Chapter 1 Linear Equations and Inequalities in One Variable

Section 1.1 Practice Exercises

1. **a.** equation
b. solution
c. linear
d. first
e. solution; set
f. solution
g. conditional
h. contradiction
i. empty set; { } or Ø
j. identity

2. $-\frac{1}{2}(6x-8y+10)$
$=-\frac{1}{2}(6x)-\frac{1}{2}(-8y)-\frac{1}{2}(10)$
$=-3x+4y-5$

3. $8x-3y+2xy-5x+12xy$
$=3x-3y+14xy$

4. $5ab+5a-13-2a+17=3a+5ab+4$

5. $2(3z-4)-(z+12)=6z-8-z-12$
$=5z-20$

6. $-(6w-5)+3(4w-5)=-6w+5+12w-15$
$=6w-10$

7. $2x+1=5$
$2x-4=0$ Linear

8. $10=x+6$
$0=x-4$
$x-4=0$ Linear

9. $x^2+7=9$ Nonlinear

10. $3+x^3-x=4$ Nonlinear

11. $-3=x$
$-x-3=0$ Linear

12. $5.2-7x=0$
$-7x+5.2=0$ Linear

13. **a.** $2x-1=5$
$2(2)-1=5$
$4-1=5$
$3\neq 5$
2 is not a solution

14. **a.** $2y-3=-22(1)-3=-2$
$2-3=-2$
$-1\neq -2$
1 is not a solution.

b. $2(3)-1=5$
$6-1=5$
$5=5$
3 is a solution.

c. $2(0)-1=5$
$0-1=5$
$-1\neq 5$
0 is not a solution.

d. $2(-1)-1=5$
$-2-1=5$
$-3\neq 5$
–1 is not a solution.

b. $2\left(\frac{1}{2}\right)-3=-2$
$1-3=-2$
$-2=-2$
$\frac{1}{2}$ is a solution.

c. $2(0)-3=-2$
$0-3=-2$
$-3\neq -2$
0 is not a solution.

d. $2\left(-\frac{1}{2}\right)-3=-2$
$-1-3=-2$
$-4\neq -2$
$-\frac{1}{2}$ is not a solution.

15. $x+7=19$
$x+7-7=19-7$
$x=12$ $\{12\}$
Check: $12+7=19$
$19=19$

16. $-3+y=-28$
$-3+3+y=-28+3$
$y=-25$ $\{-25\}$
Check: $-3+(-25)=-28$
$-28=-28$

17. $-x=2$
$x=-2$ $\{-2\}$
Check: $-(-2)=2$
$2=2$

18. $-t=\frac{3}{4}$
$t=-\frac{3}{4}$ $\left\{-\frac{3}{4}\right\}$
Check: $-\left(-\frac{3}{4}\right)=\frac{3}{4}$
$\frac{3}{4}=\frac{3}{4}$

19. $-\frac{7}{8}=-\frac{5}{6}z$
$24\left(-\frac{7}{8}\right)=24\left(-\frac{5}{6}z\right)$
$-21=-20z$

20. $-\frac{12}{13}=\frac{4}{3}b$
$\frac{3}{4}\left(-\frac{12}{13}\right)=\frac{3}{4}\left(\frac{4}{3}b\right)$
$-\frac{9}{13}=b$ $\left\{-\frac{9}{13}\right\}$

$$\frac{-21}{-20}=\frac{-20z}{-20}$$

$$z=\frac{21}{20} \quad \left\{\frac{21}{20}\right\}$$

Check: $-\frac{7}{8}=-\frac{5}{6}\left(\frac{21}{20}\right)$

$$=-\frac{105}{120}$$

$$=-\frac{7}{8}$$

Check: $-\frac{12}{13}=\frac{4}{3}\left(-\frac{9}{13}\right)$

$$-\frac{12}{13}=-\frac{12}{13}$$

21. $\frac{a}{5}=-8$

$$5\left(\frac{a}{5}\right)=5(-8)$$

$$a=-40 \quad \{-40\}$$

Check: $\frac{-40}{5}=-8$

$$-8=-8$$

22. $\frac{x}{8}=\frac{1}{2}$

$$8\left(\frac{x}{8}\right)=8\left(\frac{1}{2}\right)$$

$$x=4 \quad \{4\}$$

Check: $\frac{4}{8}=\frac{1}{2}$

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

23. $2.53=-2.3t$

$$\frac{2.53}{-2.3}=\frac{-2.3t}{-2.3}$$

$$-1.1=t \quad \{-1.1\}$$

Check: $2.53=-2.3(-1.1)$

$$=2.53$$

24. $-4.8=6.1+y$

$$-4.8-6.1=6.1-6.1+y$$

$$-10.9=y \quad \{-10.9\}$$

Check: $-4.8=6.1+(-10.9)$

$$-4.8=-4.8$$

25. $p-2.9=3.8$

$$p-2.9+2.9=3.8+2.9$$

$$p=6.7 \quad \{6.7\}$$

Check: $6.7-2.9=3.8$

$$3.8=3.8$$

26. $-4.2a=4.494$

$$\frac{-4.2a}{-4.2}=\frac{4.494}{-4.2}$$

$$a=-1.07 \quad \{-1.07\}$$

Check: $-4.2(-1.07)=4.494$

$$4.494=4.494$$

27. $6q-4=62$

$6q-4+4=62+4$

$6q=66$

$\frac{6q}{6}=\frac{66}{6}$

$q=11 \quad \{11\}$

Check:

$6(11)-4=62$

$66-4=62$

$62=62$

28. $2w-15=15$

$2w-15+15=15+15$

$2w=30$

$\frac{2w}{2}=\frac{30}{2}$

$w=15 \quad \{15\}$

Check:

$2(15)-15=15$

$30-15=15$

$15=15$

29. $4y-17=35$

$4y-17+17=35+17$

$4y=52$

$\frac{4y}{4}=\frac{52}{4}$

$y=13 \quad \{13\}$

Check: $4(13)-17=35$

$52-17=35$

$35=35$

30. $6z-25=83$

$6z-25+25=83+25$

$6z=108$

$\frac{6z}{6}=\frac{108}{6}$

$z=18 \quad \{18\}$

Check: $6(18)-25=83$

$108-25=83$

$83=83$

31. $-b-5=2$

$-b-5+5=2+5$

$-b=7$

$-1(-b)=-1(7)$

$b=-7 \quad \{-7\}$

Check: $-(-7)-5=2$

$7-5=2$

$2=2$

32. $6=-y+1$

$6-1=-y+1-1$

$5=-y$

$-1(5)=-1(-y)$

$-5=y \quad \{-5\}$

Check: $6=-(-5)+1$

$6=5+1$

$6=6$

33. $3(x-6)=2x-5$

$3x-18=2x-5$

$3x-18+18=2x-5+18$

$3x=2x+13$

$3x-2x=2x-2x+13$

$x=13 \quad \{13\}$

34. $13y+4=5(y-4)$

$13y+4=5y-20$

$13y-5y+4=5y-5y-20$

$8y+4=-20$

$8y+4-4=-20-4$

$8y=-24$

Check: $3(13-6)=2(13)-5$
$3(7)=26-5$
$21=21$

$\frac{8y}{8}=\frac{-24}{8}$
$y=-3 \quad \{-3\}$
Check: $13(-3)+4=5(-3-4)$
$-39+4=5(-7)$
$-35=-35$

35. $6-(t+2)=5(3t-4)$
$6-t-2=15t-20$
$-t+4=15t-20$
$-t-15t+4=15t-15t-20$
$-16t+4=-20$
$-16t+4-4=-20-4$
$-16t=-24$
$\frac{-16t}{-16}=\frac{-24}{-16}$
$t=\frac{3}{2} \quad \left\{\frac{3}{2}\right\}$

Check: $6-\left(\frac{3}{2}+2\right)=5\left(3\cdot\frac{3}{2}-4\right)$
$6-\frac{7}{2}=5\left(\frac{9}{2}-4\right)$
$\frac{5}{2}=5\left(\frac{1}{2}\right)$
$\frac{5}{2}=\frac{5}{2}$

36. $1-5(p+2)=2(p+13)$
$1-5p-10=2p+26$
$-5p-9=2p+26$
$-5p-2p-9=2p-2p+26$
$-7p-9=26$
$-7p-9+9=26+9$
$-7p=35$
$\frac{-7p}{-7}=\frac{35}{-7}$
$p=-5 \quad \{-5\}$
Check: $1-5(-5+2)=2(-5+13)$
$1-5(-3)=2(8)$
$1+15=16$
$16=16$

37. $6(a+3)-10=-2(a-4)$
$6a+18-10=-2a+8$
$6a+8=-2a+8$
$6a+2a+8=-2a+2a+8$
$8a+8=8$
$8a+8-8=8-8$
$8a=0$
$\frac{8a}{8}=\frac{0}{8}$

38. $8(b-2)+3b=-9(b-1)$
$8b-16+3b=-9b+9$
$11b-16=-9b+9$
$11b+9b-16=-9b+9b+9$
$20b-16=9$
$20b-16+16=9+16$
$20b=25$
$\frac{20b}{20}=\frac{25}{20}$

$a = 0 \quad \{0\}$

Check: $6(0+3)-10 = -2(0-4)$

$6(3)-10 = -2(-4)$

$18-10 = 8$

$8 = 8$

$b = \frac{5}{4} \quad \left\{\frac{5}{4}\right\}$

Check: $8\left(\frac{5}{4}-2\right)+3\left(\frac{5}{4}\right) = -9\left(\frac{5}{4}-1\right)$

$8\left(-\frac{3}{4}\right)+\frac{15}{4} = -9\left(\frac{1}{4}\right)$

$-\frac{24}{4}+\frac{15}{4} = -\frac{9}{4}$

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

39. $-2\left[5-(2z+1)\right]-4 = 2(3-z)$

$-2\left[5-2z-1\right]-4 = 6-2z$

$-10+4z+2-4 = 6-2z$

$4z-12 = 6-2z$

$4z+2z-12 = 6-2z+2z$

$6z-12 = 6$

$6z-12+12 = 6+12$

$6z = 18$

$\frac{6z}{6} = \frac{18}{6}$

$z = 3 \quad \{3\}$

Check: $-2\left[5-(2\cdot 3+1)\right]-4 = 2(3-3)$

$-2\left[5-(6+1)\right]-4 = 2(0)$

$-2\left[5-7\right]-4 = 0$

$-2\left[-2\right]-4 = 0$

$4-4 = 0$

$0 = 0$

40. $3\left[w-(10-w)\right] = 7(w+1)$

$3\left[w-10+w\right] = 7w+7$

$3\left[2w-10\right] = 7w+7$

$6w-30 = 7w+7$

$6w-6w-30 = 7w-6w+7$

$-30 = w+7$

$-30-7 = w+7-7$

$-37 = w \quad \{-37\}$

Check: $3\left[-37-(10-(-37))\right] = 7(-37+1)$

$3\left[-37-47\right] = 7(-36)$

$3(-84) = -252$

$-252 = -252$

41. $6(-y+4)-3(2y-3) = -y+5+5y$

$-6y+24-6y+9 = 4y+5$

$-12y+33 = 4y+5$

$-12y+12y+33 = 4y+12y+5$

$33 = 16y+5$

$33-5 = 16y+5-5$

42. $13+4w = -5(-w-6)+2(w+1)$

$13+4w = 5w+30+2w+2$

$13+4w = 7w+32$

$13+4w-4w = 7w-4w+32$

$13 = 3w+32$

$13-32 = 3w+32-32$

$$28 = 16y$$
$$\frac{28}{16} = \frac{16y}{16}$$
$$\frac{7}{4} = y \quad \left\{\frac{7}{4}\right\}$$

Check:

$$6\left(-\frac{7}{4}+4\right)-3\left(2\cdot\frac{7}{4}-3\right) = -\frac{7}{4}+5+5\cdot\frac{7}{4}$$
$$6\left(\frac{9}{4}\right)-3\left(\frac{14}{4}-\frac{12}{4}\right) = -\frac{7}{4}+\frac{20}{4}+\frac{35}{4}$$
$$\frac{54}{4}-3\left(\frac{2}{4}\right) = \frac{48}{4}$$
$$\frac{54}{4}-\frac{6}{4} = \frac{48}{4}$$
$$\frac{48}{4} = \frac{48}{4}$$

$$-19 = 3w$$
$$\frac{-19}{3} = \frac{3w}{3}$$
$$-\frac{19}{3} = w \quad \left\{-\frac{19}{3}\right\}$$

Check:

$$13+4\left(-\frac{19}{3}\right) = -5\left(\frac{19}{3}-6\right)+2\left(-\frac{19}{3}+1\right)$$
$$13-\frac{76}{3} = -5\left(\frac{1}{3}\right)+2\left(-\frac{16}{3}\right)$$
$$\frac{39}{3}-\frac{76}{3} = -\frac{5}{3}-\frac{32}{3}$$
$$-\frac{37}{3} = -\frac{37}{3}$$

43.
$$14-2x+5x = -4(-2x-5)-6$$
$$14+3x = 8x+20-6$$
$$14+3x = 8x+14$$
$$14+3x-8x = 8x-8x+14$$
$$14-5x = 14$$
$$14-14-5x = 14-14$$
$$-5x = 0$$
$$\frac{-5x}{-5} = \frac{0}{-5}$$
$$x = 0 \quad \{0\}$$

Check:

$$14-2\cdot 0+5\cdot 0 = -4(-2\cdot 0-5)-6$$
$$14-0+0 = -4(0-5)-6$$
$$14 = -4(-5)-6$$
$$14 = 20-6$$
$$14 = 14$$

44.
$$8-(p+2)+6p+7 = p+13$$
$$8-p-2+6p+7 = p+13$$
$$5p+13 = p+13$$
$$5p-p+13 = p-p+13$$
$$4p+13 = 13$$
$$4p+13-13 = 13-13$$
$$4p = 0$$
$$\frac{4p}{4} = \frac{0}{4}$$
$$p = 0 \quad \{0\}$$

Check:

$$8-(0+2)+6\cdot 0+7 = 0+13$$
$$8-2+0+7 = 13$$
$$13 = 13$$

45.
$$\frac{2}{3}x-\frac{1}{6} = -\frac{5}{12}x+\frac{3}{2}-\frac{1}{6}x$$
$$12\left(\frac{2}{3}x-\frac{1}{6}\right) = 12\left(-\frac{5}{12}x+\frac{3}{2}-\frac{1}{6}x\right)$$

46.
$$-\frac{1}{2}y+4 = -\frac{9}{10}y+\frac{2}{5}$$
$$10\left(-\frac{1}{2}y+4\right) = 10\left(-\frac{9}{10}y+\frac{2}{5}\right)$$

$$\begin{aligned}
8x-2 &= -5x+18-2x \\
8x-2 &= -7x+18 \\
8x+7x-2 &= -7x+7x+18 \\
15x-2 &= 18 \\
15x-2+2 &= 18+2 \\
15x &= 20 \\
\frac{15x}{15} &= \frac{20}{15} \\
x &= \frac{4}{3} \quad \left\{\frac{4}{3}\right\}
\end{aligned}$$

$$\begin{aligned}
-5y+40 &= -9y+4 \\
-5y+9y+40 &= -9y+9y+4 \\
4y+40 &= 4 \\
4y+40-40 &= 4-40 \\
4y &= -36 \\
\frac{4y}{4} &= \frac{-36}{4} \\
y &= -9 \quad \{-9\}
\end{aligned}$$

47.

$$\begin{aligned}
\frac{1}{5}(p-5) &= \frac{3}{5}p+\frac{1}{10}p+1 \\
\frac{1}{5}p-1 &= \frac{3}{5}p+\frac{1}{10}p+1 \\
10\left(\frac{1}{5}p-1\right) &= 10\left(\frac{3}{5}p+\frac{1}{10}p+1\right) \\
2p-10 &= 6p+p+10 \\
2p-10 &= 7p+10 \\
2p-7p-10 &= 7p-7p+10 \\
-5p-10 &= 10 \\
-5p-10+10 &= 10+10 \\
-5p &= 20 \\
\frac{-5p}{-5} &= \frac{20}{-5} \\
p &= -4 \quad \{-4\}
\end{aligned}$$

48.

$$\begin{aligned}
\frac{5}{6}(q+2) &= -\frac{7}{9}q-\frac{1}{3}+2 \\
\frac{5}{6}q+\frac{10}{6} &= -\frac{7}{9}q-\frac{1}{3}+2 \\
18\left(\frac{5}{6}q+\frac{10}{6}\right) &= 18\left(-\frac{7}{9}q-\frac{1}{3}+2\right) \\
15q+30 &= -14q-6+36 \\
15q+30 &= -14q+30 \\
15q+14q+30 &= -14q+14q+30 \\
29q+30 &= 30 \\
29q+30-30 &= 30-30 \\
29q &= 0 \\
\frac{29q}{29} &= \frac{0}{29} \\
q &= 0 \quad \{0\}
\end{aligned}$$

49.

$$\begin{aligned}
\frac{3x-7}{2}+\frac{3-5x}{3} &= \frac{3-6x}{5} \\
30\left(\frac{3x-7}{2}+\frac{3-5x}{3}\right) &= 30\left(\frac{3-6x}{5}\right) \\
15(3x-7)+10(3-5x) &= 6(3-6x) \\
45x-105+30-50x &= 18-36x \\
-5x-75 &= 18-36x \\
-5x+36x-75 &= 18-36x+36x \\
31x-75 &= 18 \\
31x-75+75 &= 18+75
\end{aligned}$$

50.

$$\begin{aligned}
\frac{2y-4}{5} &= \frac{5y+13}{4}+\frac{y}{2} \\
20\left(\frac{2y-4}{5}\right) &= 20\left(\frac{5y+13}{4}+\frac{y}{2}\right) \\
4(2y-4) &= 5(5y+13)+10y \\
8y-16 &= 25y+65+10y \\
8y-16 &= 35y+65 \\
8y-35y-16 &= 35y-35y+65 \\
-27y-16 &= 65 \\
-27y-16+16 &= 65+16
\end{aligned}$$

$$31x = 93$$
$$\frac{31x}{31} = \frac{93}{31}$$
$$x = 3 \quad \{3\}$$

$$-27y = 81$$
$$\frac{-27y}{-27} = \frac{81}{-27}$$
$$y = -3 \quad \{-3\}$$

51.
$$\frac{4}{3}(2q+6) - \frac{5q-6}{6} - \frac{q}{3} = 0$$
$$6\left[\frac{4}{3}(2q+6) - \frac{5q-6}{6} - \frac{q}{3}\right] = 6(0)$$
$$8(2q+6) - (5q-6) - 2q = 0$$
$$16q + 48 - 5q + 6 - 2q = 0$$
$$9q + 54 = 0$$
$$9q + 54 - 54 = 0 - 54$$
$$9q = -54$$
$$\frac{9q}{9} = \frac{-54}{9}$$
$$q = -6 \quad \{-6\}$$

52.
$$\frac{-3a+9}{15} - \frac{2a-5}{5} - \frac{a+2}{10} = 0$$
$$30\left(\frac{-3a+9}{15} - \frac{2a-5}{5} - \frac{a+2}{10}\right) = 30(0)$$
$$2(-3a+9) - 6(2a-5) - 3(a+2) = 0$$
$$-6a + 18 - 12a + 30 - 3a - 6 = 0$$
$$-21a + 42 = 0$$
$$-21a + 42 - 42 = 0 - 42$$
$$-21a = -42$$
$$\frac{-21a}{-21} = \frac{-42}{-21}$$
$$a = 2 \quad \{2\}$$

53.
$$6.3w - 1.5 = 4.8$$
$$10(6.3w - 1.5) = 10(4.8)$$
$$63w - 15 = 48$$
$$63w - 15 + 15 = 48 + 15$$
$$63w = 63$$
$$\frac{63w}{63} = \frac{63}{63}$$
$$w = 1 \quad \{1\}$$

54.
$$0.2x + 53.6 = x$$
$$10(0.2x + 53.6) = 10(x)$$
$$2x + 536 = 10x$$
$$2x - 2x + 536 = 10x - 2x$$
$$536 = 8x$$
$$\frac{536}{8} = \frac{8x}{8}$$
$$67 = x \quad \{67\}$$

55.
$$0.75(m-2) + 0.25m = 0.5$$
$$100[0.75(m-2) + 0.25m] = 100[0.5]$$
$$75(m-2) + 25m = 50$$
$$100m - 150 = 50$$
$$100m - 150 + 150 = 50 + 150$$
$$100m = 200$$
$$\frac{100m}{100} = \frac{200}{100}$$
$$m = 2 \quad \{2\}$$

56.
$$0.4(n+10) + 0.6n = 2$$
$$10[0.4(n+10) + 0.6n] = 10[2]$$
$$4(n+10) + 6n = 20$$
$$10n + 40 = 20$$
$$10n + 40 - 40 = 20 - 40$$
$$10n = -20$$
$$\frac{10n}{10} = \frac{-20}{10}$$
$$n = -2 \quad \{-2\}$$

57. A conditional equation is an equation that is true for some values of the variable but false for other values of the variable.

58. A contradiction has no solution, and an identity has all real numbers as solutions.

59.
$$\begin{aligned} 4x+1 &= 2(2x+1)-1 \\ 4x+1 &= 4x+2-1 \\ 4x+1 &= 4x+1 \\ 0 &= 0 \end{aligned}$$
This is an identity. $\{x \mid x \text{ is a real number}\}$

60.
$$\begin{aligned} 3x+6 &= 3x \\ 3x-3x+6 &= 3x-3x \\ 6 &= 0 \end{aligned}$$
This is a contradiction. $\{\ \}$

61.
$$\begin{aligned} -11x+4(x-3) &= -2x-12 \\ -11x+4x-12 &= -2x-12 \\ -7x-12 &= -2x-12 \\ -7x+2x-12 &= -2x+2x-12 \\ -5x-12 &= -12 \\ -5x-12+12 &= -12+12 \\ -5x &= 0 \\ \frac{-5x}{-5} &= \frac{0}{-5} \\ x &= 0 \end{aligned}$$
This is a conditional equation. $\{0\}$

62.
$$\begin{aligned} 5(x+2)-7 &= 3 \\ 5x+10-7 &= 3 \\ 5x+3 &= 3 \\ 5x+3-3 &= 3-3 \\ 5x &= 0 \\ \frac{5x}{5} &= \frac{0}{5} \\ x &= 0 \end{aligned}$$
This is a conditional equation. $\{0\}$

63.
$$\begin{aligned} 2x-4+8x &= 7x-8+3x \\ 10x-4 &= 10x-8 \\ 10x-10x-4 &= 10x-10x-8 \\ -4 &= -8 \end{aligned}$$
This is a contradiction. $\{\ \}$

64.
$$\begin{aligned} -7x+8+4x &= -3(x-3)-1 \\ -3x+8 &= -3x+9-1 \\ -3x+8 &= -3x+8 \\ 0 &= 0 \end{aligned}$$
This is an identity. $\{x \mid x \text{ is a real number}\}$

65.
$$\begin{aligned} -5b+9 &= -71 \\ -5b+9-9 &= -71-9 \end{aligned}$$

66.
$$\begin{aligned} -3x+18 &= -66 \\ -3x+18-18 &= -66-18 \end{aligned}$$

$$-5b = -80$$
$$\frac{-5b}{-5} = \frac{-80}{-5}$$
$$b = 16 \quad \{16\}$$

$$-3x = -84$$
$$\frac{-3x}{-3} = \frac{-84}{-3}$$
$$x = 28 \quad \{28\}$$

67.
$$16 = -10 + 13x$$
$$16 + 10 = -10 + 10 + 13x$$
$$26 = 13x$$
$$\frac{26}{13} = \frac{13x}{13}$$
$$2 = x \quad \{2\}$$

68.
$$15 = -12 + 9x$$
$$15 + 12 = -12 + 12 + 9x$$
$$27 = 9x$$
$$\frac{27}{9} = \frac{9x}{9}$$
$$3 = x \quad \{3\}$$

69.
$$10c + 3 = -3 + 12c$$
$$10c - 12c + 3 = -3 + 12c - 12c$$
$$-2c + 3 = -3$$
$$-2c + 3 - 3 = -3 - 3$$
$$-2c = -6$$
$$\frac{-2c}{-2} = \frac{-6}{-2}$$
$$c = 3 \quad \{3\}$$

70.
$$2w + 21 = 6w - 7$$
$$2w - 6w + 21 = 6w - 6w - 7$$
$$-4w + 21 = -7$$
$$-4w + 21 - 21 = -7 - 21$$
$$-4w = -28$$
$$\frac{-4w}{-4} = \frac{-28}{-4}$$
$$w = 7 \quad \{7\}$$

71.
$$12b - 8b - 8 + 13 = 4b + 6 - 1$$
$$4b + 5 = 4b + 5$$
$$0 = 0$$

The equation is an identity. The solution set is $\{b \mid b \text{ is a real number}\}$.

