## Chapter 1 Equations and Inequalities

### Section 1.1 Linear Equations and Rational Equations

**1.** linear
**2.** first
**3.** solution
**4.** conditional
**5.** identity
**6.** contradiction
**7.** rational
**8.** empty (or null); $\{\}$ or $\phi$

**9. a.** Linear; $-2x = 8$

$$\frac{-2x}{-2} = \frac{8}{-2}$$
$$x = -4$$
$\{-4\}$

**b.** Nonlinear

**c.** Linear; $-\frac{1}{2}x = 8$

$$-2\left(-\frac{1}{2}x\right) = -2(8)$$
$$x = -16$$
$\{-16\}$

**d.** Nonlinear

**e.** Linear; $x - 2 = 8$

$$x - 2 + 2 = 8 + 2$$
$$x = 10$$
$\{10\}$

**10. a.** Linear; $12 = 4x$

$$\frac{12}{4} = \frac{4x}{4}$$
$$3 = x$$
$\{3\}$

**b.** Nonlinear

**c.** Linear; $12 = \frac{1}{4}x$

$$4(12) = 4\left(\frac{1}{4}x\right)$$
$$48 = x$$
$\{48\}$

**d.** Nonlinear

**e.** Linear; $12 = 4 + x$

$$12 - 4 = 4 + x - 4$$
$$8 = x$$
$\{8\}$

**11.** $-6x - 4 = 20$

$$-6x = 24$$
$$x = -4$$
$\{-4\}$

**12.** $-8y + 6 = 22$

$$-8y = 16$$
$$y = -2$$
$\{-2\}$

**13.** $4 = 7 - 3(4t + 1)$

$$4 = 7 - 12t - 3$$
$$4 = 4 - 12t$$
$$0 = -12t$$
$$0 = t$$
$\{0\}$

**14.** $11 = 7 - 2(5p - 2)$

$$11 = 7 - 10p + 4$$
$$11 = 11 - 10p$$
$$0 = -10p$$
$$0 = p$$
$\{0\}$

**15.** $-6(v-2)+3=9-(v+4)$

$-6v+12+3=9-v-4$

$-6v+15=5-v$

$-5v=-10$

$v=2$

$\{2\}$

**16.** $-5(u-4)+2=11-(u-3)$

$-5u+20+2=11-u+3$

$-5u+22=14-u$

$-4u=-8$

$u=2$

$\{2\}$

**17.** $2.3=4.5x+30.2$

$-27.9=4.5x$

$-6.2=x$

$\{-6.2\}$

**18.** $9.4=3.5p-0.4$

$9.8=3.5p$

$2.8=p$

$\{2.8\}$

**19.** $0.05y+0.02(6000-y)=270$

$0.05y+120-0.02y=270$

$0.03y+120=270$

$0.03y=150$

$y=5000$

$\{5000\}$

**20.** $0.06x+0.04(10{,}000-x)=520$

$0.06x+400-0.04x=520$

$0.02x=120$

$x=6000$

$\{6000\}$

**21.** $2(5x-6)=4[x-3(x-10)]$

$10x-12=4(x-3x+30)$

$10x-12=4(-2x+30)$

$10x-12=-8x+120$

$18x=132$

$x=\frac{132}{18}=\frac{22}{3}$

$\left\{\frac{22}{3}\right\}$

**22.** $4(y-3)=3[y+2(y-2)]$

$4y-12=3(y+2y-4)$

$4y-12=3(3y-4)$

$4y-12=9y-12$

$-5y=0$

$y=0$

$\{0\}$

**23.** $\frac{1}{4}x-\frac{3}{2}=2$

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

$x-6=8$

$x=14$

$\{14\}$

**24.** $\frac{1}{6}x-\frac{5}{3}=1$

$6\left(\frac{1}{6}x-\frac{5}{3}\right)=6(1)$

$x-10=6$

$x=16$

$\{16\}$

**25.** $\frac{1}{2}w-\frac{3}{4}=\frac{2}{3}w+2$

$12\left(\frac{1}{2}w-\frac{3}{4}\right)=12\left(\frac{2}{3}w+2\right)$

$6w-9=8w+24$

$-2w=33$

$w=-\frac{33}{2}$

$\left\{-\frac{33}{2}\right\}$

**26.** $\frac{2}{5}p-\frac{3}{10}=\frac{7}{15}p-1$

$30\left(\frac{2}{5}p-\frac{3}{10}\right)=30\left(\frac{7}{15}p-1\right)$

$12p-9=14p-30$

$-2p=-21$

$p=\frac{21}{2}$

$\left\{\frac{21}{2}\right\}$

**27.** $\frac{y-1}{5}+\frac{y}{4}=\frac{y+3}{2}+1$

$20\left(\frac{y-1}{5}+\frac{y}{4}\right)=20\left(\frac{y+3}{2}+1\right)$

$4(y-1)+5y=10(y+3)+20$

$4y-4+5y=10y+30+20$

$9y-4=10y+50$

$-y=54$

$y=-54$

$\{-54\}$

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

$21\left(\frac{x-6}{3}+\frac{x}{7}\right)=21\left(\frac{x+1}{3}+2\right)$

$7(x-6)+3x=7(x+1)+42$

$7x-42+3x=7x+7+42$

$10x-42=7x+49$

$3x=91$

$x=\frac{91}{3}$

$\left\{\frac{91}{3}\right\}$

**29.** $\frac{n+3}{4}-\frac{n-2}{5}=\frac{n+1}{10}-1$

$20\left(\frac{n+3}{4}-\frac{n-2}{5}\right)=20\left(\frac{n+1}{10}-1\right)$

$5(n+3)-4(n-2)=2(n+1)-20$

$5n+15-4n+8=2n+2-20$

$n+23=2n-18$

$-n=-41$

$n=41$

$\{41\}$

**30.** $\frac{t-2}{3}-\frac{t+7}{5}=\frac{t-4}{10}+2$

$30\left(\frac{t-2}{3}-\frac{t+7}{5}\right)=30\left(\frac{t-4}{10}+2\right)$

$10(t-2)-6(t+7)=3(t-4)+60$

$10t-20-6t-42=3t-12+60$

$4t-62=3t+48$

$t=110$

$\{110\}$

**31. a.** $T=-1.83a+212$

$T=-1.83(4)+212$

$=204.68°\text{F}$

$\approx 205°\text{F}$

**b.** $T=-1.83a+212$

$193=-1.83a+212$

$-19=-1.83a$

$10.4\approx a$

$10.4\times 10^3=10{,}400$

Approximately10, 400 ft

**32. a.** $C=167.95x+94$

$C=167.95(9)+94$

$=\$1605.55$

**b.** $C=167.95x+94$

$2445.30=167.95x+94$

$2351.30=167.95x$

$14=x$

14 credit-hours

**33.** $S=14.2t+149$

$362=14.2t+149$

$213=14.2t$

$15=t$

$2004+15=2019$

In 2019

**34.** $S = 18t + 232$

$628 = 18t + 232$

$396 = 18t$

$22 = t$

$2000 + 22 = 2022$

In 2022

**35. a.** $C = 7x$

**b.** $C = 105$

$7x = 105$

$x = 15$

The motorist will save money beginning on the 16th working day.

**36. a.** $C = 2.25x$

**b.** $C = 89$

$2.25x = 89$

$x \approx 39.6$

The commuter will save money on the 40th ride.

**37. a.** $S_1 = 45{,}000 + 2250x$

**b.** $S_2 = 48{,}000 + 2000x$

**c.** $S_1 = S_2$

$45{,}000 + 2250x = 48{,}000 + 2000x$

$250x = 3000$

$x = 12 \text{ yr}$

**38. a.** $S_1 = 25{,}000 + 0.16x$

**b.** $S_2 = 30{,}000 + 0.15x$

**c.** $S_1 = S_2$

$25{,}000 + 0.16x = 30{,}000 + 0.15x$

$0.01x = 5000$

$x = \$500{,}000$

**39.** $2x - 3 = 4(x-1) - 1 - 2x$

$2x - 3 = 4x - 4 - 1 - 2x$

$2x - 3 = 2x - 5$

$-3 = -5$

Contradiction

**40.** $4(3 - 5n) + 1 = -4n - 8 - 16n$

$12 - 20n + 1 = -4n - 8 - 16n$

$-20n + 13 = -20n - 8$

$13 = -8$

Contradiction

**41.** $-(6 - 2w) = 4(w + 1) - 2w - 10$

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

$-6 + 2w = 2w - 6$

$0 = 0$

Identity; ☐

**42.** $-5 + 3x = 3(x-1) - 2$

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

$-5 + 3x = 3x - 5$

$0 = 0$

Identity; ☐

**43.** $\frac{1}{2}x + 3 = \frac{1}{4}x + 1$

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

$2x + 12 = x + 4$

$x = -8$

Conditional equation; $\{-8\}$

**44.** $\frac{2}{3}y - 5 = \frac{1}{6}y - 4$

$6\left(\frac{2}{3}y - 5\right) = 6\left(\frac{1}{6}y - 4\right)$

$4y - 30 = y - 24$

$3y = 6$

$y = 2$

Conditional equation; $\{2\}$

**45.** $\frac{3}{x-5} + \frac{2}{x+4} = \frac{5}{7}$

$x \neq 5, x \neq -4$

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

$x \neq -1, x \neq 7$

**47.** $\frac{5}{2x-3} - \frac{3}{5x} = \frac{1}{3-x}$

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

$x \neq \frac{3}{2}, x \neq 0, x \neq 3$

**48.** $\frac{1}{2x}-\frac{3}{6-x}=\frac{2}{4x-5}$

$\frac{1}{2x}-\frac{3}{6-x}=\frac{2}{4\left(x-\frac{5}{4}\right)}$

$x\neq 0, x\neq 6, x\neq \frac{5}{4}$

**49.** $\frac{1}{2}-\frac{7}{2y}=\frac{5}{y}$

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

$y-7=10$

$y=17$

$\{17\}$

**50.** $\frac{1}{3}-\frac{4}{3t}=\frac{7}{t}$

$3t\left(\frac{1}{3}-\frac{4}{3t}\right)=3t\left(\frac{7}{t}\right)$

$t-4=21$

$t=25$

$\{25\}$

**51.** $\frac{w+3}{4w}+1=\frac{w-5}{w}$

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

$w+3+4w=4(w-5)$

$5w+3=4w-20$

$w=-23$

$\{-23\}$

**52.** $\frac{x+2}{6x}+1=\frac{x-7}{x}$

$6x\left(\frac{x+2}{6x}+1\right)=6x\left(\frac{x-7}{x}\right)$

$x+2+6x=6(x-7)$

$7x+2=6x-42$

$x=-44$

$\{-44\}$

**53.** $\frac{c}{c-3}=\frac{3}{c-3}-\frac{3}{4}$

$4(c-3)\left(\frac{c}{c-3}\right)=4(c-3)\left(\frac{3}{c-3}-\frac{3}{4}\right)$

$4c=12-3(c-3)$

$4c=12-3c+9$

$7c=21$

$c=3$

$\{\ \}$ ; The value 3 does not check.

**54.** $\frac{7}{d-7}-\frac{7}{8}=\frac{d}{d-7}$

$8(d-7)\left(\frac{7}{d-7}-\frac{7}{8}\right)=8(d-7)\left(\frac{d}{d-7}\right)$

$56-7(d-7)=8d$

$56-7d+49=8d$

$-15d=-105$

$d=7$

$\{\ \}$ ; The value 7 does not check.

**55.** $\frac{1}{t-1}=\frac{3}{t^2-1}$

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

$(t+1)(t-1)\left(\frac{1}{t-1}\right)=(t+1)(t-1)\left[\frac{3}{(t+1)(t-1)}\right]$

$t+1=3$

$t=2$

$\{2\}$

**56.**

$$\frac{1}{w+2}=\frac{5}{w^2-4}$$

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

$$(w+2)(w-2)\left(\frac{1}{w+2}\right)=(w+2)(w-2)\left[\frac{5}{(w+2)(w-2)}\right]$$

$$w-2=5$$

$$w=7$$

$\{7\}$

**57.**

$$\frac{2}{x-5}-\frac{1}{x+5}=\frac{11}{x^2-25}$$

$$\frac{2}{x-5}-\frac{1}{x+5}=\frac{11}{(x+5)(x-5)}$$

$$(x+5)(x-5)\left(\frac{2}{x-5}-\frac{1}{x+5}\right)=(x+5)(x-5)\left[\frac{11}{(x+5)(x-5)}\right]$$

$$2(x+5)-1(x-5)=11$$

$$2x+10-x+5=11$$

$$x+15=11$$

$$x=-4$$

$\{-4\}$

**58.**

$$\frac{2}{c+3}-\frac{1}{c-3}=\frac{10}{c^2-9}$$

$$\frac{2}{c+3}-\frac{1}{c-3}=\frac{10}{(c+3)(c-3)}$$

$$(c+3)(c-3)\left(\frac{2}{c+3}-\frac{1}{c-3}\right)=(c+3)(c-3)\left[\frac{10}{(c+3)(c-3)}\right]$$

$$2(c-3)-1(c+3)=10$$

$$2c-6-c-3=10$$

$$c-9=10$$

$$c=19$$

$\{19\}$

**59.**
$$\frac{-14}{x^2-x-12}-\frac{1}{x-4}=\frac{4}{x+3}$$
$$\frac{-14}{(x-4)(x+3)}-\frac{1}{(x-4)}=\frac{2}{(x+3)}$$
$$(x-4)(x+3)\left[\frac{-14}{(x-4)(x+3)}-\frac{1}{(x-4)}\right]=(x-4)(x+3)\left[\frac{2}{(x+3)}\right]$$
$$-14-(x+3)=2(x-4)$$
$$-14-x-3=2x-8$$
$$-17-x=2x-8$$
$$-3=x$$

$\{\ \}$ ; The value $-3$ does not check.

**60.**
$$\frac{2}{x^2+5x+6}-\frac{2}{x+2}=\frac{1}{x+3}$$
$$\frac{2}{(x+2)(x+3)}-\frac{2}{(x+2)}=\frac{1}{(x+3)}$$
$$(x+2)(x+3)\left[\frac{2}{(x+2)(x+3)}-\frac{2}{(x+2)}\right]=(x+2)(x+3)\left[\frac{1}{(x+3)}\right]$$
$$2-2(x+3)=(x+2)$$
$$2-2x-6=x+2$$
$$-4-2x=x+2$$
$$-2=x$$

$\{\ \}$ ; The value $-2$ does not check.

**61.**
$$\frac{5}{x^2-x-2}-\frac{2}{x^2-4}=\frac{4}{x^2+3x+2}$$
$$\frac{5}{(x-2)(x+1)}-\frac{2}{(x-2)(x+2)}=\frac{4}{(x+2)(x+1)}$$
$$(x+2)(x-2)(x+1)\left[\frac{5}{(x-2)(x+1)}-\frac{2}{(x-2)(x+2)}\right]=(x+2)(x-2)(x+1)\left[\frac{4}{(x+2)(x+1)}\right]$$
$$5(x+2)-2(x+1)=4(x-2)$$
$$5x+10-2x-2=4x-8$$
$$3x+8=4x-8$$
$$16=x$$

$\{16\}$

**62.**

$$\frac{4}{x^2-2x-8}-\frac{1}{x^2-16}=\frac{2}{x^2+6x+8}$$

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

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

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

$$4x+16-x-2=2x-8$$

$$3x+14=2x-8$$

$$x=-22$$

$\{-22\}$

**63.**

$$\frac{5}{m-2}=\frac{3m}{m^2+2m-8}-\frac{2}{m+4}$$

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

$$(m+4)(m-2)\left(\frac{5}{m-2}\right)=(m+4)(m-2)\left[\frac{3m}{(m+4)(m-2)}-\frac{2}{m+4}\right]$$

$$5(m+4)=3m-2(m-2)$$

$$5m+20=3m-2m+4$$

$$5m+20=m+4$$

$$4m=-16$$

$$m=-4$$

$\{\ \}$ ; The value $-4$ does not check.

**64.**

$$\frac{10}{n-6}=\frac{15n}{n^2-2n-24}-\frac{6}{n+4}$$

$$\frac{10}{n-6}=\frac{15n}{(n-6)(n+4)}-\frac{6}{n+4}$$

$$(n-6)(n+4)\left(\frac{10}{n-6}\right)=(n-6)(n+4)\left[\frac{15n}{(n-6)(n+4)}-\frac{6}{n+4}\right]$$

$$10(n+4)=15n-6(n-6)$$

$$10n+40=15n-6n+36$$

$$10n+40=9n+36$$

$$n=-4$$

$\{\ \}$ ; The value –4 does not check.

**65.**
$$\frac{5x}{3x^2-5x-2}-\frac{1}{3x+1}=\frac{3}{2-x}$$
$$\frac{5x}{(3x+1)(x-2)}-\frac{1}{3x+1}=\frac{-3}{x-2}$$
$$(3x+1)(x-2)\left[\frac{5x}{(3x+1)(x-2)}-\frac{1}{3x+1}\right]=(3x+1)(x-2)\left(\frac{-3}{x-2}\right)$$
$$5x-1(x-2)=-3(3x+1)$$
$$5x-x+2=-9x-3$$
$$4x+2=-9x-3$$
$$13x=-5$$
$$x=-\frac{5}{13}$$
$$\left\{-\frac{5}{13}\right\}$$

**66.**
$$\frac{3x}{2x^2+x-3}-\frac{2}{2x+3}=\frac{4}{1-x}$$
$$\frac{3x}{(2x+3)(x-1)}-\frac{2}{2x+3}=\frac{-4}{x-1}$$
$$(2x+3)(x-1)\left[\frac{3x}{(2x+3)(x-1)}-\frac{2}{2x+3}\right]=(2x+3)(x-1)\left(\frac{-4}{x-1}\right)$$
$$3x-2(x-1)=-4(2x+3)$$
$$3x-2x+2=-8x-12$$
$$x+2=-8x-12$$
$$9x=-14$$
$$x=-\frac{14}{9}$$
$$\left\{-\frac{14}{9}\right\}$$

**67.** $A=lw$ for $l$

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

**68.** $E=IR$ for $R$

$$\frac{E}{I}=\frac{IR}{I}$$
$$\frac{E}{I}=R \text{ or } R=\frac{E}{I}$$

**69.** $P=a+b+c$ for $c$

$$P-a-b=c \text{ or } c=P-a-b$$

**70.** $W=K-T$ for $K$

$$W+T=K \text{ or } K=W+T$$

**71.** $\Delta s=s_2-s_1$ for $s_1$

$$\Delta s-s_2=-s_1$$
$$s_1=s_2-\Delta s$$

**72.** $\Delta t=t_f-t_i$ for $t_i$

$$\Delta t-t_f=-t_i$$
$$t_i=t_f-\Delta t$$

**73.** $7x+2y=8$ for $y$

$$2y=-7x+8$$
$$\frac{2y}{2}=\frac{-7x+8}{2}$$
$$y=\frac{-7x+8}{2} \text{ or } y=-\frac{7}{2}x+4$$

**74.** $3x+5y=15$ for $y$

$$5y=-3x+15$$
$$\frac{5y}{5}=\frac{-3x+15}{5}$$
$$y=\frac{-3x+15}{5} \text{ or } y=-\frac{3}{5}x+3$$

**75.** $5x-4y=2$ for $y$

$$-4y=-5x+2$$
$$\frac{-4y}{-4}=\frac{-5x+2}{-4}$$
$$y=\frac{5x-2}{4} \text{ or } y=\frac{5}{4}x-\frac{1}{2}$$

**76.** $7x-2y=5$ for $y$

$$-2y=-7x+5$$
$$\frac{-2y}{-2}=\frac{-7x+5}{-2}$$
$$y=\frac{7x-5}{2} \text{ or } y=\frac{7}{2}x-\frac{5}{2}$$

**77.** $\frac{1}{2}x+\frac{1}{3}y=1$ for $y$

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

**78.** $\frac{1}{4}x-\frac{2}{3}y=2$ for $y$

$$12\left(\frac{1}{4}x-\frac{2}{3}y\right)=12(2)$$
$$3x-8y=24$$
$$-8y=-3x+24$$
$$\frac{-8y}{-8}=\frac{-3x+24}{-8}$$
$$y=\frac{3x-24}{8} \text{ or } y=\frac{3}{8}x-3$$

**79.** $S=\frac{n}{2}(a+d)$ for $d$

$$2(S)=2\left[\frac{n}{2}(a+d)\right]$$
$$2S=n(a+d)$$
$$2S=na+nd$$
$$2S-na=nd$$
$$\frac{2S-na}{n}=\frac{nd}{n}$$
$$\frac{2S-na}{n}=d$$
$$d=\frac{2S-na}{n} \text{ or } d=\frac{2S}{n}-a$$

**80.** $S=\frac{n}{2}\left[2a+(n-1)d\right]$ for $a$

$$2(S)=2\left\{\frac{n}{2}\left[2a+(n-1)d\right]\right\}$$
$$2S=n\left[2a+(n-1)d\right]$$
$$2S=n(2a+nd-d)$$
$$2S=2an+n^2d-nd$$
$$2S-n^2d+nd=2an$$
$$\frac{2S-n^2d+nd}{2n}=\frac{2an}{2n}$$
$$\frac{2S-n^2d+nd}{2n}=a \text{ or } a=\frac{2S-n^2d+nd}{2n}$$

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

$$3(V) = 3\left(\frac{1}{3}\pi r^2 h\right)$$
$$3V = \pi r^2 h$$
$$\frac{3V}{\pi r^2} = \frac{\pi r^2 h}{\pi r^2}$$
$$\frac{3V}{\pi r^2} = h \text{ or } h = \frac{3V}{\pi r^2}$$

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

$$3(V) = 3\left(\frac{1}{3}Bh\right)$$
$$3V = Bh$$
$$\frac{3V}{h} = \frac{Bh}{h}$$
$$\frac{3V}{h} = B \text{ or } B = \frac{3V}{h}$$

**83.** $6 = 4x + tx$ for $x$

$$6 = x(4+t)$$
$$\frac{6}{4+t} = \frac{x(4+t)}{4+t}$$
$$\frac{6}{4+t} = x \text{ or } x = \frac{6}{4+t}$$

**84.** $8 = 3x + kx$ for $x$

$$8 = x(3+k)$$
$$\frac{8}{3+k} = \frac{x(3+k)}{3+k}$$
$$\frac{8}{3+k} = x \text{ or } x = \frac{8}{3+k}$$

**85.** $6x + ay = bx + 5$ for $x$

$$6x - bx = 5 - ay$$
$$x(6-b) = 5 - ay$$
$$\frac{x(6-b)}{6-b} = \frac{5-ay}{6-b}$$
$$x = \frac{5-ay}{6-b} \text{ or } x = \frac{ay-5}{b-6}$$

**86.** $3x + 2y = cx + d$ for $x$

$$3x - cx = d - 2y$$
$$x(3-c) = d - 2y$$
$$\frac{x(3-c)}{3-c} = \frac{d-2y}{3-c}$$
$$x = \frac{d-2y}{3-c} \text{ or } x = \frac{2y-d}{c-3}$$

**87.** $A = P + Prt$ for $P$

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

**88.** $C = A + Ar$ for $A$

$$C = A(1+r)$$
$$\frac{C}{1+r} = \frac{A(1+r)}{1+r}$$
$$\frac{C}{1+r} = A \text{ or } A = \frac{C}{1+r}$$

**89.**
$$\frac{5}{2n+1} = \frac{-2}{3n-4}$$
$$(2n+1)(3n-4)\left(\frac{5}{2n+1}\right) = (2n+1)(3n-4)\left(\frac{-2}{3n-4}\right)$$
$$5(3n-4) = -2(2n+1)$$
$$15n - 20 = -4n - 2$$
$$19n = 18$$
$$n = \frac{18}{19}$$
$$\left\{\frac{18}{19}\right\}$$

