$= 25$$
The cost for 200 text messages will be \$25.

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%.

$$\begin{aligned} 0.04x - 0.03(4000 - x) &= 55 \\ 0.04x - 120 + 0.03x &= 55 \\ 0.07x - 120 &= 55 \\ 0.07x &= 175 \\ x &= \frac{175}{0.07} \\ x &= 2500 \\ 4000 - x &= 1500 \end{aligned}$$

\$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

$$\begin{aligned} 2l + 2w &= P \\ 2(2x+5) + 2x &= 46 \\ 4x + 10 + 2x &= 46 \\ 6x + 10 &= 46 \\ 6x &= 36 \\ \frac{6x}{6} &= \frac{36}{6} \\ x &= 6 \\ 2x + 5 &= 17 \end{aligned}$$

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

$$\begin{aligned} lw &= A \\ (2x-1)x &= 28 \\ 2x^2 - x &= 28 \\ 2x^2 - x - 28 &= 0 \\ (2x+7)(x-4) &= 0 \end{aligned}$$

$2x + 7 = 0$ or $x - 4 = 0$

$2x = -7$ $\qquad x = 4$

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

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

$$\begin{aligned} x^2 + 5^2 &= 13^2 \\ x^2 + 25 &= 169 \\ x^2 &= 144 \\ x &= \pm 12 \end{aligned}$$

–12 must be rejected.
The wires are attached 12 yards up the pole.

38. **a.**

$$\begin{aligned} P &= -10x^2 + 475x + 3500 \\ 5990 &= -10x^2 + 475x + 3500 \\ 0 &= -10x^2 + 475x - 2490 \\ 0 &= 2x^2 - 95x + 498 \\ 0 &= (x-6)(2x-83) \end{aligned}$$

$x - 6 = 0$ or $2x - 83 = 0$

$x = 6$ $\qquad 2x = 83$

$x = 41.5$

The population reached 5990 after 6 years.

b. This is represented by the point (6, 5990).

39.

$$\begin{aligned} P &= 0.004x^2 - 0.37x + 14.1 \\ 25 &= 0.004x^2 - 0.37x + 14.1 \\ 0 &= 0.004x^2 - 0.37x - 10.9 \end{aligned}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-0.37) \pm \sqrt{(-0.37)^2 - 4(0.004)(-10.9)}}{2(0.004)}$$

$$x = \frac{0.37 \pm \sqrt{0.1369 + 0.1744}}{0.008}$$

$x \approx 116$, $\quad x \approx -23$ (rejected)

The percentage of foreign born Americans will be 25% about 116 years after 1920, or 2036.

40. $(6 - 2i) - (7 - i) = 6 - 2i - 7 + i = -1 - i$

41. $3i(2 + i) = 6i + 3i^2 = -3 + 6i$

42.

$$\begin{aligned} (1+i)(4-3i) &= 4 - 3i + 4i - 3i^2 \\ &= 4 + i + 3 = 7 + i \end{aligned}$$

43.

$$\begin{aligned} \frac{1+i}{1-i} = \frac{1+i}{1-i} \cdot \frac{1+i}{1+i} &= \frac{1+i+i+i^2}{1-i^2} \\ &= \frac{1+2i-1}{1+1} \\ &= \frac{2i}{2} \\ &= i \end{aligned}$$

44. $\sqrt{-75} - \sqrt{-12} = 5i\sqrt{3} - 2i\sqrt{3} = 3i\sqrt{3}$

45.

$$\begin{aligned} \left(2 - \sqrt{-3}\right)^2 &= \left(2 - i\sqrt{3}\right)^2 \\ &= 4 - 4i\sqrt{3} + 3i^2 \\ &= 4 - 4i\sqrt{3} - 3 \\ &= 1 - 4i\sqrt{3} \end{aligned}$$