72.
$$4z + 2 - 3z + 5 = 3 + z + 4$$
$$z + 7 = z + 7$$
$$0 = 0$$
$$\{z \mid z \text{ is a real number}\}$$

73.
$$5(x - 2) - 2x = 3x + 7$$
$$5x - 10 - 2x = 3x + 7$$
$$3x - 10 = 3x + 7$$
$$3x - 3x - 10 = 3x - 3x + 7$$
$$-10 = 7$$
$$\{\ \}$$

74.
$$2x + 3(x - 5) = 15$$
$$2x + 3x - 15 = 15$$
$$5x - 15 = 15$$
$$5x - 15 + 15 = 15 + 15$$
$$5x = 30$$
$$\frac{5x}{5} = \frac{30}{5}$$
$$x = 6 \quad \{6\}$$

75.
$$\frac{c}{2}-\frac{c}{4}+\frac{3c}{8}=1$$
$$8\left(\frac{c}{2}-\frac{c}{4}+\frac{3c}{8}\right)=8(1)$$
$$4c-2c+3c=8$$
$$5c=8$$
$$\frac{5c}{5}=\frac{8}{5}$$
$$c=\frac{8}{5} \quad \left\{\frac{8}{5}\right\}$$

76.
$$\frac{d}{5}-\frac{d}{10}+\frac{5d}{20}=\frac{7}{10}$$
$$20\left(\frac{d}{5}-\frac{d}{10}+\frac{5d}{20}\right)=20\left(\frac{7}{10}\right)$$
$$4d-2d+5d=14$$
$$7d=14$$
$$\frac{7d}{7}=\frac{14}{7}$$
$$d=2 \quad \{2\}$$

77.
$$0.75(8x-4)=\frac{2}{3}(6x-9)$$
$$6x-3=4x-6$$
$$6x-4x-3=4x-4x-6$$
$$2x-3=-6$$
$$2x-3+3=-6+3$$
$$2x=-3$$
$$\frac{2x}{2}=\frac{-3}{2}$$
$$x=-\frac{3}{2} \quad \left\{-\frac{3}{2}\right\}$$

78.
$$-\frac{1}{2}(4z-3)=-z$$
$$-2z+\frac{3}{2}=-z$$
$$-2z+2z+\frac{3}{2}=-z+2z$$
$$\frac{3}{2}=z \quad \left\{\frac{3}{2}\right\}$$

79.
$$7(p+2)-4p=3p+14$$
$$7p+14-4p=3p+14$$
$$3p+14=3p+14$$
$$3p-3p+14=3p-3p+14$$
$$14=14$$
$$\{p \mid p \text{ is a real number}\}$$

80.
$$6(z-2)=3z-8+3z$$
$$6z-12=6z-8$$
$$6z-6z-12=6z-6z-8$$
$$-12=-8 \quad \{\ \}$$

81.
$$4\left[3+5(3-b)+2b\right]=6-2b$$
$$4\left[3+15-5b+2b\right]=6-2b$$
$$4\left[-3b+18\right]=6-2b$$

82.
$$\frac{1}{3}(x+3)-\frac{1}{6}=\frac{1}{6}(2x+5)$$
$$6\left[\frac{1}{3}(x+3)-\frac{1}{6}\right]=6\left[\frac{1}{6}(2x+5)\right]$$

$$\begin{aligned}
-12b+72 &= 6-2b \\
-12b+2b+72 &= 6-2b+2b \\
-10b+72 &= 6 \\
-10b+72-72 &= 6-72 \\
-10b &= -66 \\
\frac{-10b}{-10} &= \frac{-66}{-10} \\
b &= \frac{33}{5} \\
&= 6.6 \qquad \left\{\frac{33}{5}\right\}
\end{aligned}$$

$$\begin{aligned}
2(x+3)-1 &= 2x+5 \\
2x+6-1 &= 2x+5 \\
2x+5 &= 2x+5 \\
2x-2x+5 &= 2x-2x+5 \\
5 &= 5
\end{aligned}$$

$$\{x \mid x \text{ is a real number}\}$$

83.
$$\begin{aligned}
3-\frac{3}{4}x &= 3\left(3-\frac{1}{4}x\right) \\
3-\frac{3}{4}x &= 9-\frac{3}{4}x \\
3 &= 9
\end{aligned}$$

The equation is a contradiction.

The solution set is { }.

84.
$$\begin{aligned}
\frac{9}{5}-8w &= 8\left(\frac{3}{5}-w\right) \\
\frac{9}{5}-8w &= \frac{24}{5}-8w \\
\frac{9}{5} &= \frac{24}{5}
\end{aligned}$$

The equation is a contradiction.

The solution set is { }.

85.
$$\begin{aligned}
\frac{5}{4}+\frac{y-3}{8} &= \frac{2y+1}{2} \\
8\left(\frac{5}{4}+\frac{y-3}{8}\right) &= 8\left(\frac{2y+1}{2}\right) \\
10+y-3 &= 4(2y+1) \\
y+7 &= 8y+4 \\
y-8y+7 &= 8y-8y+4 \\
-7y+7 &= 4 \\
-7y+7-7 &= 4-7 \\
-7y &= -3 \\
\frac{-7y}{-7} &= \frac{-3}{-7} \\
y &= \frac{3}{7} \qquad \left\{\frac{3}{7}\right\}
\end{aligned}$$

86.
$$\begin{aligned}
\frac{2}{3}-\frac{x+2}{6} &= \frac{5x-2}{2} \\
6\left(\frac{2}{3}-\frac{x+2}{6}\right) &= 6\left(\frac{5x-2}{2}\right) \\
4-(x+2) &= 3(5x-2) \\
4-x-2 &= 15x-6 \\
-x+2 &= 15x-6 \\
-x-15x+2 &= 15x-15x-6 \\
-16x+2 &= -6 \\
-16x+2-2 &= -6-2 \\
-16x &= -8 \\
\frac{-16x}{-16} &= \frac{-8}{-16} \\
x &= \frac{1}{2} \qquad \left\{\frac{1}{2}\right\}
\end{aligned}$$

87.
$$\frac{2y-9}{10}+\frac{3}{2}=y$$
$$10\left(\frac{2y-9}{10}+\frac{3}{2}\right)=10y$$
$$2y-9+15=10y$$
$$2y+6=10y$$
$$2y-2y+6=10y-2y$$
$$6=8y$$
$$\frac{6}{8}=\frac{8y}{8}$$
$$\frac{3}{4}=y \quad \left\{\frac{3}{4}\right\}$$

88.
$$\frac{2}{3}x-\frac{5}{6}x-3=\frac{1}{2}x-5$$
$$6\left(\frac{2}{3}x-\frac{5}{6}x-3\right)=6\left(\frac{1}{2}x-5\right)$$
$$4x-5x-18=3x-30$$
$$-x-18=3x-30$$
$$-x-3x-18=3x-3x-30$$
$$-4x-18=-30$$
$$-4x-18+18=-30+18$$
$$-4x=-12$$
$$\frac{-4x}{-4}=\frac{-12}{-4}$$
$$x=3 \quad \{3\}$$

89.
$$0.48x-0.08x=0.12(260-x)$$
$$100(0.48x-0.08x)=100\left[0.12(260-x)\right]$$
$$48x-8x=12(260-x)$$
$$40x=3120-12x$$
$$40x+12x=3120-12x+12x$$
$$52x=3120$$
$$\frac{52x}{52}=\frac{3120}{52}$$
$$x=60 \quad \{60\}$$

90.
$$0.07w+0.06(140-w)=90$$
$$100\left[0.07w+0.06(140-w)\right]=100\left[90\right]$$
$$7w+6(140-w)=9000$$
$$7w+840-6w=9000$$
$$w+840=9000$$
$$w+840-840=9000-840$$
$$w=8160 \quad \{8160\}$$

91.
$$0.5x+0.25=\frac{1}{3}x+\frac{5}{4}$$
$$\frac{1}{2}x+\frac{1}{4}=\frac{1}{3}x+\frac{5}{4}$$
$$12\left(\frac{1}{2}x+\frac{1}{4}\right)=12\left(\frac{1}{3}x+\frac{5}{4}\right)$$
$$6x+3=4x+15$$
$$6x-4x+3=4x-4x+15$$
$$2x+3=15$$
$$2x+3-3=15-3$$
$$2x=12$$

92.
$$0.2b+\frac{1}{3}=\frac{7}{15}$$
$$\frac{1}{5}b+\frac{1}{3}=\frac{7}{15}$$
$$15\left(\frac{1}{5}b+\frac{1}{3}\right)=15\left(\frac{7}{15}\right)$$
$$3b+5=7$$
$$3b+5-5=7-5$$
$$3b=2$$

$$\frac{2x}{2}=\frac{12}{2}$$
$$x=6 \quad \{6\}$$

$$\frac{3b}{3}=\frac{2}{3}$$
$$b=\frac{2}{3} \quad \left\{\frac{2}{3}\right\}$$

93.
$$0.3b-1.5=0.25(b+2)+0.05b$$
$$0.3b-1.5=0.25b+0.5+0.05b$$
$$0.3b-1.5=0.3b+0.5$$
$$1.5=0.5$$

The equation is a contradiction. The solution set is { }.

94.
$$0.7(a-1)=0.25+0.7a$$
$$100\left[0.7(a-1)\right]=100\left[0.25+0.7a\right]$$
$$70(a-1)=25+70a$$
$$70a-70=25+70a$$
$$70a-70a-70=25+70a-70a$$
$$-70=25$$
$$\{\ \}$$

95.
$$-\frac{7}{8}y+\frac{1}{4}=\frac{1}{2}\left(5-\frac{3}{4}y\right)$$
$$-\frac{7}{8}y+\frac{1}{4}=\frac{5}{2}-\frac{3}{8}y$$
$$8\left(-\frac{7}{8}y+\frac{1}{4}\right)=8\left(\frac{5}{2}-\frac{3}{8}y\right)$$
$$-7y+2=20-3y$$
$$-7y+3y+2=20-3y+3y$$
$$-4y+2=20$$
$$-4y+2-2=20-2$$
$$-4y=18$$
$$\frac{-4y}{-4}=\frac{18}{-4}$$
$$y=-\frac{9}{2} \quad \left\{-\frac{9}{2}\right\}$$

96.
$$5x-(8-x)=2\left[-4-(3+5x)-13\right]$$
$$5x-8+x=2\left[-4-3-5x-13\right]$$
$$6x-8=2\left[-5x-20\right]$$
$$6x-8=-10x-40$$
$$6x+10x-8=-10x+10x-40$$
$$16x-8=-40$$
$$16x-8+8=-40+8$$
$$16x=-32$$
$$\frac{16x}{16}=\frac{-32}{16}$$
$$x=-2 \quad \{-2\}$$

97.
$$0.12h+14.89=137.77$$
$$0.12h=137.77-14.89$$
$$0.12h=122.88$$
$$h=\frac{122.88}{0.12}$$
$$h=1024$$

The family used 1024 kWh.

98.
$$105h+50=1415$$
$$105h=1415-50$$
$$105h=1365$$
$$h=\frac{1365}{105}$$
$$h=13$$

The student is taking 13 credit-hours.

99. a. $-2(y-1)+3(y+2)=-2y+2+3y+6$
$=y+8$

b. $2(y-1)+3(y+2)=0$
$y+8=0$
$y+8-8=0-8$
$y=-8 \quad \{-8\}$

c. To simplify an expression, clear parentheses and combine like terms. To solve an equation, isolate the variable to find a solution.

100. a. $4w-8(2+w)=4w-16-8w$
$=-4w-16$

b. $4w-8(2+w)=0$
$-4w-16=0$
$-4w-16+16=0+16$
$-4w=16$
$\frac{-4w}{-4}=\frac{16}{-4}$
$w=-4 \quad \{-4\}$

c. To simplify an expression, clear parentheses and combine like terms. To solve an equation, isolate the variable to find a solution.

Problem Recognition Exercises

1. Expression
$4x-2+6-8x$
$=4x-8x-2+6$
$=-4x+4$

2. Expression
$-3y-3-4y+8$
$=-3y-4y-3+8$
$=-7y+5$

3. Equation
$7b-1=2b+4$
$7b-2b-1=2b-2b+4$
$5b-1=4$
$5b-1+1=4+1$
$5b=5$
$\frac{5b}{5}=\frac{5}{5}$
$b=1 \quad \{1\}$

4. Equation
$10t+2=2-7t$
$10t+7t+2=2-7t+7t$
$17t+2=2$
$17t+2-2=2-2$
$17t=0$
$\frac{17t}{17}=\frac{0}{17}$
$t=0 \quad \{0\}$

5. Expression
$4(a-8)-7(2a+1)$

6. Expression
$10(2x+3)-8(5-x)$

$$= 4a - 32 - 14a - 7$$
$$= -10a - 39$$

$$= 20x + 30 - 40 + 8x$$
$$= 28x - 10$$

7. Equation

$$7(2 - w) = 5w + 8$$
$$14 - 7w = 5w + 8$$
$$14 - 7w - 5w = 5w - 5s + 8$$
$$14 - 12w = 8$$
$$14 - 14 - 12w = 8 - 14$$
$$-12w = -6$$
$$\frac{-12w}{-12} = \frac{-6}{-12}$$
$$w = \frac{1}{2} \quad \left\{\frac{1}{2}\right\}$$

8. Equation

$$15(3 - 2y) = 21 + 2y$$
$$45 - 30y = 21 + 2y$$
$$45 - 30y - 2y = 21 + 2y - 2y$$
$$45 - 32y = 21$$
$$45 - 45 - 32y = 21 - 45$$
$$-32y = -24$$
$$\frac{-32y}{-32} = \frac{-24}{-32}$$
$$y = \frac{3}{4} \quad \left\{\frac{3}{4}\right\}$$

9. Equation

$$2(3x - 4) - 4(5x + 1) = -8x + 7$$
$$6x - 8 - 20x - 4 = -8x + 7$$
$$-14x - 12 = -8x + 7$$
$$-14x + 8x - 12 = -8x + 8x + 7$$
$$-6x - 12 = 7$$
$$-6x - 12 + 12 = 7 + 12$$
$$-6x = 19$$
$$\frac{-6x}{-6} = \frac{19}{-6}$$
$$x = -\frac{19}{6} \quad \left\{-\frac{19}{6}\right\}$$

10. Equation

$$6(2 - 3a) - 2(8a + 3) = -12a - 19$$
$$12 - 18a - 16a - 6 = -12a - 19$$
$$-34a + 6 = -12a - 19$$
$$-34a + 12a + 6 = -12a + 12a - 19$$
$$-22a + 6 = -19$$
$$-22a + 6 - 6 = -19 - 6$$
$$-22a = -25$$
$$\frac{-22a}{-22} = \frac{-25}{-22}$$
$$a = \frac{25}{22} \quad \left\{\frac{25}{22}\right\}$$

11. Expression

$$\frac{1}{2}v + \frac{3}{5} - \frac{2}{3}v - \frac{7}{10}$$
$$= \frac{15}{30}v + \frac{18}{30} - \frac{20}{30}v - \frac{21}{30}$$
$$= -\frac{5}{30}v - \frac{3}{30}$$
$$= -\frac{1}{6}v - \frac{1}{10}$$

12. Expression

$$-\frac{7}{8}t - \frac{4}{3}u - \frac{5}{4}t + \frac{11}{6}u$$
$$= -\frac{7}{8}t - \frac{10}{8}t - \frac{8}{6}u + \frac{11}{6}u$$
$$= -\frac{17}{8}t + \frac{3}{6}u$$
$$= -\frac{17}{8}t + \frac{1}{2}u$$

13. Equation

$$20x-8+7x+28=27x-9$$
$$27x+20=27x-9$$
$$27x-27x+20=27x-27x-9$$
$$20=-9$$
$$\{\ \}$$

14. Equation

$$7+8w-12=3w-8+5w$$
$$8w-5=8b-8$$
$$-5=-8$$
$$\{\ \}$$

15. Equation

$$\frac{5}{6}y-\frac{7}{8}=\frac{1}{2}y+\frac{3}{4}$$
$$24\left(\frac{5}{6}y-\frac{7}{8}\right)=24\left(\frac{1}{2}y+\frac{3}{4}\right)$$
$$\left(\frac{120}{6}y-\frac{168}{8}\right)=\left(\frac{24}{2}y+\frac{72}{4}\right)$$
$$20y-21=12y+18$$
$$20y-12y-21=12y-12y+18$$
$$8y-21=18$$
$$8y-21+21=18+21$$
$$8y=39$$
$$\frac{8y}{8}=\frac{39}{8}$$
$$y=\frac{39}{8}\quad\left\{\frac{39}{8}\right\}$$

16. Equation

$$\frac{4}{5}+3z=\frac{1}{2}z+1$$
$$10\left(\frac{4}{5}+3z\right)=\left(\frac{1}{2}z+1\right)$$
$$\left(\frac{40}{5}+30z\right)=\left(\frac{10}{2}z+10\right)$$
$$8+30z=5z+10$$
$$8+30z-5z=5z-5z+10$$
$$8+25z=10$$
$$8-8+25z=10-8$$
$$25z=2$$
$$\frac{25z}{25}=\frac{2}{25}$$
$$z=\frac{2}{25}\quad\left\{\frac{2}{25}\right\}$$

17. Expression

$$0.29c+4.495-0.12c$$
$$=0.17c+4.495$$

18. Expression

$$0.45k-1.67+0.89-1.456k$$
$$=-1.006k-0.78$$

19. Equation

$$0.125(2p-8)=0.25(p-4)$$
$$0.25p-1=0.25p-1$$
$$0.25p-0.25p-1=0.25p-0.25p-1$$
$$-1=-1$$
$$\{p\,|\,p \text{ is a real number}\}$$

20. Equation

$$0.5u+1.2-0.74u=0.8-0.24u+0.4$$
$$-0.24u+1.2=-0.24u+1.2$$
$$-0.24u+0.24u+1.2=-0.24u+0.24u+1.2$$
$$1.2=1.2$$
$$\{u\,|\,u \text{ is a real number}\}$$

Section 1.2 Practice Exercises

1. **a.** consecutive

b. even; odd

c. 1; 2; 2

d. $x+1$

e. $x + 2$

f. $x + 2$; $x + 4$

g. Prt; interest

h. \$1300

i. 0.48 L; $0.12(x+8)$

j. $\frac{d}{t}$; $\frac{d}{r}$

2. The smallest positive integer that could be used to clear the fractions is the LCD of 3, 5, and 6, or 30.

3.
$$\begin{aligned} 7a-2&=11\\ 7a-2+2&=11+2\\ 7a&=13\\ \frac{7a}{7}&=\frac{13}{7}\\ a&=\frac{13}{7} \end{aligned}$$
$\left\{\frac{13}{7}\right\}$

4.
$$\begin{aligned} 2z+6&=-15\\ 2z+6-6&=-15-6\\ 2z&=-21\\ \frac{2z}{2}&=\frac{-21}{2}\\ z&=-\frac{21}{2} \end{aligned}$$
$\left\{-\frac{21}{2}\right\}$

5.
$$\begin{aligned} 4(x-3)+7&=19\\ 4x-12+7&=19\\ 4x-5&=19\\ 4x&=24\\ \frac{4x}{4}&=\frac{24}{4}\\ x&=6 \end{aligned}$$
$\{6\}$

6.
$$\begin{aligned} -3(y-5)+4&=1\\ -3y+15+4&=1\\ -3y+19&=1\\ -3y&=-18\\ \frac{-3y}{-3}&=\frac{-18}{-3}\\ y&=6 \end{aligned}$$
$\{6\}$

7.
$$\begin{aligned} &\frac{3}{8}p+\frac{3}{4}=p-\frac{3}{2}\\ &8\left(\frac{3}{8}p+\frac{3}{4}\right)=8\left(p-\frac{3}{2}\right) \end{aligned}$$

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

$$\begin{aligned} 3p+6 &= 8p-12 \\ 3p-8p+6 &= 8p-8p-12 \\ -5p+6 &= -12 \\ -5p+6-6 &= -12-6 \\ -5p &= -18 \\ \frac{-5p}{-5} &= \frac{-18}{-5} \\ p &= \frac{18}{5} \quad \left\{\frac{18}{5}\right\} \end{aligned}$$

$$\begin{aligned} 1-8x &= 20 \\ 1-1-8x &= 20-1 \\ -8x &= 19 \\ \frac{-8x}{-8} &= \frac{19}{-8} \\ x &= -\frac{19}{8} \quad \left\{-\frac{19}{8}\right\} \end{aligned}$$

9. $x + 5$

10. $n - 10$

11. $2t - 7$

12. $3y+4$

13. Let x = the smaller number

$2x + 3$ = the larger number

(larger number) – (smaller number) = 8

$$\begin{aligned} (2x+3)-x &= 8 \\ 2x+3-x &= 8 \\ x+3 &= 8 \\ x+3-3 &= 8-3 \\ x &= 5 \\ 2x+3 &= 2(5)+3 \\ &= 10+3 \\ &= 13 \end{aligned}$$

The smaller number is 5 and the larger is 13.

14. Let x = one number

$x - 3$ = the other number

(one number) + (other number) = 15

$$\begin{aligned} x+(x-3) &= 15 \\ x+x-3 &= 15 \\ 2x-3 &= 15 \\ 2x-3+3 &= 15+3 \\ 2x &= 18 \\ \frac{2x}{2} &= \frac{18}{2} \\ x &= 9 \\ x-3 &= 9-3 \\ &= 6 \end{aligned}$$

One number is 9 and the other is 6.

15. Let x = the number

$3x + 2$ = the sum

$x - 4$ = the difference

(sum) = (difference)

$$\begin{aligned} 3x+2 &= x-4 \\ 3x-x+2 &= x-x-4 \\ 2x+2 &= -4 \end{aligned}$$

16. Let x = the number

$x + 3$ = the sum

$x - 1$ = the difference

(twice the sum) = (difference)

$$\begin{aligned} x+6 &= -1 \\ x+6-6 &= -1-6 \\ x &= -7 \end{aligned}$$

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

The number is –3.

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

The number is –7.

17. Let x = the first page number

$x + 1$ = the consecutive page number

(first) + (second) = 223

$$x+(x+1)=223$$
$$2x+1=223$$
$$2x+1-1=223-1$$
$$2x=222$$
$$\frac{2x}{2}=\frac{222}{2}$$
$$x=111$$
$$x+1=111+1=112$$

The consecutive page numbers are 111 and 112.

18. Let x = the first raffle ticket number

$x + 1$ = the consecutive raffle number

(first) + (second) = 808,455

$$x+(x+1)=808,455$$
$$2x+1=808,455$$
$$2x+1-1=808,455-1$$
$$2x=808,454$$
$$\frac{2x}{2}=\frac{808,454}{2}$$
$$x=404,227$$
$$x+1=404,227+1=404,228$$

The consecutive raffle ticket numbers are 404,227 and 404,228.

19. Let x = the first odd integer

$x + 2$ = the consecutive odd integer

(first) + (second) = –148

$$x+(x+2)=-148$$
$$2x+2=-148$$
$$2x+2-2=-148-2$$
$$2x=-150$$
$$\frac{2x}{2}=\frac{-150}{2}$$
$$x=-75$$
$$x+2=-75+2=-73$$

The two consecutive odd integers are –75 and –73.

20. Let x = the first integer

$x + 1$ = the second consecutive integer

$x + 2$ = the third consecutive integer

(first) + (second) + (third) = –57

$$x+(x+1)+(x+2)=-57$$
$$3x+3=-57$$
$$3x+3-3=-57-3$$
$$3x=-60$$
$$\frac{3x}{3}=\frac{-60}{3}$$
$$x=-20$$
$$x+1=-20+1=-19$$
$$x+2=-20+2=-18$$

The three consecutive integers are –20, –19, and –18.

21. Let x = the smaller even integer
$x + 2$ = larger consecutive even integer
(3 times small) = (–146 minus 4 times larger)

$$\begin{aligned} 3x &= -146 - 4(x+2) \\ 3x &= -146 - 4x - 8 \\ 3x &= -154 - 4x \\ 3x + 4x &= -154 - 4x + 4x \\ 7x &= -154 \\ \frac{7x}{7} &= \frac{-154}{7} \\ x &= -22 \\ x + 2 &= -22 + 2 = -20 \end{aligned}$$

The two consecutive even integers are –22 and –20.

22. Let x = the smaller odd integer
$x + 2$ = larger consecutive odd integer
(4 times smaller) = (5 times larger minus 73)

$$\begin{aligned} 4x &= 5(x+2) - 73 \\ 4x &= 5x + 10 - 73 \\ 4x &= 5x - 63 \\ 4x - 5x &= 5x - 5x - 63 \\ -x &= -63 \\ x &= 63 \\ x + 2 &= 63 + 2 = 65 \end{aligned}$$

The two consecutive odd integers are 63 and 65.

23. Let x = first odd integer
$x + 2$ = second consecutive odd integer
$x + 4$ = third consecutive odd integer
(2 times sum) = (23 more than 5 times third)

$$\begin{aligned} 2(x + x + 2 + x + 4) &= 5(x+4) + 23 \\ 2(3x + 6) &= 5x + 20 + 23 \\ 6x + 12 &= 5x + 43 \\ 6x - 5x + 12 &= 5x - 5x + 43 \\ x + 12 &= 43 \\ x + 12 - 12 &= 43 - 12 \\ x &= 31 \\ x + 2 &= 31 + 2 = 33 \\ x + 4 &= 31 + 4 = 35 \end{aligned}$$

The three consecutive odd integers are 31, 33, and 35.

24. Let x = the smaller even integer
$x + 2$ = second consecutive even integer
$x + 4$ = third consecutive even integer
(5 times smallest)=(10 more than 2 times largest)

$$\begin{aligned} 5x &= 2(x+4) + 10 \\ 5x &= 2x + 8 + 10 \\ 5x &= 2x + 18 \\ 5x - 2x &= 2x - 2x + 18 \\ 3x &= 18 \\ \frac{3x}{3x} &= \frac{18}{3} \\ x &= 6 \\ x + 2 &= 6 + 2 = 8 \\ x + 4 &= 6 + 4 = 10 \end{aligned}$$

The three consecutive even integers are 6, 8, and 10.

25. Option 1:
Principal amount borrowed: P=15,000
Interest rate: $r = 0.085$
Duration of loan: $t = 4$

26. Option 1:
Principal amount borrowed: $P = 7000$
Interest rate: $r = 0.08$
Duration of loan: $t = 3$

$x = Prt$

$x = 15{,}000(0.085)(4)$

$x = 5100$

Option 2:

Principal amount borrowed:

$P = 15{,}000$

Interest rate: $r = 0.0775$

Duration of loan: $t = 5$

$x = Prt$

$x = 15{,}000(0.0775)(5)$

$x = 5812.50$

She would pay \$5100 for 4 yr at 8.5% and \$5812.50 for 5 yr at 7.75%; the 8.5% option for 4 yr requires less interest.

$x = Prt$

$x = 7000(0.08)(3)$

$x = 1680$

Option 2:

Principal amount borrowed: $P = 7000$

Interest rate: $r = 0.085$

Duration of loan: $t = 2$

$x = Prt$

$x = 7000(0.085)(2)$

$x = 1190$

He would pay \$1680 for 3 yr at 8% and \$1190 for 2 yr at $8\frac{1}{2}\%$; the $8\frac{1}{2}\%$ option for 2 yr requires less interest.

27. Let $x =$ the amount of sales

(earnings) = 600 + (sales amt)(comm. rate)

$$2400 = 600 + x(0.03)$$
$$2400 - 600 = 600 - 600 + 0.03x$$
$$1800 = 0.03x$$
$$\frac{1800}{0.03} = \frac{0.03x}{0.03}$$
$$60{,}000 = x$$

She needs to sell \$60,000 to earn \$2400.

28. Let $x =$ the sales amount

(earnings) = (sales amt – 200)(comm. rate)

$$76.88 = (x - 200)(0.12) + 50$$
$$26.88 = (x - 200)(0.12)$$
$$26.88 = 0.12x - 24$$
$$50.88 = 0.12x$$
$$424 = x$$

She sold \$424 worth of merchandise.

29. Let $c =$ the sales before tax

(total cash) = (sales) + (sales tax)

(sales tax) = (tax rate)(sales)

$$1293.38 = c + 0.0805c$$
$$1293.38 = 1.0805c$$
$$\frac{1293.38}{1.0805} = \frac{1.0805c}{1.0805}$$
$$1197.02 = c$$
$$t = 0.0805(1197.02) = 96.36$$

30. Let $c =$ the cost before tax

(total bill) = (cost) + (sales tax)

(sales tax) = (tax rate)(cost)

$$13{,}888.60 = c + 0.07c$$
$$13{,}888.60 = 1.07c$$
$$\frac{13{,}888.60}{1.07} = \frac{1.07c}{1.07}$$
$$12{,}980 = c$$

The cost before sales tax was \$12,980.