**90.**
$$\frac{4}{5z-3}=\frac{-2}{4z+7}$$
$$(5z-3)(4z+7)\left(\frac{4}{5z-3}\right)=(5z-3)(4z+7)\left(\frac{-2}{4z+7}\right)$$
$$4(4z+7)=-2(5z-3)$$
$$16z+28=-10z+6$$
$$26z=-22$$
$$z=-\frac{22}{26}=-\frac{11}{13}$$
$$\left\{-\frac{11}{13}\right\}$$

**91.**
$$5-2\{3-[5v+3(v-7)]\}=8v+6(3-4v)-61$$
$$5-2[3-(5v+3v-21)]=8v+18-24v-61$$
$$5-2[3-(8v-21)]=-16v-43$$
$$5-2(3-8v+21)=-16v-43$$
$$5-2(24-8v)=-16v-43$$
$$5-48+16v=-16v-43$$
$$16v-43=-16v-43$$
$$32v=0$$
$$v=0$$
$$\{0\}$$

**92.**
$$6-\{4-2[8u-2(u-3)]\}=-4u+3(2-u)+8$$
$$6-[4-2(8u-2u+6)]=-4u+6-3u+8$$
$$6-[4-2(6u+6)]=-7u+14$$
$$6-(4-12u-12)=-7u+14$$
$$6-(12u-8)=-7u+14$$
$$6-12u+8=-7u+14$$
$$-5u=0$$
$$u=0$$
$$\{0\}$$

**93.**
$$(x-7)(x+2)=x^2+4x+13$$
$$x^2+2x-7x-14=x^2+4x+13$$
$$x^2-5x-14=x^2+4x+13$$
$$-9x=27$$
$$x=-3$$
$$\{-3\}$$

**94.** $(m+3)(2m-5) = 2m^2 + 4m - 3$

$$2m^2 + 6m - 5m - 15 = 2m^2 + 4m - 3$$
$$2m^2 + m - 15 = 2m^2 + 4m - 3$$
$$-3m = 12$$
$$m = -4$$

$\{-4\}$

**95.** $$\frac{3}{c^2-4c} - \frac{9}{2c^2+3c} = \frac{2}{2c^2-5c-12}$$

$$\frac{3}{c(c-4)} - \frac{9}{c(2c+3)} = \frac{2}{(2c+3)(c-4)}$$

$$c(2c+3)(c-4)\left[\frac{3}{c(c-4)} - \frac{9}{c(2c+3)}\right] = c(2c+3)(c-4)\left[\frac{2}{(2c+3)(c-4)}\right]$$

$$3(2c+3) - 9(c-4) = 2c$$
$$6c + 9 - 9c + 36 = 2c$$
$$-3c + 45 = 2c$$
$$-5c = -45$$
$$c = 9$$

$\{9\}$

**96.** $$\frac{4}{d^2-d} - \frac{5}{2d^2+5d} = \frac{2}{2d^2+3d-5}$$

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

$$d(2d+5)(d-1)\left[\frac{4}{d(d-1)} - \frac{5}{d(2d+5)}\right] = d(2d+5)(d-1)\left[\frac{2}{(2d+5)(d-1)}\right]$$

$$4(2d+5) - 5(d-1) = 2d$$
$$8d + 20 - 5d + 5 = 2d$$
$$3d + 25 = 2d$$
$$d = -25$$

$\{-25\}$

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

$$6\left(\frac{1}{3}x + \frac{1}{2}\right) = 6\left[\frac{1}{2}(x+1) - \frac{1}{6}x\right]$$
$$2x + 3 = 3(x+1) - x$$
$$2x + 3 = 3x + 3 - x$$
$$2x + 3 = 2x + 3$$
$$0 = 0$$

□

**98.** $$\frac{1}{2}x + \frac{2}{5} = \frac{2}{5}(x+1) + \frac{1}{10}x$$

$$10\left(\frac{1}{2}x + \frac{2}{5}\right) = 10\left[\frac{2}{5}(x+1) + \frac{1}{10}x\right]$$
$$5x + 4 = 4(x+1) + x$$
$$5x + 4 = 4x + 4 + x$$
$$5x + 4 = 5x + 4$$
$$0 = 0$$

□

**99.** $(t+2)^2=(t-4)^2$

$t^2+4t+4=t^2-8t+16$

$12t=12$

$t=1$

$\{1\}$

101. $\frac{3}{3a+4}=\frac{5}{5a-1}$

$\left[(3a+4)(5a-1)\right]\left(\frac{3}{3a+4}\right)=\left[(3a+4)(5a-1)\right]\left(\frac{5}{5a-1}\right)$

$3(5a-1)=5(3a+4)$

$15a-3=15a+20$

$-3=20$

$\{\ \}$

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

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

$8(2x+5)=2(8x-3)$

$16x+40=16x-6$

$40=-6$

$\{\ \}$

**103.** $P=\frac{40+20x}{1+0.05x}$

$200=\frac{40+20x}{1+0.05x}$

$(1+0.05x)(200)=(1+0.05x)\left(\frac{40+20x}{1+0.05x}\right)$

$200+10x=40+20x$

$-10x=-160$

$x=16\text{ yr}$

**100.** $(y-3)^2=(y+1)^2$

$y^2-6y+9=y^2+2y+1$

$-8y=-8$

$y=1$

$\{1\}$

**104.** $v=\frac{180t}{2t+10}$

$60=\frac{180t}{2t+10}$

$(2t+10)(60)=(2t+10)\left(\frac{180t}{2t+10}\right)$

$120t+600=180t$

$-60t=-600$

$t=10\text{ sec}$

**105.** $A=\frac{1}{22}c+\frac{1}{30}h$

$7=\frac{1}{22}c+\frac{1}{30}(165)$

$7=\frac{1}{22}c+\frac{11}{2}$

$22(7)=22\left(\frac{1}{22}c+\frac{11}{2}\right)$

$154=c+121$

$c=33\text{ mi}$

**106.** $A=\frac{1}{24}c+\frac{1}{32}h$

$9=\frac{1}{24}(60)+\frac{1}{32}h$

$9=\frac{5}{2}+\frac{1}{32}h$

$32(9)=32\left(\frac{5}{2}+\frac{1}{32}h\right)$

$288=80+h$

$h=208\text{ mi}$

**107.** The value 5 is not defined within the expressions in the equation. Substituting 5 into the equation would result in division by 0.

**108.** The equation is an identity. The solution set is all real numbers.

**109.** The equation cannot be written in the form $ax+b=0$. The term $\frac{3}{x}=3x^{-1}$. Therefore, the term $\frac{3}{x}$ is not first degree and the equation is not a first-degree equation.

**110.** The equation cannot be written in the form $ax+b=0$. The term $2\sqrt{x}=2x^{1/2}$. Therefore, the term $2\sqrt{x}$ is not first degree and the equation is not a first-degree equation.

**111.** The equation is a contradiction. There is no real number *x* to which we add 1 that will equal the same real number *x* to which we add 2.

**112.** In each case, we can clear fractions by multiplying both sides of the equation by the LCD. For the equation $\frac{x}{3}+\frac{1}{2}=1$, the LCD is 6, whereas for $\frac{3}{x}+\frac{1}{2}=1$, the LCD is $2x$.

**113.**
$$ax+6=4x+14$$
$$a(4)+6=4(4)+14$$
$$4a+6=16+14$$
$$4a+6=30$$
$$4a=24$$
$$a=6$$

**114.**
$$ax-3=2x+9$$
$$a(3)-3=2(3)+9$$
$$3a-3=6+9$$
$$3a-3=15$$
$$3a=18$$
$$a=6$$

**115.**
$$a(2x-5)+6=5x+7$$
$$a[2(16)-5]+6=5(16)+7$$
$$a(32-5)+6=80+7$$
$$27a+6=87$$
$$27a=81$$
$$a=3$$

**116.**
$$a(2x+4)+12x=3(2-x)$$
$$a[2(34)+4]+12(34)=3[2-(34)]$$
$$a(68+4)+408=3(-32)$$
$$72a+408=-96$$
$$72a=-504$$
$$a=-7$$

## Section 1.2 Applications with Linear and Rational Equations

**1.** \$900

**2.** $0.08(2)=0.16$ L

**3.** $\frac{d}{r}$

**4.** $\frac{d}{t}$

**5.** $P=2l+2w$

**6.** 180°

**7.** Let *x* represent the amount borrowed at 3%. Then, $(5000-x)$ is the amount borrowed at 2.5%.

| | **3% Interest Loan** | **2.5% Interest Loan** | **Total** |
|---|---|---|---|
| **Principal** | $x$ | $5000-x$ | |
| **Interest (*I* = *Prt*)** | $x(0.03)(1)$ | $(5000-x)(0.025)(1)$ | 132.50 |

$$\begin{aligned} x(0.03)+(5000-x)(0.025) &= 132.50 \\ 0.03x+125-0.025x &= 132.50 \\ 0.005x+125 &= 132.50 \\ 0.005x &= 7.50 \\ x &= 1500 \\ 5000-x &= 5000-1500 \\ &= 3500 \end{aligned}$$

Rocco borrowed \$1500 at 3% and \$3500 at 2.5%.

**8.** Let *x* represent the amount borrowed at 4%. Then, $(22{,}000-x)$ is the amount borrowed at 5.5%.

| | **4% Interest Loan** | **5.5% Interest Loan** | **Total** |
|---|---|---|---|
| **Principal** | *x* | $22{,}000-x$ | |
| **Interest (*I* = *Prt*)** | $x(0.04)(1)$ | $(22{,}000-x)(0.055)(1)$ | 910 |

$$\begin{aligned} x(0.04)+(22{,}000-x)(0.055) &= 910 \\ 0.04x+1210-0.055x &= 910 \\ -0.015x+1210 &= 910 \\ -0.015x &= -300 \\ x &= 20{,}000 \\ 22{,}000-x &= 22{,}000-20{,}000 \\ &= 2000 \end{aligned}$$

Laura borrowed \$20,000 from the bank charging 4% interest, and \$2000 from the bank charging 5.5% interest.

**9.** Let *x* represent the amount invested in the 3-yr CD. Then, $x-2000$ is the amount invested in the 18-month CD.

| | **3-yr CD** | **18-month (1.5-yr) CD** | **Total** |
|---|---|---|---|
| **Principal** | *x* | $x-2000$ | |
| **Interest (*I* = *Prt*)** | $x(0.044)(3)$ | $(x-2000)(0.03)(1.5)$ | 706.50 |

$$\begin{aligned} x(0.044)(3)+(x-2000)(0.03)(1.5) &= 706.50 \\ 0.132x+0.045x-90 &= 706.50 \\ 0.177x-90 &= 706.50 \\ 0.177x &= 796.50 \\ x &= 4500 \\ x-2000 &= 4500-2000 \\ &= 2500 \end{aligned}$$

Fernando invested \$4500 in the 3-yr CD and \$2500 in the 18-month CD.

**10.** Let *x* represent the amount invested in the 5-yr Treasury note. Then, $(x+5000)$ is the amount invested in the 10-yr bond.

| | 5-yr Note | 10-yr Bond | Total |
|---|---|---|---|
| **Principal** | $x$ | $x+5000$ | |
| **Interest (*I* = *Prt*)** | $x(0.028)(5)$ | $(x+5000)(0.036)(10)$ | 5300 |

$$\begin{aligned} x(0.028)(5)+(x+5000)(0.036)(10) &= 5300 \\ 0.14x+0.36x+1800 &= 5300 \\ 0.5x+1800 &= 5300 \\ 0.5x &= 3500 \\ x &= 7000 \\ x+5000 &= 7000+5000 \\ &= 12{,}000 \end{aligned}$$

Ebony invested $7000 in the Treasury note and $12,000 in the bond.

**11.** Let *x* represent the amount of the 5% solution (in gallons). 5000 gal is the amount of the

10% solution. Therefore, $x+5000$ is the amount of the resulting 9% solution.

| | 5% Solution | 10% Solution | 9% Solution |
|---|---|---|---|
| **Amount of Solution** | $x$ | 5000 | $x+5000$ |
| **Pure Ethanol** | 0.05$x$ | $0.1(5000)$ | $0.09(x+5000)$ |

$$\begin{aligned} 0.05x+0.1(5000) &= 0.09(x+5000) \\ 0.05x+500 &= 0.09x+450 \\ 50 &= 0.04x \\ 1250 &= x \end{aligned}$$

1250 gal of E5 should be mixed with the E10.

**12.** Let *x* represent the amount of the 10% solution (in cubic centimeters). 60 cc is the amount of the 50% solution. Therefore, $x+60$ is the amount of the resulting 25% solution.

| | 10% Solution | 50% Solution | 25% Solution |
|---|---|---|---|
| **Amount of Solution** | $x$ | 60 | $x+60$ |
| **Pure Saline** | 0.1$x$ | $0.5(60)$ | $0.25(x+60)$ |

$$\begin{aligned} 0.1x+0.5(60) &= 0.25(x+60) \\ 0.1x+30 &= 0.25x+15 \\ 15 &= 0.15x \\ 100 &= x \end{aligned}$$

100 cc of 10% saline solution should be mixed with the 50% saline solution.

**13.** Let *x* represent the amount of the pure sand (in cubic feet). 480 ft$^2$ is the amount of the

concrete mix that is 70% sand. Therefore, $(x+480)$ is the amount of the resulting 75%

sand mixture.

| | 100% Sand | 70% Sand | 75% Sand |
|---|---|---|---|

| **Amount of Mixture** | *x* | 480 | $x+480$ |
|---|---|---|---|
| **Pure Sand** | *x* | $0.7(480)$ | $0.75(x+480)$ |

$$x+0.7(480)=0.75(x+480)$$
$$x+336=0.75x+360$$
$$0.25x=24$$
$$x=96$$

96 ft$^2$ of sand should be mixed with the 70% sand mixture.

**14**. Let *x* represent the amount of 50% antifreeze solution (in gallons) to be drained (and therefore the amount of 100% antifreeze solution to be added). 4 gal is the amount of the resulting 65% antifreeze solution. Therefore, $(4-x)$ is the amount of 50% antifreeze solution that is not drained.

| | **100% Solution** | **50% Solution** | **65% Solution** |
|---|---|---|---|
| **Amount of Solution** | *x* | $4-x$ | 4 |
| **Pure Antifreeze** | *x* | $0.5(4-x)$ | $0.65(4)$ |

$$x+0.5(4-x)=0.65(4)$$
$$x+2-0.5x=2.6$$
$$0.5x=0.6$$
$$x=1.2$$

1.2 gal of 50% antifreeze solution should be drained and replaced with 100% antifreeze.

**15.** Let *x* represent the speed of the plane flying to Los Angeles. Then, $(x+60)$ is the speed of the plane flying to New York City.

| | **Distance** | **Rate** | **Time** |
|---|---|---|---|
| **Los Angeles Flight** | $3.4x$ | *x* | 3.4 |
| **New York City Flight** | $2.4(x+60)$ | $x+60$ | 2.4 |

$$3.4x+2.4(x+60)=2464$$
$$3.4x+2.4x+144=2464$$
$$5.8x=2320$$
$$x=400$$
$$x+60=400+60$$
$$=460$$

The plane to Los Angeles travels 400 mph and the plane to New York City travels 460 mph.

**16.** Let *x* represent the speed of the plane flying to Seattle. Then, $(x-44)$ is the speed of the
plane flying to Boston.

| | **Distance** | **Rate** | **Time** |
|---|---|---|---|
| **Seattle Flight** | $5.2x$ | *x* | 5.2 |
| **Boston Flight** | $2.5(x-44)$ | $x-44$ | 2.5 |

$$\begin{aligned} 5.2x+2.5(x-44) &= 3124 \\ 5.2x+2.5x-110 &= 3124 \\ 7.7x &= 3234 \\ x &= 420 \\ x-44 &= 420-44 \\ &= 376 \end{aligned}$$

The plane to Seattle travels 420 mph, and the plane to Boston travels 376 mph.

**17.** Let *x* represent the distance from Darren's home to his school.

| | **Distance** | **Rate** | **Time** |
|---|---|---|---|
| **To School** | *x* | 32 | $\frac{x}{32}$ |
| **To Home** | *x* | 48 | $\frac{x}{48}$ |

$$\begin{aligned} \frac{x}{32}+\frac{x}{48} &= 1.25 \\ 96\left(\frac{x}{32}+\frac{x}{48}\right) &= 96(1.25) \\ 3x+2x &= 120 \\ 5x &= 120 \\ x &= 24 \end{aligned}$$

The distance is 24 mi.

**18.** Let *x* represent the distance of the loop.

| | **Distance** | **Rate** | **Time** |
|---|---|---|---|
| **Running** | *x* | 8 | $\frac{x}{8}$ |
| **Riding** | 5*x* | 16 | $\frac{5x}{16}$ |

$$\begin{aligned} \frac{x}{8}+\frac{5x}{16} &= 1.75 \\ 16\left(\frac{x}{8}+\frac{5x}{16}\right) &= 16(1.75) \\ 2x+5x &= 28 \\ 7x &= 28 \\ x &= 4 \end{aligned}$$

The loop is 4 mi.

**19.** Let *t* represent the time it takes for the runners to cover $\frac{1}{4}$ mile.

$$\frac{1 \text{ lap}}{66 \text{ sec}} + \frac{1 \text{ lap}}{60 \text{ sec}} = \frac{1 \text{ lap}}{t \text{ sec}}$$
$$660t\left(\frac{1}{66} + \frac{1}{60}\right) = 660t\left(\frac{1}{t}\right)$$
$$10t + 11t = 660$$
$$21t = 660$$
$$t = \frac{220}{7} \approx 31.4 \text{ sec}$$

**20.** Let *t* represent the time it takes Marta and her daughter to vacuum the house together.

$$\frac{1 \text{ job}}{40 \text{ min}} + \frac{1 \text{ job}}{60 \text{ min}} = \frac{1 \text{ job}}{t \text{ min}}$$
$$120t\left(\frac{1}{40} + \frac{1}{60}\right) = 120t\left(\frac{1}{t}\right)$$
$$3t + 2t = 120$$
$$5t = 120$$
$$t = 24 \text{ min}$$

**21.** Let *t* represent the time it takes the second pump to fill the pool by itself.

$$\frac{1 \text{ job}}{10 \text{ hr}} + \frac{1 \text{ job}}{t \text{ hr}} = \frac{1 \text{ job}}{6 \text{ hr}}$$
$$30t\left(\frac{1}{10} + \frac{1}{t}\right) = 30t\left(\frac{1}{6}\right)$$
$$3t + 30 = 5t$$
$$30 = 2t$$
$$t = 15 \text{ hr}$$

**22.** Let *t* represent the time it takes Angelina to mow the lawn by herself.

$$\frac{1 \text{ job}}{50 \text{ min}} + \frac{1 \text{ job}}{t \text{ min}} = \frac{1 \text{ job}}{30 \text{ min}}$$
$$150t\left(\frac{1}{50} + \frac{1}{t}\right) = 150t\left(\frac{1}{30}\right)$$
$$3t + 150 = 5t$$
$$150 = 2t$$
$$t = 75 \text{ min or } 1 \text{ hr } 15 \text{ min}$$

**23.** Let *x* represent the amount of cement and *y* represent the amount of gravel.

$$\frac{1}{2.4} = \frac{x}{150}$$
$$2.4x = 150$$
$$x = 62.5$$
$$\frac{2.4}{3.6} = \frac{150}{y}$$
$$2.4y = 540$$
$$y = 225$$

62.5 lb of cement and 225 lb of gravel

**24.** Let *x* represent the property tax on a house that is \$240,000.

$$\frac{180{,}000}{1296} = \frac{240{,}000}{x}$$
$$180{,}000x = 1296(240{,}000)$$
$$x = \frac{1296(240{,}000)}{180{,}000}$$
$$x = \$1728$$

**25.** Let *x* represent the patient's LDL cholesterol level. The HDL cholesterol level is 60 g/dL, and the total cholesterol is $(x + 60)$.

$$\frac{x + 60}{60} = 3.4$$
$$60\left(\frac{x + 60}{60}\right) = 60(3.4)$$
$$x + 60 = 204$$
$$x = 144$$
$$x + 60 = 144 + 60$$
$$= 204$$

LDL is 144 mg/dL and the total cholesterol is 204 mg/dL.

**26.** Let *x* represent the number of Democrats. Then, $(x - 10)$ represents the number of Republicans.

$$\frac{x}{x-10}=\frac{11}{9}$$
$$9(x-10)\left(\frac{x}{x-10}\right)=9(x-10)\left(\frac{11}{9}\right)$$
$$9x=11(x-10)$$
$$9x=11x-110$$
$$110=2x$$
$$55=x$$
$$x-10=55-10=45$$

There were 55 Democrat and 45 Republican senators.

**27.** Let *x* represent the number of deer in the population.

$$\frac{30}{x}=\frac{5}{80}$$
$$5x=2400$$
$$x=480 \text{ deer}$$

**28.** Let *x* represent the number of bass in the lake.

$$\frac{24}{x}=\frac{4}{40}$$
$$4x=960$$
$$x=240 \text{ bass}$$

**29.** Let *x* represent the distance from the epicenter to the station.

| | Distanc | Rat | Tim |
|---|---|---|---|
| **P Waves** | *x* | 5 | $\frac{x}{5}$ |
| **S Waves** | *x* | 3 | $\frac{x}{3}$ |

$$\frac{x}{3}-\frac{x}{5}=40$$
$$15\left(\frac{x}{3}-\frac{x}{5}\right)=15(40)$$
$$5x-3x=600$$
$$2x=600$$
$$x=300 \text{ km}$$

**30.** Let *x* represent the distance from the epicentre to the station.

| | Distanc | Rat | Tim |
|---|---|---|---|
| **P Waves** | *x* | 8 | $\frac{x}{8}$ |
| **S Waves** | *x* | 4.8 | $\frac{x}{4.8}$ |

$$\frac{x}{4.8}-\frac{x}{8}=20$$
$$24\left(\frac{x}{4.8}-\frac{x}{8}\right)=24(20)$$
$$5x-3x=480$$
$$2x=480$$
$$x=240 \text{ km}$$

**31.** Let *x* represent the price set by the merchant.

$$x-0.25x=180+0.40(180)$$
$$0.75x=180+72$$
$$0.75x=252$$
$$x=\$336$$

**32.** Let *x* represent the price set by the bookstore.

$$x-0.10x=80+0.35(80)$$
$$0.90x=80+28$$
$$0.90x=108$$
$$x=\$120$$

**33.** **a.** $C=110+60x$

**b.**
$$C=350$$
$$110+60x=350$$
$$60x=240$$
$$x=4 \text{ hr}$$

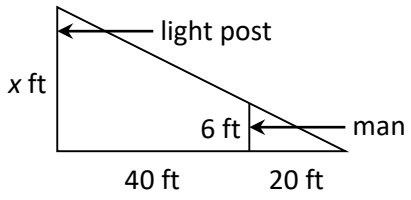
**34.** **a.** $C=2400+80x$

**b.**
$$C=5520$$
$$2400+80x=5520$$
$$80x=3120$$
$$x=39 \text{ hr}$$

**35.** Let *x* represent the height of the Washington Monument.

$$\frac{5}{4}=\frac{x}{444}$$
$$4x=2220$$
$$x=555 \text{ ft}$$

**36.** Let *x* represent the height of the light post.



$$\frac{6}{20}=\frac{x}{40+20}$$
$$\frac{6}{20}=\frac{x}{60}$$
$$20x=360$$
$$x=18 \text{ ft}$$

**37.** Let *x* represent the height of the pole. Then, $\frac{1}{8}x$ is the length of the pole that is in the ground, and $\frac{2}{3}x$ is the length of the pole that is in the snow.

$$x=1.5+\frac{2}{3}x+\frac{1}{8}x$$
$$x-\frac{2}{3}x-\frac{1}{8}x=1.5$$
$$24\left(x-\frac{2}{3}x-\frac{1}{8}x\right)=24(1.5)$$
$$24x-16x-3x=36$$
$$5x=36$$
$$x=7.2$$

The pole is 7.2 ft long, and the snow is 4.8 ft deep.

**38.**
$$C=\frac{5}{9}(F-32)$$
$$F=\frac{5}{9}(F-32)$$
$$9(F)=9\left[\frac{5}{9}(F-32)\right]$$
$$9F=5F-160$$
$$4F=-160$$
$$F=-40$$
$$-40°\text{C}=-40°\text{F}$$

**39.** Let *x* represent the amount of 20% fertilizer solution (in litres) to be drained (and therefore the amount of water to be added). 40 L is the amount of the resulting 15% fertilizer solution. Therefore, $(40-x)$ is the amount of 20% fertilizer solution that is not drained.

| | **0% Solution** | **20% Solution** | **15% Solution** |
|---|---|---|---|
| **Amount of Solution** | *x* | $40-x$ | 40 |
| **Pure fertilizer** | $0(x)$ | $0.20(40-x)$ | $0.15(40)$ |

$$0(x)+0.20(40-x)=0.15(40)$$
$$8-0.20x=6$$
$$-0.20x=-2$$
$$x=10$$

10 L should be drained and replaced by water.

**40.** Let *x* represent the amount of water (in litres) to be evaporated. Therefore, $(200-x)$ is the amount of the final 25% salt solution.

| | **0% Solution** | **5% Solution** | **25% Solution** |
|---|---|---|---|
| **Amount of Solution** | *x* | 200 | $200-x$ |
| **Pure salt** | $0(x)$ | $0.05(200)$ | $0.25(200-x)$ |

$$0(x)+0.05(200)=0.25(200-x)$$
$$10=50-0.25x$$
$$-40=-0.25x$$
$$160=x$$

160 mL should be evaporated.

**41.** The length of the lot is $l=128+2x$. The width of the lot is $w=60+2x$.

$$P=2l+2w$$
$$440=2(128+2x)+2(60+2x)$$
$$440=256+4x+120+4x$$
$$440=8x+376$$
$$64=8x$$
$$8=x$$

The width of the easement is 8 ft.

**42.** The length of the play area is $l=78+2x$. The width of the play area is $w=36+2x$.

$$P=2l+2w$$
$$396=2(78+2x)+2(36+2x)$$
$$396=156+4x+72+4x$$
$$396=8x+228$$
$$168=8x$$
$$21=x$$

The width of the border is 21 ft.

**43. a.** The width of the kitchen is *w*. The length of the kitchen is $l=w+4$.

$$P=2l+2w$$
$$48=2(w+4)+2w$$
$$48=2w+8+2w$$
$$48=4w+8$$
$$40=4w$$
$$10=w$$

The kitchen is 14 ft by 10 ft.

**b.** $A=lw+0.1lw$
$=1.1lw$
$A=1.1(14)(10)$
$=154 \text{ ft}^2$

**c.** $C=1.06(12)(154)$
$=\$1958.88$

**44. a.** The width of the porch is *w*. The length of the porch is $l=2w+2$.

$$P=2l+2w$$
$$64=2(2w+2)+2w$$
$$64=4w+4+2w$$
$$64=6w+4$$
$$60=6w$$
$$10=w$$
$$l=2w+2$$
$$=2(10)+2$$
$$=22$$

The porch is 22 ft by 10 ft.

**b.** $A=lw+0.1lw$
$=1.1lw$
$A=1.1(22)(10)$
$=242 \text{ ft}^2$

**c.** $C=1.075(5.85)(242)$
$\approx\$1521.88$

**45.** Aliyah had $8000-0.28(8000)=8000-2240=5760$ to invest. Let *x* represent the amount she invested at 11%. Then, $(5760-x)$ is the amount she invested at 5%.

| | **11% Investment** | **5% Investment** | **Total** |
|---|---|---|---|
| **Principal** | $x$ | $5760-x$ | |
| **Interest (*I* = *Prt*)** | $x(0.11)(1)$ | $(5760-x)(0.05)(1)$ | 453.60 |

$$\begin{aligned} x(0.11)+(5760-x)(0.05) &= 453.60 \\ 0.11x+288-0.05x &= 453.60 \\ 0.06x+288 &= 453.60 \\ 0.06x &= 165.60 \\ x &= 2760 \\ 5760-x &= 5760-2760 \\ &= 3000 \end{aligned}$$

Aliyah invested \$2760 in the stock returning 11% and \$3000 in the stock returning 5%.

**46.** Let *x* represent the amount Caitlin invested in the balanced fund. Then, $(2x)$ is the amount she invested in the stock fund.

| | **Balanced Fund (3.5%)** | **Stock Fund (17%)** | **Total** |
|---|---|---|---|
| **Principal** | *x* | 2*x* | |
| **Interest (*I* = *Prt*)** | $x(0.035)(1)$ | $(2x)(0.17)(1)$ | 1125 |

$$\begin{aligned} x(0.035)+(2x)(0.17) &= 1125 \\ 0.035x+0.34x &= 1125 \\ 0.375x &= 1125 \\ x &= 3000 \\ 2x &= 2(3000) \\ &= 6000 \end{aligned}$$

Caitlin invested \$3000 in the balanced fund and \$6000 in the stock fund.

**47.**
$$\frac{7}{8}=\frac{x}{12.8}$$
$$8x=89.6$$
$$x=11.2$$
$$\frac{8}{y}=\frac{12.8}{12}$$
$$12.8y=96$$
$$y=7.5$$

$x$ = 11.2 ft and $y$ = 7.5 cm

**48.**
$$\frac{1.2}{0.96}=\frac{x}{1.04}$$
$$0.96x=1.248$$
$$x=1.3$$
$$\frac{0.5}{y}=\frac{1.2}{0.96}$$
$$1.2y=0.48$$
$$y=0.4$$

$x$ = 1.3 m and $y$ = 0.4 in.

**49.** No. If $x$ represents the measure of the smallest angle, then the equation $x+(x+2)+(x+4)=180$ does not result in an odd integer value for $x$. Instead the measures of the angles would be even integers.

**50.** No. If $x$ represents the number of each type of bill, then the solution to the equation $20x+10x+5x=100$ is not a whole number.

**51.** Let x represent the smaller number. Then, $(x+16)$ is the larger number.
$$\frac{x+16}{x}=3+\frac{2}{x}$$
$$x\left(\frac{x+16}{x}\right)=x\left(3+\frac{2}{x}\right)$$
$$x+16=3x+2$$
$$14=2x$$
$$7=x$$
$$x+16=7+16$$
$$=23$$

The numbers are 7 and 23.

**52.** Let x represent the smaller number. Then, $(x+25)$ is the larger number.
$$\frac{x+25}{x}=4+\frac{1}{x}$$
$$x\left(\frac{x+25}{x}\right)=x\left(4+\frac{1}{x}\right)$$
$$x+25=4x+1$$
$$24=3x$$
$$8=x$$
$$x+25=8+25$$
$$=33$$

The numbers are 8 and 33.

**53.** Let $x$ represent the tens digit of the number. Then, $(14-x)$ is the ones digit.
$$10(14-x)+1(x)=10(x)+1(14-x)+18$$
$$140-10x+x=10x+14-x+18$$
$$140-9x=9x+32$$
$$108=18x$$
$$6=x$$
$$14-x=14-6$$
$$=8$$

The original number is 68.

**54.** Let $x$ represent the tens digit of the number. Then, $(9-x)$ is the ones digit.
$$10(9-x)+1(x)=10(x)+1(9-x)-45$$
$$90-10x+x=10x+9-x-45$$
$$90-9x=9x-36$$
$$126=18x$$
$$7=x$$
$$9-x=9-7$$
$$=2$$

The original number is 72.

**55.**
$$m_1x_1+m_2x_2=0$$
$$(30)(-1.2)+(20)x_2=0$$
$$20x_2=36$$
$$x_2=1.8\text{ m}$$

**56.**
$$m_1x_1+m_2x_2=0$$
$$(64)x_1+(80)(2)=0$$
$$64x_1=-160$$
$$x_1=-2.5\text{ m}$$

**57.** $m_1x_1 + m_2x_2 = 0$

$(10)(-3.2) + m_2(8) = 0$

$8m_2 = -32$

$m_2 = -4 \text{ kg}$

**58.** $m_1x_1 + m_2x_2 = 0$

$m_1(-10) + (6)(7) = 0$

$-10m_1 = -42$

$m_1 = 4.2 \text{ kg}$

## Section 1.3 Complex Numbers

**1.** $-1$

**2.** $i\sqrt{b}$

**3.** real; imaginary

**4.** conjugate

**5.** $\sqrt{-121} = i\sqrt{121} = 11i$

**6.** $\sqrt{-100} = i\sqrt{100} = 10i$

**7.** $\sqrt{-98} = i\sqrt{98} = 7i\sqrt{2}$

**8.** $\sqrt{-63} - i\sqrt{63} = 3i\sqrt{7}$

**9.** $\sqrt{-19} = i\sqrt{19}$

**10.** $\sqrt{-23} = i\sqrt{23}$

**11.** $-\sqrt{-16} = -i\sqrt{16} = -4i$

**12.** $-\sqrt{-25} = -i\sqrt{25} = -5i$

**13.** $\sqrt{-4}\sqrt{-9} = i\sqrt{4} \cdot i\sqrt{9}$

$= 2i \cdot 3i = 6i^2$

$= 6(-1) = -6$

**14.** $\sqrt{-1}\sqrt{-36} = i\sqrt{1} \cdot i\sqrt{36}$

$= 1i \cdot 6i = 6i^2$

$= 6(-1) = -6$

**15.** $\sqrt{-10}\sqrt{-5} = i\sqrt{10} \cdot i\sqrt{5}$

$= i^2\sqrt{50}$

$= (-1)\sqrt{5^2 \cdot 2}$

$= -5\sqrt{2}$

**16.** $\sqrt{-6}\sqrt{-15} = i\sqrt{6} \cdot i\sqrt{15}$

$= i^2\sqrt{90}$

$= (-1)\sqrt{3^2 \cdot 10}$

$= -3\sqrt{10}$

**17.** $\sqrt{-6}\sqrt{-14} = i\sqrt{6} \cdot i\sqrt{14}$

$= i^2\sqrt{84}$

$= (-1)\sqrt{2^2 \cdot 21}$

$= -2\sqrt{21}$

**18.** $\sqrt{-10}\sqrt{-15} = i\sqrt{10} \cdot i\sqrt{15}$

$= i^2\sqrt{150}$

$= (-1)\sqrt{5^2 \cdot 6}$

$= -5\sqrt{6}$

**19.** $\dfrac{\sqrt{-98}}{\sqrt{-2}} = \dfrac{i\sqrt{98}}{i\sqrt{2}}$

$= \sqrt{\dfrac{98}{2}}$

$= \sqrt{49} = 7$

**20.** $\dfrac{\sqrt{-45}}{\sqrt{-5}} = \dfrac{i\sqrt{45}}{i\sqrt{5}}$

$= \sqrt{\dfrac{45}{5}}$

$= \sqrt{9} = 3$

**21.** $\dfrac{\sqrt{-63}}{\sqrt{7}} = \dfrac{i\sqrt{63}}{\sqrt{7}}$

$= i\sqrt{\dfrac{63}{7}}$

$= i\sqrt{9} = 3i$

**22.** $\dfrac{\sqrt{-80}}{\sqrt{5}} = \dfrac{i\sqrt{80}}{\sqrt{5}}$

$= i\sqrt{\dfrac{80}{5}}$

$= i\sqrt{16}$

$= 4i$

**23.** Real part: 3; Imaginary part: $-7$

**24.** Real part: 2; Imaginary part: $-4$

**25.** Real part: 0; Imaginary part: 19

**26.** Real part: 0; Imaginary part: 40

**27.** Real part: $-\dfrac{1}{4}$ ; Imaginary part: 0

**28.** Real part: $-\dfrac{4}{7}$ ; Imaginary part: 0

**29.** $4\sqrt{-4} = 4 \cdot 2i$

$= 8i = 0 + 8i$

**30.** $2\sqrt{-144} = 2 \cdot 12i$
$= 24i = 0 + 24i$

**31.** $2 + \sqrt{-12} = 2 + 2\sqrt{3}i \text{ or } 2 + 2i\sqrt{3}$

**32.** $6 - \sqrt{-24} = 6 + \left(-2\sqrt{6}\right)i \text{ or } 6 - 2i\sqrt{6}$

**33.** $\frac{8+3i}{14} = \frac{8}{14} + \frac{3}{14}i$
$= \frac{4}{7} + \frac{3}{14}i$

**34.** $\frac{4+5i}{6} = \frac{4}{6} + \frac{5}{6}i$
$= \frac{2}{3} + \frac{5}{6}i$

**35.** $\frac{-4-6i}{-2} = \frac{-4}{-2} + \frac{-6}{-2}i$
$= 2 + 3i$

**36.** $\frac{9-15i}{-3} = \frac{9}{-3} - \frac{15}{-3}i$
$= -3 + 5i$

**37.**
$$\frac{-18+\sqrt{-48}}{4} = \frac{-18+4\sqrt{3}i}{4}$$
$$= -\frac{18}{4} + \frac{4\sqrt{3}i}{4}$$
$$= -\frac{9}{2} + \sqrt{3}i \text{ or } -\frac{9}{2} + i\sqrt{3}$$

**38.** $\frac{-20+\sqrt{-50}}{-10} = \frac{-20+5\sqrt{2}i}{-10}$
$= \frac{-20}{-10} + \frac{5\sqrt{2}i}{-10}$
$= 2 - \frac{\sqrt{2}}{2}i \text{ or } 2 - i\frac{\sqrt{2}}{2}$

**39.** $\frac{14-\sqrt{-98}}{-7} = \frac{14-7\sqrt{2}i}{-7}$
$= -\frac{14}{7} + \frac{7\sqrt{2}i}{7}$
$= -2 + \sqrt{2}i \text{ or } -2 + i\sqrt{2}$

**40.**
$$\frac{-10+\sqrt{-125}}{5} = \frac{-10+5\sqrt{5}i}{5}$$
$$= -\frac{10}{5} + \frac{5\sqrt{5}i}{5}$$
$$= -2 + \sqrt{5}i \text{ or } -2 + i\sqrt{5}$$

**41. a.** $i^{20} = 1$

**b.** $i^{29} = i^{28} \cdot i^{1}$
$= (1) \cdot i^{1} = i$

**c.** $i^{50} = i^{48} \cdot i^{2}$
$= (1) \cdot i^{2} = -1$

**d.** $i^{-41} = i^{-44} \cdot i^{3}$
$= (1) \cdot i^{3} = -i$

**42. a.** $i^{32} = 1$

**b.** $i^{47} = i^{44} \cdot i^{3}$
$= (1) \cdot i^{3} = -i$

**c.** $i^{66} = i^{64} \cdot i^{2}$
$= (1) \cdot i^{2} = -1$

**d.** $i^{-27} = i^{-28} \cdot i^{1}$
$= (1) \cdot i^{1} = i$

**43. a.** $i^{37} = i^{36} \cdot i^{1}$
$= i$

**b.** $i^{-37} = i^{-40} \cdot i^{3}$
$= (1) \cdot i^{3} = -i$

**c.** $i^{82} = i^{80} \cdot i^{2}$
$= (1) \cdot i^{2} = -1$

**d.** $i^{-82} = i^{-84} \cdot i^{2}$
$= (1) \cdot i^{2} = -1$

**44. a.** $i^{103} = i^{100} \cdot i^{3}$
$= (1) \cdot i^{3} = -i$

**b.** $i^{-103} = i^{-104} \cdot i^{1}$
$= (1) \cdot i^{1} = i$

**c.** $i^{52} = 1$

**d.** $i^{-52} = 1$

**45.** $(2 - 7i) + (8 - 3i)$
$= (2+8) + (-7-3)i$
$= 10 - 10i$

**46.** $(6 - 10i) + (8 + 4i)$

$$=(6+8)+(-10+4)i$$
$$=14-6i$$

**47.** $(15+21i)-(18-40i)$
$$=(15-18)+[21-(-40)]i$$
$$=-3+61i$$

**48.** $(250+100i)-(80+25i)$
$$=(250-80)+(100-25)i$$
$$=170+75i$$

**49.** $\left(\frac{1}{2}+\frac{2}{3}i\right)-\left(\frac{5}{6}+\frac{1}{12}i\right)$
$$=\left(\frac{1}{2}-\frac{5}{6}\right)+\left(\frac{2}{3}-\frac{1}{12}\right)i$$
$$=\left(\frac{3}{6}-\frac{5}{6}\right)+\left(\frac{8}{12}-\frac{1}{12}\right)i$$
$$=-\frac{2}{6}+\frac{7}{12}i$$
$$=-\frac{1}{3}+\frac{7}{12}i$$

**50.** $\left(\frac{3}{5}-\frac{1}{8}i\right)-\left(\frac{7}{10}+\frac{1}{6}i\right)$
$$=\left(\frac{3}{5}-\frac{7}{10}\right)+\left(-\frac{1}{8}-\frac{1}{6}\right)i$$
$$=\left(\frac{6}{10}-\frac{7}{10}\right)+\left(-\frac{3}{24}-\frac{4}{24}\right)i$$
$$=-\frac{1}{10}-\frac{7}{24}i$$

**51.** $(2.3+4i)-(8.1-2.7i)+(4.6-6.7i)$
$$=(2.3-8.1+4.6)+(4+2.7-6.7)i$$
$$=-1.2+0i$$

**52.** $\begin{pmatrix}0.05\\-0.03i\end{pmatrix}+\begin{pmatrix}-0.12\\+0.08i\end{pmatrix}-\begin{pmatrix}0.07\\+0.05i\end{pmatrix}$
$$=(0.05-0.12-0.07)$$
$$+(-0.03+0.08-0.05)i$$
$$=-0.14+0i$$

**53.** $-\frac{1}{8}(16+24i)=-2-3i$

**54.** $-\frac{1}{6}(60-30i)=-10+5i$

**55.** $2i(5+i)=10i+2i^2$
$$=10i+2(-1)$$
$$=-2+10i$$

**56.** $4i(6+5i)=24i+20i^2$
$$=24i+20(-1)$$
$$=-20+24i$$

**57.** $\sqrt{-3}\left(\sqrt{11}-\sqrt{-7}\right)=i\sqrt{3}\left(\sqrt{11}-i\sqrt{7}\right)$
$$=i\sqrt{33}-i^2\sqrt{21}$$
$$=i\sqrt{33}-(-1)\sqrt{21}$$
$$=\sqrt{21}+i\sqrt{33}$$

**58.** $\sqrt{-2}\left(\sqrt{13}+\sqrt{-5}\right)=i\sqrt{2}\left(\sqrt{13}+i\sqrt{5}\right)$
$$=i\sqrt{26}+i^2\sqrt{10}$$
$$=i\sqrt{26}+(-1)\sqrt{10}$$
$$=-\sqrt{10}+i\sqrt{26}$$

**59.** $(3-6i)(10+i)$
$$=3(10)+3(i)+(-6i)(10)+(-6i)(i)$$
$$=30+3i-60i-6i^2$$
$$=30-57i-6(-1)$$
$$=36-57i$$

**60.** $(2-5i)(8+2i)$
$$=2(8)+2(2i)+(-5i)(8)+(-5i)(2i)$$
$$=16+4i-40i-10i^2$$
$$=16-36i-10(-1)$$
$$=26-36i$$

**61.** $(3-7i)^2=(3)^2-2(3)(7i)+(7i)^2$
$$=9-42i+49i^2$$
$$=9-42i+49(-1)$$
$$=9-42i-49$$
$$=-40-42i$$

**62.** $(10-3i)^2=(10)^2-2(10)(3i)+(3i)^2$
$$=100-60i+9i^2$$
$$=100-60i+9(-1)$$
$$=100-60i-9$$
$$=91-60i$$

**63.** $\left(3-\sqrt{-5}\right)\left(4+\sqrt{-5}\right)$

$$= \left(3 - i\sqrt{5}\right)\left(4 + i\sqrt{5}\right)$$
$$= 3(4) + 3\left(i\sqrt{5}\right) + \left(-i\sqrt{5}\right)(4) + \left(-i\sqrt{5}\right)\left(i\sqrt{5}\right)$$
$$= 12 + 3i\sqrt{5} - 4i\sqrt{5} - 5i^2$$
$$= 12 - i\sqrt{5} - 5(-1)$$
$$= 17 - i\sqrt{5}$$

**64.** $\left(2 + \sqrt{-7}\right)\left(10 + \sqrt{-7}\right)$
$$= \left(2 + i\sqrt{7}\right)\left(10 + i\sqrt{7}\right)$$
$$= 2(10) + 2\left(i\sqrt{7}\right) + i\sqrt{7}(10) + i\sqrt{7}\left(i\sqrt{7}\right)$$
$$= 20 + 2i\sqrt{7} + 10i\sqrt{7} + 7i^2$$
$$= 20 + 12i\sqrt{7} + 7(-1)$$
$$= 13 + 12i\sqrt{7}$$

**65.** $4(6 + 2i) - 5i(3 - 7i)$
$$= 24 + 8i - 15i + 35i^2$$
$$= 24 - 7i + 35(-1)$$
$$= -11 - 7i$$

**66.** $-3(8 - 3i) - 6i(2 + i)$
$$= -24 + 9i - 12i - 6i^2$$
$$= -24 - 3i - 6(-1)$$
$$= -18 - 3i$$

**67.** $(2 - i)^2 + (2 + i)^2$
$$= (2)^2 - 2(2)(i) + i^2 + (2)^2 + 2(2)(i) + i^2$$
$$= 4 - 4i + i^2 + 4 + 4i + i^2$$
$$= 8 + 2i^2$$
$$= 8 + 2(-1) = 6$$

**68.** $(3 - 2i)^2 + (3 + 2i)^2$
$$= (3)^2 - 2(3)(2i) + (2i)^2 + (3)^2 + 2(3)(2i) + (2i)^2$$
$$= 9 - 12i + 4i^2 + 9 + 12i + 4i^2$$
$$= 18 + 8i^2$$
$$= 18 + 8(-1) = 10$$

**69. a.** $3 + 6i$

**b.** $(3 - 6i)(3 + 6i) = (3)^2 + (6)^2$
$$= 9 + 36$$
$$= 45$$

**70. a.** $4 + 5i$

**b.** $(4 - 5i)(4 + 5i) = (4)^2 + (5)^2$
$$= 16 + 25$$
$$= 41$$

**71. a.** $0 - 8i$

**b.** $(0 - 8i)(0 + 8i) = (0)^2 + (8)^2$
$$= 0 + 64$$
$$= 64$$

**72. a.** $0 - 9i$

**b.** $(0 - 9i)(0 + i) = (0)^2 + (9)^2$
$$= 0 + 81$$
$$= 81$$

**73.** $(10 - 4i)(10 + 4i) = (10)^2 + (4)^2$
$$= 100 + 16$$
$$= 116$$

**74.** $(3 - 9i)(3 + 9i) = (3)^2 + (9)^2$
$$= 9 + 81$$
$$= 90$$

**75.** $(7i)(-7i) = 7^2 = 49$

**76.** $(-5i)(5i) = (5)^2 = 25$

**77.** $\left(\sqrt{2} + \sqrt{3}i\right)\left(\sqrt{2} + \sqrt{3}i\right)$
$$= \left(\sqrt{2}\right)^2 + \left(\sqrt{3}\right)^2$$
$$= 2 + 3 = 5$$

**78.** $\left(\sqrt{5} + \sqrt{7}i\right)\left(\sqrt{5} - \sqrt{7}i\right)$
$$= \left(\sqrt{5}\right)^2 + \left(\sqrt{7}\right)^2$$
$$= 5 + 7 = 12$$