The total merchandise was \$1197.02
and the sales tax was \$96.36.

31. Let c = the cost before markup
(price) = (cost) + (markup)
(markup) = (markup rate)(cost)

$$43.08 = c + 0.20c$$
$$43.08 = 1.20c$$
$$\frac{43.08}{1.20} = \frac{1.20c}{1.20}$$
$$35.90 = c$$

The price before markup
was \$35.90.

32. Let p = the original price
(sale price) = (price) – (markdown)
(markdown) = (markdown rate)(price)

$$29.25 = p - 0.35p$$
$$29.25 = 0.65p$$
$$\frac{29.25}{0.65} = \frac{0.65p}{0.65}$$
$$45.00 = p$$

The original price
was \$45.00.

33.

	2% Account	5% Account	Total
Amount Invested	x	$12{,}500 - x$	12500
Interest Earned	$0.02x$	$0.05(12{,}500 - x)$	370

(int at 2%) + (int at 5%) = (total int)

$$0.02x + 0.05(12{,}500 - x) = 370$$
$$0.02x + 625 - 0.05x = 370$$
$$-0.03x + 625 = 370$$
$$-0.03x + 625 - 625 = 370 - 625$$
$$-0.03x = -340$$
$$\frac{-0.03x}{-0.03} = \frac{-255}{-0.03}$$
$$x = \frac{-255}{-0.03}$$
$$x = 8500$$
$$12{,}500 - x = 12{,}500 - 8500$$
$$= 4000$$

\$8500 was invested at 2% and \$4000 was invested at 5%.

34.

	9% Account	10% Account	Total
Amount Invested	x	$15{,}000-x$	15,000
Interest Earned	$0.09x$	$0.10(15{,}000-x)$	1432

(int at 9%) + (int at 10%) = (total int)

$$0.09x+0.10(15{,}000-x)=1432$$
$$0.09x+1500-0.10x=1432$$
$$-0.01x+1500=1432$$
$$-0.01x+1500-1500=1432-1500$$
$$-0.01x=-68$$
$$\frac{-0.01x}{-0.01}=\frac{-68}{-0.01}$$
$$x=6800$$
$$15{,}000-x=15{,}000-6800=8200$$

\$6800 was invested at 9% and \$8200 was invested at 10%.

35.

	11% Loan	6% Loan	Total
Amount Borrowed	x	$18{,}000-x$	18,000
Interest Paid	$0.11x$	$0.06(18{,}000-x)$	1380

(int at 11%) + (int at 6%) = (total int)

$$0.11x+0.06(18{,}000-x)=1380$$
$$0.11x+1080-0.06x=1380$$
$$0.05x+1080=1380$$
$$0.05x+1080-1080=1380-1080$$
$$0.05x=300$$
$$\frac{0.05x}{0.05}=\frac{300}{0.05}$$
$$x=6000$$
$$18{,}000-x=18{,}000-6000=12{,}000$$

\$6000 was borrowed at 11% and \$12,000 was borrowed at 6%.

36.

	3% Loan	8% Loan	Total
Amount Borrowed	x	$6000-x$	6000
Interest Paid	$0.03x$	$0.08(6000-x)$	255

(int at 3%) + (int at 8%) = (total int)

$$0.03x + 0.08(6000 - x) = 255$$
$$0.03x + 480 - 0.08x = 255$$
$$-0.05x + 480 = 255$$
$$-0.05x + 480 - 480 = 255 - 480$$
$$-0.05x = -225$$
$$\frac{-0.05x}{-0.05} = \frac{-225}{-0.05}$$
$$x = 4500$$
$$6000 - x = 6000 - 4500$$
$$= 1500$$

She borrowed \$4500 from her parents and \$1500 from the credit union.

37.

	4% Account	3% Account	Total
Amount Invested	x	$x-4000$	
Interest Earned	$0.04x$	$0.03(x-4000)$	720

(int at 4%) + (int at 3%) = (total int)

$$0.04x + 0.03(x - 4000) = 720$$
$$0.04x + 0.03x - 120 = 720$$
$$0.07x - 120 = 720$$
$$0.07x - 120 + 120 = 720 + 120$$
$$0.07x = 840$$
$$\frac{0.07x}{0.07} = \frac{840}{0.07}$$
$$x = 12,000$$

$$x - 4000 = 12,000 - 4000$$
$$= 8000$$

\$12,000 was invested at 4% and \$8000 was invested at 3%.

38.

	4.5% Account	6% Account	Total
Amount Invested	x	$x + 5000$	
Interest Earned	$0.045x$	$0.06(x+5000)$	1140

(int at 4.5%) + (int at 6%) = (total int)

$$0.045x + 0.06\left(x + 5000\right) = 1140$$
$$0.045x + 0.06x + 300 = 1140$$
$$0.105x + 300 = 1140$$
$$0.105x + 300 - 300 = 1140 - 300$$
$$0.105x = 840$$
$$\frac{0.105x}{0.105} = \frac{840}{0.105}$$
$$x = 8000$$
$$x + 5000 = 8000 + 5000$$
$$= 13,000$$

\$8000 was invested at 4.5% and \$13,000 was invested at 6%.

39.

	15% nitrogen	10% nitrogen	14% nitrogen
Amount of fertilizer	x	2	$x + 2$
Amount of nitrogen	$0.15(x)$	$0.10(2)$	$0.14(x + 2)$

(amt of 15%) + (amt of 10%) = (amt of 14%)

$$0.15x + 0.10\left(2\right) = 0.14\left(x + 2\right)$$
$$0.15x + 0.20 = 0.14x + 0.28$$
$$0.15x - 0.14x + 0.20 = 0.14x - 0.14x + 0.28$$
$$0.01x + 0.20 = 0.28$$
$$0.01x + 0.20 - 0.20 = 0.28 - 0.20$$

$$0.01x = 0.08$$
$$\frac{0.01x}{0.01} = \frac{0.08}{0.01}$$
$$x = 8$$

8 oz of 15% nitrogen fertilizer should be used.

40.

	8% Solution	18% Solution	12% Solution
Amount of Solution	x	80	$x + 80$
Amount of Saline	$0.08x$	$0.18(80)$	$0.12(x + 80)$

(amt of 8%) + (amt of 18%) = (amt of 12%)

$$0.08x + 0.18(80) = 0.12(x + 80)$$
$$0.08x + 14.4 = 0.12x + 9.6$$
$$0.08x - 0.12x + 14.4 = 0.12x - 0.12x + 9.6$$
$$-0.04x + 14.4 = 9.6$$
$$-0.04x + 14.4 - 14.4 = 9.6 - 14.4$$
$$-0.04x = -4.8$$
$$\frac{-0.04x}{-0.04} = \frac{-4.8}{-0.04}$$
$$x = 120$$

120 cc of 8% saline solution should be used.

41.

	50% antifreeze	75% antifreeze	60% antifreeze
Amount of fertilizer	3	x	$x + 3$
Amount of nitrogen	$0.50(3)$	$0.75(x)$	$0.60(x + 3)$

(amt of 50%) + (amt of 75%) = (amt of 60%)

$$0.50(3) + 0.75x = 0.60(x + 3)$$
$$1.5 + 0.75x = 0.60x + 1.8$$
$$0.75x - 0.60x + 1.5 = 0.60x - 0.60x + 1.8$$
$$0.15x + 1.5 = 1.8$$
$$0.15x + 1.5 - 1.5 = 1.8 - 1.5$$

$$0.15x = 0.3$$
$$\frac{0.15x}{0.15} = \frac{0.3}{0.15}$$
$$x = 2$$

2 L of the 75% antifreeze solution should be used.

42.

	40% fruit juice	70% fruit juice	45% fruit juice
Amount of Punch	x	10	$x + 10$
Amount of Fruit juice	$0.40x$	$0.70(10)$	$0.45(x + 10)$

(amt of 40%) + (amt of 70%) = (amt of 45%)

$$0.40x + 0.70(10) = 0.45(x + 10)$$
$$0.40x + 7 = 0.45x + 4.5$$
$$0.40x - 0.45x + 7 = 0.45x - 0.45x + 4.5$$
$$-0.05x + 7 = 4.5$$
$$-0.05x + 7 - 7 = 4.5 - 7$$
$$-0.05x = -2.5$$
$$\frac{-0.05x}{-0.05} = \frac{-2.5}{-0.05}$$
$$x = 50$$

50 gal of the 40% punch should be used.

43.

	18% Solution	10% Solution	15% Solution
Amount of Solution	x	$20–x$	20
Amount of Alcohol	$0.18x$	$0.10(20–x)$	$0.15(20)$

(amt of 18%) + (amt of 10%) = (amt of 15%)

$$0.18x + 0.10(20 - x) = 0.15(20)$$
$$0.18x + 2 - 0.10x = 3$$
$$0.08x + 2 = 3$$
$$0.08x + 2 - 2 = 3 - 2$$
$$0.08x = 1$$

$$\frac{0.08x}{0.08} = \frac{1}{0.08}$$
$$x = 12.5$$
$$20 - x = 20 - 12.5$$
$$= 7.5$$

12.5 L of 18% solution and 7.5 L of 10% solution must be mixed.

44.

	2.5% Solution	10% Solution	5% Solution
Amount of Solution	x	$600-x$	600
Amount of bleach	$0.025x$	$0.10(600-x)$	$0.05(600)$

(amt of 2.5%) + (amt of 10%) = (amt of 5%)

$$0.025x + 0.10(600 - x) = 0.05(600)$$
$$0.025x + 60 - 0.10x = 30$$
$$-0.075x + 60 = 30$$
$$-0.075x + 60 - 60 = 30 - 60$$
$$-0.075x = -30$$
$$\frac{-0.075x}{-0.075} = \frac{-30}{-0.075}$$
$$x = 400$$
$$600 - x = 600 - 400 = 200$$

400 mL of 2.5% solution and 200 mL of 10% solution must be mixed.

45.

	12% Super Grow	Pure Super Grow	17.5% Super Grow
Amount of Solution	$32-x$	x	32
Amount of Super Grow	$0.12(32-x)$	$1.00x$	$0.175(32)$

(amt of 12%)+(amt of pure) = (amt of 17.5%)

$$0.12(32 - x) + 1.00x = 0.175(32)$$
$$3.84 - 0.12x + x = 5.6$$

$$0.88x + 3.84 = 5.6$$
$$0.88x + 3.84 - 3.84 = 5.6 - 3.84$$
$$0.88x = 1.76$$
$$\frac{0.88x}{0.88} = \frac{1.76}{0.88}$$
$$x = 2$$

2 oz of pure Super Grow must be added.

46.

	0% Salt Solution	8% Salt Solution	2% Salt Solution
Amount of Solution	x	20	$x + 20$
Amount of Salt	$0x$	$0.08(20)$	$0.02(x + 20)$

(amt of 0%) + (amt of 8%) = (amt of 2%)

$$0x + 0.08(20) = 0.02(x + 20)$$
$$0 + 1.6 = 0.02x + 0.4$$
$$1.6 - 0.4 = 0.02x + 0.4 - 0.4$$
$$1.2 = 0.02x$$
$$\frac{1.2}{0.02} = \frac{0.02x}{0.02}$$
$$60 = x$$

60 oz of water must be added.

47.

	Distance	Rate	Time
To FL	$2(x + 60)$	$x + 60$	2
Return	$2.5x$	x	2.5

(dist to FL) = (dist back to Atlanta)

$$2(x + 60) = 2.5x$$
$$2x + 120 = 2.5x$$
$$2x + 120 - 2x = 2.5x - 2x$$
$$120 = 0.5x$$
$$\frac{120}{0.5} = \frac{0.5x}{0.5}$$
$$240 = x$$
$$x + 60 = 240 + 60$$
$$= 300$$

The plane flies 300 mph from Atlanta to Fort Lauderdale and 240 mph on the return trip.

48.

	Distance	Rate	Time
Down	$3(x+1)$	$x+1$	3
Back	6x	x	6

(dist down) = (dist back)

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

Her rate is 2 mph to the lake.

49.

	Distance	Rate	Time
Car A	$2x$	x	2
Car B	$2(x+4)$	$x+4$	2

(dist car A) + (dist car B) = (total dist)

$$2x+2(x+4)=192$$
$$2x+2x+8=192$$
$$4x+8=192$$
$$4x+8-8=192-8$$
$$4x=184$$
$$\frac{4x}{4}=\frac{184}{4}$$
$$x=46$$
$$x+4=46+4=50$$

The cars are traveling at 46 mph and 50 mph.

50.

	Distance	Rate	Time
Car A	$2x$	x	2
Car B	$2(x-5)$	$x-5$	2

(dist car A) + (dist car B) = (total dist)

$$\begin{aligned}
2x+2(x-5)&=190\\
2x+2x-10&=190\\
4x-10&=190\\
4x-10+10&=190+10\\
4x&=200\\
\frac{4x}{4}&=\frac{200}{4}\\
x&=50\\
x-5&=50-5\\
&=45
\end{aligned}$$

The cars are traveling at 50 mph and 45 mph.

51. Let x = the first integer

$30-x$ = the second integer

(ten times first) = (five times second)

$$\begin{aligned}
10x&=5(30-x)\\
10x&=150-5x\\
10x+5x&=150-5x+5x\\
15x&=150\\
\frac{15x}{15}&=\frac{150}{15}\\
x&=10\\
30-x&=30-10\\
&=20
\end{aligned}$$

The integers are 10 and 20.

52. Let x = the first integer

$10-x$ = the second integer

(3 times first) = (3 less than 8 times second)

$$\begin{aligned}
3x&=8(10-x)-3\\
3x&=80-8x-3\\
3x&=77-8x\\
3x+8x&=77-8x+8x\\
11x&=77\\
\frac{11x}{11}&=\frac{77}{11}\\
x&=7\\
10-x&=10-7\\
&=3
\end{aligned}$$

The integers are 7 and 3.

53. New Price = Original Price – Markdown

$$\begin{aligned}
89.55&=x-0.55x\\
89.55&=(1-0.55)x\\
89.55&=0.45x\\
\frac{89.55}{0.45}&=x\\
x&=199
\end{aligned}$$

The original price was \$199.

54. New Price = Original Price – Markdown

$$\begin{aligned}
15.60&=x-0.35x\\
15.60&=(1-0.35)x\\
15.60&=0.65x\\
\frac{15.60}{0.65}&=x\\
x&=24
\end{aligned}$$

The original price was \$24.

55.

	Distance	Rate	Time
Boat A	$3x$	x	3
Boat B	$3(2x)$	$2x$	3

(dist boat B) – (dist boat A) = (dist between)

$$3(2x) - 3x = 60$$
$$6x - 3x = 60$$
$$3x = 60$$
$$\frac{3x}{3} = \frac{60}{3}$$
$$x = 20$$
$$2x = 2(20)$$
$$= 40$$

The boat's rates are 20 mph and 40 mph.

56.

	Distance	Rate	Time
Canoe A	$3.5x$	x	3.5
Canoe B	$3.5(2x)$	$2x$	3.5

(dist canoe B) – (dist canoe A) = (dist between)

$$3.5(2x) - 3.5x = 5.25$$
$$7x - 3.5x = 5.25$$
$$3.5x = 5.25$$
$$\frac{3.5x}{3.5} = \frac{5.25}{3.5}$$
$$x = 1.5$$
$$2x = 2(1.5)$$
$$= 3$$

The canoe's rates are 1.5 mph and 3 mph.

57.

	5% Account	6% Account	Total
Amount Invested	x	$2x$	
Interest Earned	$0.05x$	$0.06(2x)$	765

(int at 5%) + (int at 6%) = (total int)

$$0.05x + 0.06(2x) = 765$$
$$0.05x + 0.12x = 765$$
$$0.17x = 765$$
$$\frac{0.17x}{0.17} = \frac{765}{0.17}$$
$$x = 4500$$
$$2x = 2(4500)$$
$$= 9000$$

$4500 was invested at 5% and $9000 was invested at 6%.

58.

	4.2% Account	4% Account	Total
Amount Invested	x	$2x$	
Interest Earned	$0.042x$	$0.04(2x)$	488

(int at 4.2%) + (int at 4%) = (total int)

$$0.042x + 0.04(2x) = 488$$
$$0.042x + 0.08x = 488$$
$$0.122x = 488$$
$$\frac{0.122x}{0.122} = \frac{488}{0.122}$$
$$x = 4000$$
$$2x = 2(4000) = 8000$$

Sienna deposited $8000 in her money market account.

59.

	Black Tea	Orange Pekoe Tea	Total
Pounds of Tea	x	$4-x$	4
Cost of Tea	$2.20x$	$3.00(4-x)$	$2.50(4)$

(cost black) + (cost orange) = (cost blend)

$$2.20x + 3.00(4 - x) = 2.50(4)$$
$$2.20x + 12 - 3x = 10$$
$$-0.80x + 12 = 10$$
$$-0.80x + 12 - 12 = 10 - 12$$

$$-0.80x = -2$$
$$\frac{-0.80x}{-0.80} = \frac{-2}{-0.80}$$
$$x = 2.5$$
$$4 - x = 4 - 2.5 = 1.5$$

2.5 lb of black tea and 1.5 lb of orange pekoe tea are used in the blend.

60.

	Almonds	Cashews	Total
Pounds of Nuts	x	$16-x$	16
Cost of Nuts	$4.98x$	$6.98(16-x)$	$5.73(16)$

(cost almonds) + (cost cashews) = (cost mix)

$$4.98x + 6.98(16 - x) = 5.73(16)$$
$$4.98x + 111.68 - 6.98x = 91.68$$
$$-2x + 111.68 = 91.68$$
$$-2x + 111.68 - 111.68 = 91.68 - 111.68$$
$$-2x = -20$$
$$\frac{-2x}{-2} = \frac{-20}{-2}$$
$$x = 10$$
$$16 - x = 16 - 10 = 6$$

10 lb of almonds and 6 lb of cashews must be mixed.

61.
$$\text{New Price} = \text{Original Price} - \text{Price Drop}$$
$$202{,}100 = x - 0.06x$$
$$202{,}100 = 0.94x$$
$$\frac{202{,}100}{0.94} = x$$
$$x = 215{,}000$$

The median price the previous year was $215,000.

62. Let x = Associate's salary

Bachelor's salary = Associate's salary + Increase

$$1026 = x + 0.35x$$
$$1026 = 1.35x$$
$$\frac{1026}{1.35} = x$$
$$x = 760$$

The median weekly salary for an individual with an associate's degree is $760.

Section 1.3 Practice Exercises

1. **a.** $2l + 2w$

b. 90°

c. supplementary

d. 180°

2.
$$\begin{aligned} 7+5x-(2x-6) &= 6(x+1)+21 \\ 7+5x-2x+6 &= 6x+6+21 \\ 3x+13 &= 6x+27 \\ 3x-6x+13 &= 6x-6x+27 \\ -3x+13 &= 27 \\ -3x+13-13 &= 27-13 \\ -3x &= 14 \\ \frac{-3x}{-3} &= \frac{14}{-3} \\ x &= -\frac{14}{3} \end{aligned}$$

$\left\{-\frac{14}{3}\right\}$

3.
$$\begin{aligned} \frac{3}{5}y-3+2y &= 5 \\ 5\left(\frac{3}{5}y-3+2y\right) &= 5(5) \\ 3y-15+10y &= 25 \\ 13y-15 &= 25 \\ 13y-15+15 &= 25+15 \\ 13y &= 40 \\ y &= \frac{40}{13} \end{aligned}$$

$\left\{\frac{40}{13}\right\}$

4.
$$\begin{aligned} 3\left[z-(2-3z)-4\right] &= z-7 \\ 3\left[z-2+3z-4\right] &= z-7 \\ 3\left[4z-6\right] &= z-7 \\ 12z-18 &= z-7 \\ 12z-z-18 &= z-z-7 \\ 11z-18 &= -7 \\ 11z-18+18 &= -7+18 \\ 11z &= 11 \\ z &= 1 \end{aligned}$$

$\{1\}$

5.
$$\begin{aligned} 2a-4+8a &= 7a-8+3a \\ 10a-4 &= 10a-8 \\ 10a-10a-4 &= 10a-10a-8 \\ -4 &= -8 \end{aligned}$$

$\{\ \}$

6.
$$\begin{aligned} 3(t+6)+t+2 &= 5(t+4)-t \\ 3t+18+t+2 &= 5t+20-t \\ 4t+20 &= 4t+20 \\ 4t-4t+20 &= 4t-4t+20 \\ 20 &= 20 \end{aligned}$$

$\{t \mid t \text{ is a real number}\}$

7. Let w = the width of the rectangle

$l = 2w$ = the length of the rectangle

$$\begin{aligned} P &= 2l+2w \\ 177 &= 2(2w)+2w \\ 177 &= 4w+2w \\ 177 &= 6w \\ w &= 29.5 \end{aligned}$$

$l = 2w$
$= 2(29.5)$
$= 59$
The court's dimensions are 29.5 ft by 59 ft.

8. Let w = the width of the rectangle
$l = 2w - 4$ = the length of the rectangle

$$P = 2l + 2w$$
$$112 = 2(2w - 4) + 2w$$
$$112 = 4w - 8 + 2w$$
$$112 = 6w - 8$$
$$112 + 8 = 6w - 8 + 8$$
$$120 = 6w$$
$$w = 20$$
$$l = 2w - 4 = 2(20) - 4$$
$$= 40 - 4 = 36$$

The frame's dimensions are 20 in. by 36 in.

9. Let x = the length of the one side
$x + 2$ = the length of the second side
$x + 4$ = the length of the third side

$$P = a + b + c$$
$$24 = x + x + 2 + x + 4$$
$$24 = 3x + 6$$
$$24 - 6 = 3x + 6 - 6$$
$$18 = 3x$$
$$6 = x$$
$$x + 2 = 6 + 2 = 8$$
$$x + 4 = 6 + 4 = 10$$

The lengths of the sides of the triangle are 6 m, 8 m, and 10 m.

10. Let x = the length of the one side
$x + 1$ = the length of the second side
$x + 2$ = the length of the third side

$$P = a + b + c$$
$$15 = x + x + 1 + x + 2$$
$$15 = 3x + 3$$
$$15 - 3 = 3x + 3 - 3$$
$$12 = 3x$$
$$4 = x$$
$$x + 1 = 4 + 1$$
$$= 5$$
$$x + 2 = 4 + 2$$
$$= 6$$

The lengths of the sides of the triangle are 4 ft, 5 ft, and 6 ft.

11. a. Let l = the length of the run

$$A = lw$$
$$100 = l\left(12\tfrac{1}{2}\right)$$
$$100 = \frac{25}{2}l$$
$$2(100) = 2\left(\frac{25}{2}l\right)$$
$$200 = 25l$$
$$8 = l$$

The dimensions are 8yd by 12.5 yd.

b.
$$P = 2l + 2w$$
$$P = 2(8) + 2(12.5)$$
$$P = 16 + 25$$
$$P = 41$$

The perimeter is 41 yd.

12. Let x = the length of a side of the trapezoid

$2x$ = the length of the top of the trapezoid

(fence backyard) = (side) + (side) + (top)

(fence front yard) = $\frac{1}{2}$(side) + $\frac{1}{2}$(side) + (top)

(fence backyd) + (fence frontyd) = (total fence)

$$\left(x+x+2x\right)+\left(\tfrac{1}{2}x+\tfrac{1}{2}x+x\right)=60$$
$$4x+2x=60$$
$$6x=60$$
$$x=10$$

The sides of the back garden are 10 ft, 20 ft, and 10 ft. The sides of the front garden are 5 ft, 10 ft, and 5 ft.

13. Let w = the width of the pen

$2w - 7$ = the length of the pen

$$P=2l+2w$$
$$40=2\left(2w-7\right)+2w$$
$$40=4w-14+2w$$
$$40=6w-14$$
$$40+14=6w-14+14$$
$$54=6w$$
$$9=w$$
$$2w-7=2\left(9\right)-7=18-7=11$$

The width is 9 ft and the length is 11 ft.

14. Let s = the length of a side of the square

$$P=4s$$
$$18=4s$$
$$s=\frac{9}{2}=4\tfrac{1}{2}$$

The lengths of a side of the square is $4\frac{1}{2}$ ft.

15. Let x = the measure of the two equal angles

$2(x + x)$ = the measure of the third angle

$$x+x+2\left(x+x\right)=180$$
$$x+x+2x+2x=180$$
$$6x=180$$
$$x=30$$
$$2\left(x+x\right)=2\left(30+30\right)=120$$

The measures of the angles are 30º, 30º, and 120º.

16. Let x = the measure of the largest angle

$\frac{1}{2}x$ = the measure of the smallest angle

$x - 25$ = the measure of the middle angle

$$x+\tfrac{1}{2}x+\left(x-25\right)=180$$
$$2.5x-25=180$$

17. Let x = the measure of one angle

$5x$ = the measure of the other angle

$$x+5x=90$$
$$6x=90$$
$$x=15$$
$$5x=5\left(15\right)=75$$

$$2.5x - 25 + 25 = 180 + 25$$
$$2.5x = 205$$
$$x = 82$$
$$\tfrac{1}{2}x = \tfrac{1}{2}(82) = 41$$
$$x - 25 = 82 - 25 = 57$$

The measures of the angles are 82º, 41º, and 57º.

The measures of the complementary angles are 15º and 75º.

18. Let x = the measure of one angle
$3x - 12$ = the measure of the other angle

$$x + (3x - 12) = 180$$
$$4x - 12 = 180$$
$$4x - 12 + 12 = 180 + 12$$
$$4x = 192$$
$$x = 48$$
$$3x - 12 = 3(48) - 12 = 144 - 12 = 132$$

The measures of the supplementary angles are 48º and 132º.

19. $(7x - 1) + (2x + 1) = 180$

$$9x = 180$$
$$x = 20$$
$$7x - 1 = 7(20) - 1 = 139$$
$$2x + 1 = 2(20) + 1 = 41$$

The measures of the angles are 139º, and 41º.

20. $(10x + 36) + 2(x + 15) = 90$

$$10x + 36 + 2x + 30 = 90$$
$$12x + 66 = 90$$
$$12x + 66 - 66 = 90 - 66$$
$$12x = 24$$
$$x = 2$$
$$10x + 36 = 10(2) + 36 = 56$$
$$2(x + 15) = 2(2 + 15) = 34$$

The measures of the angles are 56º and 34º.

21. $(2x + 5) + (x + 2.5) = 90$

$$3x + 7.5 = 90$$
$$3x + 7.5 - 7.5 = 90 - 7.5$$
$$3x = 82.5$$
$$x = 27.5$$
$$2x + 5 = 2(27.5) + 5 = 60$$
$$x + 2.5 = 27.5 + 2.5 = 30$$

The measures of the angles are 60º, and 30º.

22. $(3x - 3) + 3(5x + 1) = 180$

$$3x - 3 + 15x + 3 = 180$$
$$18x = 180$$
$$x = 10$$

23. $(2x) + (5x + 1) + (x + 35) = 180$

$$8x + 36 = 180$$
$$8x + 36 - 36 = 180 - 36$$
$$8x = 144$$

$$\begin{aligned} 3x-3 &= 3(10)-3 \\ &= 27 \\ 3(5x+1) &= 3(5\cdot 10+1) \\ &= 3(51) \\ &= 153 \end{aligned}$$

The measures of the angles are 27º and 153º.

$$\begin{aligned} x &= 18 \\ 2x &= 2(18) \\ &= 36 \\ 5x+1 &= 5(18)+1 \\ &= 91 \\ x+35 &= 18+35 \\ &= 53 \end{aligned}$$

The measures of the angles are 36º, 91º, and 53º.

24. $(10x)+(x-2)+(20x-4)=180$

$$\begin{aligned} 31x-6 &= 180 \\ 31x-6+6 &= 180+6 \\ 31x &= 186 \\ x &= 6 \\ 10x &= 10(6)=60 \\ x-2 &= 6-2=4 \\ 20x-4 &= 20(6)-4 \\ &= 116 \end{aligned}$$

The measures of the angles are 60º, 4º, and 116º.

25. $(2x-4)+3(x-7)=90$

$$\begin{aligned} 2x-4+3x-21 &= 90 \\ 5x-25 &= 90 \\ 5x-25+25 &= 90+25 \\ 5x &= 115 \\ x &= 23 \\ 2x-4 &= 2(23)-4=42 \\ 3(x-7) &= 3(23-7) \\ &= 3(16) \\ &= 48 \end{aligned}$$

The measures of the angles are 42º and 48º.

26. $(x+2)+4(x-8)=90$

$$\begin{aligned} x+2+4x-32 &= 90 \\ 5x-30 &= 90 \\ 5x-30+30 &= 90+30 \\ 5x &= 120 \\ x &= 24 \\ x+2 &= 24+2 \\ &= 26 \\ 4(x-8) &= 4(24-8) \\ &= 4(16)=64 \end{aligned}$$

The measures of the angles are 26º and 64º.

27. a. $d = r\,t$

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

b. $r = \dfrac{500}{3.099} \approx 161.3 \text{ mph}$

The average speed was 161.3 mph.

28. **a.** $d = rt$

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

$$t = \frac{500}{157.5} \approx 3.2 \text{ hr}$$

b. The total time was 3.2 hr.

29. **a.** $I = Prt$

$$t = \frac{I}{Pr}$$

b. $$t = \frac{1400}{5000(0.04)} = 7 \text{ years}$$

30. **a.** $F = ma$

$$m = \frac{F}{a}$$

b. $$m = \frac{24.5}{9.8} = 2.5 \text{ kg}$$

31. $A = lw$ for l

$$\frac{A}{w} = \frac{lw}{w}$$

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

32. $$C_1 = \frac{5}{2}R \quad \text{for } R$$

$$\frac{2}{5}C_1 = \frac{2}{5} \cdot \frac{5}{2}R$$

$$R = \frac{2}{5}C_1$$

33. $I = Prt$ for P

$$\frac{I}{rt} = \frac{Prt}{rt}$$

$$P = \frac{I}{rt}$$

34. $$a + b + c = P \quad \text{for } b$$

$$a + b + c - a - c = P - a - c$$

$$b = P - a - c$$

35. $$W = K_2 - K_1 \quad \text{for } K_1$$

$$W + K_1 = K_2 - K_1 + K_1$$

$$W + K_1 = K_2$$

$$W - W + K_1 = K_2 - W$$

$$K_1 = K_2 - W$$

36. $$y = mx + b \quad \text{for } x$$

$$y - b = mx + b - b$$

$$y - b = mx$$

$$\frac{y - b}{m} = \frac{mx}{m}$$

$$x = \frac{y - b}{m}$$

37. $$F = \frac{9}{5}C + 32 \quad \text{for } C$$

$$5F = 5\left(\frac{9}{5}C + 32\right)$$

$$5F = 9C + 160$$

$$5F - 160 = 9C + 160 - 160$$

$$5F - 160 = 9C$$

$$\frac{5F-160}{9}=\frac{9C}{9}$$
$$C=\frac{5F-160}{9}$$
$$C=\frac{5(F-32)}{9}$$
$$=\frac{5}{9}(F-32)$$

38.
$$C=\frac{5}{9}(F-32) \quad \text{for } F$$
$$\frac{9}{5}C=\frac{9}{5}\cdot\frac{5}{9}(F-32)$$
$$\frac{9}{5}C=F-32$$
$$\frac{9}{5}C+32=F-32+32$$
$$F=\frac{9}{5}C+32$$

39.
$$K=\frac{1}{2}mv^2 \quad \text{for } v^2$$
$$2K=2\cdot\frac{1}{2}mv^2$$
$$2K=mv^2$$
$$\frac{2K}{m}=\frac{mv^2}{m}$$
$$v^2=\frac{2K}{m}$$

40.
$$I=Prt \quad \text{for } r$$
$$\frac{I}{Pt}=\frac{Prt}{Pt}$$
$$r=\frac{I}{Pt}$$

41.
$$v=v_0+at \quad \text{for } a$$
$$v-v_0=v_0-v_0+at$$
$$v-v_0=at$$
$$\frac{v-v_0}{t}=\frac{at}{t}$$
$$a=\frac{v-v_0}{t}$$

42.
$$a^2+b^2=c^2 \quad \text{for } b^2$$
$$a^2+b^2-a^2=c^2-a^2$$
$$b^2=c^2-a^2$$

43.
$$w=p(v_2-v_1) \quad \text{for } v_2$$
$$\frac{w}{p}=\frac{p(v_2-v_1)}{p}$$
$$\frac{w}{p}=v_2-v_1$$
$$\frac{w}{p}+v_1=v_2-v_1+v_1$$
$$v_2=\frac{w}{p}+v_1$$
$$v_2=\frac{w+pv_1}{p}$$

44. $A = lw$ for w

$$\frac{A}{l} = \frac{lw}{l}$$
$$w = \frac{A}{l}$$

45. $ax + by = c$ for y

$$ax + by - ax = c - ax$$
$$by = c - ax$$
$$\frac{by}{b} = \frac{c - ax}{b}$$
$$y = \frac{c - ax}{b}$$

46. $P = 2L + 2W$ for L

$$P - 2W = 2L + 2W - 2W$$
$$P - 2W = 2L$$
$$\frac{P - 2W}{2} = \frac{2L}{2}$$
$$L = \frac{P - 2W}{2}$$
$$L = \frac{P}{2} - W$$

47. $V = \frac{1}{3}Bh$ for B

$$3V = 3 \cdot \frac{1}{3}Bh$$
$$3V = Bh$$
$$\frac{3V}{h} = \frac{Bh}{h}$$
$$B = \frac{3V}{h}$$

48. $V = \frac{1}{3}\pi r^2 h$ for h

$$3V = 3 \cdot \frac{1}{3}\pi r^2 h$$
$$3V = \pi r^2 h$$
$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$$
$$h = \frac{3V}{\pi r^2}$$

49. $3x + y = 6$

$$3x - 3x + y = 6 - 3x$$
$$y = -3x + 6$$

50. $x + y = -4$

$$x - x + y = -4 - x$$
$$y = -x - 4$$

51. $5x - 4y = 20$

$$5x - 5x - 4y = 20 - 5x$$
$$-4y = 20 - 5x$$
$$\frac{-4y}{-4} = \frac{20 - 5x}{-4}$$
$$y = \frac{20 - 5x}{-4}$$
$$y = \frac{5}{4}x - 5$$

52.
$$\begin{aligned} -4x-5y &= 25 \\ -4x+4x-5y &= 25+4x \\ -5y &= 4x+25 \\ \frac{-5y}{-5} &= \frac{4x+25}{-5} \\ y &= -\frac{4}{5}x-5 \end{aligned}$$

53.
$$\begin{aligned} -6x-2y &= 13 \\ -6x+6x-2y &= 13+6x \\ -2y &= 6x+13 \\ \frac{-2y}{-2} &= \frac{6x+13}{-2} \\ y &= -3x-\frac{13}{2} \end{aligned}$$

54.
$$\begin{aligned} 5x-7y &= 15 \\ 5x-5x-7y &= 15-5x \\ -7y &= -5x+15 \\ \frac{-7y}{-7} &= \frac{-5x+15}{-7} \\ y &= \frac{5}{7}x-\frac{15}{7} \end{aligned}$$

55.
$$\begin{aligned} 3x-3y &= 6 \\ 3x-3x-3y &= 6-3x \\ -3y &= -3x+6 \\ \frac{-3y}{-3} &= \frac{-3x+6}{-3} \\ y &= x-2 \end{aligned}$$

56.
$$\begin{aligned} 2x-2y &= 8 \\ 2x-2x-2y &= 8-2x \\ -2y &= -2x+8 \\ \frac{-2y}{-2} &= \frac{-2x+8}{-2} \\ y &= x-4 \end{aligned}$$

57.
$$\begin{aligned} 9x+\frac{4}{3}y &= 5 \\ 3\left(9x+\frac{4}{3}y\right) &= 3(5) \\ 27x+4y &= 15 \\ 27x-27x+4y &= 15-27x \\ 4y &= -27x+15 \\ \frac{4y}{4} &= \frac{-27x+15}{4} \\ y &= -\frac{27}{4}x+\frac{15}{4} \end{aligned}$$

58.
$$\begin{aligned} 4x-\frac{1}{3}y &= 5 \\ 3\left(4x-\frac{1}{3}y\right) &= 3(5) \\ 12x-y &= 15 \\ 12x-12x-y &= 15-12x \\ -y &= -12x+15 \\ -1(-y) &= -1(-12x+15) \\ y &= 12x-15 \end{aligned}$$

59.
$$\begin{aligned} -x+\frac{2}{3}y &= 0 \\ -x+x+\frac{2}{3}y &= 0+x \\ \frac{2}{3}y &= x \\ \frac{3}{2}\cdot\frac{2}{3}y &= \frac{3}{2}x \\ y &= \frac{3}{2}x \end{aligned}$$

60.
$$x-\frac{1}{4}y=0$$
$$4\left(x-\frac{1}{4}y\right)=4(0)$$
$$4x-y=0$$
$$4x-y+y=0+y$$
$$y=4x$$

61. **a.**
$$z\cdot\sigma=\frac{x-\mu}{\sigma}\cdot\sigma$$
$$z=\frac{x-\mu}{\sigma}$$
$$z\sigma=x-\mu$$
$$z\sigma+\mu=x-\mu+\mu$$
$$x=z\sigma+\mu$$

b. $x=2.5(12)+100=30+100=130$

62. **a.**
$$z=\frac{x-\mu}{\sigma}$$
$$z\cdot\sigma=\frac{x-\mu}{\sigma}\cdot\sigma$$
$$z\sigma=x-\mu$$
$$z\sigma-x=-\mu$$
$$x-z\sigma=\mu \quad \text{or} \quad \mu=x-z\sigma$$

b.
$$\mu=x-z\sigma$$
$$=150-2.5(16)$$
$$=110$$

63.
$$\frac{-5}{x-3}=-\frac{5}{x-3}$$
$$\frac{-5}{x-3}=\frac{-1}{-1}\cdot\frac{-5}{x-3}$$
$$=\frac{5}{-x+3}$$
$$=\frac{5}{3-x}$$

Expressions a, b, and c are equivalent.

64.
$$\frac{z-1}{-2}=\frac{-1}{-1}\cdot\frac{z-1}{-2}=\frac{-z+1}{2}=\frac{1-z}{2}$$
$$\frac{z-1}{-2}=-\frac{z-1}{2}$$

Expressions a, b, and c are equivalent.

65.
$$\frac{-x-7}{y}=\frac{-1}{-1}\cdot\frac{-x-7}{y}=\frac{x+7}{-y}=-\frac{x+7}{y}$$

Expressions a and b are equivalent.

66.
$$\frac{-3w}{-x-y}=-\frac{3w}{-x-y}$$
$$\frac{-3w}{-x-y}=\frac{-1}{-1}\cdot\frac{-3w}{-x-y}$$
$$=\frac{3w}{x+y}$$
$$\frac{-3w}{-x-y}=\frac{-1}{-1}\cdot\frac{-3w}{-x-y}$$
$$=-\frac{-3w}{x+y}$$

Expressions a, b, and c are equivalent.

67. $6t-rt=12$ for t
$$t(6-r)=12$$
$$\frac{t(6-r)}{6-r}=\frac{12}{6-r}$$
$$t=\frac{12}{6-r}$$

68. $5 = 4a + ca$ for a

$$5 = a(4 + c)$$
$$\frac{5}{4+c} = \frac{a(4+c)}{4+c}$$
$$a = \frac{5}{4+c}$$

69. $ax + 5 = 6x + 3$ for x

$$ax - 6x + 5 = 6x - 6x + 3$$
$$ax - 6x + 5 = 3$$
$$ax - 6x + 5 - 5 = 3 - 5$$
$$ax - 6x = -2$$
$$x(a-6) = -2$$
$$\frac{x(a-6)}{a-6} = \frac{-2}{a-6}$$
$$x = \frac{-2}{a-6}$$
$$\text{or } x = \frac{2}{6-a}$$

70. $cx - 4 = dx + 9$ for x

$$cx - dx - 4 = dx - dx + 9$$
$$x(c-d) - 4 = 9$$
$$x(c-d) - 4 + 4 = 9 + 4$$
$$x(c-d) = 13$$
$$\frac{x(c-d)}{c-d} = \frac{13}{c-d}$$
$$x = \frac{13}{c-d} \text{ or } x = \frac{-13}{d-c}$$

71. $A = P + Prt$ for P

$$A = P(1 + rt)$$
$$\frac{A}{1+rt} = \frac{P(1+rt)}{1+rt}$$
$$P = \frac{A}{1+rt}$$

72. $A = P + Prt$ for r

$$A - P = P - P + Prt$$
$$A - P = Prt$$
$$\frac{A-P}{Pt} = \frac{Prt}{Pt}$$
$$r = \frac{A-P}{Pt}$$

73. $T = mg - mf$ for m

$$T = m(g - f)$$
$$\frac{T}{g-f} = \frac{m(g-f)}{g-f}$$
$$m = \frac{T}{g-f}$$

74. $T = mg - mf$ for f

$$T - mg = mg - mg - mf$$
$$T - mg = -mf$$

75. $ax + by = cx + z$ for x

$$ax - cx + by = cx - cx + z$$
$$x(a-c) + by = z$$

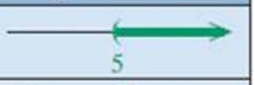
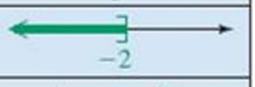
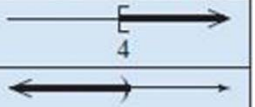
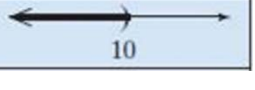
$$\frac{T-mg}{-m}=\frac{-mf}{-m}$$
$$f=\frac{T-mg}{-m} \text{ or } f=\frac{mg-T}{m}$$

$$x(a-c)+by-by=z-by$$
$$x(a-c)=z-by$$
$$\frac{x(a-c)}{a-c}=\frac{z-by}{a-c}$$
$$x=\frac{z-by}{a-c} \text{ or } x=\frac{by-z}{c-a}$$

Section 1.4 Practice Exercises

1. **a.** linear; inequality
b. negative
c. Both statements are correct.

2. parenthesis

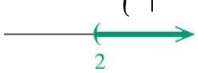
	Set-Builder Notation	Interval Notation	Graph
3.	$\{x \mid x > 5\}$	$(5, \infty)$	
4.	$\{x \mid x \le -2\}$	$(-\infty, -2]$	
5.	$\{x \mid -3 < x \le 6\}$	$(-3, 6]$	
6.	$\{x \mid 0 \le x < 4\}$	$[0, 4)$	
7.	$\{x \mid x \ge 4\}$	$[4, \infty)$	
8.	$\{x \mid x < 10\}$	$(-\infty, 10)$	

9. **a.** $-2x+4=10$
$-2x=10-4$
$-2x=6$
$x=-3$ $\{-3\}$ n/a

b. $-2x+4<10$
$-2x<10-4$
$-2x<6$
$x<-3$
$\{x \mid x>-3\}$ $(-3, \infty)$

10. **a.** $-4x+2=-6$
$-4x=-6-2$
$-4x=-8$
$x=2$ $\{2\}$ n/a

b. $-4x+2<-6$
$-4x<-6-2$
$-4x<-8$
$x<2$
$\{x \mid x>2\}$ $(2, \infty)$



c. $-2x+4>10$

$-2x>10-4$

$-2x>6$

$x<-3$

$\{x \mid x<-3\}$ $\quad (-\infty,-3)$

c. $-4x+2>-6$

$-4x>-6-2$

$-4x>-8$

$x<2$

$\{x \mid x<2\}$ $\quad (-\infty, 2)$

11. $2y+6\le 4$

$2y+6-6\le 4-6$

$2y\le -2$

$\frac{2y}{2}\le\frac{-2}{2}$

$y\le -1$

a. $\{y \mid y\le -1\}$

b. $(-\infty,-1]$

12. $3y+11>5$

$3y+11-11>5-11$

$3y>-6$

$\frac{3y}{3}>\frac{-6}{3}$

$y>-2$

a. $\{y \mid y>-2\}$

b. $(-2,\infty)$

13. $-2x-5\le -25$

$-2x-5+5\le -25+5$

$-2x\le -20$

$\frac{-2x}{-2}\ge\frac{-20}{-2}$

$x\ge\frac{-20}{-2}$

$x\ge 10$

a. $\{x \mid x\ge 10\}$

b. $[10,\infty)$

14. $-4z-2>-22$

$-4z-2+2>-22+2$

$-4z>-20$

$\frac{-4z}{-4}<\frac{-20}{-4}$

$z<\frac{-20}{-4}$

$z<5$

a. $\{z \mid z<5\}$

b. $(-\infty,5)$

15.
$$6z+3>16$$
$$6z+3-3>16-3$$
$$6z>13$$
$$\frac{6z}{6}>\frac{13}{6}$$
$$z>\frac{13}{6}$$

a. $\left\{z \,\middle|\, z>\frac{13}{6}\right\}$

b. $\left(\frac{13}{6},\infty\right)$

16.
$$8w-2\le 13$$
$$8w-2+2\le 13+2$$
$$8w\le 15$$
$$\frac{8w}{8}\le\frac{15}{8}$$
$$w\le\frac{15}{8}$$

a. $\left\{w \,\middle|\, w\le\frac{15}{8}\right\}$

b. $\left(-\infty,\frac{15}{8}\right]$

17.
$$-8>\frac{2}{3}t$$
$$\frac{3}{2}(-8)>\frac{3}{2}\cdot\frac{2}{3}t$$
$$-12>t$$
$$t<-12$$

a. $\{t \mid t<-12\}$

b. $(-\infty,-12)$

18.
$$-4\le\frac{1}{5}p$$
$$5(-4)\le 5\left(\frac{1}{5}p\right)$$
$$-20\le p$$
$$p\ge -20$$

a. $\{p \mid p\ge -20\}$

b. $[-20,\infty)$

19.
$$\frac{3}{4}(8y-9)<3$$
$$\frac{4}{3}\left[\frac{3}{4}(8y-9)\right]<\frac{4}{3}[3]$$
$$8y-9<4$$
$$8y-9+9<4+9$$
$$8y<13$$
$$\frac{8y}{8}<\frac{13}{8}$$
$$y<\frac{13}{8}$$

20.
$$\frac{2}{5}(2x-1)>10$$
$$\frac{5}{2}\left[\frac{2}{5}(2x-1)\right]>\frac{5}{2}[10]$$
$$2x-1>25$$
$$2x-1+1>25+1$$
$$2x>26$$
$$\frac{2x}{2}>\frac{26}{2}$$
$$x>13$$

a. $\left\{ y \,\middle|\, y < \frac{13}{8} \right\}$

b. $\left(-\infty, \frac{13}{8} \right)$

21.
$$0.8a - 0.5 \le 0.3a - 11$$
$$10(0.8a - 0.5) \le 10(0.3a - 11)$$
$$8a - 5 \le 3a - 110$$
$$8a - 3a - 5 \le 3a - 3a - 110$$
$$5a - 5 \le -110$$
$$5a - 5 + 5 \le -110 + 5$$
$$5a \le -105$$
$$\frac{5a}{5} \le \frac{-105}{5}$$
$$a \le -21$$

a. $\{ a \mid a \le -21 \}$

b. $(-\infty, -21]$

22.
$$0.2w - 0.7 < 0.4 - 0.9w$$
$$10(0.2w - 0.7) < 10(0.4 - 0.9w)$$
$$2w - 7 < 4 - 9w$$
$$2w + 9w - 7 < 4 - 9w + 9w$$
$$11w - 7 < 4$$
$$11w - 7 + 7 < 4 + 7$$
$$11w < 11$$
$$\frac{11w}{11} < \frac{11}{11}$$
$$w < 1$$

a. $\{ w \mid w < 1 \}$

b. $(-\infty, 1)$

23.
$$-5x + 7 < 22$$
$$-5x + 7 - 7 < 22 - 7$$
$$-5x < 15$$
$$\frac{-5x}{-5} > \frac{15}{-5}$$
$$x > \frac{15}{-5}$$
$$x > -3$$

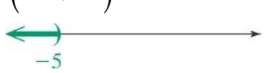
a. $\{ x \mid x > -3 \}$

b. $(-3, \infty)$

24.
$$-3w - 6 > 9$$
$$-3w - 6 + 6 > 9 + 6$$
$$-3w > 15$$
$$\frac{-3w}{-3} < \frac{15}{-3}$$
$$w < \frac{15}{-3}$$
$$w < -5$$

a. $\{ w \mid w < -5 \}$

b. $(-\infty, -5)$



25.

$$-\frac{5}{6}x \le -\frac{3}{4}$$
$$-\frac{6}{5}\left(-\frac{5}{6}x\right) \ge -\frac{6}{5}\left(-\frac{3}{4}\right)$$
$$x \ge \frac{18}{20}$$
$$x \ge \frac{9}{10}$$

a. $\left\{x \middle| x \ge \frac{9}{10}\right\}$

b. $\left[\frac{9}{10}, \infty\right)$

26.

$$-\frac{3}{2}y > -\frac{21}{16}$$
$$-\frac{2}{3}\left(-\frac{3}{2}y\right) < -\frac{2}{3}\left(-\frac{21}{16}\right)$$
$$y < \frac{42}{48}$$
$$y < \frac{7}{8}$$

a. $\left\{y \middle| y < \frac{7}{8}\right\}$

b. $\left(-\infty, \frac{7}{8}\right)$

27.

$$\frac{3p-1}{-2} > 5$$
$$-2\left(\frac{3p-1}{-2}\right) < -2(5)$$
$$3p-1 < -10$$
$$3p-1+1 < -10+1$$
$$3p < -9$$
$$\frac{3p}{3} < \frac{-9}{3}$$
$$p < -3$$

a. $\{p \mid p < -3\}$

b. $(-\infty, -3)$

28.

$$\frac{3k-2}{-5} \le 4$$
$$-5\left(\frac{3k-2}{-5}\right) \ge -5(4)$$
$$3k-2 \ge -20$$
$$3k-2+2 \ge -20+2$$
$$3k \ge -18$$
$$\frac{3k}{3} \ge \frac{-18}{3}$$
$$k \ge -6$$

a. $\{k \mid k \ge -6\}$

b. $[-6, \infty)$

29.

$$0.2t+1 > 2.4t-10$$
$$10(0.2t+1) > 10(2.4t-10)$$
$$2t+10 > 24t-100$$
$$2t-24t+10 > 24t-24t-100$$
$$-22t+10 > -100$$

30.

$$20 \le 8-\frac{1}{3}x$$
$$20-8 \le 8-8-\frac{1}{3}x$$
$$12 \le -\frac{1}{3}x$$

$$\begin{aligned} -22t+10-10 &> -100-10 \\ -22t &> -110 \\ \frac{-22t}{-22} &< \frac{-110}{-22} \\ t &< 5 \end{aligned}$$

a. $\{t \mid t < 5\}$

b. $(-\infty, 5)$

$$\begin{aligned} -3(12) &\geq -3\left(-\frac{1}{3}x\right) \\ -36 &\geq x \\ x &\leq -36 \end{aligned}$$

a. $\{x \mid x \leq -36\}$

b. $(-\infty, -36]$

31.
$$\begin{aligned} 3-4(y+2) &\leq 6+4(2y+1) \\ 3-4y-8 &\leq 6+8y+4 \\ -4y-5 &\leq 8y+10 \\ -4y-8y-5 &\leq 8y-8y+10 \\ -12y-5 &\leq 10 \\ -12y-5+5 &\leq 10+5 \\ -12y &\leq 15 \\ \frac{-12y}{-12} &\geq \frac{15}{-12} \\ y &\geq -\frac{5}{4} \end{aligned}$$

a. $\left\{y \mid y \geq -\frac{5}{4}\right\}$

b. $\left[-\frac{5}{4}, \infty\right)$

32.
$$\begin{aligned} 1+4(b-2) &< 2(b-5)+4 \\ 1+4b-8 &< 2b-10+4 \\ 4b-7 &< 2b-6 \\ 4b-2b-7 &< 2b-2b-6 \\ 2b-7 &< -6 \\ 2b-7+7 &< -6+7 \\ 2b &< 1 \\ \frac{2b}{2} &< \frac{1}{2} \\ b &< \frac{1}{2} \end{aligned}$$

a. $\left\{b \mid b < \frac{1}{2}\right\}$

b. $\left(-\infty, \frac{1}{2}\right)$

33.
$$\begin{aligned} 7.2k-5.1 &\geq 5.7 \\ 10(7.2k-5.1) &\geq 10(5.7) \\ 72k-51 &\geq 57 \\ 72k-51+51 &\geq 57+51 \\ 72k &\geq 108 \\ \frac{72k}{72} &\geq \frac{108}{72} \\ k &\geq \frac{3}{2} \quad \text{or} \quad k \geq 1.5 \end{aligned}$$