**79.** $\dfrac{6+2i}{3-i}=\dfrac{(6+2i)(3+i)}{(3-i)(3+i)}$

$=\dfrac{18+6i+6i+2i^2}{(3)^2+(1)^2}$

$=\dfrac{18+12i+2(-1)}{9+1}$

$=\dfrac{16+12i}{10}$

$=\dfrac{16}{10}+\dfrac{12}{10}i$

$=\dfrac{8}{5}+\dfrac{6}{5}i$

**80.** $\dfrac{5+i}{4-i}=\dfrac{(5+i)(4+i)}{(4-i)(4+i)}$

$=\dfrac{20+5i+4i+i^2}{(4)^2+(1)^2}$

$=\dfrac{20+9i+1(-1)}{16+1}$

$=\dfrac{19+9i}{17}$

$=\dfrac{19}{17}+\dfrac{9}{17}i$

**81.** $\dfrac{8-5i}{13+2i}=\dfrac{(8-5i)(13-2i)}{(13+2i)(13-2i)}$

$=\dfrac{104-16i-65i+10i^2}{(13)^2+(2)^2}$

$=\dfrac{104-81i+10(-1)}{169+4}$

$=\dfrac{94-81i}{173}$

$=\dfrac{94}{173}-\dfrac{81}{173}i$

**82.** $\dfrac{10-3i}{11+4i}=\dfrac{(10-3i)(11-4i)}{(11+4i)(11-4i)}$

$=\dfrac{110-40i-33i+12i^2}{(11)^2+(4)^2}$

$=\dfrac{110-73i+12(-1)}{121+16}$

$=\dfrac{98-73i}{137}$

$=\dfrac{98}{137}-\dfrac{73}{137}i$

**83.** $(6+\sqrt{5}i)^{-1}=\dfrac{1}{6+\sqrt{5}i}$

$=\dfrac{1(6-\sqrt{5}i)}{(6+\sqrt{5}i)(6-\sqrt{5}i)}$

$=\dfrac{6-\sqrt{5}i}{(6)^2+(\sqrt{5})^2}$

$=\dfrac{6-\sqrt{5}i}{36+5}$

$=\dfrac{6-\sqrt{5}i}{41}$

$=\dfrac{6}{41}-\dfrac{\sqrt{5}}{41}i$

**84.** $(4-\sqrt{3}i)^{-1}=\dfrac{1}{4-\sqrt{3}i}$

$=\dfrac{1(4+\sqrt{3}i)}{(4-\sqrt{3}i)(4+\sqrt{3}i)}$

$=\dfrac{4+\sqrt{3}i}{(4)^2+(\sqrt{3})^2}$

$=\dfrac{4+\sqrt{3}i}{16+3}$

$=\dfrac{4+\sqrt{3}i}{19}$

$=\dfrac{4}{19}+\dfrac{\sqrt{3}}{19}i$

**85.** $\dfrac{5}{13i}=\dfrac{5\cdot i}{13i\cdot i}$

$=\dfrac{5i}{13i^2}=\dfrac{5i}{13(-1)}$

$=\dfrac{5i}{-13}=-\dfrac{5}{13}i$

$=0-\dfrac{5}{13}i$

**86.** $\dfrac{6}{7i}=\dfrac{6(-i)}{7i(-i)}$

$=\dfrac{-6i}{-7i^2}=\dfrac{-6i}{-7(-1)}$

$=-\dfrac{6}{7}i=0-\dfrac{6}{7}i$

**87.** $\dfrac{-1}{\sqrt{-3}}=\dfrac{-1}{\sqrt{3}i}$

$=\dfrac{-1\cdot\sqrt{3}i}{\sqrt{3}i\cdot\sqrt{3}i}=\dfrac{-\sqrt{3}i}{3i^2}$

$=\dfrac{-\sqrt{3}i}{3(-1)}=\dfrac{-\sqrt{3}i}{-3}$

$=\dfrac{\sqrt{3}i}{3}=0+\dfrac{\sqrt{3}i}{3}$

**88.** $\dfrac{-2}{\sqrt{-11}}=\dfrac{-2}{\sqrt{11}i}$

$=\dfrac{-2\cdot\sqrt{11}i}{\sqrt{11}i\cdot\sqrt{11}i}$

$=\dfrac{-2\sqrt{11}i}{11i^2}=\dfrac{-2\sqrt{11}i}{11(-1)}$

$=\dfrac{2\sqrt{11}}{11}i=0+\dfrac{2\sqrt{11}}{11}i$

**89.** $\sqrt{b^2-4ac}=\sqrt{(4)^2-4(2)(6)}$

$=\sqrt{16-48}$

$=\sqrt{-32}=i\sqrt{32}$

$=4i\sqrt{2}$

**90.** $\sqrt{b^2-4ac}=\sqrt{(-5)^2-4(5)(10)}$

$=\sqrt{25-200}$

$=\sqrt{-175}=i\sqrt{175}$

$=5i\sqrt{7}$

**91.** $\sqrt{b^2-4ac}=\sqrt{(-6)^2-4(2)(5)}$

$=\sqrt{36-40}$

$=\sqrt{-4}=i\sqrt{4}$

$=2i$

**92.** $\sqrt{b^2-4ac}=\sqrt{(4)^2-4(2)(4)}$

$=\sqrt{16-32}$

$=\sqrt{-16}=i\sqrt{16}$

$=4i$

**93. a.** $x^2+25=0$

$(5i)^2+25=0$

$25(-1)+25=0$

$-25+25=0$

$0=0$ ✓

**b.** $x^2+25=0$

$(-5i)^2+25=0$

$25(-1)+25=0$

$-25+25=0$

$0=0$ ✓

**94. a.** $x^2+49=0$

$(7i)^2+49=0$

$49(-1)+49=0$

$-49+49=0$

$0=0$ ✓

**b.** $x^2+49=0$

$(-7i)^2+49=0$

$49(-1)+49=0$

$-49+49=0$

$0=0$ ✓

**95. a.** $x^2-4x+7=0$

$\left(2+i\sqrt{3}\right)^2-4\left(2+i\sqrt{3}\right)+7=0$

$4+4i\sqrt{3}+3i^2-8-4i\sqrt{3}+7=0$

$4+3(-1)-8+7=0$

$4-3-1=0$

$0=0$ ✓

**b.**
$$x^2-4x+7=0$$
$$\left(2-i\sqrt{3}\right)^2-4\left(2-i\sqrt{3}\right)+7=0$$
$$4-4i\sqrt{3}+3i^2-8+4i\sqrt{3}+7=0$$
$$4+3(-1)-8+7=0$$
$$4-3-1=0$$
$$0=0\ \checkmark$$

**96. a.**
$$x^2-6x+11=0$$
$$\left(3+i\sqrt{2}\right)^2-6\left(3+i\sqrt{2}\right)+11=0$$
$$9+6i\sqrt{3}+2i^2-18-6i\sqrt{2}+11=0$$
$$9+2(-1)-18+11=0$$
$$9-2-7=0$$
$$0=0\ \checkmark$$

**b.**
$$x^2-6x+11=0$$
$$\left(3-i\sqrt{2}\right)^2-6\left(3-i\sqrt{2}\right)+11=0$$
$$9-6i\sqrt{3}+2i^2-18+6i\sqrt{2}+11=0$$
$$9+2(-1)-18+11=0$$
$$9-2-7=0$$
$$0=0\ \checkmark$$

**97.** $(a+bi)(c+di)$
$$=ac+adi+bci+bdi^2$$
$$=ac+(ad+bc)i+bd(-1)$$
$$=(ac-bd)+(ad+bc)i$$

**98.** $(a+bi)^2=(a)^2+2(a)(bi)+(bi)^2$
$$=a^2+(2ab)i+b^2i^2$$
$$=a^2+(2ab)i+b^2(-1)$$
$$=(a^2-b^2)+(2ab)i$$

**99.** The second step does not follow because the multiplication property of radicals can be applied only if the individual radicals are real numbers. Because $\sqrt{-9}$ and $\sqrt{-4}$ are imaginary numbers, the correct logic for simplification would be
$$\sqrt{-9}\cdot\sqrt{-4}=i\sqrt{9}\cdot i\sqrt{4}$$
$$=i^2\sqrt{36}$$
$$=-1\cdot 6=-6$$

**100.** The product $(a+b)(a-b)$ simplifies to $a^2-b^2$. The product $(a+bi)(a-bi)$ simplifies to $a^2-(bi)^2$, which simplifies to $a^2+b^2$.

**101.** Any real number. For example: 5.

**102.** Any complex number and its conjugate. For example: $2+5i$ and $2-5i$. In general, for real numbers, *a* and *b*, $(a+bi)(a-bi)=a^2+b^2$, which is a real number.

**103.** $z\cdot\overline{z}=(a+bi)(a-bi)=a^2+b^2$

**104.** $z^2-\overline{z}^2$
$$=(a+bi)^2-(a-bi)^2$$
$$=a^2+2abi+(bi)^2-\left[a^2-2abi+(bi)^2\right]$$
$$=a^2+2abi+b^2i^2-a^2+2abi-b^2i^2$$
$$=(4ab)i$$

**105. a.** $x^2-9=(x+3)(x-3)$

**b.** $x^2+9=(x+3i)(x-3i)$

**106. a.** $x^2-100=(x+10)(x-10)$

**b.** $x^2+100=(x+10i)(x-10i)$

**107. a.** $x^2-64=(x+8)(x-8)$

**b.** $x^2+64=(x+8i)(x-8i)$

**108. a.** $x^2-25=(x+5)(x-5)$

**b.** $x^2+25=(x+5i)(x-5i)$

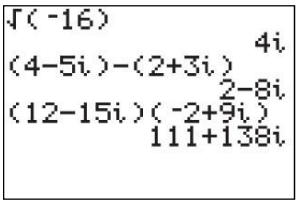
**109. a.** $x^2-3=\left(x+\sqrt{3}\right)\left(x-\sqrt{3}\right)$

**b.** $x^2+3=\left(x+i\sqrt{3}\right)\left(x-i\sqrt{3}\right)$

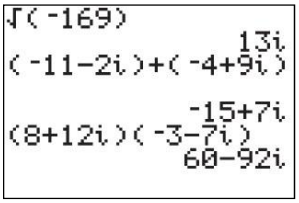
**110. a.** $x^2-11=\left(x+\sqrt{11}\right)\left(x-\sqrt{11}\right)$

**b.** $x^2+11=\left(x+i\sqrt{11}\right)\left(x-i\sqrt{11}\right)$

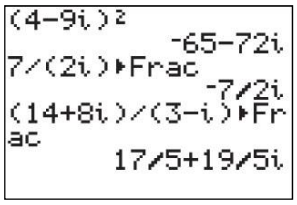
**111.**



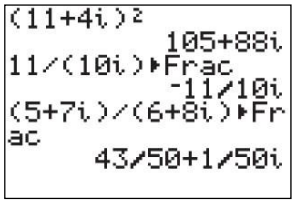

**112.**




**113.**




**114.**




## Section 1.4 Quadratic Equation

**1.** quadratic
**2.** linear
**3.** $\pm\sqrt{k}$
**4.** 100
**5.** $x=\dfrac{-b\pm\sqrt{b^2-4ac}}{2a}$
**6.** $b^2-4ac$
**7.** $(x-3)(x+7)=0$

$x-3=0 \quad \text{or} \quad x+7=0$

$x=3 \qquad x=-7$

$\{3,-7\}$

**8.** $(t+4)(t-1)=0$

$t+4=0 \quad \text{or} \quad t-1=0$

$t=-4 \qquad t=1$

$\{-4,1\}$

**9.** $n^2+5n=24$

$n^2+5n-24=0$

$(n+8)(n-3)=0$

$n+8=0 \quad \text{or} \quad n-3=0$

$n=-8 \qquad n=3$

$\{-8,3\}$

**10.** $y^2=18-7y$

$y^2+7y-18=0$

$(y+9)(y-2)=0$

$y+9=0 \quad \text{or} \quad y-2=0$

$y=-9 \qquad y=2$

$\{-9,2\}$

**11.** $8t(t+3)=2t-5$

$8t^2+24t=2t-5$

$8t^2+22t+5=0$

$(2t+5)(4t+1)=0$

$2t+5=0 \quad \text{or} \quad 4t+1=0$

$2t=-5 \qquad 4t=-1$

$t=-\dfrac{5}{2} \qquad t=-\dfrac{1}{4}$

$\left\{-\dfrac{5}{2},-\dfrac{1}{4}\right\}$

**12.** $6m(m+4)=m-15$

$6m^2+24m=m-15$

$6m^2+23m+15=0$

$(6m+5)(m+3)=0$

$6m+5=0 \quad \text{or} \quad m+3=0$

$6m=-5 \qquad m=-3$

$m=-\dfrac{5}{6}$

$\left\{-\dfrac{5}{6},-3\right\}$

**13.** $40p^2-90=0$

$$10\left(4p^2-9\right)=0$$
$$10(2p-3)(2p+3)=0$$
$$2p-3=0 \quad \text{or} \quad 2p+3=0$$
$$2p=3 \qquad 2p=-3$$
$$p=\frac{3}{2} \qquad p=-\frac{3}{2}$$
$$\left\{\frac{3}{2},-\frac{3}{2}\right\}$$

**14.** $32n^2-162=0$

$$2\left(16n^2-81\right)=0$$
$$2(4n-9)(4n+9)=0$$
$$4n-9=0 \quad \text{or} \quad 4n+9=0$$
$$4n=9 \qquad 4n=-9$$
$$n=\frac{9}{4} \qquad n=-\frac{9}{4}$$
$$\left\{\frac{9}{4},-\frac{9}{4}\right\}$$

**15.** $3x^2=12x$

$$3x^2-12x=0$$
$$3x(x-4)=0$$
$$3x=0 \quad \text{or} \quad x-4=0$$
$$x=0 \qquad x=4$$
$$\{0,4\}$$

**16.** $z^2=25z$

$$z^2-25z=0$$
$$z(z-25)=0$$
$$z=0 \quad \text{or} \quad z-25=0$$
$$z=25$$
$$\{0,25\}$$

**17.** $(m+4)(m-5)=-8$

$$m^2+4m-5m-20=-8$$
$$m^2-m-12=0$$
$$(m+3)(m-4)=0$$
$$m+3=0 \text{ or } m-4=0$$
$$m=-3 \qquad m=4$$
$$\{-3,4\}$$

**18.** $(n+2)(n-4)=27$

$$n^2-4n+2n-8=27$$
$$n^2-2n-35=0$$
$$(n+5)(n-7)=0$$
$$n+5=0 \text{ or } n-7=0$$
$$n=-5 \qquad n=7$$
$$\{-5,7\}$$

**19.** $x^2=81$

$$x=\pm\sqrt{81}$$
$$=\pm 9$$
$$\{9,-9\}$$

**20.** $w^2=121$

$$w=\pm\sqrt{121}$$
$$=\pm 11$$
$$\{11,-11\}$$

**21.** $5y^2-35=0$

$$5y^2=35$$
$$y^2=7$$
$$y=\pm\sqrt{7}$$
$$\left\{\sqrt{7},-\sqrt{7}\right\}$$

**22.** $6v^2-30=0$

$$6v^2=30$$
$$v^2=5$$
$$v=\pm\sqrt{5}$$
$$\left\{\sqrt{5},-\sqrt{5}\right\}$$

**23.** $4u^2+64=0$

$$4u^2=-64$$
$$u^2=-16$$
$$u=\pm\sqrt{-16}=\pm 4i$$
$$\{4i,-4i\}$$

**24.** $8p^2+72=0$

$$8p^2=-72$$
$$p^2=-9$$
$$p=\pm\sqrt{-9}=\pm 3i$$
$$\{3i,-3i\}$$

**25.** $(k+2)^2 = 28$

$k+2 = \pm\sqrt{28}$

$k = -2 \pm \sqrt{28}$

$= -2 \pm 2\sqrt{7}$

$\{-2 \pm 2\sqrt{7}\}$

**26.** $3(z+11)^2 - 10 = 110$

$3(z+11)^2 = 120$

$(z+11)^2 = 40$

$z+11 = \pm\sqrt{40}$

$z = -11 \pm \sqrt{40}$

$= -11 \pm 2\sqrt{10}$

$\{-11 \pm 2\sqrt{10}\}$

**27.** $2(w-5)^2 + 5 = 23$

$2(w-5)^2 = 18$

$w-5 = \pm\sqrt{9}$

$w = 5 \pm \sqrt{9}$

$w = 5 \pm 3$

$w = 5+3$ or $w = 5-3$

$w = 8$ $\quad$ $w = 2$

$\{8, 2\}$

**28.** $(c-3)^2 = 49$

$c-3 = \pm\sqrt{49}$

$c = 3 \pm \sqrt{49}$

$c = 3 \pm 7$

$c = 3+7$ or $c = 3-7$

$c = 10$ $\quad$ $c = -4$

$\{10, -4\}$

**29.** $\left(t - \frac{1}{2}\right)^2 = -\frac{17}{4}$

$t - \frac{1}{2} = \pm\sqrt{-\frac{17}{4}}$

$t = \frac{1}{2} \pm \sqrt{-\frac{17}{4}}$

$= \frac{1}{2} \pm \frac{i\sqrt{17}}{2}$

$= \frac{1}{2} \pm \frac{\sqrt{17}}{2} i$

$\left\{\frac{1}{2} \pm \frac{\sqrt{17}}{2} i\right\}$

**30.** $\left(a - \frac{1}{3}\right)^2 = -\frac{47}{9}$

$a - \frac{1}{3} = \pm\sqrt{-\frac{47}{9}}$

$a = \frac{1}{3} \pm \sqrt{-\frac{47}{9}}$

$= \frac{1}{3} \pm \frac{i\sqrt{47}}{3}$

$= \frac{1}{3} \pm \frac{\sqrt{47}}{3} i$

$\left\{\frac{1}{3} \pm \frac{\sqrt{47}}{3} i\right\}$

**31.** $x^2 + 14x + n = x^2 + 14x + \left[\frac{1}{2}(14)\right]^2$

$= x^2 + 14x + (7)^2$

$= x^2 + 14x + 49$

$= (x+7)^2$

$n = 49; (x+7)^2$

**32.** $y^2 + 22y + n = y^2 + 22y + \left[\frac{1}{2}(22)\right]^2$

$= y^2 + 22y + (11)^2$

$= y^2 + 22y + 121$

$= (y+11)^2$

$n = 121; (y+11)^2$

**33.** $p^2-26p+n=p^2-26p+\left[\frac{1}{2}(-26)\right]^2$

$=p^2-26p+(-13)^2$

$=p^2-26p+169$

$=(p-13)^2$

$n=169;(p-13)^2$

**34.** $u^2-4u+n=u^2-4u+\left[\frac{1}{2}(-4)\right]^2$

$=u^2-4u+(-2)^2$

$=u^2-4u+4$

$=(u-2)^2$

$n=4;(u-2)^2$

**35.** $w^2-3w+n=w^2-3w+\left[\frac{1}{2}(-3)\right]^2$

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

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

$=\left(w-\frac{3}{2}\right)^2$

$n=\frac{9}{4};\left(w-\frac{3}{2}\right)^2$

**36.** $v^2-11v+n=v^2-11v+\left[\frac{1}{2}(-11)\right]^2$

$=v^2-11v+\left(-\frac{11}{2}\right)^2$

$=v^2-11v+\frac{121}{4}$

$=\left(v-\frac{11}{2}\right)^2$

$n=\frac{121}{4};\left(v-\frac{11}{2}\right)^2$

**37.** $m^2+\frac{2}{9}m+n=m^2+\frac{2}{9}m+\left[\frac{1}{2}\left(\frac{2}{9}\right)\right]^2$

$=m^2+\frac{2}{9}m+\left(\frac{1}{9}\right)^2$

$=m^2+\frac{2}{9}m+\frac{1}{81}$

$=\left(m+\frac{1}{9}\right)^2$

$n=\frac{1}{81};\left(m+\frac{1}{9}\right)^2$

**38.** $k^2+\frac{2}{5}k+n=k^2+\frac{2}{5}k+\left[\frac{1}{2}\left(\frac{2}{5}\right)\right]^2$

$=k^2+\frac{2}{5}k+\left(\frac{1}{5}\right)^2$

$=k^2+\frac{2}{5}k+\frac{1}{25}$

$=\left(k+\frac{1}{5}\right)^2$

$n=\frac{1}{25};\left(k+\frac{1}{5}\right)^2$

**39.** $y^2+22y-4=0$

$y^2+22y=4$

$y^2+22y+\left[\frac{1}{2}(22)\right]^2=4+\left[\frac{1}{2}(22)\right]^2$

$y^2+22y+121=4+121$

$(y+11)^2=125$

$y+11=\pm\sqrt{125}$

$y=-11\pm5\sqrt{5}$

$\left\{-11\pm5\sqrt{5}\right\}$

**40.**
$$x^2+14x-3=0$$
$$x^2+14x=3$$
$$x^2+14x+\left[\frac{1}{2}(14)\right]^2=3+\left[\frac{1}{2}(14)\right]^2$$
$$x^2+14x+49=3+49$$
$$(x+7)^2=52$$
$$x+7=\pm\sqrt{52}$$
$$x=-7\pm 2\sqrt{13}$$
$$\left\{-7\pm 2\sqrt{13}\right\}$$

**41.**
$$t^2-8t=-24$$
$$t^2-8t+\left[\frac{1}{2}(-8)\right]^2=-24+\left[\frac{1}{2}(-8)\right]^2$$
$$t^2-8t+16=-24+16$$
$$(t-4)^2=-8$$
$$t-4=\pm\sqrt{-8}$$
$$t=4\pm 2i\sqrt{2}$$
$$\left\{4\pm 2i\sqrt{2}\right\}$$

**42.**
$$p^2-24p=-156$$
$$p^2-24p+\left[\frac{1}{2}(-24)\right]^2=-156+\left[\frac{1}{2}(-24)\right]^2$$
$$p^2-24p+144=-156+144$$
$$(p-12)^2=-12$$
$$p-12=\pm\sqrt{-12}$$
$$p=12\pm 2i\sqrt{3}$$
$$\left\{12\pm 2i\sqrt{3}\right\}$$

**43.**
$$4z^2+24z=-160$$
$$\frac{4z^2}{4}+\frac{24z}{4}=\frac{-160}{4}$$
$$z^2+6z=-40$$
$$z^2+6z+\left[\frac{1}{2}(6)\right]^2=-40+\left[\frac{1}{2}(6)\right]^2$$
$$z^2+6z+9=-40+9$$
$$(z+3)^2=-31$$
$$z+3=\pm\sqrt{-31}$$
$$z=-3\pm i\sqrt{31}$$
$$\left\{-3\pm i\sqrt{31}\right\}$$

**44.**
$$2m^2+20m=-70$$
$$\frac{2m^2}{2}+\frac{20m}{2}=\frac{-70}{2}$$
$$m^2+10m=-35$$
$$m^2+10m+\left[\frac{1}{2}(10)\right]^2=-35+\left[\frac{1}{2}(10)\right]^2$$
$$m^2+10m+25=-35+25$$
$$(m+5)^2=-10$$
$$m+5=\pm\sqrt{-10}$$
$$m=-5\pm i\sqrt{10}$$
$$\left\{-5\pm i\sqrt{10}\right\}$$

**45.**
$$2x(x-3)=4+x$$
$$2x^2-6x=4+x$$
$$2x^2-7x=4$$
$$\frac{2x^2}{2}-\frac{7x}{2}=\frac{4}{2}$$
$$x^2-\frac{7}{2}x=2$$
$$x^2-\frac{7}{2}x+\left[\frac{1}{2}\left(-\frac{7}{2}\right)\right]^2=2+\left[\frac{1}{2}\left(-\frac{7}{2}\right)\right]^2$$
$$x^2-\frac{7}{2}x+\frac{49}{16}=\frac{32}{16}+\frac{49}{16}$$
$$\left(x-\frac{7}{4}\right)^2=\frac{81}{16}$$
$$x-\frac{7}{4}=\pm\sqrt{\frac{81}{16}}$$
$$x=\frac{7}{4}\pm\frac{9}{4}$$
$$x=\frac{7}{4}+\frac{9}{4} \quad \text{or} \quad x=\frac{7}{4}-\frac{9}{4}$$
$$x=\frac{16}{4}=4 \qquad x=\frac{-2}{4}=-\frac{1}{2}$$
$$\left\{4,-\frac{1}{2}\right\}$$