34.
$$\begin{aligned} 6h-2.92 &\leq 16.58 \\ 6h-2.92+2.92 &\leq 16.58+2.92 \\ 6h &\leq 19.5 \\ \frac{6h}{6} &\leq \frac{19.5}{6} \\ h &\leq 3.25 \end{aligned}$$

a. $\{k \mid k \geq 1.5\}$

b. $[1.5, \infty)$

35.
$$\frac{3}{4}x - 8 \leq 1$$
$$\frac{3}{4}x - 8 + 8 \leq 1 + 8$$
$$\frac{3}{4}x \leq 9$$
$$\frac{4}{3}\left(\frac{3}{4}x\right) \leq \frac{4}{3}(9)$$
$$x \leq \frac{4}{3}(9)$$
$$x \leq 12$$

a. $\{x \mid x \leq 12\}$

b. $(-\infty, 12]$

37.
$$-1.2b - 0.4 \geq -0.4b$$
$$-1.2b + 1.2b - 0.4 \geq -0.4b + 1.2b$$
$$-0.4 \geq 0.8b$$
$$\frac{-0.4}{0.8} \geq \frac{0.8b}{0.8}$$
$$-0.5 \geq b$$
$$b \leq -0.5$$

a. $\{b \mid b \leq -0.5\}$

b. $(-\infty, -0.5]$

a. $\{h \mid h \leq 3.25\}$

b. $(-\infty, 3.25]$

36.
$$-\frac{2}{5}a - 3 > 5$$
$$-\frac{2}{5}a - 3 + 3 > 5 + 3$$
$$-\frac{2}{5}a > 8$$
$$-\frac{5}{2}\left(-\frac{2}{5}a\right) < -\frac{5}{2}(8)$$
$$a < -\frac{5}{2}(8)$$
$$a < -20$$

a. $\{a \mid a < -20\}$

b. $(-\infty, -20)$

38.
$$-0.4t + 1.2 < -2$$
$$-0.4t + 1.2 - 1.2 < -2 - 1.2$$
$$-0.4t < -3.2$$
$$\frac{-0.4t}{-0.4} > \frac{-3.2}{-0.4}$$
$$t > \frac{-3.2}{-0.4}$$
$$t > 8$$

a. $\{t \mid t > 8\}$

b. $(8, \infty)$

39.

$$-\frac{3}{4}c-\frac{5}{4}\ge 2c$$
$$4\left(-\frac{3}{4}c-\frac{5}{4}\right)\ge 4(2c)$$
$$-3c-5\ge 8c$$
$$-3c+3c-5\ge 8c+3c$$
$$-5\ge 11c$$
$$\frac{-5}{11}\ge\frac{11c}{11}$$
$$-\frac{5}{11}\ge c$$
$$\text{or}\quad c\le -\frac{5}{11}$$

a. $\left\{c\,\middle|\,c\le -\frac{5}{11}\right\}$

b. $\left(-\infty,-\frac{5}{11}\right]$

40.

$$-\frac{2}{3}q-\frac{1}{3}>\frac{1}{2}q$$
$$6\left(-\frac{2}{3}q-\frac{1}{3}\right)>6\left(\frac{1}{2}q\right)$$
$$-4q-2>3q$$
$$-4q+4q-2>3q+4q$$
$$-2>7q$$
$$\frac{-2}{7}>\frac{7q}{7}$$
$$-\frac{2}{7}>q$$
$$\text{or}\quad q<-\frac{2}{7}$$

a. $\left\{q\,\middle|\,q<-\frac{2}{7}\right\}$

b. $\left(-\infty,-\frac{2}{7}\right)$

41.

$$4-4(y-2)<-5y+6$$
$$4-4y+8<-5y+6$$
$$-4y+12<-5y+6$$
$$-4y+5y+12<-5y+5y+6$$
$$y+12<6$$
$$y+12-12<6-12$$
$$y<-6$$

a. $\{y\,|\,y<-6\}$

b. $(-\infty,-6)$

42.

$$6-6(k-3)\ge -4k+12$$
$$6-6k+18\ge -4k+12$$
$$-6k+24\ge -4k+12$$
$$-6k+4k+24\ge -4k+4k+12$$
$$-2k+24\ge 12$$
$$-2k+24-24\ge 12-24$$
$$-2k\ge -12$$
$$\frac{-2k}{-2}\le\frac{-12}{-2}$$
$$k\le\frac{-12}{-2}$$
$$k\le 6$$

a. $\{k\,|\,k\le 6\}$

b. $(-\infty,6]$

43.
$$\begin{aligned} -6(2x+1) &< 5-(x-4)-6x \\ -12x-6 &< 5-x+4-6x \\ -12x-6 &< -7x+9 \\ -12x+7x-6 &< -7x+7x+9 \\ -5x-6 &< 9 \\ -5x-6+6 &< 9+6 \\ -5x &< 15 \\ \frac{-5x}{-5} &> \frac{15}{-5} \\ x &> -3 \end{aligned}$$

a. $\{x \mid x > -3\}$

b. $(-3, \infty)$

44.
$$\begin{aligned} 2(4p+3)-p &\le 5+3(p-3) \\ 8p+6-p &\le 5+3p-9 \\ 7p+6 &\le 3p-4 \\ 7p-3p+6 &\le 3p-3p-4 \\ 4p+6 &\le -4 \\ 4p+6-6 &\le -4-6 \\ 4p &\le -10 \\ \frac{4p}{4} &\le \frac{-10}{4} \\ p &\le -\frac{5}{2} \end{aligned}$$

a. $\left\{p \mid p \le -\frac{5}{2}\right\}$

b. $\left(-\infty, -\frac{5}{2}\right]$

45.
$$\begin{aligned} 6a-(9a+1)-3(a-1) &\ge 2 \\ 6a-9a-1-3a+3 &\ge 2 \\ -6a+2 &\ge 2 \\ -6a+2-2 &\ge 2-2 \\ -6a &\ge 0 \\ \frac{-6a}{-6} &\le \frac{0}{-6} \\ a &\le 0 \end{aligned}$$

a. $\{a \mid a \le 0\}$

b. $(-\infty, 0]$

46.
$$\begin{aligned} 8(q+1)-(2q+1)+5 &> 12 \\ 8q+8-2q-1+5 &> 12 \\ 6q+12 &> 12 \\ 6q+12-12 &> 12-12 \\ 6q &> 0 \\ \frac{6q}{6} &> \frac{0}{6} \\ q &> 0 \end{aligned}$$

a. $\{q \mid q > 0\}$

b. $(0, \infty)$

47. a.
$$80 \le \frac{80+86+73+91+x}{5} < 90$$
$$5 \cdot 80 \le 5 \cdot \frac{80+86+73+91+x}{5} < 5 \cdot 90$$

48. a.
$$75 \le \frac{78+75+71+83+73+x}{6} < 80$$
$$6 \cdot 75 \le 6 \cdot \frac{78+75+71+83+73+x}{6} < 6 \cdot 80$$

$$400 \le 330 + x < 450$$
$$400 - 330 \le 330 - 330 + x < 450 - 330$$
$$70 \le x < 120$$

Nadia needs to score at least a 70% but less than 120% to get a B average.

$$450 \le 380 + x < 480$$
$$450 - 380 \le 380 - 380 + x < 480 - 380$$
$$70 \le x < 100$$

Ty needs to score at least a 70% but less than 100% to get a C average.

b.
$$\frac{80+86+73+91+x}{5} \ge 90$$
$$5 \cdot \frac{80+86+73+91+x}{5} \ge 5 \cdot 90$$
$$330 + x \ge 450$$
$$330 - 330 + x \ge 450 - 330$$
$$x \ge 120$$

It would be impossible for Nadia to get an A because she would have to earn 120% on her last quiz and it is impossible to earn more than 100%.

b.
$$\frac{78+75+71+83+73+x}{6} \ge 80$$
$$6 \cdot \frac{78+75+71+83+73+x}{6} \ge 6 \cdot 80$$
$$380 + x \ge 480$$
$$380 - 380 + x \ge 480 - 380$$
$$x \ge 100$$

It would be possible for Ty to get a B if he scored 100% on his last exam, but it would be impossible to get an A.

49.
$$2.5a + 31 \ge 51$$
$$2.5a + 31 - 31 \ge 51 - 31$$
$$2.5a \ge 20$$
$$\frac{2.5a}{2.5} \ge \frac{20}{2.5}$$
$$a \ge 8$$

Boys 8 years old or older will be on average at least 51 in. tall.

50.
$$2.5a + 31 \ge 41$$
$$2.5a + 31 - 31 \ge 41 - 31$$
$$2.5a \ge 10$$
$$\frac{2.5a}{2.5} \ge \frac{10}{2.5}$$
$$a \ge 4$$

Boys 4 years old or older will be on average at least 41 in. tall.

51.
$$2.5a + 31 \le 46$$
$$2.5a + 31 - 31 \le 46 - 31$$
$$2.5a \le 15$$
$$\frac{2.5a}{2.5} \le \frac{15}{2.5}$$
$$a \le 6$$

Boys 6 years old or younger will be on average no more than 46 in. tall.

52.
$$2.5a + 31 \le 53.5$$
$$2.5a + 31 - 31 \le 53.5 - 31$$
$$2.5a \le 22.5$$
$$\frac{2.5a}{2.5} \le \frac{22.5}{2.5}$$
$$a \le 9$$

Boys 9 years old or younger will be on average at most 53.5 in. tall.

53. a.
$$25,000 + 0.04x > 40,000$$
$$25,000 - 25,000 + 0.04x > 40,000 - 25,000$$
$$0.04x > 15,000$$
$$\frac{0.04x}{0.04} > \frac{15,000}{0.04}$$
$$x > 375,000$$

Her sales must exceed \$375,000.

b.
$$25,000 + 0.04x > 80,000$$
$$25,000 - 25,000 + 0.04x > 80,000 - 25,000$$
$$0.04x > 55,000$$
$$\frac{0.04x}{0.04} > \frac{55,000}{0.04}$$
$$x > 1,375,000$$

Her sales must exceed \$1,375,000.

c. The base salary is still the same; the increase comes solely from commission.

54. a.
$$5000 + 5000(0.065)t > 10,000$$
$$5000 - 5000 + 325t > 10,000 - 5000$$
$$325t > 5000$$
$$\frac{325t}{325} > \frac{5000}{325}$$
$$t > 15.4$$

It will take at least 15.4 years.

b.
$$5000 + 5000(0.065)t > 15,000$$
$$5000 - 5000 + 325t > 15,000 - 5000$$
$$325t > 10,000$$
$$\frac{325t}{325} > \frac{10,000}{325}$$
$$t > 30.8$$

It will take at least 30.8 years.

55.
$$R > C$$
$$49.95x > 2300 + 18.50x$$
$$49.95x - 18.50x > 2300 + 18.50x - 18.50x$$
$$31.45x > 2300$$

56.
$$R > C$$
$$249.95x > 56,000 + 140x$$
$$249.95x - 140x > 56,000 + 140x - 140x$$
$$109.95x > 56,000$$

$$\frac{31.45x}{31.45} > \frac{2300}{31.45}$$
$$x > 73.13$$

There will be a profit if more than 73 jackets are sold.

$$\frac{109.95x}{109.95} > \frac{56{,}000}{109.95}$$
$$x > 509.32$$

There will be a profit if more than 509 bicycles are sold.

57. $a > b$
$a + c > b + c$

58. $a > b$
$a + c > b + c$

59. $a > b$
$ac < bc$ for $c < 0$

60. $a > b$
$ac > bc$ for $c > 0$

Section 1.5 Practice Exercises

1. **a.** union; $A \cup B$

b. intersection; $A \cap B$

c. intersection

d. $a < x < b$

e. union

2. $4 < x + 1$
$3 < x$
$x > 3 \qquad \{x \mid x > 3\} \qquad (3, \infty)$

3. $-6u + 8 > 2$
$-6u > -6$
$\frac{-6u}{-6} < \frac{-6}{-6}$
$u < 1 \qquad (-\infty, 1)$

4. $2 - 3z \geq -4$
$-3z \geq -6$
$\frac{-3z}{-3} \leq \frac{-6}{-3}$
$z \leq 2 \qquad (-\infty, 2]$

5. $-12 \leq \frac{3}{4}p$
$\frac{4}{3}(-12) \leq \frac{4}{3}\left(\frac{3}{4}p\right)$
$-16 \leq p$
$p \geq -16 \qquad [-16, \infty)$

6. $5 > \frac{1}{3}w$
$3(5) > 3\left(\frac{1}{3}w\right)$
$15 > w \qquad (-\infty, 15)$

7. **a.** $M \cap N = \{-3, -1\}$

b. $M \cup N = \{-4, -3, -2, -1, 0, 1, 3, 5\}$

8. **a.** $P \cap Q = \{a, e, i\}$

b. $P \cup Q = \{a, b, c, d, e, f, g, h, i, o, u\}$

9. $A \cap C = [-7,-4)$

10. $B \cap C = (2,\infty)$

11. $A \cup B = (-\infty,-4) \cup (2,\infty)$

12. $A \cup D = (-\infty,-4) \cup [0,5)$

13. $A \cap B = \{\ \}$

14. $A \cap D = \{\ \}$

15. $B \cup C = [-7,\infty)$

16. $B \cup D = [0,\infty)$

17. $C \cap D = [0,5)$

18. $B \cap D = (2,5)$

19. $C \cup D = [-7,\infty)$

20. $A \cup C = (-\infty,\infty)$

21. **a.** $(-2,5) \cap [-1,\infty)$
$= [-1,5)$

b. $(-2,5) \cup [-1,\infty)$
$= (-2,\infty)$

22. **a.** $(-\infty,4) \cap [-1,5)$
$= [-1,4)$

b. $(-\infty,4) \cup [-1,5)$
$= (-\infty,5)$

23. **a.** $\left(-\frac{5}{2},3\right) \cap \left(-1,\frac{9}{2}\right)$
$= (-1,3)$

b. $\left(-\frac{5}{2},3\right) \cup \left(-1,\frac{9}{2}\right)$
$= \left(-\frac{5}{2},\frac{9}{2}\right)$

24. **a.** $(-3.4,1.6) \cap (-2.2,4.1)$
$= (-2.2,1.6)$

b. $(-3.4,1.6) \cup (-2.2,4.1)$
$= (-3.4,4.1)$

25. **a.** $(-4,5] \cap (0,2] = (0,2]$

b. $(-4,5] \cup (0,2] = (-4,5]$

26. **a.** $[-1,5) \cap (0,3) = (0,3)$

b. $[-1,5) \cup (0,3) = [-1,5)$

27. $y - 7 \geq -9$ and $y + 2 \leq 5$

$y \geq -2 \quad \cap \quad y \leq 3$

$[-2,\infty) \cap (-\infty,3] = [-2,3]$

28. $a + 6 > -2$ and $5a < 30$

$a > -8 \quad \cap \quad a < 6$

$(-8,\infty) \cap (-\infty,6) = (-8,6)$

29. $2t+7<19$ and $5t+13>28$

$2t<12 \quad \cap \quad 5t>15$

$t<6 \quad \cap \quad t>3$

$(-\infty,6)\cap(3,\infty)=(3,6)$

30. $5p+2p\geq -21$ and $-9p+3p\geq -24$

$7p\geq -21 \quad \cap \quad -6p\geq -24$

$p\geq -3 \quad \cap \quad p\leq 4$

$[-3,\infty)\cap(-\infty,4]=[-3,4]$

31. $2.1k-1.1\leq 0.6k+1.9$ and $0.3k-1.1<-0.1k+0.9$

$10(2.1k-1.1)\leq 10(0.6k+1.9)$ and $10(0.3k-1.1)<10(-0.1k+0.9)$

$21k-11\leq 6k+19$ and $3k-11<-k+9$

$15k-11\leq 19 \quad \cap \quad 4k-11<9$

$15k\leq 30 \quad \cap \quad 4k<20$

$k\leq 2 \quad \cap \quad k<5$

$(-\infty,2]\cap(-\infty,5)=(-\infty,2]$

32. $0.6w+0.1>0.3w-1.1$ and $2.3w+1.5\geq 0.3w+6.5$

$10(0.6w+0.1)>10(0.3w-1.1)$ and $10(2.3w+1.5)\geq 10(0.3w+6.5)$

$6w+1>3w-11$ and $23w+15\geq 3w+65$

$3w+1>-11 \quad \cap \quad 20w+15\geq 65$

$3w>-12 \quad \cap \quad 20w\geq 50$

$w>-4 \quad \cap \quad w\geq \frac{50}{20}=\frac{5}{2}$

$(-4,\infty)\cap\left[\frac{5}{2},\infty\right)=\left[\frac{5}{2},\infty\right)$

33. $\frac{2}{3}(2p-1)\geq 10$ and $\frac{4}{5}(3p+4)\geq 20$

$\frac{3}{2}\cdot\frac{2}{3}(2p-1)\geq\frac{3}{2}\cdot 10\cap\frac{5}{4}\cdot\frac{4}{5}(3p+4)\geq\frac{5}{4}\cdot 20$

$2p-1\geq 15 \quad \cap \quad 3p+4\geq 25$

$2p\geq 16 \quad \cap \quad 3p\geq 21$

$p\geq 8 \quad \cap \quad p\geq 7$

34. $\frac{5}{2}(a+2)<-6$ and $\frac{3}{4}(a-2)<1$

$5(a+2)<2(-6)$ and $3(a-2)<4(1)$

$5a+10<-12 \quad \cap \quad 3a-6<4$

$5a<-22 \quad \cap \quad 3a<10$

$a<-\frac{22}{5} \quad \cap \quad a<\frac{10}{3}$

$\left(-\infty,-\frac{22}{5}\right)\cap\left(-\infty,\frac{10}{3}\right)=\left(-\infty,-\frac{22}{5}\right)$

$[8,\infty)\cap[7,\infty)=[8,\infty)$

35. $-2<-x-12$ and $-14<5(x-3)+6x$

$10<-x \quad \cap \quad -14<5x-15+6x$

$-10>x \quad \cap \quad -14<11x-15$

$x<-10 \quad \cap \quad 1<11x$

$x<-10 \quad \cap \quad x>\frac{1}{11}$

$(-\infty,-10)\cap\left(\frac{1}{11},\infty\right)=\{\ \}$

36. $-8\geq -3y-2$ and $3(y-7)+16>4y$

$-6\geq -3y \quad \cap \quad 3y-21+16>4y$

$2\leq y \quad \cap \quad 3y-5>4y$

$y\geq 2 \quad \cap \quad -5>y$

$y\geq 2 \quad \cap \quad y<-5$

$[2,\infty)\cap(-\infty,-5)=\{\ \}$

37. $-4\leq t$ and $t<\frac{3}{4}$

38. $-2.8<y$ and $y\leq 15$

39. The statement $6<x<2$ is equivalent to $6<x$ and $x<2$. However, no real number is greater than 6 and also less than 2.

40. The statement $4<t<1$ is equivalent to $4<t$ and $t<1$. However, no real number is greater than 4 and also less than 1.

41. The statement $-5>y>-2$ is equivalent to $-5>y$ and $y>-2$. However, no real number is less than –5 and also greater than –2.

42. The statement $-3>w>-1$ is equivalent to $-3>w$ and $w>-1$.
However, no real number is less than –3 and also greater than –1.

43. $0\leq 2b-5<9$

$5\leq 2b<14$

$\frac{5}{2}\leq b<7 \quad \left[\frac{5}{2},7\right)$

44. $-6<3k-9\leq 0$

$3<3k\leq 9$

$1<k\leq 3$

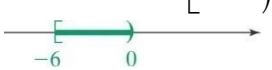
$(1,3]$

45. $-1<\frac{a}{6}\leq 1$

$-6<a\leq 6 \quad (-6,6]$

46. $-3\leq\frac{1}{2}x<0$

$-6\leq x<0 \quad [-6,0)$



47. $-\frac{2}{3} < \frac{y-4}{-6} < \frac{1}{3}$

$4 > y-4 > -2$

$8 > y > 2 \qquad (2,8)$

48. $\frac{1}{3} > \frac{t-4}{-3} > -2$

$-1 < t-4 < 6$

$3 < t < 10 \qquad (3,10)$

49. $5 \le -3x-2 \le 8$

$7 \le -3x \le 10$

$-\frac{7}{3} \ge x \ge -\frac{10}{3}$

$\left[-\frac{10}{3}, -\frac{7}{3}\right]$

50. $-1 < -2x+4 \le 5$

$-5 < -2x \le 1$

$\frac{5}{2} > x \ge -\frac{1}{2}$

$\left[-\frac{1}{2}, \frac{5}{2}\right)$

51. $12 > 6x+3 \ge 0$

$9 > 6x \ge -3$

$\frac{3}{2} > x \ge -\frac{1}{2} \qquad \left[-\frac{1}{2}, \frac{3}{2}\right)$

52. $-4 \ge 2x-5 > -7$

$1 \ge 2x > -2$

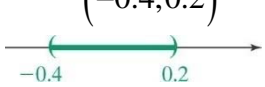
$\frac{1}{2} \ge x > -1 \qquad \left(-1, \frac{1}{2}\right]$

53. $-0.2 < 2.6+7t < 4$

$-2.8 < 7t < 1.4$

$-0.4 < t < 0.2$

$(-0.4, 0.2)$



54. $-1.5 < 0.1x \le 8.1$

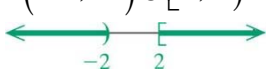
$-15 < x \le 81 \qquad (-15, 81]$

55. $2y-1 \ge 3$ or $y < -2$

$2y \ge 4 \cup y < -2$

$y \ge 2 \cup y < -2$

$(-\infty, -2) \cup [2, \infty)$

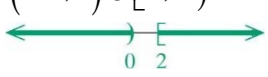


56 $x < 0$ or $3x+1 \ge 7$

$x < 0 \cup 3x \ge 6$

$x < 0 \cup x \ge 2$

$(-\infty, 0) \cup [2, \infty)$



57. $1 > 6z - 8$ or $8z - 6 \le 10$

$9 > 6z \quad \cup \quad 8z \le 16$

$\frac{3}{2} > z \quad \cup \quad z \le 2$

$\left(-\infty, \frac{3}{2}\right) \cup \left(-\infty, 2\right] = \left(-\infty, 2\right]$

58. $22 > 4t - 10$ or $7 > 2t - 5$

$32 > 4t \quad \cup \quad 12 > 2t$

$8 > t \quad \cup \quad 6 > t$

$\left(-\infty, 8\right) \cup \left(-\infty, 6\right) = \left(-\infty, 8\right)$

59. $5(x-1) \ge -5$ or $5 - x \le 11$

$5x - 5 \ge -5 \quad \cup \quad -x \le 6$

$5x \ge 0 \quad \cup \quad x \ge -6$

$x \ge 0 \quad \cup \quad x \ge -6$

$\left[0, \infty\right) \cup \left[-6, \infty\right) = \left[-6, \infty\right)$

60. $-p + 7 \ge 10$ or $3(p-1) \le 12$

$-p \ge 3 \quad \cup \quad 3p - 3 \le 12$

$p \le -3 \quad \cup \quad 3p \le 15$

$p \le -3 \quad \cup \quad p \le 5$

$\left(-\infty, -3\right] \cup \left(-\infty, 5\right] = \left(-\infty, 5\right]$

61. $\frac{5}{3}v \le 5$ or $-v - 6 < 1$

$\frac{3}{5} \cdot \frac{5}{3}v \le \frac{3}{5} \cdot 5 \cup \quad -v < 7$

$v \le 3 \quad \cup \quad v > -7$

$\left(-\infty, 3\right] \cup \left(-7, \infty\right) = \left(-\infty, \infty\right)$

62. $\frac{3}{8}u + 1 > 0$ or $-2u \ge -4$

$\frac{3}{8}u > -1 \quad \cup \; u \le 2$

$\frac{8}{3} \cdot \frac{3}{8}u > \frac{8}{3}(-1) \cup \; u \le 2$

$u > -\frac{8}{3} \quad \cup \; u \le 2$

$\left(-\frac{8}{3}, \infty\right) \cup \left(-\infty, 2\right] = \left(-\infty, \infty\right)$

63. $0.5w + 5 < 2.5w - 4$

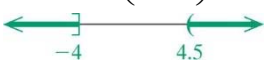
or $0.3w \le -0.1w - 1.6$

$-2w + 5 < -4 \quad \cup \quad 0.4w \le -1.6$

$-2w < -9 \quad \cup \quad w \le -4$

$w > \frac{9}{2} \quad \cup \quad w \le -4$

$\left(\frac{9}{2}, \infty\right) \cup \left(-\infty, -4\right]$



64. $1.25a + 3 \le 0.5a - 6$ or $2.5a - 1 \ge 9 - 1.5a$

$0.75a + 3 \le -6 \quad \cup \quad 4a - 1 \ge 9$

$0.75a \le -9 \quad \cup \quad 4a \ge 10$

$a \le -12 \quad \cup \quad a \ge \frac{5}{2}$

$\left(-\infty, -12\right] \cup \left[\frac{5}{2}, \infty\right)$

65. **a.** $3x-5<19$ and $-2x+3<23$

$3x<24 \quad \cap \quad -2x<20$

$x<8 \quad \cap \quad x>-10$

$(-\infty,8)\cap(-10,\infty)=(-10,8)$

b. $3x-5<19$ or $-2x+3<23$

$3x<24 \quad \cup \quad -2x<20$

$x<8 \quad \cup \quad x>-10$

$(-\infty,8)\cup(-10,\infty)=(-\infty,\infty)$

66. **a.** $0.5(6x+8)>0.8x-7$ and $4(x+1)<7.2$

$3x+4>0.8x-7 \quad \cap \quad 4x+4<7.2$

$2.2x+4>-7 \quad \cap \quad 4x<3.2$

$2.2x>-11 \quad \cap \quad x<0.8$

$x>-5 \quad \cap \quad x<0.8$

$(-5,\infty)\cap(-\infty,0.8)=(-5,0.8)$

b. $0.5(6x+8)>0.8x-7$ or $4(x+1)<7.2$

$3x+4>0.8x-7 \quad \cup \quad 4x+4<7.2$

$2.2x+4>-7 \quad \cup \quad 4x<3.2$

$2.2x>-11 \quad \cup \quad x<0.8$

$x>-5 \quad \cup \quad x<0.8$

$(-5,\infty)\cup(-\infty,0.8)=(-\infty,\infty)$

67. **a.** $8x-4\geq 6.4$ or $0.3(x+6)\leq -0.6$

$8x\geq 10.4 \quad \cup \quad x+6\leq -2$

$x\geq 1.3 \quad \cup \quad x\leq -8$

$[1.3,\infty)\cup(-\infty,-8]$

b. $8x-4\geq 6.4$ and $0.3(x+6)\leq -0.6$

$8x\geq 10.4 \quad \cap \quad x+6\leq -2$

$x\geq 1.3 \quad \cap \quad x\leq -8$

$[1.3,\infty)\cap(-\infty,-8]=$ No Solution

68. **a.** $-2r+4\leq -8$ or $3r+5\leq 8$

$-2r\leq -12 \cup \quad 3r\leq 3$

$r\geq 6 \quad \cup \quad r\leq 1$

$[6,\infty)\cup(-\infty,1]$

b. $-2r+4\leq -8$ and $3r+5\leq 8$

$-2r\leq -12 \cap \quad 3r\leq 3$

$r\geq 6 \quad \cap \quad r\leq 1$

$[6,\infty)\cap(-\infty,1]=$ No Solution

69. $-4\leq \dfrac{2-4x}{3}<8$

$-12\leq 2-4x<24$

$-14\leq -4x<22$

$\dfrac{7}{2}\geq x>-\dfrac{11}{2} \quad \left(-\dfrac{11}{2},\dfrac{7}{2}\right]$