**46.**
$$5c(c-2)=6+3c$$
$$5c^2-10c=6+3c$$
$$5c^2-13c=6$$
$$\frac{5c^2}{5}-\frac{13c}{5}=\frac{6}{5}$$
$$c^2-\frac{13}{5}c=\frac{6}{5}$$
$$c^2-\frac{13}{5}c+\left[\frac{1}{2}\left(-\frac{13}{5}\right)\right]^2=\frac{6}{5}+\left[\frac{1}{2}\left(-\frac{13}{5}\right)\right]^2$$
$$c^2-\frac{13}{5}c+\frac{169}{100}=\frac{120}{100}+\frac{169}{100}$$
$$\left(c-\frac{13}{10}\right)^2=\frac{289}{100}$$
$$c-\frac{13}{10}=\pm\sqrt{\frac{289}{100}}$$
$$c=\frac{30}{10}=3 \text{ or } c=\frac{-4}{10}=-\frac{2}{5}$$
$$\left\{3,-\frac{2}{5}\right\}$$

**47.**
$$-4y^2-12y+5=0$$
$$\frac{-4y^2}{-4}-\frac{12y}{-4}+\frac{5}{-4}=\frac{0}{-4}$$
$$y^2+3y=\frac{5}{4}$$
$$y^2+3y+\left[\frac{1}{2}(3)\right]^2=\frac{5}{4}+\left[\frac{1}{2}(3)\right]^2$$
$$y^2+3y+\frac{9}{4}=\frac{5}{4}+\frac{9}{4}$$
$$\left(y+\frac{3}{2}\right)^2=\frac{7}{2}$$
$$y+\frac{3}{2}=\pm\sqrt{\frac{7}{2}}$$
$$y+\frac{3}{2}=\pm\frac{\sqrt{7}\cdot\sqrt{2}}{\sqrt{2}\cdot\sqrt{2}}$$
$$y+\frac{3}{2}=\pm\frac{\sqrt{14}}{2}$$
$$y=-\frac{3}{2}\pm\frac{\sqrt{14}}{2}$$
$$\left\{-\frac{3}{2}\pm\frac{\sqrt{14}}{2}\right\}$$

**48.**
$$-2x^2-14x+5=0$$
$$\frac{-2x^2}{-2}-\frac{14x}{-2}+\frac{5}{-2}=\frac{0}{-2}$$
$$x^2+7x=\frac{5}{2}$$
$$x^2+7x+\left[\frac{1}{2}(7)\right]^2=\frac{5}{2}+\left[\frac{1}{2}(7)\right]^2$$
$$x^2+7x+\frac{49}{4}=\frac{10}{4}+\frac{49}{4}$$
$$\left(x+\frac{7}{2}\right)^2=\frac{59}{4}$$
$$x+\frac{7}{2}=\pm\sqrt{\frac{59}{4}}$$
$$x+\frac{7}{2}=\pm\frac{\sqrt{59}}{2}$$
$$x=-\frac{7}{2}\pm\frac{\sqrt{59}}{2}$$
$$\left\{-\frac{7}{2}\pm\frac{\sqrt{59}}{2}\right\}$$

**49.**
$$3x^2+5x-6=0$$
$$\frac{3x^2}{3}+\frac{5x}{3}-\frac{6}{3}=\frac{0}{3}$$
$$x^2+\frac{5}{3}x=2$$
$$x^2+\frac{5}{3}x+\left[\frac{1}{2}\left(\frac{5}{3}\right)\right]^2=2+\left[\frac{1}{2}\left(\frac{5}{3}\right)\right]^2$$
$$x^2+\frac{5}{3}x+\frac{25}{36}=\frac{72}{36}+\frac{25}{36}$$
$$\left(x+\frac{5}{6}\right)^2=\frac{97}{36}$$
$$x+\frac{5}{6}=\pm\sqrt{\frac{97}{36}}$$
$$x+\frac{5}{6}=\pm\frac{\sqrt{97}}{6}$$
$$x=-\frac{5}{6}\pm\frac{\sqrt{97}}{6}$$
$$\left\{-\frac{5}{6}\pm\frac{\sqrt{97}}{6}\right\}$$

**50.**
$$4x^2+3x-8=0$$
$$\frac{4x^2}{4}+\frac{3x}{4}-\frac{8}{4}=\frac{0}{4}$$
$$x^2+\frac{3}{4}x=2$$
$$x^2+\frac{3}{4}x+\left[\frac{1}{2}\left(\frac{3}{4}\right)\right]^2=2+\left[\frac{1}{2}\left(\frac{3}{4}\right)\right]^2$$
$$x^2+\frac{3}{4}x+\frac{9}{64}=\frac{128}{64}+\frac{9}{64}$$
$$\left(x+\frac{3}{8}\right)^2=\frac{137}{64}$$
$$x+\frac{3}{8}=\pm\sqrt{\frac{137}{64}}$$
$$x+\frac{3}{8}=\pm\frac{\sqrt{137}}{8}$$
$$x=-\frac{3}{8}\pm\frac{\sqrt{137}}{8}$$
$$\left\{-\frac{3}{8}\pm\frac{\sqrt{137}}{8}\right\}$$

**51.**
$$x^2=7x-4$$
$$x^2-7x+4=0$$
$$ax^2+bx+c=0$$
$$a=1,b=-7,c=4$$

**52.**
$$x^2=3(x-2)$$
$$x^2=3x-6$$
$$x^2-3x+6=0$$
$$ax^2+bx+c=0$$
$$a=1,b=-3,c=6$$

**53.**
$$5x^2+3x=0$$
$$5x^2+3x=0$$
$$ax^2+bx+c=0$$
$$a=5,b=3,c=0$$

**54.**
$$2x^2-18=0$$
$$ax^2+bx+c=0$$
$$a=2,b=0,c=-18$$

**55.** $x^2-3x-7=0$
$$a=1,b=-3,c=-7$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-3)\pm\sqrt{(-3)^2-4(1)(-7)}}{2(1)}$$
$$=\frac{3\pm\sqrt{9+28}}{2}$$
$$=\frac{3\pm\sqrt{37}}{2}$$
$$\left\{\frac{3\pm\sqrt{37}}{2}\right\}$$

**56.** $x^2-5x-9=0$
$$a=1,b=-5,c=-9$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-5)\pm\sqrt{(-5)^2-4(1)(-9)}}{2(1)}$$
$$=\frac{5\pm\sqrt{25+36}}{2}$$
$$=\frac{5\pm\sqrt{61}}{2}$$
$$\left\{\frac{5\pm\sqrt{61}}{2}\right\}$$

**57.**
$$y^2=-4y-6$$
$$y^2+4y+6=0$$
$$a=1,b=4,c=6$$
$$y=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(4)\pm\sqrt{(4)^2-4(1)(6)}}{2(1)}$$
$$=\frac{-4\pm\sqrt{16-24}}{2}$$
$$=\frac{-4\pm\sqrt{-8}}{2}$$
$$=\frac{-4\pm 2i\sqrt{2}}{2}$$
$$=-2\pm i\sqrt{2}$$
$$\left\{-2\pm i\sqrt{2}\right\}$$

**58.** $z^2 = -8z - 19$

$z^2 + 8z + 19 = 0$

$a = 1, b = 8, c = 19$

$$z = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(8) \pm \sqrt{(8)^2 - 4(1)(19)}}{2(1)}$$
$$= \frac{-8 \pm \sqrt{64 - 76}}{2}$$
$$= \frac{-8 \pm \sqrt{-12}}{2}$$
$$= \frac{-8 \pm 2i\sqrt{3}}{2}$$
$$= -4 \pm i\sqrt{3}$$

$\{-4 \pm i\sqrt{3}\}$

**59.** $t(t - 6) = -10$

$t^2 - 6t + 10 = 0$

$a = 1, b = -6, c = 10$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(10)}}{2(1)}$$
$$= \frac{6 \pm \sqrt{36 - 40}}{2}$$
$$= \frac{6 \pm \sqrt{-4}}{2}$$
$$= \frac{6 \pm 2i}{2}$$
$$= 3 \pm i$$

$\{3 \pm i\}$

**60.** $m(m + 10) = -34$

$m^2 + 10m + 34 = 0$

$a = 1, b = 10, c = 34$

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(10) \pm \sqrt{(10)^2 - 4(1)(34)}}{2(1)}$$
$$= \frac{-10 \pm \sqrt{100 - 136}}{2}$$
$$= \frac{-10 \pm \sqrt{-36}}{2}$$
$$= \frac{-10 \pm 6i}{2}$$
$$= -5 \pm 3i$$

$\{-5 \pm 3i\}$

**61.** $-7c + 3 = -5c^2$

$5c^2 - 7c + 3 = 0$

$a = 5, b = -7, c = 3$

$$c = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(-7) \pm \sqrt{(-7)^2 - 4(5)(3)}}{2(5)}$$
$$= \frac{7 \pm \sqrt{49 - 60}}{10}$$
$$= \frac{7 \pm \sqrt{-11}}{10}$$
$$= \frac{7 \pm i\sqrt{11}}{10}$$

$\left\{\frac{7 \pm i\sqrt{11}}{10}\right\}$

**62.** $-5d + 2 = -6d^2$

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

$a = 6, b = -5, c = 2$

$$d=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-5)\pm\sqrt{(-5)^2-4(6)(2)}}{2(6)}$$
$$=\frac{5\pm\sqrt{25-48}}{12}$$
$$=\frac{5\pm\sqrt{-23}}{12}$$
$$=\frac{5\pm i\sqrt{23}}{12}$$
$$\left\{\frac{5\pm i\sqrt{23}}{12}\right\}$$

**63.** $(6x+5)(x-3)=-2x(7x+5)+x-12$

$$6x^2-18x+5x-15=-14x^2-10x+x-12$$
$$6x^2-13x-15=-14x^2-9x-12$$
$$20x^2-4x-3=0$$
$$a=20, b=-4, c=-3$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-4)\pm\sqrt{(-4)^2-4(20)(-3)}}{2(20)}$$
$$=\frac{4\pm\sqrt{16+240}}{40}$$
$$=\frac{4\pm\sqrt{256}}{40}$$
$$=\frac{4\pm16}{40}$$
$$x=\frac{4+16}{40} \quad \text{or} \quad x=\frac{4-16}{40}$$
$$x=\frac{20}{40}=\frac{1}{2} \qquad x=\frac{-12}{40}=-\frac{3}{10}$$
$$\left\{\frac{1}{2},-\frac{3}{10}\right\}$$

**64.** $(5c+7)(2c-3)=-2c(c+15)-35$

$$10c^2-15c+14c-21=-2c^2-30c-35$$
$$10c^2-c-21=-2c^2-30c-35$$
$$12c^2+29c+14=0$$
$$a=12, b=29, c=14$$

$$c=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(29)\pm\sqrt{(29)^2-4(12)(14)}}{2(12)}$$
$$=\frac{-29\pm\sqrt{841-672}}{24}$$
$$=\frac{-29\pm\sqrt{169}}{24}$$
$$=\frac{-29\pm13}{24}$$
$$c=\frac{-29+13}{24} \quad \text{or} \quad c=\frac{-29-13}{24}$$
$$c=\frac{-16}{24}=-\frac{2}{3} \qquad c=\frac{-42}{24}=-\frac{7}{4}$$
$$\left\{-\frac{2}{3},-\frac{7}{4}\right\}$$

**65.** $9x^2+49=0$

$$a=9, b=0, c=49$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(0)\pm\sqrt{(0)^2-4(9)(49)}}{2(9)}$$
$$=\frac{\pm\sqrt{-1764}}{18}$$
$$=\frac{\pm42i}{18}$$
$$=\pm\frac{7}{3}i$$
$$\left\{\pm\frac{7}{3}i\right\}$$

**66.** $121x^2+4=0$

$$a=121, b=0, c=4$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(0)\pm\sqrt{(0)^2-4(121)(4)}}{2(121)}$$
$$=\frac{\pm\sqrt{-1936}}{242}$$
$$=\frac{\pm44i}{242}$$
$$=\pm\frac{2}{11}i$$
$$\left\{\pm\frac{2}{11}i\right\}$$

**67.**
$$\frac{1}{2}x^2-\frac{2}{7}=\frac{5}{14}x$$
$$14\left(\frac{1}{2}x^2-\frac{2}{7}\right)=14\left(\frac{5}{14}x\right)$$
$$7x^2-4=5x$$
$$7x^2-5x-4=0$$
$$a=7,b=-5,c=-4$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-5)\pm\sqrt{(-5)^2-4(7)(-4)}}{2(7)}$$
$$=\frac{5\pm\sqrt{25+112}}{14}$$
$$=\frac{5\pm\sqrt{137}}{14}$$
$$\left\{\frac{5\pm\sqrt{137}}{14}\right\}$$

**68.**
$$\frac{1}{3}x^2-\frac{7}{6}=\frac{3}{2}x$$
$$6\left(\frac{1}{3}x^2-\frac{7}{6}\right)=6\left(\frac{3}{2}x\right)$$
$$2x^2-7=9x$$
$$2x^2-9x-7=0$$
$$a=2,b=-9,c=-7$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-9)\pm\sqrt{(-9)^2-4(2)(-7)}}{2(2)}$$
$$=\frac{9\pm\sqrt{81+56}}{4}$$
$$=\frac{9\pm\sqrt{137}}{4}$$
$$\left\{\frac{9\pm\sqrt{137}}{4}\right\}$$

**69.**
$$0.4y^2=2y-2.5$$
$$10(0.4y^2)=10(2y-2.5)$$
$$4y^2=20y-25$$
$$4y^2-20y+25=0$$
$$a=4,b=-20,c=25$$
$$y=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-20)\pm\sqrt{(-20)^2-4(4)(25)}}{2(4)}$$
$$=\frac{20\pm\sqrt{400-400}}{8}$$
$$=\frac{20\pm\sqrt{0}}{8}$$
$$=\frac{20}{8}=\frac{5}{2}$$
$$\left\{\frac{5}{2}\right\}$$

**70.**
$$0.09n^2=0.42n-0.49$$
$$100(0.09n^2)=100(0.42n-0.49)$$
$$9n^2=42n-49$$
$$9n^2-42n+49=0$$
$$a=9,b=-42,c=49$$

$$n=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-42)\pm\sqrt{(-42)^2-4(9)(49)}}{2(9)}$$
$$=\frac{42\pm\sqrt{1764-1764}}{18}$$
$$=\frac{42\pm\sqrt{0}}{18}$$
$$=\frac{42}{18}=\frac{7}{3}$$

$$\left\{\frac{7}{3}\right\}$$

**71.** Linear

$$2y+4=0$$
$$2y=-4$$
$$y=\frac{-4}{2}$$
$$=-2$$

$$\{-2\}$$

**72.** Linear

$$3z-9=0$$
$$3z=9$$
$$z=3$$

$$\{3\}$$

**73.** Quadratic

$$2y^2+4y=0$$
$$\frac{2y^2}{2}+\frac{4y}{2}=\frac{0}{2}$$
$$y^2+2y=0$$
$$y(y+2)=0$$
$$y=0 \quad \text{or} \quad y+2=0$$
$$y=-2$$

$$\{0,-2\}$$

**74.** Quadratic

$$3z^2-9z=0$$
$$\frac{3z^2}{3}-\frac{9z}{3}=\frac{0}{3}$$
$$z^2-3z=0$$
$$z(z-3)=0$$
$$z=0 \quad \text{or} \quad z-3=0$$
$$z=3$$

$$\{0,3\}$$

**75.** Linear

$$5x(x+6)=5x^2+27x+3$$
$$5x^2+30x=5x^2+27x+3$$
$$3x=3$$
$$x=1$$

$$\{1\}$$

**76.** Linear

$$3x(x-4)=3x^2-11x+4$$
$$3x^2-12x=3x^2-11x+4$$
$$-x=4$$
$$x=-4$$

$$\{-4\}$$

**77.** Neither

**78.** Neither

**79.** $(3x-4)^2=0$

$$3x-4=0$$
$$3x=4$$
$$x=\frac{4}{3}$$

$$\left\{\frac{4}{3}\right\}$$

**80.** $(2x+1)^2=0$

$$2x+1=0$$
$$2x=-1$$
$$x=-\frac{1}{2}$$

$$\left\{-\frac{1}{2}\right\}$$

**81.** $m^2+4m=-2$

$$m^2+4m+\left[\frac{1}{2}(4)\right]^2=-2+\left[\frac{1}{2}(4)\right]^2$$
$$m^2+4m+4=-2+4$$
$$(m+2)^2=2$$
$$m+2=\pm\sqrt{2}$$
$$m=-2\pm\sqrt{2}$$

$\left\{-2\pm\sqrt{2}\right\}$

**82.** $n^2+8n=-3$

$$n^2+8n+\left[\frac{1}{2}(8)\right]^2=-3+\left[\frac{1}{2}(8)\right]^2$$
$$n^2+8n+16=-3+16$$
$$(n+4)^2=13$$
$$n+4=\pm\sqrt{13}$$
$$n=-4\pm\sqrt{13}$$

$\left\{-4\pm\sqrt{13}\right\}$

**83.** $\frac{x^2-4x}{6}-\frac{5x}{3}=1$

$$6\left(\frac{x^2-4x}{6}-\frac{5x}{3}\right)=6(1)$$
$$x^2-4x-10x=6$$
$$x^2-14x=6$$
$$x^2-14x+\left[\frac{1}{2}(-14)\right]^2=6+\left[\frac{1}{2}(-14)\right]^2$$
$$x^2-14x+49=6+49$$
$$(x-7)^2=55$$
$$x-7=\pm\sqrt{55}$$
$$x=7\pm\sqrt{55}$$

$\left\{7\pm\sqrt{55}\right\}$

**84.** $\frac{m^2+2m}{7}-\frac{9m}{14}=\frac{3}{2}$

$$14\left(\frac{m^2+2m}{7}-\frac{9m}{14}\right)=14\left(\frac{3}{2}\right)$$
$$2m^2+4m-9m=21$$
$$2m^2-5m-21=0$$
$$a=2, b=-5, c=-21$$
$$m=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-5)\pm\sqrt{(-5)^2-4(2)(-21)}}{2(2)}$$
$$=\frac{5\pm\sqrt{25+168}}{4}=\frac{5\pm\sqrt{193}}{4}$$

$\left\{\frac{5\pm\sqrt{193}}{4}\right\}$

**85.** $2(x+4)+x^2=x(x+2)+8$

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

□

**86.** $3(y-5)+y^2=y(y+3)-15$

$$3y-15+y^2=y^2+3y-15$$
$$0=0$$

□

**87.** $\frac{3}{5}x^2-\frac{1}{10}x=\frac{1}{2}$

$$10\left(\frac{3}{5}x^2-\frac{1}{10}x\right)=10\left(\frac{1}{2}\right)$$
$$6x^2-x=5$$
$$6x^2-x-5=0$$
$$(x-1)(6x+5)=0$$
$$x-1=0 \quad \text{or} \quad 6x+5=0$$
$$x=1 \qquad 6x=-5$$
$$x=-\frac{5}{6}$$

$\left\{1,-\frac{5}{6}\right\}$

**88.** $\frac{1}{12}x^2-\frac{11}{24}x=-\frac{1}{2}$

$$24\left(\frac{1}{12}x^2-\frac{11}{24}x\right)=24\left(-\frac{1}{2}\right)$$

$$2x^2 - 11x = -12$$
$$2x^2 - 11x + 12 = 0$$
$$(2x-3)(x-4) = 0$$
$$2x - 3 = 0 \quad \text{or} \quad x - 4 = 0$$
$$2x = 3 \qquad x = 4$$
$$x = \frac{3}{2}$$
$$\left\{\frac{3}{2}, 4\right\}$$

**89.** $x^2 - 5x = 5x(x-1) - 4x^2 + 1$
$$x^2 - 5x = 5x^2 - 5x - 4x^2 + 1$$
$$x^2 - 5x = x^2 - 5x + 1$$
$$0 = 1$$
$$\{\ \}$$

**90.** $p^2 - 4p = 4p(p-1) - 3p^2 + 2$
$$p^2 - 4p = 4p^2 - 4p - 3p^2 + 2$$
$$p^2 - 4p = p^2 - 4p + 2$$
$$0 = 2$$
$$\{\ \}$$

**91.** $(2y+7)(y+1) = 2y^2 - 11$
$$2y^2 + 2y + 7y + 7 = 2y^2 - 11$$
$$2y^2 + 9y + 7 = 2y^2 - 11$$
$$9y = -18$$
$$y = -2$$
$$\{-2\}$$

**92.** $(3z-8)(z+2) = 3z^2 + 10$
$$3z^2 + 6z - 8z - 16 = 3z^2 + 10$$
$$3z^2 - 2z - 16 = 3z^2 + 10$$
$$-2z = 26$$
$$z = -13$$
$$\{-13\}$$

**93.** $7d^2 + 5 = 0$
$$7d^2 = -5$$
$$d^2 = -\frac{5}{7}$$
$$d = \pm\sqrt{-\frac{5}{7}} = \pm i\sqrt{\frac{5}{7}}$$
$$= \pm\frac{\sqrt{5}}{\sqrt{7}}i = \pm\frac{\sqrt{5}\cdot\sqrt{7}}{\sqrt{7}\cdot\sqrt{7}}i$$
$$= \pm\frac{\sqrt{35}}{7}i$$
$$\left\{\pm\frac{\sqrt{35}}{7}i\right\}$$

**94.** $11t^2 + 3 = 0$
$$11t^2 = -3$$
$$t^2 = -\frac{3}{11}$$
$$t = \pm\sqrt{-\frac{3}{11}} = \pm i\sqrt{\frac{3}{11}}$$
$$= \pm\frac{\sqrt{3}}{\sqrt{11}}i = \pm\frac{\sqrt{3}\cdot\sqrt{11}}{\sqrt{11}\cdot\sqrt{11}}i$$
$$= \pm\frac{\sqrt{33}}{11}i$$
$$\left\{\pm\frac{\sqrt{33}}{11}i\right\}$$

**95.** $x^2 - \sqrt{5} = 0$
$$x^2 = \sqrt{5}$$
$$x = \pm\sqrt[4]{5}$$
$$\left\{\pm\sqrt[4]{5}\right\}$$

**96.** $y^2 - \sqrt{11} = 0$
$$y^2 = \sqrt{11}$$
$$y = \pm\sqrt[4]{11}$$
$$\left\{\pm\sqrt[4]{11}\right\}$$

**97. a.** $3x^2 - 4x + 6 = 0$
$$b^2 - 4ac = (-4)^2 - 4(3)(6)$$
$$= 16 - 72$$
$$= -56$$

**b.** $-56 < 0$; there are two nonreal solutions.

**98. a.** $5x^2 - 2x + 4 = 0$

$$b^2-4ac=(-2)^2-4(5)(4)$$
$$=4-80$$
$$=-76$$

**b.** $-76<0$; there are two nonreal solutions.

**99. a.** $-2w^2+8w=3$

$$-2w^2+8w-3=0$$
$$b^2-4ac=(8)^2-4(-2)(-3)$$
$$=64-24$$
$$=40$$

**b.** $40>0$; there are two real solutions.

**100. a.** $-6d^2+9d=2$

$$-6d^2+9d-2=0$$
$$6d^2-9d+2=0$$
$$b^2-4ac=(-9)^2-4(6)(2)$$
$$=81-48$$
$$=33$$

**b.** $33>0$; there are two real solutions.

**101. a.** $3x(x-4)=x-4$

$$3x^2-12x=x-4$$
$$3x^2-13x+4=0$$
$$b^2-4ac=(-13)^2-4(3)(4)$$
$$=169-48$$
$$=121$$