70. $-1<\dfrac{3-x}{2}\leq 0$

$-2<3-x\leq 0$

$-5<-x\leq -3$

$5>x\geq 3 \quad [3,5)$

71. $5\geq -4(t-3)+3t$ or $6<12t+8(4-t)$

$5\geq -4t+12+3t \cup \quad 6<12t+32-8t$

$5\geq -t+12 \quad \cup \quad 6<4t+32$

72. $3>-(w-3)+4w$ or $-5\geq -3(w-5)+6w$

$3>-w+3+4w \cup \quad -5\geq -3w+15+6w$

$3>3w+3 \quad \cup \quad -5\geq 3w+15$

$$\begin{array}{lcl} -7 \geq -t & \cup & -26 < 4t \\ 7 \leq t & \cup & -\frac{13}{2} < t \end{array}$$

$$[7,\infty) \cup \left(-\frac{13}{2},\infty\right)$$

$$= \left(-\frac{13}{2},\infty\right)$$

$$\begin{array}{lcl} 0 > 3w & \cup & -20 \geq 3w \\ 0 > w & \cup & -\frac{20}{3} \geq w \end{array}$$

$$(-\infty,0) \cup \left(-\infty,-\frac{20}{3}\right]$$

$$= (-\infty,0)$$

73. $\dfrac{-x+3}{2} > \dfrac{4+x}{5}$ or $\dfrac{1-x}{4} > \dfrac{2-x}{3}$

$$5(-x+3) > 2(4+x) \cup 3(1-x) > 4(2-x)$$

$$\begin{array}{lcl} -5x+15 > 8+2x & \cup & 3-3x > 8-4x \\ -7x+15 > 8 & \cup & 3+x > 8 \\ -7x > -7 & \cup & x > 5 \\ x < 1 & \cup & x > 5 \end{array}$$

$$(-\infty,1) \cup (5,\infty)$$

74. $\dfrac{y-7}{-3} < \dfrac{1}{4}$ or $\dfrac{y+1}{-2} > -\dfrac{1}{3}$

$$-12\left(\frac{y-7}{-3}\right) > -12\left(\frac{1}{4}\right) \cup -6\left(\frac{y+1}{-2}\right) < -6\left(-\frac{1}{3}\right)$$

$$\begin{array}{lcl} 4(y-7) > -3 & \cup & 3(y+1) < 2 \\ 4y-28 > -3 & \cup & 3y+3 < 2 \\ 4y > 25 & \cup & 3y < -1 \\ y > \frac{25}{4} & \cup & y < -\frac{1}{3} \end{array}$$

$$\left(\frac{25}{4},\infty\right) \cup \left(-\infty,-\frac{1}{3}\right)$$

75. **a.** $4800 \leq x \leq 10{,}800$

b. $x < 4800$ or $x > 10{,}800$

76. **a.** $13 \leq x \leq 16$

b. $x < 13$ or $x > 16$

77. **a.** $44\% < x < 48\%$

b. $x \leq 44\%$ or $x \geq 48\%$

78. **a.** $2.4 < x < 2.6$

b. $x \leq 2.4$ or $x \geq 2.6$

79. $-3 < 2x < 12$

$-\dfrac{3}{2} < x < 6$

All real numbers between $-\dfrac{3}{2}$ and 6

80. $0 < x-6 < 8$

$6 < x < 14$

All real numbers between 6 and 14

81. $2x+1 > 5$ or $2x+1 < -1$

$2x > 4$ or $2x < -2$

$x > 2$ or $x < -1$

All real numbers greater than 2 or less than -1

82. $\dfrac{1}{3}x < -2$ or $\dfrac{1}{3}x > 5$

$x < -6$ or $x > 15$

All real numbers less than -6 or greater than 15

83. **a.** $0.8(92)+0.2x \ge 90$

$73.6+0.2x \ge 90$

$0.2x \ge 16.4$

$x \ge 82$

Amy would need 82% or better on her final exam.

b. $80 \le 0.8(92)+0.2x < 90$

$80 \le 73.6+0.2x < 90$

$6.4 \le 0.2x < 16.4$

$32 \le x < 82$

If Amy scores at least 32% and less than 82% on her final exam, she will receive a "B" in the class.

84. **a.** $0.6(89)+0.4x \ge 90$

$53.4+0.4x \ge 90$

$0.4x \ge 36.6$

$x \ge 91.5$

Robert would need 91.5% or better on his final exam.

b. $80 \le 0.6(89)+0.4x < 90$

$80 \le 53.4+0.4x < 90$

$26.6 \le 0.4x < 36.6$

$66.5 \le x < 91.5$

If Robert scores at least 66.5% and less than 91.5% on his final exam, he will receive a "B" in the class.

85. $0.0 \le \frac{5}{9}(F-32) \le 5.6$

$9(0.0) \le 9 \cdot \frac{5}{9}(F-32) \le 9(5.6)$

$0 \le 5(F-32) \le 50.4$

$0 \le 5F-160 \le 50.4$

$0+160 \le 5F-160+160 \le 50.4+160$

$160 \le 5F \le 210.4$

$\frac{160}{5} \le \frac{5F}{5} \le \frac{210.4}{5}$

$32° \le F \le 42.08°$

86. $20 \le \frac{5}{9}(F-32) \le 29$

$9(20) \le 9 \cdot \frac{5}{9}(F-32) \le 9(29)$

$180 \le 5(F-32) \le 261$

$180 \le 5F-160 \le 261$

$180+160 \le 5F-160+160 \le 261+160$

$340 \le 5F \le 421$

$\frac{340}{5} \le \frac{5F}{5} \le \frac{421}{5}$

$68° \le F \le 84.2°$

Section 1.6 Practice Exercises

1. **a.** absolute; $\{a,-a\}$

b. Subtract 5 from both sides.

c. y; $-y$

d. $\{\ \}$; $\{-4\}$

2. $3(a+2)-6>2$ and $-2(a-3)+14>-3$

$3a+6-6>2 \ \cap \ -2a+6+14>-3$

$3a>2 \ \cap \ -2a>-23$

$a>\frac{2}{3} \ \cap \ a<\frac{23}{2}$

$\left(\frac{2}{3},\infty\right)\cap\left(-\infty,\frac{23}{2}\right)=\left(\frac{2}{3},\frac{23}{2}\right)$

3. $3x-5\ge 7x+3$ or $2x-1\le 4x-5$

$-4x-5\ge 3 \quad \cup \quad -2x-1\le -5$

$-4x\ge 8 \quad \cup \quad -2x\le -4$

$x\le -2 \quad \cup \quad x\ge 2$

$(-\infty,-2]\cup[2,\infty)$

4. $-5<2-x\le 6$

$-7<-x\le 4$

$-1(-7)>-1(-x)\ge -1(4)$

$7>x\ge -4$

$-4\le x<7 \quad [-4,7)$

5. $5\ge \dfrac{x-4}{-2}>-3$

$-2(5)\le -2\left(\dfrac{x-4}{-2}\right)<-2(-3)$

$-10\le x-4<6$

$-6\le x<10 \quad [-6,10)$

6. $4\le \dfrac{1}{3}x-2<7$

$6\le \dfrac{1}{3}x<9$

$3(6)\le 3\left(\dfrac{1}{3}x\right)<3(9)$

$18\le x<27 \quad [18,27)$

7. $|p|=7$

$p=7$ or $p=-7 \quad \{7,-7\}$

8. $|q|=10$

$q=10$ or $q=-10 \quad \{10,-10\}$

9. $|x|+5=11$

$|x|=6$

$x=6$

or $x=-6 \quad \{6,-6\}$

10. $|x|-3=20$

$|x|=23$

$x=23$

or $x=-23 \quad \{23,-23\}$

11. $|y|+8=5$

$|y|=-3 \quad \{\ \}$

12. $|x|+12=6$

$|x|=-6 \quad \{\ \}$

13. $|w|-3=-1$

$|w|=2$

$w=-2$ or $w=2 \quad \{-2,2\}$

14. $|z|-14=-10$

$|z|=4$

$z=-4$ or $z=4 \quad \{-4,4\}$

15. $|y|=\sqrt{2}$

$y=\sqrt{2}$ or $y=-\sqrt{2} \quad \{\sqrt{2},-\sqrt{2}\}$

16. $|y|=\sqrt{5}$

$y=\sqrt{5}$ or $y=-\sqrt{5} \quad \{\sqrt{5},-\sqrt{5}\}$

17. $|w|-3=-5$

$|w|=-2 \quad \{\ \}$

18. $|w|+4=-8$

$|w|=-12 \quad \{\ \}$

19. $|3q|=0$

$3q=0$ or $3q=-0$

$q=0 \quad \{0\}$

20. $|4p|=0$

$4p=0$ or $4p=-0$

$p=0 \quad \{0\}$

21. $|3x-4|=8$

$3x-4=8$ or $3x-4=-8$

$3x=12$ or $3x=-4$

$x=4$ or $x=-\frac{4}{3} \quad \left\{4,-\frac{4}{3}\right\}$

22. $|4x+1|=6$

$4x+1=6$ or $4x+1=-6$

$4x=5$ or $4x=-7$

$x=\frac{5}{4}$ or $x=-\frac{7}{4} \quad \left\{\frac{5}{4},-\frac{7}{4}\right\}$

23. $5=|2x-4|$

$2x-4=5$ or $2x-4=-5$

$2x=9$ or $2x=-1$

$x=\frac{9}{2}$ or $x=-\frac{1}{2} \quad \left\{\frac{9}{2},-\frac{1}{2}\right\}$

24. $10=|3x+7|$

$3x+7=10$ or $3x+7=-10$

$3x=3$ or $3x=-17$

$x=1$ or $x=-\frac{17}{3} \quad \left\{1,-\frac{17}{3}\right\}$

25. $\left|\frac{7z}{3}-\frac{1}{3}\right|+3=6$

$\left|\frac{7z}{3}-\frac{1}{3}\right|=3$

$\frac{7z}{3}-\frac{1}{3}=3$ or $\frac{7z}{3}-\frac{1}{3}=-3$

$7z-1=9$ or $7z-1=-9$

$7z=10$ or $7z=-8$

$z=\frac{10}{7}$ or $z=-\frac{8}{7} \quad \left\{\frac{10}{7},-\frac{8}{7}\right\}$

26. $\left|\frac{w}{2}+\frac{3}{2}\right|-2=7$

$\left|\frac{w}{2}+\frac{3}{2}\right|=9$

$\frac{w}{2}+\frac{3}{2}=9$ or $\frac{w}{2}+\frac{3}{2}=-9$

$w+3=18$ or $w+3=-18$

$w=15$ or $w=-21 \quad \{15,-21\}$

27. $|0.2x-3.5|=-5.6$

$\{\ \}$

28. $|1.81+2x|=-2.2$

$\{\ \}$

29.
$$1 = -4 + \left|2 - \frac{1}{4}w\right|$$
$$\left|2 - \frac{1}{4}w\right| = 5$$
$$2 - \frac{1}{4}w = 5 \quad \text{or} \quad 2 - \frac{1}{4}w = -5$$
$$8 - w = 20 \quad \text{or} \quad 8 - w = -20$$
$$-w = 12 \quad \text{or} \quad -w = -28$$
$$w = -12 \text{ or } \quad w = 28 \quad \{-12, 28\}$$

30.
$$-12 = -6 - \left|6 - 2x\right|$$
$$\left|6 - 2x\right| = 6$$
$$6 - 2x = 6 \text{ or } 6 - 2x = -6$$
$$-2x = 0 \text{ or } -2x = -12$$
$$x = 0 \text{ or } \quad x = 6 \quad \{0, 6\}$$

31.
$$10 = 4 + \left|2y + 1\right|$$
$$\left|2y + 1\right| = 6$$
$$2y + 1 = 6 \text{ or } 2y + 1 = -6$$
$$2y = 5 \text{ or } \quad 2y = -7$$
$$y = \frac{5}{2} \text{ or } \quad y = -\frac{7}{2} \quad \left\{\frac{5}{2}, -\frac{7}{2}\right\}$$

32.
$$-1 = -\left|5x + 7\right|$$
$$\left|5x + 7\right| = 1$$
$$5x + 7 = 1 \quad \text{or } 5x + 7 = -1$$
$$5x = -6 \text{ or } \quad 5x = -8$$
$$x = -\frac{6}{5} \text{ or } \quad x = -\frac{8}{5} \quad \left\{-\frac{6}{5}, -\frac{8}{5}\right\}$$

33.
$$-2\left|3b - 7\right| - 9 = -9$$
$$-2\left|3b - 7\right| = 0$$
$$\left|3b - 7\right| = 0$$
$$3b - 7 = 0 \text{ or } 3b - 7 = -0$$
$$3b = 7$$
$$b = \frac{7}{3} \quad \left\{\frac{7}{3}\right\}$$

34.
$$-3\left|5x + 1\right| + 4 = 4$$
$$-3\left|5x + 1\right| = 0$$
$$\left|5x + 1\right| = 0$$
$$5x + 1 = 0 \text{ or } 5x + 1 = -0$$
$$5x = -1$$
$$x = -\frac{1}{5} \quad \left\{-\frac{1}{5}\right\}$$

35.
$$-2\left|x + 3\right| = 5$$
$$\left|x + 3\right| = -\frac{5}{2} \quad \{\ \}$$

36.
$$-3\left|x - 5\right| = 7$$
$$\left|x - 5\right| = -\frac{7}{3} \quad \{\ \}$$

37.
$$0 = \left|6x - 9\right|$$
$$6x - 9 = 0 \text{ or } 6x - 9 = -0$$
$$6x = 9$$
$$x = \frac{3}{2} \quad \left\{\frac{3}{2}\right\}$$

38.
$$7 = \left|4k - 6\right| + 7$$
$$0 = \left|4k - 6\right|$$
$$4k - 6 = 0 \text{ or } 4k - 6 = -0$$
$$4k = 6$$
$$k = \frac{3}{2} \quad \left\{\frac{3}{2}\right\}$$

39. $\left|-\frac{1}{5}-\frac{1}{2}k\right|=\frac{9}{5}$

$-\frac{1}{5}-\frac{1}{2}k=\frac{9}{5}$ or $-\frac{1}{5}-\frac{1}{2}k=-\frac{9}{5}$

$-2-5k=18$ or $-2-5k=-18$

$-5k=20$ or $-5k=-16$

$k=-4$ or $k=\frac{16}{5}$ $\left\{-4,\frac{16}{5}\right\}$

40. $\left|-\frac{1}{6}-\frac{2}{9}h\right|=\frac{1}{2}$

$-\frac{1}{6}-\frac{2}{9}h=\frac{1}{2}$ or $-\frac{1}{6}-\frac{2}{9}h=-\frac{1}{2}$

$-3-4h=9$ or $-3-4h=-9$

$-4h=12$ or $-4h=-6$

$h=-3$ or $h=\frac{3}{2}$ $\left\{-3,\frac{3}{2}\right\}$

41. $-3\left|2-6x\right|+5=-10$

$-3\left|2-6x\right|=-15$

$\left|2-6x\right|=5$

$2-6x=5$ or $2-6x=-5$

$-6x=3$ or $-6x=-7$

$x=-\frac{1}{2}$ or $x=\frac{7}{6}$ $\left\{-\frac{1}{2},\frac{7}{6}\right\}$

42. $5\left|1-2x\right|-7=3$

$5\left|1-2x\right|=10$

$\left|1-2x\right|=2$

$1-2x=2$ or $1-2x=-2$

$-2x=1$ or $-2x=-3$

$x=-\frac{1}{2}$ or $x=\frac{3}{2}$ $\left\{-\frac{1}{2},\frac{3}{2}\right\}$

43. $\left|4x-2\right|=\left|-8\right|$

$\left|4x-2\right|=8$

$4x-2=8$ or $4x-2=-8$

$4x=10$ or $4x=-6$

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

44. $\left|3x+5\right|=\left|-5\right|$

$\left|3x+5\right|=5$

$3x+5=5$ or $3x+5=-5$

$3x=0$ or $3x=-10$

$x=0$ or $x=-\frac{10}{3}$ $\left\{0,-\frac{10}{3}\right\}$

45. $\left|4w+3\right|=\left|2w-5\right|$

$4w+3=2w-5$ or $4w+3=-\left(2w-5\right)$

$4w+3=2w-5$ or $4w+3=-2w+5$

$2w+3=-5$ or $6w+3=5$

$2w=-8$ or $6w=2$

$w=-4$ or $w=\frac{1}{3}$ $\left\{-4,\frac{1}{3}\right\}$

46. $\left|3y+1\right|=\left|2y-7\right|$

$3y+1=2y-7$ or $3y+1=-\left(2y-7\right)$

$3y+1=2y-7$ or $3y+1=-2y+7$

$y+1=-7$ or $5y+1=7$

$y=-8$ or $5y=6$

$y=-8$ or $y=\frac{6}{5}$ $\left\{-8,\frac{6}{5}\right\}$

47. $|2y+5|=|7-2y|$

$2y+5=7-2y$ or $2y+5=-(7-2y)$

$2y+5=7-2y$ or $2y+5=-7+2y$

$4y+5=7$ or $5=-7$

$4y=2$ or contradiction

$y=\frac{1}{2}$ $\left\{\frac{1}{2}\right\}$

48. $|9a+5|=|9a-1|$

$9a+5=9a-1$ or $9a+5=-(9a-1)$

$9a+5=9a-1$ or $9a+5=-9a+1$

$5=-1$ or $18a+5=1$

contradiction or $18a=-4$

$a=-\frac{2}{9}$ $\left\{-\frac{2}{9}\right\}$

49. $\left|\frac{4w-1}{6}\right|=\left|\frac{2w}{3}+\frac{1}{4}\right|$

$\frac{4w-1}{6}=\frac{2w}{3}+\frac{1}{4}$ or $\frac{4w-1}{6}=-\left(\frac{2w}{3}+\frac{1}{4}\right)$

$\frac{4w-1}{6}=\frac{2w}{3}+\frac{1}{4}$ or $\frac{4w-1}{6}=-\frac{2w}{3}-\frac{1}{4}$

$2(4w-1)=8w+3$ or $2(4w-1)=-8w-3$

$8w-2=8w+3$ or $8w-2=-8w-3$

$-2=3$ or $16w-2=-3$

contradiction or $16w=-1$

$w=-\frac{1}{16}$ $\left\{-\frac{1}{16}\right\}$

50. $\left|\frac{6p+3}{8}\right|=\left|\frac{3}{4}p-2\right|$

$\frac{6p+3}{8}=\frac{3}{4}p-2$ or $\frac{6p+3}{8}=-\left(\frac{3}{4}p-2\right)$

$\frac{6p+3}{8}=\frac{3}{4}p-2$ or $\frac{6p+3}{8}=-\frac{3}{4}p+2$

$6p+3=6p-16$ or $6p+3=-6p+16$

$3=-16$ or $12p=13$

contradiction or $p=\frac{13}{12}$ $\left\{\frac{13}{12}\right\}$

51. $|x+2|=|-x-2|$

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

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

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

$\{x \mid x \text{ is a real number}\}$

52. $|2y-3|=|-2y+3|$

$2y-3=-2y+3$ or $2y-3=-(-2y+3)$

$4y=6$ or $2y-3=2y-3$

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

$\{y \mid y \text{ is a real number}\}$

53. $|3.5m-1.2|=|8.5m+6|$

$3.5m-1.2=8.5m+6$ or

$3.5m-1.2=-(8.5m+6)$

$3.5m-1.2=8.5m+6$ or

$3.5m-1.2=-8.5m-6$

54. $|11.2n+9|=|7.2n-2.1|$

$11.2n+9=7.2n-2.1$ or

$11.2n+9=-(7.2n-2.1)$

$11.2n+9=7.2n-2.1$ or

$11.2n+9=-7.2n+2.1$

$-5m-1.2=6$ or $12m-1.2=-6$

$-5m=7.2$ or $12m=-4.8$

$m=-1.44$ or $m=-0.4$

$\{-1.44,-0.4\}$

$4n+9=-2.1$ or $18.4n+9=2.1$

$4n=-11.1$ or $18.4n=-6.9$

$n=-2.775$ or $n=-0.375$

$\{-2.775,-0.375\}$

55. $|4x-3|=-|2x-1|$

$\{\ \}$ - A positive number cannot equal a negative number.

56. $-|3-6y|=|8-2y|$

$\{\ \}$ - A negative number cannot equal a positive number.

57. $|8-7w|=|7w-8|$

$8-7w=7w-8$ or $8-7w=-(7w-8)$

$-14w=-16$ or $8-7w=-7w+8$

$w=\frac{8}{7}$ or $w=w$

$\{w\,|\,w \text{ is a real number}\}$

58. $|4-3z|=|3z-4|$

$4-3z=3z-4$ or $4-3z=-(3z-4)$

$-6z=-8$ or $4-3z=-3z+4$

$z=\frac{4}{3}$ or $z=z$

$\{z\,|\,z \text{ is a real number}\}$

59. $|x+2|+|x-4|=0$

$|x+2|=-|x-4|$

$\{\ \}$ - A positive number cannot equal a negative number.

60. $|t+6|+|t-1|=0$

$|t+6|=-|t-1|$

$\{\ \}$ - A positive number cannot equal a negative number.

61. $|x|=6$

62. $|x|=\frac{7}{2}$

63. $|x|=\frac{4}{3}$

64. $|x|=9$

Section 1.7 Practice Exercises

1. a. $-a\,;\ a$

2. a. $-4x-3=5$

$-4x=8$

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

b. $-a\ ;\ >$

c. $\{\ \}\ ;\ (-\infty,\infty)$

d. includes; excludes

3.
$$2=|5-7x|+1$$
$$1=|5-7x|$$
$$5-7x=1 \quad \text{or} \quad 5-7x=-1$$
$$-7x=-4 \quad \text{or} \quad -7x=-6$$
$$x=\frac{4}{7} \quad \text{or} \quad x=\frac{6}{7} \qquad \left\{\frac{4}{7},\frac{6}{7}\right\}$$

4.
$$|3x-12|+4=6-2$$
$$|3x-12|=0$$
$$3x-12=0$$
$$3x=12$$
$$x=4 \qquad \{4\}$$

5.
$$-15<3w-6\le -9$$
$$-9<3w\le -3$$
$$-3<w\le -1 \qquad (-3,-1]$$

6.
$$5-2y\le 1 \text{ and } 3y+2\ge 14$$
$$-2y\le -4 \cap \quad 3y\ge 12$$
$$y\ge 2 \quad \cap \quad y\ge 4$$
$$[2,\infty)\cap[4,\infty)=[4,\infty)$$

7.
$$m-7\le -5 \text{ or } m-7\ge -10$$
$$m\le 2 \cup m\ge -3$$
$$(-\infty,2]\cup[-3,\infty)=(-\infty,\infty)$$

8.
$$3b-2<7 \text{ or } b-2>4$$
$$3b<9 \cup \quad b>6$$
$$b<3 \cup \quad b>6$$
$$(-\infty,3)\cup(6,\infty)$$

9. **a.**
$$|x|=5$$
$$x=-5 \text{ or } x=5 \qquad \{-5,5\}$$

b.
$$|x|>5$$
$$x<-5 \text{ or } x>5 \qquad (-\infty,-5)\cup(5,\infty)$$

10. **a.**
$$|a|=4$$
$$a=-4 \text{ or } a=4 \qquad \{-4,4\}$$

b.
$$|a|>4$$
$$a<-4 \text{ or } a>4 \qquad (-\infty,-4)\cup(4,\infty)$$

c. $|x| < 5$

$-5 < x < 5 \quad (-5,5)$

11. a. $|x-3| = 7$

$x-3 = -7$ or $x-3 = 7$

$x = -4$ or $x = 10 \quad \{-4,10\}$

b. $|x-3| > 7$

$x-3 < -7$ or $x-3 > 7$

$x < -4$ or $x > 10$

$(-\infty,-4) \cup (10,\infty)$

c. $|x-3| < 7$

$-7 < x-3 < 7$

$-4 < x < 10 \quad (-4,10)$

12. a. $|w+2| = 6$

$w+2 = -6$ or $w+2 = 6$

$w = -8$ or $w = 4 \quad \{-8,4\}$

b. $|w+2| > 6$

$w+2 < -6$ or $w+2 > 6$

$w < -8$ or $w > 4$

$(-\infty,-8) \cup (4,\infty)$

c. $|w+2| < 6$

$-6 < w+2 < 6$

$-8 < w < 4 \quad (-8,4)$

13. a. $|p| = -2 \quad \{\ \}$

b. $|p| > -2$

All real numbers $(-\infty,\infty)$

c. $|p| < -2 \quad \{\ \}$

14. a. $|x| = -14 \quad \{\ \}$

b. $|x| > -14$

All real numbers $(-\infty,\infty)$

c. $|x| < -14 \quad \{\ \}$

15. a. $|y+1| = -6 \quad \{\ \}$

b. $|y+1| > -6$

All real numbers $(-\infty,\infty)$

c. $|y+1| < -6 \quad \{\ \}$

16. a. $|z-4| = -3 \quad \{\ \}$

b. $|z-4| > -3$

All real numbers $(-\infty,\infty)$

c. $|z-4| < -3 \quad \{\ \}$

17. **a.** $|x| = 0$

$x = 0 \quad \{0\}$

b. $|x| > 0$

$x < 0$ or $x > 0$

$(-\infty, 0) \cup (0, \infty)$

c. $|x| < 0 \quad \{\ \}$

18. **a.** $|p+3| = 0$

$p+3 = 0$

$p = -3 \quad \{-3\}$

b. $|p+3| > 0$

$p+3 < 0$ or $p+3 > 0$

$p < -3$ or $p > -3$

$(-\infty, -3) \cup (-3, \infty)$

c. $|p+3| < 0 \quad \{\ \}$

19. **a.** $|k-7| = 0$

$k-7 = 0$

$k = 7 \quad \{7\}$

b. $|k-7| > 0$

$k-7 < 0$ or $k-7 > 0$

$k < 7$ or $k > 7$

$(-\infty, 7) \cup (7, \infty)$

c. $|k-7| < 0 \quad \{\ \}$

20. **a.** $|2x+4| + 3 = 2$

$|2x+4| = -1 \quad \{\ \}$

b. $|2x+4| + 3 > 2$

$|2x+4| > -1$

All real numbers

$(-\infty, \infty)$

c. $|2x+4| + 3 < 2$

$|2x+4| < -1 \quad \{\ \}$

21. $|x| > 6$

$x < -6$ or $x > 6$

$(-\infty, -6) \cup (6, \infty)$

22. $|x| \le 6$

$-6 \le x \le 6 \quad [-6, 6]$

23. $|t| \le 3$

$-3 \le t \le 3 \quad [-3, 3]$

24. $|p| > 3$

$p < -3$ or $p > 3$

$(-\infty, -3) \cup (3, \infty)$

25. $|y+2| \geq 0$

All real numbers $(-\infty, \infty)$

26. $0 \leq |7n+2|$

All real numbers $(-\infty, \infty)$

27. $5 \leq |2x-1|$

$|2x-1| \geq 5$

$2x-1 \leq -5$ or $2x-1 \geq 5$

$2x \leq -4$ or $2x \geq 6$

$x \leq -2$ or $x \geq 3$

$(-\infty, -2] \cup [3, \infty)$

28. $|x-2| \geq 7$

$x-2 \leq -7$ or $x-2 \geq 7$

$x \leq -5$ or $x \geq 9$

$(-\infty, -5] \cup [9, \infty)$

29. $|k-7| < -3$ $\{\ \}$

30. $|h+2| < -9$ $\{\ \}$

31. $\left|\frac{w-2}{3}\right| - 3 \leq 1$

$\left|\frac{w-2}{3}\right| \leq 4$

$-4 \leq \frac{w-2}{3} \leq 4$

$-12 \leq w-2 \leq 12$

$-10 \leq w \leq 14$ $[-10, 14]$

32. $\left|\frac{x+3}{2}\right| - 2 \geq 4$

$\left|\frac{x+3}{2}\right| \geq 6$

$\frac{x+3}{2} \leq -6$ or $\frac{x+3}{2} \geq 6$

$x+3 \leq -12$ or $x+3 \geq 12$

$x \leq -15$ or $x \geq 9$

$(-\infty, -15] \cup [9, \infty)$

33. $12 \leq |9-4y| - 2$

$|9-4y| \geq 14$

$9-4y \leq -14$ or $9-4y \geq 14$

$-4y \leq -23$ or $-4y \geq 5$

$y \geq \frac{23}{4}$ or $y \leq -\frac{5}{4}$

$\left(-\infty, -\frac{5}{4}\right] \cup \left[\frac{23}{4}, \infty\right)$

34. $5 > |2m-7| + 4$

$1 > |2m-7|$

$|2m-7| < 1$

$-1 < 2m-7 < 1$

$6 < 2m < 8$

$3 < m < 4$ $(3, 4)$

35.
$$4 > -1 + \left|\frac{2x+1}{4}\right|$$
$$5 > \left|\frac{2x+1}{4}\right|$$
$$-5 < \frac{2x+1}{4} < 5$$
$$-20 < 2x+1 < 20$$
$$-21 < 2x < 19$$
$$-\frac{21}{2} < x < \frac{19}{2} \qquad \left(-\frac{21}{2}, \frac{19}{2}\right)$$

36.
$$9 \geq 2 + \left|\frac{x-4}{5}\right|$$
$$7 \geq \left|\frac{x-4}{5}\right|$$
$$-7 \leq \frac{x-4}{5} \leq 7$$
$$-35 \leq x-4 \leq 35$$
$$-31 \leq x \leq 39 \qquad [-31, 39]$$

37.
$$8 < \left|4-3x\right| + 12$$
$$-4 < \left|4-3x\right|$$
$$\left|4-3x\right| > -4$$
All real numbers $\qquad (-\infty, \infty)$

38.
$$-16 < \left|5x-1\right| - 1$$
$$-15 < \left|5x-1\right|$$
$$\left|5x-1\right| > -15$$
All real numbers $\qquad (-\infty, \infty)$

39.
$$5 - \left|2m+1\right| > 5$$
$$-\left|2m+1\right| > 0$$
$$\left|2m+1\right| < 0 \qquad \{\ \}$$

40.
$$3 - \left|5x+3\right| > 3$$
$$-\left|5x+3\right| > 0$$
$$\left|5x+3\right| < 0 \qquad \{\ \}$$

41.
$$\left|p+5\right| \leq 0$$
$$-0 \leq p+5 \leq 0$$
$$-5 \leq p \leq -5$$
$$\{-5\}$$

42.
$$\left|y+1\right| - 4 \leq -4$$
$$\left|y+1\right| \leq 0$$
$$-0 \leq y+1 \leq 0$$
$$-1 \leq y \leq -1$$
$$\{-1\}$$

43.
$$\left|z-6\right| + 5 > 5$$
$$\left|z-6\right| > 0$$
$$z-6 < -0 \text{ or } z-6 > 0$$

44.
$$\left|2c-1\right| - 4 > -4$$
$$\left|2c-1\right| > 0$$
$$2c-1 < -0 \text{ or } 2c-1 > 0$$

$$z<6 \quad \text{or} \quad z>6$$
$$(-\infty,6)\cup(6,\infty)$$

$$2c<1 \quad \text{or} \quad 2c>1$$
$$c<\frac{1}{2} \quad \text{or} \quad c>\frac{1}{2}$$
$$\left(-\infty,\frac{1}{2}\right)\cup\left(\frac{1}{2},\infty\right)$$

45. $5|2y-6|+3\ge 13$

$$5|2y-6|\ge 10$$
$$|2y-6|\ge 2$$
$$2y-6\le -2 \quad \text{or} \quad 2y-6\ge 2$$
$$2y\le 4 \quad \text{or} \quad 2y\ge 8$$
$$y\le 2 \quad \text{or} \quad y\ge 4$$
$$(-\infty,2]\cup[4,\infty)$$

46. $7|y+1|-3\ge 11$

$$7|y+1|\ge 14$$
$$|y+1|\ge 2$$
$$y+1\le -2 \quad \text{or} \quad y+1\ge 2$$
$$y\le -3 \quad \text{or} \quad y\ge 1$$
$$(-\infty,-3]\cup[1,\infty)$$

47. $-3|6-t|+1>-5$

$$-3|6-t|>-6$$
$$|6-t|<2$$
$$-2<6-t<2$$
$$-8<-t<-4$$
$$8>t>4 \qquad (4,8)$$

48. $-4|8-x|+2>-14$

$$-4|8-x|>-16$$
$$|8-x|<4$$
$$-4<8-x<4$$
$$-12<-x<-4$$
$$12>x>4 \qquad (4,12)$$

49. $|0.02x+0.06|-0.1<0.05$

$$|0.02x+0.06|<0.15$$
$$-0.15<0.02x+0.06<0.15$$
$$-0.21<0.02x<0.09$$
$$-10.5<x<4.5 \quad (-10.5,4.5)$$

50. $|0.05x-0.04|-0.01<0.11$

$$|0.05x-0.04|<0.12$$
$$-0.12<0.05x-0.04<0.12$$
$$-0.08<0.05x<0.16$$
$$-1.6<x<3.2 \quad (-1.6,3.2)$$

51. $|x|>7$

52. $|x+3|<4$

53. $|x-2| \le 13$

54. $|x| \ge 6$

55. $|x-32| \le 0.05$

56. $|x-32.3| \le 0.2$

57. $\left|x-6\frac{3}{4}\right| \le \frac{1}{8}$

58. $\left|x-\frac{7}{8}\right| \le \frac{1}{16}$

59. $|w-2| \le 0.01$

$-0.01 \le w-2 \le 0.01$

$1.99 \le w \le 2.01 \quad [1.99, 2.01]$

The solution set is $\{w \mid 1.99 \le w \le 2.01\}$ or equivalently in interval notation, $[1.99, 2.01]$. This means that the actual width of the bolt could be between 1.99 cm and 2.01 cm, inclusive.

60. $|p-0.53| \le 0.03$

$-0.03 \le p-0.53 \le 0.03$

$0.50 \le p \le 0.56 \quad [0.50, 0.56]$

The solution set is $\{p \mid 0.50 \le p \le 0.56\}$ or equivalently $[0.50, 0.56]$. This means that the percentage of votes received by the frontrunner was projected to be between 50% and 56%, inclusive.

61. b

62. d

63. a

64. c

Problem Recognition Exercises

1. **a.** $3x-9=18$

$3x=27$

$x=9 \quad \{9\}$

b. $|3x-9|=18$

$3x-9=18$ or $3x-9=-18$

$3x=27$ or $3x=-9$

$x=9$ or $x=-3 \quad \{9,-3\}$

c. $|3x-9|<18$

$-18<3x-9<18$

$-9<3x<27$

$-3<x<9 \quad (-3,9)$

2. **a.** $5y+2=-20$

$5y=-22 \Leftrightarrow y=-\frac{22}{5} \quad \left\{-\frac{22}{5}\right\}$

b. $|5y+2|=-20 \quad \{\ \}$

c. $|5y+2| \le -20 \quad \{\ \}$

d. $|3x-9| \geq 18$

$3x-9 \geq 18$ or $3x-9 \leq -18$

$3x \geq 27$ or $3x \leq -9$

$x \geq 9$ or $x \leq -3$

$(-\infty,-3] \cup [9,\infty)$

d. $|5y+2| > -20$ $(-\infty,\infty)$

3. **a.** $-2t-14=0$

$-2t=14$

$t=-7$ $\{-7\}$

b. $-2t-14>0$

$-2t>14$

$t<-7$ $(-\infty,-7)$

c. $-2t-14 \leq 0$

$-2t \leq 14$

$t \geq -7$ $[-7,\infty)$

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

$x-2=27$

$x=29$ $\{29\}$

b. $\frac{x-2}{3} \geq 9$

$x-2 \geq 27$

$x \geq 29$ $[29,\infty)$

c. $\frac{x-2}{3}<9$

$x-2<27$

$x<29$ $(-\infty,29)$

5. **a.** $|8t-2|=|-2t+3|$

$8t-2=-2t+3$ or $8t-2=-(-2t+3)$

$10t-2=3$ or $8t-2=2t-3$

$10t=5$ or $6t-2=-3$

$t=\frac{5}{10}$ or $6t=-1$

$t=\frac{1}{2}$ or $t=-\frac{1}{6}$ $\left\{\frac{1}{2},-\frac{1}{6}\right\}$

b. $8t-2=-2t+3$

$10t=5$

$t=\frac{1}{2}$ $\left\{\frac{1}{2}\right\}$

6. **a.** $-5<x+2$ and $x+2 \leq 8$

$-7<x$ and $x \leq 6$ $(-7,6]$

b. $-5<x+2 \leq 8$

$-7<x \leq 6$ $(-7,6]$

7. **a.** $-4x-9<11$ or $2\le x+1$

$-4x<20$ or $1\le x$

$x>-5$ or $x\ge 1$ $\quad(-5,\infty)$

b. $-4x-9<11$ and $2\le x+1$

$-4x<20$ and $1\le x$

$x>-5$ and $x\ge 1$

$[1,\infty)$

8. **a.** $4<2y$ or $-3(y+2)>-2y+1$

$2<y$ or $-3y-6>-2y+1$

$y>2$ or $-7>y$ $\quad(-\infty,-7)\cup(2,\infty)$

b. $4<2y$ and $-3(y+2)>-2y+1$

$2<y$ and $-3y-6>-2y+1$

$y>2$ and $-7>y$ $\quad\{\ \}$

9. **a.** linear equation

b. $-0.5y+0.7=3.7$

$-0.5y=3$

$y=-6$ $\quad\{-6\}$

10. **a.** linear equation

b. $3m-9=18$

$3m=27$

$m=9$ $\quad\{9\}$

11. **a.** absolute value inequality

b. $|2t+8|\le 4$

$-4\le 2t+8\le 4$

$-12\le 2t\le -4$

$-6\le t\le -2$ $\quad[-6,-2]$

12. **a.** absolute value inequality

b. $|1-3x|<-1$ $\quad\{\ \}$

13. **a.** compound inequality

b. $-11<2t+1<19$

$-12<2t<18$

$-6<t<9$ $\quad(-6,9)$

14. **a.** compound inequality

b. $2z-3\ge 11$ or $3z+3<9$

$2z\ge 14$ or $3z<6$

$z\ge 7$ or $z<2$

$(-\infty,2)\cup[7,\infty)$

15. **a.** absolute value equation

b. $\left|\frac{1}{2}y+3\right|=5$

$\frac{1}{2}y+3=5$ or $\frac{1}{2}y+3=-5$

$\frac{1}{2}y=2$ or $\frac{1}{2}y=-8$

$y=4$ or $y=-16$ $\{4,-16\}$

16. **a.** absolute value equation

b. $|4x+3|=|9-2x|$

$4x+3=9-2x$ or $4x+3=-(9-2x)$

$6x+3=9$ or $4x+3=-9+2x$

$6x=6$ or $2x=-12$

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

$\{1,-6\}$

17. **a.** linear inequality

b.
$$-\frac{3}{4}p \ge -9$$
$$-\frac{4}{3}\left(-\frac{3}{4}p\right) \le -\frac{4}{3}(-9)$$
$$p \le 12 \quad (-\infty, 12]$$

18. **a.** linear inequality

b.
$$8w+4 \ge 5w+1$$
$$3w+4 \ge 1$$
$$3w \ge -3$$
$$w \ge -1 \quad [-1, \infty)$$

19. **a.** absolute value inequality

b.
$$\left|\frac{2x-9}{3}\right| \ge 5$$
$$\frac{2x-9}{3} \ge 5 \text{ or } \frac{2x-9}{3} \le -5$$
$$2x-9 \ge 15 \text{ or } 2x-9 \le -15$$
$$2x \ge 24 \text{ or } 2x \le -6$$
$$x \ge 12 \text{ or } x \le -3 \quad (-\infty, -3] \cup [12,)$$

20. **a.** absolute value inequality

b.
$$\left|\frac{10-x}{5}\right| < 3$$
$$-3 < \frac{10-x}{5} < 3$$
$$-15 < 10-x < 15$$
$$-25 < -x < 5$$
$$25 > x > -5 \quad (-5, 25)$$

21. **a.** absolute value equation

b.
$$|2-c|+5 = 3$$
$$|2-c| = -2 \quad \{\ \}$$

22. **a.** absolute value equation

b.
$$|10n+2|+7 = 7$$
$$|10n+2| = 0$$
$$10n+2 = 0$$
$$10n = -2$$
$$n = -\frac{2}{10} = -\frac{1}{5} \quad \left\{-\frac{1}{5}\right\}$$

23. **a.** linear equation

b.
$$\frac{w-4}{5} - \frac{w+1}{3} = 1$$
$$15\left(\frac{w-4}{5} - \frac{w+1}{3}\right) = 15(1)$$
$$3(w-4) - 5(w+1) = 15$$
$$3w - 12 - 5w - 5 = 15$$
$$-2w - 17 = 15$$
$$-2w = 32$$
$$w = -16 \quad \{-16\}$$

24. **a.** linear equation

b.
$$\frac{1}{3}y - \frac{5}{6} = \frac{1}{2}y + 1$$
$$6\left(\frac{1}{3}y - \frac{5}{6}\right) = 6\left(\frac{1}{2}y + 1\right)$$
$$2y - 5 = 3y + 6$$
$$-11 = y \quad \{-11\}$$

25. **a.** compound inequality

b. $2x-7>9$ and $3x\le 36$

$2x>16$ and $x\le 12$

$x>8$ and $x\le 12$ $(8,12]$

26. **a.** compound inequality

b. $-3+x>2x$ and $2\ge -\frac{1}{3}x$

$-3>x$ and $-6\le x$ $[-6,-3)$

27. **a.** linear equation

b. $5(x-2)+7=2x+3(x-1)$

$5x-10+7=2x+3x-3$

$5x-3=5x-3$

$-3=-3$ $(-\infty,\infty)$

28. **a.** linear equation

b. $7y-4=3(y+1)+4y$

$7y-4=3y+3+4y$

$7y-4=7y+3$

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

Group Activity

1. False

2. True

3. True

4. False

5. True

6. True

7. True

8. True

9. True

10. False

11. False

12. True

13. False

14. True

15. False

16. True

17. False

18. False

19. False

20. True

21. True

22. True

23. False

24. False

Chapter 1 Review Exercises

Section 1.1

1. The empty set; no solution

2. All real numbers

3.
$$x - 27 = -32$$
$$x - 27 + 27 = -32 + 27$$
$$x = -5 \quad \{-5\}$$
A conditional equation

4.
$$y + \frac{7}{8} = 1$$
$$y + \frac{7}{8} - \frac{7}{8} = 1 - \frac{7}{8}$$
$$y = \frac{1}{8} \quad \left\{\frac{1}{8}\right\}$$
A conditional equation

5.
$$7.23 + 0.6x = 0.2x$$
$$7.23 + 0.6x - 0.6x = 0.2x - 0.6x$$
$$7.23 = -0.4x$$
$$\frac{7.23}{-0.4} = \frac{-0.4x}{-0.4}$$
$$-18.075 = x \quad \{-18.075\}$$
A conditional equation

6.
$$0.1y + 1.122 = 5.2y$$
$$0.1y - 0.1y + 1.122 = 5.2y - 0.1y$$
$$1.122 = 5.1y$$
$$\frac{1.122}{5.1} = \frac{5.1y}{5.1}$$
$$0.22 = y \quad \{0.22\}$$
A conditional equation

7.
$$-(4 + 3m) = 9(3 - m)$$
$$-4 - 3m = 27 - 9m$$
$$-4 - 3m + 9m = 27 - 9m + 9m$$
$$-4 + 6m = 27$$
$$6m = 31$$
$$\frac{6m}{6} = \frac{31}{6}$$
$$m = \frac{31}{6} \quad \left\{\frac{31}{6}\right\}$$
A conditional equation

8.
$$-2(5n - 6) = 3(-n - 3)$$
$$-10n + 12 = -3n - 9$$
$$-10n + 3n + 12 = -3n + 3n - 9$$
$$-7n + 12 = -9$$
$$-7n + 12 - 12 = -9 - 12$$
$$-7n = -21$$
$$\frac{-7n}{-7} = \frac{-21}{-7}$$
$$n = 3 \quad \{3\}$$
A conditional equation

9.
$$\frac{x-3}{5}-\frac{2x+1}{2}=1$$
$$10\left(\frac{x-3}{5}-\frac{2x+1}{2}\right)=10(1)$$
$$2(x-3)-5(2x+1)=10$$
$$2x-6-10x-5=10$$
$$-8x-11=10$$
$$-8x=21$$
$$x=-\frac{21}{8} \qquad \left\{-\frac{21}{8}\right\}$$

A conditional equation

10.
$$3(x+3)-2=3x+2$$
$$3x+9-2=3x+2$$
$$3x+7=3x+2$$
$$3x-3x+7=3x-3x+2$$
$$7=2 \qquad \{\ \}$$

This is a contradiction.

11.
$$\frac{10}{8}m+18-\frac{7}{8}m=\frac{3}{8}m+25$$
$$\frac{3}{8}m+18=\frac{3}{8}m+25$$
$$\frac{3}{8}m-\frac{3}{8}m+18=\frac{3}{8}m-\frac{3}{8}m+25$$
$$18=25 \qquad \{\ \}$$

This is a contradiction.

12.
$$\frac{2}{3}m+\frac{1}{3}(m-1)=-\frac{1}{3}m+\frac{1}{3}(4m-1)$$
$$\frac{2}{3}m+\frac{1}{3}m-\frac{1}{3}=-\frac{1}{3}m+\frac{4}{3}m-\frac{1}{3}$$
$$m-\frac{1}{3}=m-\frac{1}{3}$$
$$m-m-\frac{1}{3}=m-m-\frac{1}{3}$$
$$-\frac{1}{3}=-\frac{1}{3} \qquad \left\{m \middle| m \text{ is a real number}\right\}$$

This is an identity.

Section 1.2

13. $x, x+1, x+2$

14. $x, x+2$

15. $D=rt$ Distance equals rate times time

16. $I=Prt$ Simple interest equals principal times rate times time.

17. **a.** Let x = the amount of tax
$$\text{tax}=(\text{tax rate})(\text{income})$$
$$x=0.28(85{,}200)$$
$$x=23{,}856$$
The tax is \$23,856.

b. Let y = net income

18. Let x = the number of men in college in 2000
(recent year) = (2000 number) + (increase)
(increase) = (increase rate)(2000 number)

$$\text{net income} = (\text{income}) - (\text{tax})$$
$$y = 85{,}200 - 23{,}856$$
$$y = 61{,}344$$

The net income is \$61,344.

$$7.2 = x + 0.08x$$
$$7.2 = 1.08x$$
$$\frac{7.2}{1.08} = \frac{1.08x}{1.08}$$
$$6.7 \approx x$$

The number of men in college in 2000 was approximately 6.7 million.

19. Let x = the number of alcohol deaths in 1999

(recent year) = (1999 deaths) + (increase)

(increase) = (increase rate)(1999 deaths)

$$17{,}430 = x + 0.05x$$
$$17{,}430 = 1.05x$$
$$\frac{17{,}430}{1.05} = \frac{1.05x}{1.05}$$
$$16{,}600 = x$$

The number of alcohol-related deaths in 1999 was 16,600.

20. Let x = the first even integer

$x + 2$ = the second even integer

$x + 4$ = the third even integer

(first) + (second) = (third) – 6

$$x + (x+2) = (x+4) - 6$$
$$2x + 2 = x - 2$$
$$2x - x + 2 = x - x - 2$$
$$x + 2 = -2$$
$$x + 2 - 2 = -2 - 2$$
$$x = -4$$
$$x + 2 = -4 + 2 = -2$$
$$x + 4 = -4 + 4 = 0$$

The integers are –4, –2, and 0.

21. Let x = the length of the first piece

$\frac{1}{3}x$ = the length of the second piece

(length of first) + (length of second) = (total)

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

The lengths are 2 ft and $\frac{2}{3}$ ft.

22.

	6% Account	9% Account	Total
Amt Invested	x	$x + 2000$	
Int Earned	$0.06x$	$0.09(x+2000)$	405

(int at 6%) + (int at 9%) = (total int)

$$0.06x + 0.09\left(x + 2000\right) = 405$$
$$0.06x + 0.09x + 180 = 405$$
$$0.15x + 180 = 405$$
$$0.15x + 180 - 180 = 405 - 180$$
$$0.15x = 225$$
$$\frac{0.15x}{0.15} = \frac{225}{0.15}$$
$$x = 1500$$
$$x + 2000 = 1500 + 2000$$
$$= 3500$$

$1500 was invested at 6% and $3500 was invested at 9%.

23.

	10% Acid Solution	25% Acid Solution	15% Acid Solution
Amount of Solution	x	1	$x + 1$
Amount of Alcohol	$0.10x$	$0.25(1)$	$0.15(x + 1)$

(amt of 10%) + (amt of 25%)=(amt of 15%)

$$0.10x + 0.25\left(1\right) = 0.15\left(x + 1\right)$$
$$0.10x + 0.25 = 0.15x + 0.15$$
$$0.10x - 0.15x + 0.25 = 0.15x - 0.15x + 0.15$$
$$-0.05x + 0.25 = 0.15$$
$$-0.05x + 0.25 - 0.25 = 0.15 - 0.25$$
$$-0.05x = -0.10$$
$$\frac{-0.05x}{-0.05} = \frac{-0.10}{-0.05}$$
$$x = 2$$

2 L of 10% solution should be used.

24.

	Distance	Rate	Time
Linda	$0.5x$	x	0.5
Lynn	$0.5(x + 15)$	$x + 15$	0.5

(distance Linda) + (distance Lynn) $= 37.5$

$$0.5x + 0.5(x + 15) = 37.5$$
$$0.5x + 0.5x + 7.5 = 37.5$$
$$x + 7.5 = 37.5$$
$$x = 30$$
$$x + 15 = 30 + 15 = 45$$

Linda drives 30 mph and Lynn drives 45 mph.

Section 1.3

25. Let $w =$ the width of the rectangle

$w + 2 =$ the length of the rectangle

$$P = 2l + 2w$$
$$40 = 2(w + 2) + 2w$$
$$40 = 2w + 4 + 2w$$
$$40 = 4w + 4$$
$$40 - 4 = 4w + 4 - 4$$
$$36 = 4w$$
$$9 = w$$
$$w + 2 = 9 + 2$$
$$= 11$$

The width is 9 ft and the length is 11 ft.

26.

$$x - 25 = \frac{x}{2} + 1$$
$$2(x - 25) = 2\left(\frac{x}{2} + 1\right)$$
$$2x - 50 = x + 2$$
$$2x - x - 50 = x - x + 2$$
$$x - 50 = 2$$
$$x - 50 + 50 = 2 + 50$$
$$x = 52$$
$$x - 25 = 52 - 25 = 27$$
$$\frac{x}{2} + 1 = \frac{52}{2} + 1 = 26 + 1 = 27$$

The measure of each angle is 27º.

27.

$$(x - 1) + (2x + 1) = 90$$
$$3x = 90$$
$$\frac{3x}{3} = \frac{90}{3}$$
$$x = 30$$
$$x - 1 = 30 - 1$$
$$= 29$$

28. $3x - 2y = 4$ for y

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

$$\begin{aligned} 2x+1 &= 2(30)+1 \\ &= 60+1 \\ &= 61 \end{aligned}$$

The measures of the angles are 29° and 61°.