**b.** $121>0$; there are two real solutions.

**102. a.** $2x(x-2)=x+3$

$$2x^2-4x=x+3$$
$$2x^2-5x-3=0$$
$$b^2-4ac=(-5)^2-4(2)(-3)$$
$$=25+24$$
$$=49$$

**b.** $49>0$; there are two real solutions.

**103. a.**

$$-1.4m+0.1=-4.9m^2$$
$$10(-1.4m+0.1)=10(-4.9m^2)$$
$$-14m+1=-49m^2$$
$$49m^2-14m+1=0$$
$$b^2-4ac=(-14)^2-4(49)(1)$$
$$=196-196$$
$$=0$$

**b.** The discriminant is 0; there is one real solution.

**104. a.**

$$3.6n+0.4=-8.1n^2$$
$$10(3.6n+0.4)=10(-8.1n^2)$$
$$36n+4=-81n^2$$
$$81n^2+36n+4=0$$
$$b^2-4ac=(36)^2-4(81)(4)$$
$$=1296-1296$$
$$=0$$

**b.** The discriminant is 0; there is one real solution.

**105.** $A=\pi r^2$

$$\frac{A}{\pi}=\frac{\pi r^2}{\pi}$$
$$\frac{A}{\pi}=r^2$$
$$r=\sqrt{\frac{A}{\pi}} \text{ or } r=\frac{\sqrt{A\pi}}{\pi}$$

**106.** $A=\pi r^2 h$

$$\frac{A}{\pi h}=\frac{\pi r^2 h}{\pi h}$$
$$\frac{A}{\pi h}=r^2$$
$$r=\sqrt{\frac{A}{\pi h}} \text{ or } r=\frac{\sqrt{A\pi h}}{\pi h}$$

**107.** $s=\frac{1}{2}gt^2$

$$2(s)=2\left(\frac{1}{2}gt^2\right)$$
$$2s=gt^2$$
$$\frac{2s}{g}=\frac{gt^2}{g}$$
$$\frac{2s}{g}=t^2$$
$$t=\sqrt{\frac{2s}{g}} \text{ or } t=\frac{\sqrt{2sg}}{g}$$

**108.** $c=\frac{d^2t}{2}$

$$2c=2\left(\frac{d^2t}{2}\right)$$
$$2c=d^2t$$
$$\frac{2c}{t}=\frac{d^2t}{t}$$
$$\frac{2c}{t}=d^2$$
$$d=\sqrt{\frac{2c}{t}} \text{ or } d=\frac{\sqrt{2ct}}{t}$$

**109.** $a^2+b^2=c^2$

$$a^2=c^2-b^2$$
$$a=\sqrt{c^2-b^2}$$

**110.** $a^2+b^2+c^2=d^2$

$$c^2=d^2-a^2-b^2$$
$$c=\sqrt{d^2-a^2-b^2}$$

**111.** $L=c^2I^2Rt$

$$\frac{L}{c^2Rt}=\frac{c^2I^2Rt}{c^2Rt}$$
$$\frac{L}{c^2Rt}=I^2$$
$$I=\sqrt{\frac{L}{c^2Rt}}=\frac{1}{c}\sqrt{\frac{L}{Rt}} \text{ or } \frac{\sqrt{LRt}}{cRt}$$

**112.** $I=cN^2r^2s$

$$\frac{I}{cr^2s}=\frac{cN^2r^2s}{cr^2s}$$
$$\frac{I}{cr^2s}=N^2$$
$$N=\sqrt{\frac{I}{cr^2s}}$$
$$N=\frac{1}{r}\sqrt{\frac{I}{cs}} \text{ or } N=\frac{\sqrt{Ics}}{crs}$$

**113.** $kw^2-cw=r$

$$kw^2-cw-r=0$$
$$a=k, b=-c, c=-r$$
$$w=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$w=\frac{-(-c)\pm\sqrt{(-c)^2-4(k)(-r)}}{2(k)}$$
$$w=\frac{c\pm\sqrt{c^2+4kr}}{2k}$$

**114.** $dy^2+my=p$

$$dy^2+my-p=0$$
$$a=d, b=m, c=-p$$
$$y=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$y=\frac{-(m)\pm\sqrt{(m)^2-4(d)(-p)}}{2(d)}$$
$$y=\frac{-m\pm\sqrt{m^2+4dp}}{2k}$$

**115.** $s=v_0t+\frac{1}{2}at^2$

$$2(s)=2\left(v_0t+\frac{1}{2}at^2\right)$$
$$2s=2v_0t+at^2$$
$$at^2+2v_0t-2s=0$$
$$a=a, b=2v_0, c=-2s$$

$$t=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$t=\frac{-\left(2v_0\right)\pm\sqrt{\left(2v_0\right)^2-4\left(a\right)\left(-2s\right)}}{2\left(a\right)}$$
$$t=\frac{-2v_0\pm\sqrt{4{v_0}^2+8as}}{2a}$$
$$t=\frac{-2v_0\pm2\sqrt{{v_0}^2+2as}}{2a}$$
$$t=\frac{-v_0\pm\sqrt{{v_0}^2+2as}}{a}$$

**116.** $S=2\pi rh+\pi r^2h$

$$\pi hr^2+2\pi hr-S=0$$
$$a=\pi h,b=2\pi h,c=-S$$
$$r=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$r=\frac{-\left(2\pi h\right)\pm\sqrt{\left(2\pi h\right)^2-4\left(\pi h\right)\left(-S\right)}}{2\left(\pi h\right)}$$
$$r=\frac{-2\pi h\pm\sqrt{4\pi^2h^2+4\pi hS}}{2\pi h}$$
$$r=\frac{-2\pi h\pm2\sqrt{\pi^2h^2+\pi hS}}{2\pi h}$$
$$r=\frac{-\pi h\pm\sqrt{\pi^2h^2+\pi hS}}{\pi h}$$

**117.** $LI^2+RI+\frac{1}{C}=0$

$$C\left(LI^2+RI+\frac{1}{C}\right)=C\left(0\right)$$
$$CLI^2+CRI+1=0$$
$$a=CL,b=CR,c=1$$
$$I=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$I=\frac{-\left(CR\right)\pm\sqrt{\left(CR\right)^2-4\left(CL\right)\left(1\right)}}{2\left(CL\right)}$$
$$I=\frac{-CR\pm\sqrt{C^2R^2-4CL}}{2CL}$$

**118.** $A=\pi r^2+\pi rs$

$$\pi r^2+\pi sr-A=0$$
$$a=\pi,b=\pi s,c=-A$$
$$r=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$r=\frac{-\left(\pi s\right)\pm\sqrt{\left(\pi s\right)^2-4\left(\pi\right)\left(-A\right)}}{2\left(\pi\right)}$$
$$r=\frac{-\pi s\pm\sqrt{\pi^2s^2+4\pi A}}{2\pi}$$

**119.** The right side of the equation is not equal to zero.

**120.** Given $ax^2+bx+c=0$, where $a\neq0$, the discriminant is $b^2-4ac$. The discriminant indicates the number and type of solutions to the equation.

**121.**

$$x^2-xy-2y^2=0$$
$$\left(x-2y\right)\left(x+y\right)=0$$
$$x-2y=0 \quad \text{or} \quad x+y=0$$
$$x=2y \qquad x=-y$$

**122.** $3a^2+2ab-b^2=0$

$$\left(3a-b\right)\left(a+b\right)=0$$
$$3a-b=0 \quad \text{or} \quad a+b=0$$
$$3a=b \qquad a=-b$$
$$a=\frac{b}{3}$$

**123.** $\left(x-4\right)\left(x+2\right)=0$

$$x^2+2x-4x-8=0$$
$$x^2-2x-8=0$$

**124.** $(x-7)(x+1)=0$

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

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

**125.** $\left(x-\frac{2}{3}\right)\left(x-\frac{1}{4}\right)=0$

$3\left(x-\frac{2}{3}\right)\cdot 4\left(x-\frac{1}{4}\right)=12\cdot 0$

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

$12x^2-3x-8x+2=0$

$12x^2-11x+2=0$

**126.** $\left(x-\frac{3}{5}\right)\left(x-\frac{1}{7}\right)=0$

$5\left(x-\frac{3}{5}\right)\cdot 7\left(x-\frac{1}{7}\right)=35\cdot 0$

$(5x-3)(7x-1)=0$

$35x^2-5x-21x+3=0$

$35x^2-26x+3=0$

**127.** $\left(x-\sqrt{5}\right)\left(x+\sqrt{5}\right)=0$

$(x)^2-\left(\sqrt{5}\right)^2=0$

$x^2-5=0$

**128.** $\left(x-\sqrt{2}\right)\left(x+\sqrt{2}\right)=0$

$(x)^2-\left(\sqrt{2}\right)^2=0$

$x^2-2=0$

**129.** $(x-2i)(x+2i)=0$

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

$x^2+4=0$

**130.** $(x-9i)(x+9i)=0$

$(x)^2+(9)^2=0$

$x^2+81=0$

**131.** $\left[x-(1+2i)\right]\left[x-(1-2i)\right]=0$

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

$\left[(x-1)-2i\right]\left[(x-1)+2i\right]=0$

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

$x^2-2x+1+4=0$

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

**132.** $\left[x-(2+9i)\right]\left[x-(2-9i)\right]=0$

$(x-2-9i)(x-2+9i)=0$

$\left[(x-2)-9i\right]\left[(x-2)+9i\right]=0$

$(x-2)^2+(9)^2=0$

$x^2-4x+4+81=0$

$x^2-4x+85=0$

**133.** $x_1+x_2$

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

$$=\frac{-b+\sqrt{b^2-4ac}+(-b)-\sqrt{b^2-4ac}}{2a}$$

$$=\frac{-2b}{2a}=-\frac{b}{a}$$

**134.** $x_1x_2$

$$=\left(\frac{-b+\sqrt{b^2-4ac}}{2a}\right)\cdot\left(\frac{-b-\sqrt{b^2-4ac}}{2a}\right)$$

$$=\frac{(-b)^2-\left(\sqrt{b^2-4ac}\right)^2}{(2a)^2}$$

$$=\frac{b^2-\left(b^2-4ac\right)}{4a^2}$$

$$=\frac{4ac}{4a^2}=\frac{c}{a}$$

## Problem Recognition Exercises: Simplifying Expressions versus Solving Equations

**1. a.** Expression

$(2x-5)(3x+1)=6x^2+2x-15x-5$

$=6x^2-13x-5$

**b.** Equation

$$(2x-5)(3x+1)=0$$
$$2x-5=0 \quad \text{or} \quad 3x+1=0$$
$$2x=5 \qquad 3x=-1$$
$$x=\frac{5}{2} \qquad x=-\frac{1}{3}$$
$$\left\{\frac{5}{2},-\frac{1}{3}\right\}$$

**2. a.** Expression

$$\frac{5}{x-3}-\frac{1}{x+7}-\frac{2}{x^2+4x-21}$$
$$=\frac{5}{x-3}-\frac{1}{x+7}-\frac{2}{(x-3)(x+7)}$$
$$=\frac{5}{x-3}\cdot\frac{x+7}{x+7}-\frac{1}{x+7}\cdot\frac{x-3}{x-3}-\frac{2}{(x-3)(x+7)}$$
$$=\frac{5(x+7)-1(x-3)-2}{(x-3)(x+7)}$$
$$=\frac{5x+35-x+3-2}{(x-3)(x+7)}$$
$$=\frac{4x+36}{(x-3)(x+7)}$$

**b.** Equation

$$\frac{5}{x-3}-\frac{1}{x+7}=\frac{2}{x^2+4x-21}$$
$$\left[(x-3)(x+7)\right]\left(\frac{5}{x-3}-\frac{1}{x+7}\right)=\left[(x-3)(x+7)\right]\left(\frac{2}{(x-3)(x+7)}\right)$$
$$5(x+7)-1(x-3)=2$$
$$5x+35-x+3=2$$
$$4x+38=2$$
$$4x=-36$$
$$x=-9$$
$$\{-9\}$$

**3. a.** Equation

$$(2x-3)^2=8$$
$$2x-3=\pm\sqrt{8}$$
$$2x-3=\pm 2\sqrt{2}$$
$$2x=3\pm\sqrt{2}$$
$$x=\frac{3\pm\sqrt{2}}{2}$$
$$\left\{\frac{3\pm\sqrt{2}}{2}\right\}$$

**b.** Expression

$$(2x-3)^2-8$$
$$=(2x)^2-2(2x)(3)+(3)^2-8$$
$$=4x^2-12x+9-8$$
$$=4x^2-12x+1$$

**4. a.** Equation

$$5-\{6+3[2-5(y-2)]+1\}=7$$
$$5-\{6+3[2-5y+10]+1\}=7$$
$$5-\{6+3[-5y+12]+1\}=7$$
$$5-\{6-15y+36+1\}=7$$
$$5-\{-15y+43\}=7$$
$$5+15y-43=7$$
$$15y-38=7$$
$$15y=45$$
$$y=3$$
$$\{3\}$$

**b.** Expression

$$5-\{6+3[2-5(y-2)]+1\}$$
$$=5-\{6+3[2-5y+10]+1\}$$
$$=5-\{6+3[-5y+12]+1\}$$
$$=5-\{6-15y+36+1\}$$
$$=5-\{-15y+43\}$$
$$=5+15y-43$$
$$=15y-38$$

**5. a.** Equation

$$x^2-11x+28=0$$
$$(x-7)(x-4)=0$$
$$x-7=0 \quad \text{or} \quad x-4=0$$
$$x=7 \qquad\qquad x=4$$
$$\{7,4\}$$

**b.** Equation

$$x^2-11x-28=0$$
$$a=1, b=-11, c=-28$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-11)\pm\sqrt{(-11)^2-4(1)(-28)}}{2(1)}$$
$$=\frac{11\pm\sqrt{121+112}}{2}=\frac{11\pm\sqrt{233}}{2}$$
$$\left\{\frac{11\pm\sqrt{233}}{2}\right\}$$

**6. a.** Equation

$$3x(x+9)=20-x$$
$$3x^2+27x=20-x$$
$$3x^2+28x-20=0$$
$$(3x-2)(x+10)=0$$
$$3x-2=0 \quad \text{or} \quad x+10=0$$
$$3x=2 \qquad\qquad x=-10$$
$$x=\frac{2}{3}$$
$$\left\{\frac{2}{3},-10\right\}$$

**b.** Equation

$$3(x+9)=20-x$$
$$3x+27=20-x$$
$$4x=-7$$
$$x=-\frac{7}{4}$$
$$\left\{-\frac{7}{4}\right\}$$

**Section 1.5 Applications of Quadratic Equations**

**7. a.** Equation

$$\frac{35}{x}+12+x=0$$
$$x\left(\frac{35}{x}+12+x\right)=x(0)$$
$$35+12x+x^2=0$$
$$x^2+12x+35=0$$
$$(x+7)(x+5)=0$$
$$x+7=0 \quad \text{or} \quad x+5=0$$
$$x=-7 \qquad\qquad x=-5$$
$$\{-7,-5\}$$

**b.** Expression

$$\frac{35}{x}+12+x=\frac{35}{x}+12\cdot\frac{x}{x}+x\cdot\frac{x}{x}$$
$$=\frac{35+12x+x^2}{x}$$

**8. a.** Equation

$$\frac{x}{x-2}+\frac{2}{3}=\frac{2}{x-2}$$
$$3(x-2)\left(\frac{x}{x-2}+\frac{2}{3}\right)=3(x-2)\left(\frac{2}{x-2}\right)$$
$$3x+2(x-2)=6$$
$$3x+2x-4=6$$
$$5x=10$$
$$x=2$$

$\{\ \}$; The value 2 does not check.

**b.** Expression

$$\frac{x}{x-2}+\frac{2}{3}-\frac{2}{x-2}=\frac{x-2}{x-2}+\frac{2}{3}$$
$$=1+\frac{2}{3}=\frac{5}{3};\ \text{for } x\neq 2$$

**1.** $A = \frac{1}{2}bh$

**2.** $A = \pi r^2$

**3.** $V = lwh$

**4.** $a^2 + b^2 = c^2$

**5. a.** Let $x$ represents the width of the rectangle (in yd). Then $(2x+3)$ is the length of the rectangle.

$$lw = A$$
$$x(2x+3) = 629$$

**b.**
$$x(2x+3) = 629$$
$$2x^2 + 3x = 629$$
$$2x^2 + 3x - 629 = 0$$
$$x^2 + \frac{3}{2}x - \frac{629}{2} = 0$$
$$x^2 + \frac{3}{2}x + \left(\frac{1}{2}\left(\frac{3}{2}\right)\right)^2 = \frac{629}{2} + \left(\frac{1}{2}\left(\frac{3}{2}\right)\right)^2$$
$$\left(x + \frac{3}{4}\right)^2 = \frac{5041}{16}$$
$$\left(x + \frac{3}{4}\right) = \pm\frac{71}{4}$$
$$x + \frac{3}{4} = \frac{71}{4} \text{ or } x + \frac{3}{4} = -\frac{71}{4}$$
$$x = 17 \qquad x \neq -\frac{37}{2}$$
$$2x + 3 = 37 \qquad 2x + 3 \neq -34$$

The width is 17 yd and the length is 37 yd.

**6. a.** Let $x$ represents the length of the rectangle (in meter). Then $\left(\frac{1}{4}x - 2\right)$ is the width of the rectangle.

$$lw = A$$
$$x\left(\frac{1}{4}x - 2\right) = 252$$

**b.**
$$x\left(\frac{1}{4}x - 2\right) = 252$$
$$\frac{1}{4}x^2 - 2x = 252$$
$$x^2 - 8x - 1008 = 0$$
$$(x - 36)(x + 28) = 0$$
$$x - 36 = 0 \text{ or } x + 28 = 0$$
$$x = 36 \qquad x \neq -28$$
$$\frac{1}{4}x - 2 = 7 \qquad \frac{1}{4}x - 2 \neq -9$$

The width is 7 m and the length is 36 m**.**

**7. a.** Let $x$ represents the base of the triangle (in feet). Then $(x-2)$ is the height of the triangle.

$$\frac{1}{2}bh = A$$
$$\frac{1}{2}x(x-2) = 40$$

**b.**
$$\frac{1}{2}x(x-2) = 40$$
$$\frac{1}{2}x^2 - x = 40$$
$$x^2 - 2x - 80 = 0$$
$$(x-10)(x+8) = 0$$
$$x - 10 = 0 \text{ or } x + 8 = 0$$
$$x = 10 \qquad x \neq -8$$
$$x - 2 = 8 \qquad x - 2 \neq -10$$

The base is 10 ft and the height is 8 ft.

**8. a.** Let $x$ represents the base of the triangle (in feet). Then $(x+4)$ is the height of the triangle.

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

$$\frac{1}{2}x(x+4) = 70$$

**b.** $$\frac{1}{2}x(x+4) = 70$$

$$\frac{1}{2}x^2 + 2x = 70$$

$$x^2 + 4x - 140 = 0$$

$$(x-10)(x+14) = 0$$

$$x-10 = 0 \quad \text{or} \quad x+14 = 0$$

$$x = 10 \qquad x \neq -14$$

$$x+4 = 14 \qquad x+4 \neq -10$$

The base is 10 yd and the height is 14 yd.

**9. a.** Let $x$ represents length of a rectangular box (in inches). Then $\frac{x}{5}$ is the height of the box.

$$lwh = V$$

$$x \cdot 8 \cdot \frac{x}{5} = 640$$

$$\frac{8}{5}x^2 = 640$$

**b.** $$\frac{8}{5}x^2 = 640$$

$$x^2 = 400$$

$$x = \pm 20$$

$$x = 20 \quad \text{or} \quad x \neq -20$$

$$\frac{x}{5} = 4 \qquad x \neq -4$$

The length is 20 in., the width is 8 in., and the height is 4 in.

**10. a.** Let $x$ represents width of a rectangular box (in feet). Then $(2x+1)$ is the length of the box.

$$lwh = V$$

$$4x(2x+1) = 312$$

**b.** $$4x(2x+1) = 312$$

$$8x^2 + 4x = 312$$

$$x^2 + \frac{1}{2}x = 39$$

$$x^2 + \frac{1}{2}x + \left(\frac{1}{2}\left(\frac{1}{2}\right)\right)^2 = 39 + \left(\frac{1}{2}\left(\frac{1}{2}\right)\right)^2$$

$$\left(x+\frac{1}{4}\right)^2 = \frac{625}{16}$$

$$\left(x+\frac{1}{4}\right) = \pm\frac{25}{4}$$

$$x+\frac{1}{4} = \frac{25}{4} \quad \text{or} \quad x+\frac{1}{4} = -\frac{25}{4}$$

$$x = 6 \qquad x \neq -\frac{13}{2}$$

$$2x+1 = 13 \qquad 2x+1 \neq -12$$

The width is 6 ft, the length is 13 ft, and the height is 4 ft.

**11. a.** Let $x$ represents length of the shorter leg of a right triangle (in feet). Then $(x+2)$ is the length of the longer leg and $(2x-2)$ is the hypotenuse of the triangle.

$$a^2 + b^2 = c^2$$

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

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

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

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

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

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

$$x = 6 \quad \text{or} \quad x \neq 0$$

$$x+2 = 8 \qquad x+2 \neq 2$$

$$2x-2 = 10 \qquad 2x-2 \neq -2$$

The legs are 6 ft and 8 ft, and the hypotenuse is 10 ft.

**12. a.** Let $x$ represents length of the shorter leg of a right triangle (in cm). Then $(x+7)$ is the length of the longer leg.

$$a^2 + b^2 = c^2$$

$$x^2 + (x+7)^2 = (17)^2$$

**b.** $x^2+(x+7)^2=(17)^2$

$2x^2+14x+49=289$

$2x^2+14x-240=0$

$x^2+7x-120=0$

$(x-8)(x+15)=0$

$x-8=0 \quad \text{or} \quad x+15=0$

$x=8 \qquad x\neq -15$

$x+7=15 \qquad x+7\neq -8$

The legs are 8 cm and 15 cm, and the hypotenuse is 17 cm.

**13.** Let *x* represents width of a rectangular garden (in yd). Then, $(x+2)$ is the length and 40 yd$^2$ is the area of the garden.

$x(x+2)=40$

$x^2+2x=40$

$x^2+2x+1=40+1$

$(x+1)^2=41$

$(x+1)=\pm\sqrt{41}$

$x=-1+\sqrt{41} \quad \text{or} \quad x=-1-\sqrt{41}$

$x=5.403\approx 5.4 \qquad x\neq -7.403$

$x+2=7.403\approx 7.4 \qquad x+2\neq -5.403$

The width is approximately 5.4 yd and the length is approximately 7.4 yd.

**14.** Let *x* represents length of a rectangular piece of carpet (in yd). Then, $(x-9)$ is the width and 200 yd$^2$ is the area of the piece of carpet.

$x(x-9)=200$

$x^2-9x=200$

$x^2-9x+\left(\frac{1}{2}(9)\right)^2=200+\left(\frac{1}{2}(9)\right)^2$

$\left(x-\frac{9}{2}\right)^2=\frac{881}{4}$

$\left(x-\frac{9}{2}\right)=\pm\frac{\sqrt{881}}{2}$

$x=\frac{9}{2}+\frac{\sqrt{881}}{2} \quad \text{or} \quad x=\frac{9}{2}-\frac{\sqrt{881}}{2}$

$x=19.341\approx 19.3 \qquad x\neq -10.341\approx 10.3$

$x-9=10.341\approx 10.3 \qquad x-9\neq -19.341$

The length is approximately 19.3 yd

and the width is approximately 10.3

yd.

**15.** Let *x* represents the base of a triangular truss (in feet). Then, $(x-8)$

is the height of the truss and 86 ft$^2$ is

the area of the truss.

$\frac{1}{2}x(x-8)=86$

$x^2-8x=172$

$x^2-8x+16=172+16$

$(x-4)^2=188$

$(x-4)=\pm\sqrt{188}$

$x=4+\sqrt{188} \quad \text{or} \quad x=4-\sqrt{188}$

$x=17.711\approx 17.7 \qquad x\neq -9.711$

$x-8=9.711\approx 9.7 \qquad x-8\neq -17.711$

The length is approximately 17.7 ft,

and the height is approximately 9.7 ft.

16. Let *x* represents the height of a triangular piece of fabric (in inches). Then, $(x+6)$ is the base and $600\ \text{in.}^2$ is the area of the piece of fabric.

$\frac{1}{2}x(x+6)=600$

$x^2+6x=1200$

$x^2+6x+9=1200+9$

$(x+3)^2=1209$

$(x+3)=\pm\sqrt{1209}$

$x=-3+\sqrt{1209}$ or $x=-3-\sqrt{1209}$

$x=31.771\approx 31.8$ $x\approx -37.771$

$x+6=37.771\approx 37.8$ $x+6\approx -31.771$

The height is approximately 31.8 in., and the base is approximately 37.8 in.

**17. a.** $x(x+2)=120$

**b.**
$$x(x+2)=120$$
$$x^2+2x=120$$
$$x^2+2x-120=0$$
$$(x-10)(x+12)=0$$
$$x-10=0 \quad \text{or} \quad x+12=0$$
$$x=10 \qquad x=-12$$
$$x+2=12 \qquad x+2=-10$$

The integers are 10 and 12 or $-10$ and $-12$.

**18. a.** $x(x+2)=35$

**b.**
$$x(x+2)=35$$
$$x^2+2x=35$$
$$x^2+2x-35=0$$
$$(x-5)(x+7)=0$$
$$x-5=0 \quad \text{or} \quad x+7=0$$
$$x=5 \qquad x=-7$$
$$x+2=7 \qquad x+2=-5$$

The integers are 5 and 7 or $-5$ and $-7$.

**19. a.** $x^2+(x+1)^2=113$

**b.**
$$x^2+(x+1)^2=113$$
$$x^2+x^2+2x+1=113$$
$$2x^2+2x-112=0$$
$$\frac{2x^2}{2}+\frac{2x}{2}-\frac{112}{2}=\frac{0}{2}$$
$$x^2+x-56=0$$
$$(x-7)(x+8)=0$$
$$x-7=0 \quad \text{or} \quad x+8=0$$
$$x=7 \qquad x=-8$$
$$x+1=8 \qquad x+1=-7$$

The integers are 7 and 8 or $-7$ and $-8$.

**20. a.** $x^2+(x+1)^2=181$

**b.**
$$x^2+(x+1)^2=181$$
$$x^2+x^2+2x+1=181$$
$$2x^2+2x-180=0$$
$$\frac{2x^2}{2}+\frac{2x}{2}-\frac{180}{2}=\frac{0}{2}$$
$$x^2+x-90=0$$
$$(x-9)(x+10)=0$$
$$x-9=0 \quad \text{or} \quad x+10=0$$
$$x=9 \qquad x=-10$$
$$x+1=10 \qquad x+1=-9$$

The integers are 9 and 10 or $-9$ and $-10$.

**21.** Let $x$ represents the width of the cargo space. The length is 12 ft and the height is $x-1$ ft.

$$V=lwh$$
$$504=(12)(x)(x-1)$$
$$504=12(x^2-x)$$
$$504=12x^2-12x$$
$$12x^2-12x-504=0$$
$$12(x^2-x-42)=0$$
$$(x-7)(x+6)=0$$
$$x-7=0 \quad \text{or} \quad x+6=0$$
$$x=7 \qquad \cancel{x=-6}$$
$$x-1=7-1$$
$$=6$$

The dimensions of the cargo space are 6 ft by 7 ft by 12 ft.

**22.** Let $x$ represents the width of the cardboard sheet. Then $(x+12)$ in. is the length of the cardboard sheet. The width of the box is $(x-12)$ in. The length of the box is $(x+12-12)=x$ in. The height of the box is 6 in.

$$V = lwh$$
$$1728 = (x)(x-12)(6)$$
$$1728 = 6(x^2 - 12x)$$
$$1728 = 6x^2 - 72x$$
$$6x^2 - 72x - 1728 = 0$$
$$6(x^2 - 12x - 288) = 0$$
$$(x-24)(x+12) = 0$$

$x - 24 = 0$ or $x + 12 = 0$

$x = 24$ ~~$x = -12$~~

$x + 12 = 24 + 12$

$= 36$

The dimensions of the cardboard sheet are 24 in. by 36 in.

**23.** Let *r* represent the radius (in yards) of the region watered.

$$A = \pi r^2$$
$$2000 = \pi r^2$$
$$\frac{2000}{\pi} = r^2$$
$$r = \pm\sqrt{\frac{2000}{\pi}} \approx \pm 25$$

The radius is approximately 25 yd.

**24.** Let *r* represent the radius (in miles) of the area in which the earthquake could be felt.

$$A = \pi r^2$$
$$46{,}000 = \pi r^2$$
$$\frac{46{,}000}{\pi} = r^2$$
$$r = \pm\sqrt{\frac{46{,}000}{\pi}}$$
$$\approx \pm 121$$

The earthquake could be felt up to 121mi from the epicentre.

**25.** Let *x* represent the height of the triangle (in feet) and $(x-3)$ represent the base of the triangle.

$$lw + 2\left(\frac{1}{2}bh\right) = A$$
$$(20)(x) + 2\left[\frac{1}{2}(x-3)(x)\right] = 348$$
$$20x + x^2 - 3x = 348$$
$$x^2 + 17x - 348 = 0$$
$$(x+29)(x-12) = 0$$

$x + 29 = 0$ or $x - 12 = 0$

~~$x = -29$~~ $x = 12$

$x - 3 = 12 - 3$

$= 9$

The base is 9 ft and the height is 12 ft.

**26.** Let *x* represent the height of the triangle and $3x$ represent the base of the triangle.

$$lw + \frac{1}{2}bh = A$$
$$(3x)(x+2) + \frac{1}{2}(3x)(x) = 336$$
$$3x^2 + 6x + \frac{3}{2}x^2 = 336$$
$$6x^2 + 12x + 3x^2 = 672$$
$$9x^2 + 12x - 672 = 0$$
$$(9x+84)(x-8) = 0$$

$9x + 84 = 0$ or $x - 8 = 0$

$9x = -84$ $x = 8$

~~$x = -\frac{84}{9}$~~

$3x = 3(8) = 24$

$x + 2 = 8 + 2 = 10$

The length is 24 ft and the height is 10 ft.

**27.** Let *x* represent the distance (in feet) from home plate to second base.

$$a^2+b^2=c^2$$
$$(90)^2+(90)^2=(x)^2$$
$$8100+8100=x^2$$
$$16{,}200=x^2$$
$$x=\pm\sqrt{16{,}200}$$
$$=\pm 90\sqrt{2}$$
$$\approx \pm 127.3$$

The distance is $90\sqrt{2}$ ft or approximately 127.3 ft.

**28. a.**
$$a^2+b^2=c^2$$
$$(6)^2+(6)^2=c^2$$
$$36+36=c^2$$
$$72=c^2$$
$$c=\pm\sqrt{72}$$
$$=\pm 6\sqrt{2} \text{ in.}$$

**b.**
$$a^2+b^2=c^2$$
$$\left(6\sqrt{2}\right)^2+(6)^2=d^2$$
$$72+36=d^2$$
$$108=d^2$$
$$d=\pm\sqrt{108}$$
$$=\pm 6\sqrt{3} \text{ in.}$$

**29. a.** Let $x$ represent the length (in feet) of the middle leg.
$$a^2+b^2=c^2$$
$$(x)^2+(x-2)^2=(x+2)^2$$
$$x^2+x^2-4x+4=x^2+4x+4$$
$$2x^2-4x+4=x^2+4x+4$$
$$x^2-8x=0$$
$$x(x-8)=0$$
$$x=0 \quad \text{or} \quad x-8=0$$
$$x=8$$
$$x-2=8-2=6$$
$$x+2=8+2=10$$

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

**b.**
$$A=A_T+A_B$$
$$=\frac{1}{2}b_T h_T+\frac{1}{2}b_B h_B$$
$$=\frac{1}{2}\left(b_T h_T+b_B h_B\right)$$
$$=\frac{1}{2}\left[(10)(4)+(8)(6)\right]$$
$$=\frac{1}{2}(40+48)$$
$$=\frac{1}{2}(88)=44$$

The total area is 44 ft$^2$.

**30.** a. Let $x$ represent the length (in feet) of the shorter leg.
$$a^2+b^2=c^2$$
$$(x)^2+(x+7)^2=(2x+1)^2$$
$$x^2+x^2+14x+49=4x^2+4x+1$$
$$2x^2+14x+49=4x^2+4x+1$$
$$-2x^2+10x+48=0$$
$$\frac{-2x^2}{-2}+\frac{10x}{-2}+\frac{48}{-2}=\frac{0}{-2}$$
$$x^2-5x-24=0$$
$$(x+3)(x-8)=0$$
$$x+3=0 \quad \text{or} \quad x-8=0$$
$$\cancel{x=-3} \qquad x=8$$

The lengths of the sides of the triangle on the left are 8 ft, 15 ft, and 17 ft.

**b.** Let $x$ represent the length (in feet) of the unlabeled side.
$$a^2+b^2=c^2$$
$$(x)^2+(9)^2=(15)^2$$
$$x^2+81=225$$
$$x^2=144$$
$$x=\pm\sqrt{144}$$
$$=\pm 12$$

The lengths of the sides of the triangle on the right are 9 ft, 12 ft, and 15 ft.

**31. a.** Let $x$ represent the width (in inches) of the cell phone. Then $1.5x$ is the length of the phone.

$$a^2+b^2=c^2$$
$$(x)^2+(1.5x^2)=(3.5)^2$$
$$x^2+2.25x^2=12.25$$
$$3.25x^2=12.25$$
$$x^2=\frac{12.25}{3.25}$$
$$x=\pm\sqrt{\frac{12.25}{3.25}}$$
$$\approx\pm 1.94$$
$$1.5x\approx 1.5(1.94)$$
$$\approx 2.91$$

The length is approximately 2.91in. and the width is approximately 1.94 in.

**b.** $2.91(326)\approx 949$

$1.94(326)\approx 632$

Using the rounded values from part (a), the screen is approximately 949 pixels by 632 pixels.

**32.** Let $x$ represent the width (in inches) of the display. Then $1.6x$ is the length of the display.

$$a^2+b^2=c^2$$
$$(x)^2+(1.6x^2)=(15)^2$$
$$x^2+2.56x^2=225$$
$$3.56x^2=225$$
$$x^2=\frac{225}{3.56}$$
$$x=\pm\sqrt{\frac{225}{3.56}}$$
$$\approx\pm 7.95$$
$$1.6x\approx 1.6(7.95)$$
$$\approx 12.72$$

The length is approximately 12.72 in., and the width is approximately 7.95 in.

**33.** Let $n$ represent the number of players.

$$N=\frac{1}{2}n(n-1)$$
$$28=\frac{1}{2}n(n-1)$$
$$56=n^2-n$$
$$n^2-n-56=0$$
$$(n-8)(n+7)=0$$
$$n-8=0 \quad \text{or} \quad n+7=0$$
$$n=8 \qquad \cancel{n=-7}$$

There were 8 players.

**34.**
$$S=\frac{1}{2}n(n+1)$$
$$171=\frac{1}{2}n(n+1)$$
$$342=n^2+n$$
$$n^2+n-342=0$$
$$(n-18)(n+19)=0$$
$$n-18=0 \quad \text{or} \quad n+19=0$$
$$n=18 \qquad \cancel{n=-19}$$

The value of $n$ is 18.

**35.** Let $t$ represent the time(s) at which the population was 600,000.

$$P=-1718t^2+82{,}000t+10{,}000$$
$$600{,}000=-1718t^2+82{,}000t+10{,}000$$
$$0=-1718t^2+82{,}000t-590{,}000$$
$$0=1718t^2-82{,}000t+590{,}000$$
$$t=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-82{,}000)\pm\sqrt{\left[\begin{matrix}(-82{,}000)^2\\ -4(1718)(590{,}000)\end{matrix}\right]}}{2(1718)}$$
$$=\frac{82{,}000\pm\sqrt{2{,}669{,}520{,}000}}{3436}$$
$$\approx 9 \text{ or } 39$$

There were 600,000 organisms approximately 9 hr and 39 hr after the culture was started.

**36.** Let $x$ represent the speed of the vehicle in mph.

$$m = -0.04x^2 + 3.6x - 49$$
$$30 = -0.04x^2 + 3.6x - 49$$
$$0 = 0.04x^2 - 3.6x + 79$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(-3.6) \pm \sqrt{(-3.6)^2 - 4(0.04)(79)}}{2(0.04)}$$
$$= \frac{3.6 \pm \sqrt{0.32}}{0.08}$$
$$x \approx 38 \text{ or } x \approx 52$$

The gas mileage will be 30 mpg for speeds of 38 mph and 52 mph.

**37. a.** $d = 0.05v^2 + 2.2v$

$$d = 0.05(50)^2 + 2.2(50)$$
$$= 0.05(2500) + 110$$
$$= 125 + 110$$
$$= 235 \text{ ft}$$

**b.** $d = 0.05v^2 + 2.2v$

$$330 = 0.05v^2 + 2.2v$$
$$d = 0.05v^2 + 2.2v - 330$$
$$v = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(2.2) \pm \sqrt{(2.2)^2 - 4(0.05)(-330)}}{2(0.05)}$$
$$= \frac{-2.2 \pm \sqrt{70.84}}{0.1}$$
$$\approx 62 \text{ or } \cancel{-106}$$

The car can travel at 62 mph and stop in time.

**38. a.** $c = 219x^2 - 26.7x + 1.64$

$$= 219(0.22)^2 - 26.7(0.22) + 1.64$$
$$= 219(0.0484) - 5.874 + 1.64$$
$$= 10.5996 - 5.874 + 1.64$$
$$\approx 6.4 \text{ ng/mL}$$

**b.** $c = 219x^2 - 26.7x + 1.64$

$$3 = 219x^2 - 26.7x + 1.64$$
$$0 = 219x^2 - 26.7x - 1.36$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(-26.7) \pm \sqrt{(-26.7)^2 - 4(219)(-1.36)}}{2(219)}$$
$$= \frac{26.7 \pm \sqrt{1904.25}}{438}$$
$$\approx 0.16 \text{ or } \cancel{-0.04}$$
$$= 16\%$$

**39. a.** $s = -\frac{1}{2}gt^2 + v_0t + s_0$

$$s = -\frac{1}{2}(32)t^2 + (16)t + 0$$
$$s = -16t^2 + 16t$$

**b.**
$$4 = -16t^2 + 16t$$
$$16t^2 - 16t + 4 = 0$$
$$4(4t^2 - 4t + 1) = 0$$
$$4(2t - 1)^2 = 0$$
$$2t - 1 = 0$$
$$2t = 1$$
$$t = \frac{1}{2}$$

It would take Michael Jordan 0.5 sec to reach his maximum height of 4 ft.

**40. a.** $s = -\frac{1}{2}gt^2 + v_0t + s_0$

$$s = -\frac{1}{2}(32)t^2 + \left(8\sqrt{5}\right)t + 0$$
$$= -16t^2 + 8\sqrt{5}t$$

**b.** $5 = -16t^2 + 8\sqrt{5}t$

$16t^2 - 8\sqrt{5}t + 5 = 0$

$\left(4t - \sqrt{5}\right)^2 = 0$

$4t - \sqrt{5} = 0$

$4t = \pm\sqrt{5}$

$t = \pm\frac{\sqrt{5}}{4}$

$\approx \pm 0.56$

It would take 0.56 sec to reach a height of 5 ft.

**41. a.** $s = -\frac{1}{2}gt^2 + v_0 t + s_0$

$s = -\frac{1}{2}(32)t^2 + (75)t + 4$

$= -16t^2 + 75t + 4$

**b.** $80 = -16t^2 + 75t + 4$

$0 = 16t^2 - 75t + 76$

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

$t = \frac{-(-75) \pm \sqrt{(-75)^2 - 4(16)(76)}}{2(16)}$

$t = \frac{75 \pm \sqrt{761}}{32}$

$\approx 1.5 \text{ or } 3.2$

The ball will be at an 80-ft height 1.5 sec and 3.2 sec after being kicked.

**42. a.** $s = -\frac{1}{2}gt^2 + v_0 t + s_0$

$s = -\frac{1}{2}(9.8)t^2 + (18)t + 1$

$= -4.9t^2 + 18t + 1$

**b.** $16 = -4.9t^2 + 18t + 10$

$= -4.9t^2 + 18t - 15$

$0 = 4.9t^2 - 18t + 15$

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

$t = \frac{-(-18) \pm \sqrt{(-18)^2 - 4(4.9)(15)}}{2(4.9)}$

$t = \frac{18 \pm \sqrt{30}}{9.8}$

$\approx 1.3 \text{ or } 2.4$

George will catch the bread 1.3 sec after release.

**43. a.** $\frac{L}{W} = \frac{L+W}{L}$

$\frac{L}{1} = \frac{L+1}{L}$

$L(L) = L\left(\frac{L+1}{L}\right)$

$L^2 = L + 1$

$L^2 - L - 1 = 0$

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

$L = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-1)}}{2(1)}$

$L = \frac{1 \pm \sqrt{5}}{2}$

$\approx \cancel{-0.62} \text{ or } 1.62$

**b.** $\frac{1.62}{1} = \frac{l}{9}$

$l = 9 \cdot 1.62$

$\approx 14.6 \text{ ft}$

**44.** Since the length of the sides of the square is 18 in., the length of the sides of the right triangles shown in the figure is $\left(\frac{18-x}{2}\right)$. Use the Pythagorean theorem,

$$a^2+b^2=c^2$$
$$\left(\frac{18-x}{2}\right)^2+\left(\frac{18-x}{2}\right)^2=x^2$$
$$2\left(\frac{18-x}{2}\right)^2=x^2$$
$$\frac{(18-x)^2}{2}=x^2$$
$$(18-x)^2=2x^2$$
$$324-36x+x^2=2x^2$$
$$x^2+36x-324=0$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(36)\pm\sqrt{(36)^2-4(1)(-324)}}{2(1)}$$
$$=\frac{-36\pm\sqrt{2592}}{2}$$
$$\approx 7.46 \text{ or } \cancel{-43.46}$$

$$y=\frac{80-2x}{3}$$
$$y=\frac{80-2(25)}{3}=\frac{30}{3}=10$$
or
$$y=\frac{80-2(15)}{3}=\frac{50}{3}$$

Each pen can be 25 yd by 10 yd, or it can be 15 yd by $\frac{50}{3}$ yd.

**46.** Let *t* represent the time when the ships are 100 nautical miles apart. Then the distance travelled by the first ship is $(10t)$ and the distance travelled by the second ship is $15(t-2)$.

$$a^2+b^2=c^2$$
$$(10t)^2+[15(t-2)]^2=(100)^2$$
$$100t^2+(15t-30)^2=10{,}000$$
$$100t^2+225t^2-900t+900=10{,}000$$
$$325t^2-900t-9100=0$$
$$13t^2-36t-364=0$$

$$t=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-36)\pm\sqrt{(-36)^2-4(13)(-364)}}{2(13)}$$
$$=\frac{36\pm\sqrt{20{,}224}}{26}$$
$$\approx 6.85 \text{ or } \cancel{-4.09}$$

$$6.85 \text{ hours} = 6 \text{ hours} + \left(\frac{85}{100} \text{ min}\right)\left(\frac{60 \text{ min}}{1 \text{ hr}}\right)$$
$$\approx 6 \text{ hours} + 51 \text{ min}$$

The sides are approximately 7.46 in.

**45. a.** $4x+6y=160$
$$6y=160-4x$$
$$y=\frac{160-4x}{6} \text{ or } y=\frac{80-2x}{3}$$

**b.** $A=lw$
$$A=x\left(\frac{80-2x}{3}\right)$$

**c.** $$A=x\left(\frac{80-2x}{3}\right)$$
$$250=x\left(\frac{80-2x}{3}\right)$$
$$750=80x-2x^2$$
$$375=40x-x^2$$
$$x^2-40x+375=0$$
$$(x-25)(x-15)=0$$
$$x-25=0 \quad \text{or} \quad x-15=0$$
$$x=25 \qquad x=15$$

The ships will be 100 nautical miles apart at approximately 6:51 PM.

## Section 1.6 More Equations and Applications

**1.** absolute; $\{k, -k\}$

**2.** $u=w \text{ or } u=-w$

**3.** quadratic; $m^{\frac{1}{3}}$

**4.** $4x^2+1$

**5.**
$$-3x(2x-1)(x+6)^2=0$$
$$-6x\left(x-\frac{1}{2}\right)(x+6)(x+6)=0$$
$$x\left(x-\frac{1}{2}\right)(x+6)(x+6)=0$$

$$x=0 \text{ or } x-\frac{1}{2}=0 \text{ or } x+6=0 \text{ or } x+6=0$$
$$x=0 \qquad x=\frac{1}{2} \qquad x=-6$$
$$\left\{0, \frac{1}{2}, -6\right\}$$

**6.**
$$5y(3-y)(4y+1)^2=0$$
$$60y\left(1-\frac{y}{3}\right)\left(y+\frac{1}{4}\right)\left(y+\frac{1}{4}\right)=0$$
$$y\left(1-\frac{y}{3}\right)\left(y+\frac{1}{4}\right)\left(y+\frac{1}{4}\right)=0$$

$$y=0 \text{ or } 1-\frac{y}{3}=0 \text{ or } y+\frac{1}{4}=0 \text{ or } y+\frac{1}{4}=0$$
$$y=0 \qquad y=3 \qquad y=-\frac{1}{4}$$
$$\left\{0, 3, -\frac{1}{4}\right\}$$