29. $-6x+y=12$ for y

$$\begin{aligned} -6x+6x+y &= 6x+12 \\ y &= 6x+12 \end{aligned}$$

30. $S=2\pi r+\pi r^2 h$ for h

$$\begin{aligned} S-2\pi r &= 2\pi r-2\pi r+\pi r^2 h \\ S-2\pi r &= \pi r^2 h \\ \frac{S-2\pi r}{\pi r^2} &= \frac{\pi r^2 h}{\pi r^2} \\ \frac{S-2\pi r}{\pi r^2} &= h \end{aligned}$$

31. $A=\frac{1}{2}bh$ for b

$$\begin{aligned} 2A &= 2\left(\frac{1}{2}bh\right) \\ 2A &= bh \\ \frac{2A}{h} &= \frac{bh}{h} \\ \frac{2A}{h} &= b \end{aligned}$$

32. a. $C=2\pi r$ for π

$$\begin{aligned} \frac{C}{2r} &= \frac{2\pi r}{2r} \\ \frac{C}{2r} &= \pi \end{aligned}$$

b. $\pi=\frac{37.7}{2\cdot 6}=\frac{37.7}{12}\approx 3.14$

Section 1.4

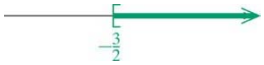
33.

$$\begin{aligned} -6x-2 &> 6 \\ -6x-2+2 &> 6+2 \\ -6x &> 8 \\ \frac{-6x}{-6} &< \frac{8}{-6} \\ x &< -\frac{4}{3} \end{aligned}$$

a. $\left\{x \mid x<-\frac{4}{3}\right\}$

34.

$$\begin{aligned} -10x &\le 15 \\ \frac{-10x}{-10} &\ge \frac{15}{-10} \\ x &\ge -\frac{3}{2} \end{aligned}$$



a. $\left\{x \mid x\ge -\frac{3}{2}\right\}$

b. $\left(-\infty,-\frac{4}{3}\right)$

35.
$$\begin{aligned} 5-7(x+3) &> 19x \\ 5-7x-21 &> 19x \\ -7x-16 &> 19x \\ -7x+7x-16 &> 19x+7x \\ -16 &> 26x \\ \frac{-16}{26} &> \frac{26x}{26} \\ -\frac{8}{13} &> x \quad \text{or} \quad x < -\frac{8}{13} \end{aligned}$$

a. $\left\{x \,\middle|\, x < -\frac{8}{13}\right\}$

b. $\left(-\infty,-\frac{8}{13}\right)$

37.
$$\begin{aligned} \frac{5-4x}{8} &\geq 9 \\ 8\left(\frac{5-4x}{8}\right) &\geq 8\cdot 9 \\ 5-4x &\geq 72 \\ 5-5-4x &\geq 72-5 \\ -4x &\geq 67 \\ \frac{-4x}{-4} &\leq \frac{67}{-4} \\ x &\leq -\frac{67}{4} \end{aligned}$$

a. $\left\{x \,\middle|\, x \leq -\frac{67}{4}\right\}$

b. $\left(-\infty,-\frac{67}{4}\right]$

b. $\left[-\frac{3}{2},\infty\right)$

36.
$$\begin{aligned} 4-3x &\geq 10(-x+5) \\ 4-3x &\geq -10x+50 \\ 4-3x+10x &\geq -10x+10x+50 \\ 7x+4 &\geq 50 \\ 7x+4-4 &\geq 50-4 \\ 7x &\geq 46 \\ \frac{7x}{7} &\geq \frac{46}{7} \\ x &\geq \frac{46}{7} \end{aligned}$$

a. $\left\{x \,\middle|\, x \geq \frac{46}{7}\right\}$

b. $\left[\frac{46}{7},\infty\right)$

38.
$$\begin{aligned} \frac{3+2x}{4} &\leq 8 \\ 4\left(\frac{3+2x}{4}\right) &\leq 4\cdot 8 \\ 3+2x &\leq 32 \\ 3-3+2x &\leq 32-3 \\ 2x &\leq 29 \\ \frac{2x}{2} &\leq \frac{29}{2} \\ x &\leq \frac{29}{2} \end{aligned}$$

a. $\left\{x \,\middle|\, x \leq \frac{29}{2}\right\}$

b. $\left(-\infty,\frac{29}{2}\right]$

39.
$$\frac{82+88+92+93+x}{5} \geq 90$$
$$5 \cdot \frac{82+88+92+93+x}{5} \geq 5 \cdot 90$$
$$355 + x \geq 450$$
$$355 - 355 + x \geq 450 - 355$$
$$x \geq 95$$
Dave must earn at least 95% on his 5th test.

Section 1.5

40. $C \cap D$ is the set of all elements in both C and D.

$C \cup D$ is the set of elements in either set C or set D, or in both sets.

41. $X \cap Y = [-10,1)$

42. $X \cup Y = (-\infty, \infty)$

43. $Y \cup Z = (-\infty, \infty)$

44. $Y \cap Z = (-1,1)$

45. $Z \cup W = (-\infty, -3] \cup (-1, \infty)$

46. $Z \cap W = \{\ \}$

47. $4m > -11$ and $4m - 3 \leq 13$
$$m > -\frac{11}{4} \cap \quad 4m \leq 16$$
$$m > -\frac{11}{4} \cap \quad m \leq 4$$
$$\left(-\frac{11}{4}, \infty\right) \cap (-\infty, 4]$$
$$= \left(-\frac{11}{4}, 4\right]$$

48. $4n-7<1$ and $7+3n\ge -8$

$4n<8 \cap 3n\ge -15$

$n<2 \cap n\ge -5$

$(-\infty,2)\cap[-5,\infty)=[-5,2)$

49. $-3y+1\ge 10$ and $-2y-5\le -15$

$-3y\ge 9 \cap -2y\le -10$

$y\le -3 \cap y\ge 5$

$(-\infty,-3]\cap[5,\infty)=\{\ \}$

50. $\frac{1}{2}-\frac{h}{12}\le\frac{-7}{12}$ and $\frac{1}{2}-\frac{h}{10}>-\frac{1}{5}$

$6-h\le -7 \cap 5-h>-2$

$-h\le -13 \cap -h>-7$

$h\ge 13 \cap h<7$

$[13,\infty)\cap(-\infty,7)=\{\ \}$

51. $\frac{2}{3}t-3\le 1$ or $\frac{3}{4}t-2>7$

$\frac{2}{3}t\le 4 \cup \frac{3}{4}t>9$

$\frac{3}{2}\cdot\frac{2}{3}t\le\frac{3}{2}\cdot 4 \cup \frac{4}{3}\cdot\frac{3}{4}t>\frac{4}{3}\cdot 9$

$t\le 6 \cup t>12$

$(-\infty,6]\cup(12,\infty)$

52. $2(3x+1)<-10$ or $3(2x-4)\ge 0$

$6x+2<-10 \cup 6x-12\ge 0$

$6x<-12 \cup 6x\ge 12$

$x<-2 \cup x\ge 2$

$(-\infty,-2)\cup[2,\infty)$

53. $-7<-7(2w+3)$ or $-2<-4(3w-1)$

$-7<-14w-21 \cup -2<-12w+4$

$14<-14w \cup -6<-12w$

$-1>w \cup \frac{1}{2}>w$

$(-\infty,-1)\cup\left(-\infty,\frac{1}{2}\right)=\left(-\infty,\frac{1}{2}\right)$

54. $5(p+3)+4>p-1$ or $4(p-1)+2>p+8$

$5p+15+4>p-1 \cup 4p-4+2>p+8$

$5p+19>p-1 \cup 4p-2>p+8$

$4p>-20 \cup 3p>10$

$p>-5 \cup p>\frac{10}{3}$

$(-5,\infty)\cup\left(\frac{10}{3},\infty\right)=(-5,\infty)$

55. $2\ge -(b-2)-5b\ge -6$

$2\ge -b+2-5b\ge -6$

$2\ge -6b+2\ge -6$

$0\ge -6b\ge -8$

$0\le b\le\frac{4}{3}$ $\left[0,\frac{4}{3}\right]$

56. $-4\le\frac{1}{2}(x-1)<-\frac{3}{2}$

$-8\le x-1<-3$

$-7\le x<-2$ $[-7,-2)$

57. $-1<\frac{1}{3}(x+3)<5$

$-3<x+3<15$

$-6<x<12$ $(-6,12)$

All real numbers between –6 and 12

58. **a.** $140 \le x \le 225$

b. $x < 140$ or $x > 225$

59. **a.** $125 \le x \le 200$

b. $x < 125$ or $x > 200$

60. **a.** Answers will vary.
For example: for a 47 year-old person, the maximum recommended heart rate is $A = 220 - 47 = 173$.

b. Answers will vary.
Given a maximum recommended heart rate of 173, the interval is $(0.60 \cdot 173, 0.75 \cdot 173) = (104, 130)$.

Section 1.6

61. $|x| = 10$

$x = 10$ or $x = -10$ $\{10, -10\}$

62. $|x| = 17$

$x = 17$ or $x = -17$ $\{17, -17\}$

63. $|8.7 - 2x| = 6.1$

$8.7 - 2x = 6.1$ or $8.7 - 2x = -6.1$

$-2x = -2.6$ or $-2x = -14.8$

$x = 1.3$ or $x = 7.4$

$\{1.3, 7.4\}$

64. $|5.25 - 5x| = 7.45$

$5.25 - 5x = 7.45$ or $5.25 - 5x = -7.45$

$-5x = 2.2$ or $-5x = -12.7$

$x = -0.44$ or $x = 2.54$

$\{-0.44, 2.54\}$

65. $16 = |x + 2| + 9$

$7 = |x + 2|$

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

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

$x = 5$ or $x = -9$ $\{5, -9\}$

66. $5 = |x - 2| + 4$

$1 = |x - 2|$

$x - 2 = 1$ or $x - 2 = -1$

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

$x = 3$ or $x = 1$ $\{3, 1\}$

67. $|4x - 1| + 6 = 4$

$|4x - 1| = -2$ $\{\ \}$

68. $|3x - 1| + 7 = 3$

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

69. $\left|\frac{7x-3}{5}\right|+4=4$

$\left|\frac{7x-3}{5}\right|=0$

$\frac{7x-3}{5}=0$ or $\frac{7x-3}{5}=-0$

$7x-3=0$

$7x=3$

$x=\frac{3}{7}$ $\left\{\frac{3}{7}\right\}$

70. $\left|\frac{4x+5}{-2}\right|-3=-3$

$\left|\frac{4x+5}{-2}\right|=0$

$\frac{4x+5}{-2}=0$ or $\frac{4x+5}{-2}=-0$

$4x+5=0$

$4x=-5$

$x=-\frac{5}{4}$ $\left\{-\frac{5}{4}\right\}$

71. $|3x-5|=|2x+1|$

$3x-5=2x+1$ or $3x-5=-(2x+1)$

$3x-5=2x+1$ or $3x-5=-2x-1$

$x-5=1$ or $5x-5=-1$

$x=6$ or $5x=4$

$x=6$ or $x=\frac{4}{5}$ $\left\{6,\frac{4}{5}\right\}$

72. $|8x+9|=|8x-1|$

$8x+9=8x-1$ or $8x+9=-(8x-1)$

$8x+9=8x-1$ or $8x+9=-8x+1$

$9=-1$ or $16x+9=1$

contradiction or $16x=-8$

$x=-\frac{1}{2}$ $\left\{-\frac{1}{2}\right\}$

73. $|2+7d|=|-7d-2|$

$2+7d=-7d-2$ or $2+7d=-(-7d-2)$

$2+7d=-7d-2$ or $2+7d=7d+2$

$14d=-4$ or $7d=7d$

$d=-\frac{2}{7}$ or $d=d$

$\{d \mid d$ is a real number$\}$

74. $-|4y+6|=|2y-3|$

$\{\ \}$ - A positive number cannot equal a negative number.

75. Both expressions give the distance between 3 and –2.

Section 1.7

76. $|x|>5$

77. $|x|<4$

78. $|x| < 6$

79. $|x| > \frac{2}{3}$

80. $|x+6| \geq 8$

$x+6 \leq -8 \quad \text{or} \quad x+6 \geq 8$

$x \leq -14 \quad \text{or} \quad x \geq 2$

$(-\infty, -14] \cup [2, \infty)$

81. $|x+8| \leq 3$

$-3 \leq x+8 \leq 3$

$-11 \leq x \leq -5$

$[-11, -5]$

82. $2|7x-1|+4 > 4$

$2|7x-1| > 0$

$|7x-1| > 0$

$7x-1 < -0 \quad \text{or} \quad 7x-1 > 0$

$7x < 1 \quad \text{or} \quad 7x > 1$

$x < \frac{1}{7} \quad \text{or} \quad x > \frac{1}{7}$

$\left(-\infty, \frac{1}{7}\right) \cup \left(\frac{1}{7}, \infty\right)$

83. $4|5x+1|-3 > -3$

$4|5x+1| > 0$

$|5x+1| > 0$

$5x+1 < -0 \quad \text{or} \quad 5x+1 > 0$

$5x < -1 \quad \text{or} \quad 5x > -1$

$x < -\frac{1}{5} \quad \text{or} \quad x > -\frac{1}{5}$

$\left(-\infty, -\frac{1}{5}\right) \cup \left(-\frac{1}{5}, \infty\right)$

84. $|3x+4|-6 \leq -4$

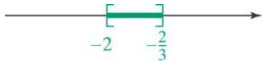
$|3x+4| \leq 2$

$-2 \leq 3x+4 \leq 2$

$-6 \leq 3x \leq -2$

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

$\left[-2, -\frac{2}{3}\right]$



85. $|5x-3|+3 \leq 6$

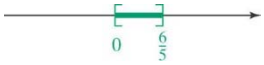
$|5x-3| \leq 3$

$-3 \leq 5x-3 \leq 3$

$0 \leq 5x \leq 6$

$0 \leq x \leq \frac{6}{5}$

$\left[0, \frac{6}{5}\right]$



86. $\left|\frac{x}{2}-6\right| < 5$

$-5 < \frac{x}{2}-6 < 5$

87. $\left|\frac{x}{3}+2\right| < 2$

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

$$1 < \frac{x}{2} < 11$$
$$2 < x < 22 \qquad (2,22)$$

$$-4 < \frac{x}{3} < 0$$
$$-12 < x < 0 \qquad (-12,0)$$

88. $|4-2x|+8 \geq 8$

$|4-2x| \geq 0$

$4-2x \leq -0$ or $4-2x \geq 0$

$-2x \leq -4$ or $-2x \geq -4$

$x \geq 2$ or $x \leq 2$

$[2,\infty) \cup (-\infty,2] = (-\infty,\infty)$

89. $|9+3x|+1 \geq 1$

$|9+3x| \geq 0$

$9+3x \leq -0$ or $9+3x \geq 0$

$3x \leq -9$ or $3x \geq -9$

$x \leq -3$ or $x \geq -3$

$(-\infty,-3] \cup [-3,\infty) = (-\infty,\infty)$

90. $-2|5.2x-7.8| < 13$

$|5.2x-7.8| > -\frac{13}{2}$

All real numbers $(-\infty,\infty)$

91. $-|2.5x+15| < 7$

$|2.5x+15| > -7$

All real numbers $(-\infty,\infty)$

92. $|3x-8| < -1$ $\{\ \}$

93. $|x+5| < -4$ $\{\ \}$

94. If an absolute value is less than a negative number, there will be no solution.

95. If an absolute value is greater than a negative number, then all real numbers are solutions.

96. $|p-0.20| \leq 0.03$

$-0.03 \leq p-0.20 \leq 0.03$

$0.17 \leq p \leq 0.23 \qquad [0.17,0.23]$

This means that the actual percentage of viewers is estimated to be between 17% and 23%, inclusive.

97. $\left|L-3\frac{3}{8}\right| \leq \frac{1}{4}$

$-\frac{1}{4} \leq L-3\frac{3}{8} \leq \frac{1}{4}$

$3\frac{1}{8} \leq L \leq 3\frac{5}{8} \qquad \left[3\frac{1}{8},3\frac{5}{8}\right]$

This means that the actual length of the screw may be between $3\frac{1}{8}$ in and $3\frac{5}{8}$ in, inclusive.

Chapter 1 Test

1.
$$\frac{x}{7}+1=20$$
$$7\left(\frac{x}{7}+1\right)=7\cdot 20$$
$$x+7=140$$
$$x+7-7=140-7$$
$$x=133 \quad \{133\}$$

2.
$$8-5(4-3z)=2(4-z)-8z$$
$$8-20+15z=8-2z-8z$$
$$15z-12=-10z+8$$
$$15z+10z-12=-10z+10z+8$$
$$25z-12=8$$
$$25z-12+12=8+12$$
$$25z=20$$
$$\frac{25z}{25}=\frac{20}{25}$$
$$z=\frac{4}{5} \quad \left\{\frac{4}{5}\right\}$$

3.
$$0.12(x)+0.08(60,000-x)=10,500$$
$$0.12x+4800-0.08x=10,500$$
$$0.04x+4800=10,500$$
$$0.04x+4800-4800=10,500-4800$$
$$0.04x=5700$$
$$\frac{0.04x}{0.04}=\frac{5700}{0.04}$$
$$x=142,500$$
$$\{142,500\}$$

4.
$$\frac{5-x}{6}-\frac{2x-3}{2}=\frac{x}{3}$$
$$6\left(\frac{5-x}{6}-\frac{2x-3}{2}\right)=6\left(\frac{x}{3}\right)$$
$$1(5-x)-3(2x-3)=2x$$
$$5-x-6x+9=2x$$
$$-7x+14=2x$$
$$-7x+14+7x=2x+7x$$
$$14=9x$$
$$\frac{14}{9}=\frac{9x}{9}$$
$$x=\frac{14}{9} \quad \left\{\frac{14}{9}\right\}$$

5.
$$\left|\frac{1}{2}x+3\right|-4=4$$
$$\left|\frac{1}{2}x+3\right|=8$$
$$\frac{1}{2}x+3=8 \quad \text{or} \quad \frac{1}{2}x+3=-8$$
$$\frac{1}{2}x=5 \quad \text{or} \quad \frac{1}{2}x=-11$$
$$x=10 \quad \text{or} \quad x=-22 \quad \{10,-22\}$$

6.
$$|3x+4|=|x-12|$$
$$3x+4=x-12 \quad \text{or} \quad 3x+4=-(x-12)$$
$$3x+4=x-12 \quad \text{or} \quad 3x+4=-x+12$$
$$2x+4=-12 \quad \text{or} \quad 4x+4=12$$
$$2x=-16 \quad \text{or} \quad 4x=8$$
$$x=-8 \quad \text{or} \quad x=2 \quad \{-8,2\}$$

7. $-5 = -8 + |2y - 3|$

$3 = |2y - 3|$

$2y - 3 = 3$ or $2y - 3 = -3$

$2y = 6$ or $2y = 0$

$y = 3$ or $y = 0$ $\{3, 0\}$

8. $|3.7x - 5| + 7 = 6.2$

$|3.7x - 5| = -0.8$

$\{\ \}$ - A positive number cannot equal a negative number.

9. $|8x + 11| = |8x + 5|$

$8x + 11 = 8x + 5$ or $8x + 11 = -(8x + 5)$

$8x + 11 = 8x + 5$ or $8x + 11 = -8x - 5$

$11 = 5$ or $16x = -16$

contradiction or $x = -1$ $\{-1\}$

10. **a.** $(5x - 9) + 19 = 5(x + 2)$

$5x + 10 = 5x + 10$ Identity

b. $2a - 2(1 + a) = 5$

$2a - 2 - 2a = 5$

$-2 = 5$ Contradiction

c. $(4w - 3) + 4 = 3(5 - w)$

$4w + 1 = 15 - 3w$

$4w + 3w + 1 = 15 - 3w + 3w$

$7w + 1 = 15$

$7w + 1 - 1 = 15 - 1$

$7w = 14$

$\frac{7w}{7} = \frac{14}{7}$

$w = 2$ Conditional equation

11. Let x = the smaller number

$5x$ = the larger number

$5x - x = 72$

$4x = 72$

$\frac{4x}{4} = \frac{72}{4}$

$x = 18$

$5x = 5(18) = 90$

The numbers are 18 and 90.

12. **a.**

	Distance	Rate	Time
To store	$4.5t$	4.5	t
From store	$3(1-t)$	3	$1-t$

(distance to store) = (distance returning)

$4.5t = 3(1 - t)$

$4.5t = 3 - 3t$

$4.5t + 3t = 3 - 3t + 3t$

$7.5t = 3$

$\frac{7.5t}{7.5} = \frac{3}{7.5}$

$t = 0.4$ hr or 24 min

b. $d = 4.5(0.4) = 1.8$ mi

13.

	5% Account	3.5% Account	Total
Amount Invested	x	$x-100$	
Interest Earned	$0.05x$	$0.035(x-100)$	81.50

(int at 5%) + (int at 3.5%) = (total int)

$$0.05x + 0.035(x-100) = 81.50$$
$$0.05x + 0.035x - 3.50 = 81.50$$
$$0.085x - 3.50 = 81.50$$
$$0.085x - 3.50 + 3.50 = 81.50 + 3.50$$
$$0.085x = 85.00$$
$$\frac{0.085x}{0.085} = \frac{85.00}{0.085}$$
$$x = 1000$$

Shawnna invested $1000 in the CD.

14. Let $x =$ the length of a side of the triangle

$$P = 3x$$
$$81 = 3x$$
$$\frac{81}{3} = \frac{3x}{3}$$
$$27 = x$$

The length of each side is 27 in.

15. Let x = first odd integer

$x + 2$ = second consecutive odd integer

$x + 4$ = third consecutive odd integer

(sum) = (4 times third less 41)

$$x + (x+2) + (x+4) = 4(x+4) - 41$$
$$3x + 6 = 4x + 16 - 41$$
$$3x + 6 = 4x - 25$$

16.

	20% acid	30% acid	22% acid
Amount of solution	x	6	$x + 6$
Amount of acid	$0.20x$	$0.30(6)$	$0.22(x + 6)$

(amt of 20%) + (amt of 30%)=(amt of 22%)

$$3x-3x+6=4x-3x-25$$
$$6=x-25$$
$$6+25=x-25+25$$
$$31=x$$
$$x+2=31+2=33$$
$$x+4=31+4=35$$

The three consecutive odd integers are 31, 33, and 35.

$$0.20x+0.30(6)=0.22(x+6)$$
$$0.20x+1.8=0.22x+1.32$$
$$0.20x-0.22x+1.8=0.22x-0.22x+1.32$$
$$-0.02x+1.8=1.32$$
$$-0.02x+1.8-1.8=1.32-1.8$$
$$-0.02x=-0.48$$
$$\frac{-0.02x}{-0.02}=\frac{-0.48}{-0.02}$$
$$x=24$$

24 gal of 20% acid solution must be used.

17. $4x+2y=6$ for y

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

18. $x=\mu+z\sigma$ for z

$$x-\mu=\mu-\mu+z\sigma$$
$$x-\mu=z\sigma$$
$$\frac{x-\mu}{\sigma}=\frac{z\sigma}{\sigma}$$
$$\frac{x-\mu}{\sigma}=z$$

19.
$$x+8>42$$
$$x+8-8>42-8$$
$$x>34$$

$(34,\infty)$

20.
$$-\frac{3}{2}x+6\ge x-3$$
$$2\left(-\frac{3}{2}x+6\right)\ge 2(x-3)$$
$$-3x+12\ge 2x-6$$
$$-3x-2x+12\ge 2x-2x-6$$
$$-5x+12\ge -6$$
$$-5x+12-12\ge -6-12$$
$$-5x\ge -18$$
$$\frac{-5x}{-5}\le\frac{-18}{-5}$$
$$x\le\frac{18}{5}$$

$\left(-\infty,\frac{18}{5}\right]$

21. $-2 < 3x - 1 \le 5$

$-2 + 1 < 3x - 1 + 1 \le 5 + 1$

$-1 < 3x \le 6$

$\frac{-1}{3} < \frac{3x}{3} \le \frac{6}{3}$

$-\frac{1}{3} < x \le 2$

$\left(-\frac{1}{3}, 2\right]$

22. $-2 \le 3x - 1 \le 5$

$-1 \le 3x \le 6$

$-\frac{1}{3} \le x \le 2 \qquad \left[-\frac{1}{3}, 2\right]$

23. $-4 \le \frac{6 - 2x}{5} < 2$

$-20 \le 6 - 2x < 10$

$-26 \le -2x < 4$

$13 \ge x > -2$

$-2 < x \le 13 \qquad (-2, 13]$

24. $-\frac{3}{5}x - 1 \le 8 \quad \text{or} \quad -\frac{2}{3}x \ge 16$

$-\frac{3}{5}x \le 9 \quad \cup \quad -\frac{2}{3}x \ge 16$

$-\frac{5}{3}\left(-\frac{3}{5}x\right) \ge -\frac{5}{3}(9) \quad \cup \quad -\frac{3}{2}\left(-\frac{2}{3}x\right) \le -\frac{3}{2}(16)$

$x \ge -15 \cup \quad x \le -24$

$(-\infty, -24] \cup [-15, \infty)$

25. $-2x - 3 > -3$ and $x + 3 \ge 0$

$-2x > 0 \quad \cap \quad x \ge -3$

$x < 0 \quad \cap \quad x \ge -3$

$(-\infty, 0) \cap [-3, \infty) = [-3, 0)$

26. $5x + 1 \le 6$ or $2x + 4 > -6$

$5x \le 5 \cup \quad 2x > -10$

$x \le 1 \cup \quad x > -5$

$(-\infty, 1] \cup (-5, \infty) = (-\infty, \infty)$

27. $2x - 3 > 1$ and $x + 4 < -1$

$2x > 4 \cap \quad x < -5$

$x > 2 \cap \quad x < -5$

$(2, \infty) \cap (-\infty, -5) = \{\ \}$

28. $|3 - 2x| + 6 < 2$

$|3 - 2x| < -4 \quad \{\ \}$

29. $|3x - 8| \ge 9$

$3x - 8 \le -9 \quad \text{or} \quad 3x - 8 \ge 9$

$3x \le -1 \quad \text{or} \quad 3x \ge 17$

30. $|0.4x + 0.3| - 0.2 < 7$

$|0.4x + 0.3| < 7.2$

$-7.2 < 0.4x + 0.3 < 7.2$

$$x \le -\frac{1}{3} \quad \text{or} \quad x \ge \frac{17}{3}$$
$$\left(-\infty, -\frac{1}{3}\right] \cup \left[\frac{17}{3}, \infty\right)$$

$$-7.5 < 0.4x < 6.9$$
$$-18.75 < x < 17.25$$
$$(-18.75, 17.25)$$

31. $|7-3x|+1 > -3$

$|7-3x| > -4$

All real numbers $(-\infty, \infty)$

32. $6 \ge |2x-5|-5$

$11 \ge |2x-5|$

$-11 \le 2x-5 \le 11$

$-6 \le 2x \le 16$

$-3 \le x \le 8 \quad [-3,8]$

33. Let x = the number of additional passengers

(weight of 4 pass)+(weight of add pass) ≤ 2000

$$4(180)+x(180) \le 2000$$
$$720+180x \le 2000$$
$$720-720+180x \le 2000-720$$
$$180x \le 1280$$
$$\frac{180x}{180} \le \frac{1280}{180}$$
$$x \le 7.1$$

The elevator can carry at most 7 additional passengers.

34. **a.** $9 \le x \le 33$

b. $x < 9$ or $x > 33$

35. $|x-15.41| \le 0.01$