**7.** $4\left(w^2-7\right)\left(w^2+4\right)=0$

$w^2-7=0 \text{ or } w^2+4=0$

$w^2=7 \qquad w^2=-4$

$w=\pm\sqrt{7} \qquad w=\pm\sqrt{-4}$

$w=\pm 2i$

$\left\{\pm\sqrt{7},\pm 2i\right\}$

**8.** $-2\left(t^2+1\right)\left(t^2-5\right)=0$

$t^2+1=0 \text{ or } t^2-5=0$

$t^2=-1 \text{ or } t^2=5$

$t=\pm\sqrt{-1} \qquad t=\pm\sqrt{5}$

$t=\pm i$

$\left\{\pm\sqrt{5},\pm i\right\}$

**9.** $75y^3+100y^2-3y-4=0$

$75y^3-3y+100y^2-4=0$

$3y\left(25y^2-1\right)+4\left(25y^2-1\right)=0$

$\left(25y^2-1\right)\left(3y+4\right)=0$

$\left(5y+1\right)\left(5y-1\right)\left(3y+4\right)=0$

$5y+1=0 \text{ or } 5y-1=0 \text{ or } 3y+4=0$

$y=-\frac{1}{5} \qquad y=\frac{1}{5} \qquad y=-\frac{4}{3}$

$\left\{\pm\frac{1}{5},-\frac{4}{3}\right\}$

**10.** $98t^3-49t^2-8t+4=0$

$49t^2\left(2t-1\right)-4\left(2t-1\right)=0$

$\left(49t^2-4\right)\left(2t-1\right)=0$

$\left(7t+2\right)\left(7t-2\right)\left(2t-1\right)=0$

$7t+2=0 \text{ or } 7t-2=0 \text{ or } 2t-1=0$

$t=-\frac{2}{7} \qquad t=\frac{2}{7} \qquad t=\frac{1}{2}$

$\left\{\pm\frac{2}{7},\frac{1}{2}\right\}$

**11.** $x^3+7x^2=4\left(x+7\right)$

$x^3+7x^2-4x-28=0$

$x^3-4x+7x^2-28=0$

$x\left(x^2-4\right)+7\left(x^2-4\right)=0$

$\left(x+7\right)\left(x^2-4\right)=0$

$\left(x+7\right)\left(x+2\right)\left(x-2\right)=0$

$x+7=0 \text{ or } x+2=0 \text{ or } x-2=0$

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

$\left\{-7,-2,2\right\}$

**12.** $2m^3+3m^2=9\left(2m+3\right)$

$2m^3+3m^2-18m-27=0$

$2m^3-18m+3m^2-27=0$

$2m\left(m^2-9\right)+3\left(m^2-9\right)=0$

$\left(2m+3\right)\left(m^2-9\right)=0$

$\left(2m+3\right)\left(m+3\right)\left(m-3\right)=0$

$2m+3=0 \text{ or } m+3=0 \text{ or } m-3=0$

$m=-\frac{3}{2} \qquad m=-3 \qquad m=3$

$\left\{-\frac{3}{2},-3,3\right\}$

**13.** $2x^4-32=0$

$2\left(x^4-16\right)=0$

$2\left(x^2-4\right)\left(x^2+4\right)=0$

$2\left(x-2\right)\left(x+2\right)\left(x^2+4\right)=0$

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

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

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

$x=\pm 2i$

$\left\{\pm 2i,\pm 2\right\}$

**14.** $5m^4-5=0$

$5\left(m^4-1\right)=0$

$5\left(m^2-1\right)\left(m^2+1\right)=0$

$5\left(m-1\right)\left(m+1\right)\left(m^2+1\right)=0$

$m-1=0 \text{ or } m+1=0 \text{ or } m^2+1=0$

$m=1 \qquad m=-1 \qquad m^2=-1$

$m=\pm\sqrt{-1}$

$m=\pm i$

$\{\pm i, \pm 1\}$

**15.** $2x^4=-128x$

$2x^4+128x=0$

$2x(x^3+64)=0$

$2x(x+4)(x^2-4x+16)=0$

$2x=0 \text{ or } x+4=0 \text{ or } x^2-4x+16=0$

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

$x=\dfrac{-(-4)\pm\sqrt{(-4)^2-4(1)(16)}}{2(1)}$

$=\dfrac{4\pm\sqrt{-48}}{2}$

$=\dfrac{4\pm 4i\sqrt{3}}{2}$

$=2\pm 2i\sqrt{3}$

$\{0,-4,2\pm 2i\sqrt{3}\}$

**16.** $10x^5=-1250x^2$

$10x^5+1250x^2=0$

$10x^2(x^3+125)=0$

$10x^2(x+5)(x^2-5x+25)=0$

$10x^2=0 \text{ or } x+5=0 \text{ or } x^2-5x+25=0$

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

$x=\dfrac{-(-5)\pm\sqrt{(-5)^2-4(1)(25)}}{2(1)}$

$=\dfrac{5\pm\sqrt{-75}}{2}=\dfrac{5\pm 5i\sqrt{3}}{2}$

$\left\{0,-5,\dfrac{5\pm 5i\sqrt{3}}{2}\right\}$

**17.** $3n^2(n^2+3)=20-2n^2$

$3n^4+9n^2=20-2n^2$

$3n^4+11n^2-20=0$

$(3n^2-4)(n^2+5)=0$

$3n^2-4=0 \qquad \text{or} \qquad n^2+5=0$

$3n^2=4 \qquad\qquad n^2=-5$

$n^2=\dfrac{4}{3} \qquad\qquad n=\pm\sqrt{-5}$

$n=\pm\sqrt{\dfrac{4}{3}}=\pm\dfrac{2\sqrt{3}}{3} \qquad n=\pm i\sqrt{5}$

$\left\{\pm\dfrac{2\sqrt{3}}{3},\pm i\sqrt{5}\right\}$

**18.** $2y^2(y^2-2)=18+y^2$

$2y^4-4y^2=18+y^2$

$2y^4-5y^2-18=0$

$(2y^2-9)(y^2+2)=0$

$2y^2-9=0 \qquad \text{or}$

$2y^2=9$

$y^2=\dfrac{9}{2}$

$y=\pm\sqrt{\dfrac{9}{2}}$

$=\pm\dfrac{3\sqrt{2}}{2}$

$y^2+2=0$

$y^2=-2$

$y=\pm\sqrt{-2}$

$y=\pm i\sqrt{2}$

$\left\{\pm\dfrac{3\sqrt{2}}{2},\pm i\sqrt{2}\right\}$

**19.** $x^3-8=x-2$

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

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

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

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

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

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

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

$x+1=\pm i\sqrt{2}$

$x=-1\pm i\sqrt{2}$

$\{2,-1\pm i\sqrt{2}\}$

**20.** $x^3-64=x-4$

$(x-4)(x^2+4x+16)=(x-4)$

$(x-4)(x^2+4x+16)-(x-4)=0$

$(x-4)(x^2+4x+16-1)=0$

$(x-4)(x^2+4x+15)=0$

$x-4=0$ or

$x=4$

$x^2+4x+15=0$

$x^2+4x+4=-15+4$

$(x+2)^2=-11$

$x+2=\pm i\sqrt{11}$

$x=-2\pm i\sqrt{11}$

$\{4,-2\pm i\sqrt{11}\}$

**21.** $\dfrac{3x}{x+2}-\dfrac{5}{x-4}=\dfrac{2x^2-14x}{x^2-2x-8}$

$\dfrac{3x}{x+2}-\dfrac{5}{x-4}=\dfrac{2x^2-14x}{(x+2)(x-4)}$

$(x+2)(x-4)\left(\dfrac{3x}{x+2}-\dfrac{5}{x-4}\right)=(x+2)(x-4)\left[\dfrac{2x^2-14x}{(x+2)(x-4)}\right]$

$3x(x-4)-5(x+2)=2x^2-14x$

$3x^2-12x-5x-10=2x^2-14x$

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

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

~~$x=-2$~~ or $x=5$

$\{5\}$; The value $-2$ does not check.

**22.**
$$\frac{4c}{c-5}-\frac{1}{c+1}=\frac{3c^2+3}{c^2-4c-5}$$
$$\frac{4c}{c-5}-\frac{1}{c+1}=\frac{3c^2+3}{(c-5)(c+1)}$$
$$(c-5)(c+1)\left(\frac{4c}{c-5}-\frac{1}{c+1}\right)=(c-5)(c+1)\left[\frac{3c^2+3}{(c-5)(c+1)}\right]$$
$$4c(c+1)-1(c-5)=3c^2+3$$
$$4c^2+4c-c+5=3c^2+3$$
$$c^2+3c+2=0$$
$$(c+1)(c+2)=0$$
$$\cancel{c=-1} \quad \text{or} \quad c=-2$$
$\{-2\}$; The value $-1$ does not check.

**23.**
$$\frac{m}{2m+1}+1=\frac{2}{m-3}$$
$$(2m+1)(m-3)\left(\frac{m}{2m+1}+1\right)=(2m+1)(m-3)\left(\frac{2}{m-3}\right)$$
$$m(m-3)+1(2m+1)(m-3)=2(2m+1)$$
$$m^2-3m+2m^2-6m+m-3=4m+2$$
$$3m^2-12m-5=0$$
$$m=\frac{-(-12)\pm\sqrt{(-12)^2-4(3)(-5)}}{2(3)}$$
$$=\frac{12\pm\sqrt{204}}{6}$$
$$=\frac{12\pm2\sqrt{51}}{6}$$
$$=\frac{6\pm\sqrt{51}}{3}$$
$$\left\{\frac{6\pm\sqrt{51}}{3}\right\}$$

**24.**
$$\frac{n}{n-3}+2=\frac{3}{2n-1}$$
$$(n-3)(2n-1)\left(\frac{n}{n-3}+2\right)=(n-3)(2n-1)\left(\frac{3}{2n-1}\right)$$
$$n(2n-1)+2(n-3)(2n-1)=3(n-3)$$
$$2n^2-n+2(2n^2-7n+3)=3n-9$$
$$2n^2-n+4n^2-14n+6=3n-9$$
$$6n^2-18n+15=0$$
$$2n^2-6n+5=0$$

$$n=\frac{-(-6)\pm\sqrt{(-6)^2-4(2)(5)}}{2(2)}$$
$$=\frac{6\pm\sqrt{-4}}{4}$$
$$=\frac{6\pm 2i}{4}$$
$$=\frac{3\pm i}{2}$$

$$\left\{\frac{3\pm i}{2}\right\}$$

**25.** $2-\frac{3}{y}=\frac{5}{y^2}$

$$y^2\left(2-\frac{3}{y}\right)=y^2\left(\frac{5}{y^2}\right)$$
$$2y^2-3y=5$$
$$2y^2-3y-5=0$$
$$(2y-5)(y+1)=0$$
$$2y-5=0 \quad \text{or} \quad y+1=0$$
$$2y=5 \qquad\qquad y=-1$$
$$y=\frac{5}{2}$$

$$\left\{\frac{5}{2};-1\right\}$$

**26.** $7+\frac{20}{z}=\frac{3}{z^2}$

$$z^2\left(7+\frac{20}{z}\right)=z^2\left(\frac{3}{z^2}\right)$$
$$7z^2+20z=3$$
$$7z^2+20z-3=0$$
$$(7z-1)(z+3)=0$$
$$7z-1=0 \quad \text{or} \quad z+3=0$$
$$7z=1 \qquad\qquad z=-3$$
$$z=\frac{1}{7}$$

$$\left\{\frac{1}{7};-3\right\}$$

**27.** $\frac{18}{m^2-3m}+2=\frac{6}{m-3}$

$$\frac{18}{m(m-3)}+2=\frac{6}{m-3}$$
$$m(m-3)\left[\frac{18}{m(m-3)}+2\right]=m(m-3)\left(\frac{6}{m-3}\right)$$
$$18+2m(m-3)=6m$$
$$18+2m^2-6m=6m$$
$$2m^2-12m+18=0$$
$$m^2-6m+9=0$$
$$(m-3)^2=0$$
$$m-3=0$$
$$\cancel{m=3}$$

$\{\ \}$; The value 3 does not check.

**28.**
$$\frac{48}{m^2-4m}+3=\frac{12}{m-4}$$
$$\frac{48}{m(m-4)}+3=\frac{12}{m-4}$$
$$m(m-4)\left[\frac{48}{m(m-4)}+3\right]=m(m-4)\left(\frac{12}{m-4}\right)$$
$$48+3m(m-4)=12m$$
$$48+3m^2-12m=12m$$
$$3m^2-24m+48=0$$
$$m^2-8m+16=0$$
$$(m-4)^2=0$$
$$m-4=0$$
$$\cancel{m=4}$$

$\{\ \}$; The value 3 does not check.

**29.** Let *x* represent the speed of the boat in still water.

| | **Distance (km)** | **Rate (kmph)** | **Time (hr)** |
|---|---|---|---|
| **With current** | 72 | $x+2$ | $\frac{72}{x+2}$ |
| **Against current** | 72 | $x-2$ | $\frac{72}{x-2}$ |

$$\frac{72}{x-2}-\frac{72}{x+2}=9$$
$$(x-2)(x+2)\left(\frac{72}{x-2}-\frac{72}{x+2}\right)=(x-2)(x+2)(9)$$
$$72(x+2)-72(x-2)=9(x^2-4)$$
$$72x+144-72x+144=9x^2-36$$
$$288=9x^2-36$$
$$324=9x^2$$
$$36=x^2$$
$$x=\pm\sqrt{36}=6 \text{ or } \cancel{-6}$$

Jesse travels 6 km/hr in still water.

**30.** Let *x* represent the speed of the plane in still air.

| | **Distance (mi)** | **Rate (mph)** | **Time (hr)** |
|---|---|---|---|
| **With wind** | 800 | $x+40$ | $\frac{800}{x+40}$ |

| | | | |
|---|---|---|---|
| **Against wind** | 800 | $x-40$ | $\frac{800}{x-40}$ |

$$\frac{800}{x-40}-\frac{800}{x+40}=0.5$$
$$(x-40)(x+40)\left(\frac{800}{x-40}-\frac{800}{x+40}\right)=(x-40)(x+40)(0.5)$$
$$800(x+40)-800(x-40)=0.5(x^2-1600)$$
$$800x+32{,}000-800x+32{,}000=0.5x^2-800$$
$$64{,}000=0.5x^2-800$$
$$64{,}800=0.5x^2$$
$$129{,}600=x^2$$
$$x=\pm\sqrt{129{,}600}=360 \text{ or } \cancel{-360}$$

The plane travels 360 mph in still air.

**31.** Let *x* represent the speed at which Jean runs. Then $(x+8)$ is the speed at which she rides.

| | **Distance (mi)** | **Rate (mph)** | **Time (hr)** |
|---|---|---|---|
| **Running** | 6 | *x* | $\frac{6}{x}$ |
| **Riding** | 24 | $x+8$ | $\frac{24}{x+8}$ |

$$\frac{6}{x}+\frac{24}{x+8}=2.25$$
$$\frac{24}{x}+\frac{96}{x+8}=9$$
$$x(x+8)\left(\frac{24}{x}+\frac{96}{x+8}\right)=x(x+8)(9)$$
$$24(x+8)+96x=9(x^2+8x)$$
$$24x+192+96x=9x^2+72x$$
$$120x+192=9x^2+72x$$
$$0=9x^2-48x-192$$
$$0=3x^2-16x-64$$
$$0=(3x+8)(x-8)$$
$$3x+8=0 \quad \text{or} \quad x-8=0$$
$$3x=-8 \qquad\qquad x=8$$
$$\cancel{x=-\frac{8}{3}}$$

$x+8=8+8=16$

Jean runs 8 mph and rides 16 mph.

**32.** Let $x$ represent the speed at which Barbara drives in clear weather. Then $(x-20)$ is the speed at which she drives during the thunderstorm.

| | Distance (mi) | Rate (mph) | Time (hr) |
|---|---|---|---|
| **Clear weather** | 50 | $x$ | $\frac{50}{x}$ |
| **Thunder-storm** | 15 | $x-20$ | $\frac{15}{x-20}$ |

$$\frac{50}{x}+\frac{15}{x-20}=1.5$$
$$\frac{100}{x}+\frac{30}{x-20}=3$$
$$x(x-20)\left(\frac{100}{x}+\frac{30}{x-20}\right)=x(x-20)(3)$$
$$100(x-20)+30x=3(x^2-20x)$$
$$100x-2000+30x=3x^2-60x$$
$$130x-2000=3x^2-60x$$
$$0=3x^2-190x+2000$$
$$0=(3x-40)(x-50)$$
$$3x-40=0 \quad \text{or} \quad x-50=0$$
$$3x=40 \qquad x=50$$
$$x=\frac{40}{3}=13\frac{1}{3}$$
$$x-20=13\frac{1}{3}-20=-6\frac{2}{3}$$
$$x-20=50-20=30$$

Barbara drives 30 mph in the thunderstorm and 50 mph in nice weather.

**33. a.** $|p|=6$

$p=6 \quad \text{or} \quad p=-6$

$\{6,-6\}$

**b.** $|p|=0$

$p=0$

$\{0\}$

**c.** $|p|=-6$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**34. a.** $|w|=2$

$w=2 \quad \text{or} \quad w=-2$

$\{2,-2\}$

**b.** $|w|=0$

$w=0$

$\{0\}$

**c.** $|w|=-2$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**35. a.** $|x-3|=4$

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

$x=7 \qquad\qquad x=-1$

$\{7,-1\}$

**b.** $|x-3|=0$

$x-3=0$

$x=3$

$\{3\}$

**c.** $|x-3|=-7$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**36. a.** $|m+1|=5$

$m+1=5 \quad \text{or} \quad m+1=-5$

$m=4 \qquad\qquad m=-6$

$\{4,-6\}$

**b.** $|m+1|=0$

$m+1=0$

$m=-1$

$\{-1\}$

**c.** $|m+1|=-1$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**37.** $2|3x-4|+7=9$

$2|3x-4|=9-7=2$

$|3x-4|=1$

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

$x=\frac{5}{3} \qquad\qquad x=1$

$\left\{\frac{5}{3},1\right\}$

**38.** $4|2t+7|+2=22$

$4|2t+7|=20$

$|2t+7|=5$

$2t+7=5 \quad \text{or} \quad 2t+7=-5$

$t=-1 \qquad\qquad t=-6$

$\{-1,-6\}$

**39.** $-3=-|c-7|+1$

$-4=-|c-7|$

$4=|c-7|$

$c-7=4 \quad \text{or} \quad c-7=-4$

$c=11 \qquad\qquad c=3$

$\{11,3\}$

**40.** $-4=-|z+8|-3$

$-1=-|z+8|$

$1=|z+8|$

$z+8=1 \quad \text{or} \quad z+8=-1$

$z=-7 \qquad\qquad z=-9$

$\{-7,-9\}$

**41.** $2=8+|11y+4|$

$-6=|11y+4|$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**42.** $6=7+|9z-3|$

$-1=|9z-3|$

$\{\ \}$; Since an absolute value cannot be negative, there is no solution.

**43.** $\left|4-\frac{1}{2}w\right|-\frac{1}{3}=\frac{1}{2}$

$\left|4-\frac{1}{2}w\right|=\frac{1}{2}+\frac{1}{3}=\frac{5}{6}$

$4-\frac{1}{2}w=\frac{5}{6} \quad \text{or} \quad 4-\frac{1}{2}w=-\frac{5}{6}$

$-\frac{1}{2}w=-\frac{19}{6} \qquad -\frac{1}{2}w=-\frac{29}{6}$

$w=\frac{19}{3} \qquad\qquad w=\frac{29}{3}$

$\left\{\frac{19}{3},\frac{29}{3}\right\}$

**44.** $\left|2-\frac{1}{3}p\right|-\frac{7}{6}=\frac{1}{2}$

$\left|2-\frac{1}{3}p\right|=\frac{1}{2}+\frac{7}{6}=\frac{10}{6}$

$$2-\frac{1}{3}p=\frac{5}{3} \quad \text{or} \quad 2-\frac{1}{3}p=-\frac{5}{3}$$
$$-\frac{1}{3}p=-\frac{1}{3} \qquad -\frac{1}{3}p=-\frac{11}{3}$$
$$p=1 \qquad p=11$$
$$\{1,11\}$$

**45.** $|3y+5|=|y+1|$

$$3y+5=y+1 \quad \text{or} \quad 3y+5=-(y+1)$$
$$2y=-4 \qquad 4y=-6$$
$$y=-2 \qquad y=-\frac{3}{2}$$
$$\left\{-2,-\frac{3}{2}\right\}$$

**46.** $|2a-3|=|a+2|$

$$2a-3=a+2 \quad \text{or} \quad 2a-3=-(a+2)$$
$$a=5 \qquad a=\frac{1}{3}$$
$$\left\{5,\frac{1}{3}\right\}$$

**47.** $|4-x|=|2x+1|$

$$4-x=2x+1 \quad \text{or} \quad 4-x=-(2x+1)$$
$$-3x=-3 \qquad x=-5$$
$$x=1$$
$$\{-5,1\}$$

**48.** $|3-2x|=|x+5|$

$$3-2x=x+5 \quad \text{or} \quad 3-2x=-(x+5)$$
$$-3x=2 \qquad -x=-8$$
$$x=-\frac{2}{3} \qquad x=8$$
$$\left\{-\frac{2}{3},8\right\}$$

**49.** $\left|\frac{1}{4}w\right|=|4w|$

$$\frac{1}{4}w=4w \quad \text{or} \quad \frac{1}{4}w=-4w$$
$$-\frac{15}{4}w=0 \qquad -\frac{17}{4}w=0$$
$$w=0 \qquad w=0$$
$$\{0\}$$

**50.** $|3z|=\left|\frac{1}{3}z\right|$

$$3z=\frac{1}{3}z \quad \text{or} \quad 3z=-\frac{1}{3}z$$
$$\frac{8}{3}z=0 \qquad \frac{10}{3}z=0$$
$$z=0 \qquad z=0$$
$$\{0\}$$

**51.** $|x+4|=|x-7|$

$$x+4=x-7 \quad \text{or} \quad x+4=-(x-7)$$
$$4\neq -7 \qquad 2x=3$$
$$x=\frac{3}{2}$$
$$\left\{\frac{3}{2}\right\}$$

**52.** $|k-3|=|k+3|$

$$-3\neq 3 \quad \text{or} \quad k-3=-(k+3)$$
$$2k=0$$
$$k=0$$
$$\{0\}$$

**53.** $|2p-1|=|1-2p|$

$$2p-1=1-2p \quad \text{or} \quad 2p-1=-(1-2p)$$
$$4p=2 \qquad -1=-1$$
$$p=\frac{1}{2}$$

The solution set is □.

**54.** $|4d-3|=|3-4d|$

$$4d-3=3-4d \quad \text{or} \quad 4d-3=-(3-4d)$$
$$8d=6 \qquad -3=-3$$
$$d=\frac{3}{4}$$

The solution set is □.

**55.** $\sqrt{2x-4}=6$

$$\left(\sqrt{2x-4}\right)^2=(6)^2$$
$$2x-4=36$$
$$2x=40$$
$$x=20$$
$$\{20\}$$

**56.** $\sqrt{3x+1}=11$

$\left(\sqrt{3x+1}\right)^2=(11)^2$

$3x+1=121$

$3x=120$

$x=40$

$\{40\}$

**57.** $1=3+\sqrt{2x+7}$

$-2=\sqrt{2x+7}$

$4=2x+7$

$-3=2x$

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

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

$1=3+\sqrt{2x+7}$

$1=3+\sqrt{2\left(-\frac{3}{2}\right)+7}$

$1=3+2$

$1=5$ false

$\{\ \}$

**58.** $6=9+\sqrt{5-3x}$

$-3=\sqrt{5-3x}$

$9=5-3x$

$4=-3x$

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

**Check:** $x=-\frac{4}{3}$

$6=9+\sqrt{5-3x}$

$6=9+\sqrt{5-3\left(-\frac{4}{3}\right)}$

$6=9+3$

$6=12$ false

$\{\ \}$

**59.** $\sqrt{7x+8}=x+2$

$\left(\sqrt{7x+8}\right)^2=(x+2)^2$

$7x+8=x^2+4x+4$

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

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

$x=-1$ or $x=4$

**Check:** $x=-1$

$\sqrt{7x+8}=x+2$

$\sqrt{7(-1)+8}=1$

$\sqrt{1}=1$

$1=1$ ✓ true

**Check:** $x=4$

$\sqrt{7x+8}=x+2$

$\sqrt{7(4)+8}=4+2$

$\sqrt{36}=6$

$6=6$ ✓ true

$\{-1,4\}$

**60.** $\sqrt{9x+19}=x+3$

$\left(\sqrt{9x+19}\right)^2=(x+3)^2$

$9x+19=x^2+6x+9$

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

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

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

**Check:** $x=-2$

$\sqrt{9x+19}=x+3$

$\sqrt{9(-2)+19}=-2+3$

$\sqrt{1}=1$

$1=1$ ✓ true

**Check:** $x=5$

$\sqrt{9x+19}=x+3$

$\sqrt{9(5)+19}=5+3$

$\sqrt{64}=8$

$8=8$ ✓ true

$\{-2,5\}$

**61.** $\sqrt{m+18}+2=m$

$\sqrt{m+18}=m-2$

$\left(\sqrt{m+18}\right)^2=(m-2)^2$

$m+18=m^2-4m+4$

$0=m^2-5m-14$

$0=(m+2)(m-7)$

$m=-2 \quad \text{or} \quad m=7$

Check: $m=-2$

$\sqrt{m+18}+2=m$

$\sqrt{(-2)+18}+2=(-2)$

$\sqrt{16}+2=-2$

$4+2=-2$

$6=-2$ false

Check: $m=7$

$\sqrt{m+18}+2=m$

$\sqrt{(7)+18}+2=(7)$

$\sqrt{25}+2=7$

$5+2=7$

$7=7$ ✓ true

$\{7\}$; The value $-2$ does not check.

**62.** $\sqrt{2n+29}+3=n$

$\sqrt{2n+29}=n-3$

$\left(\sqrt{2n+29}\right)^2=(n-3)^2$

$2n+29=n^2-6n+9$

$0=n^2-8n-20$

$0=(n+2)(n-10)$

$n=-2 \quad \text{or} \quad n=10$

Check: $n=-2$

$\sqrt{2n+29}+3=n$

$\sqrt{2(-2)+29}+3=-2$

$\sqrt{25}+3=-2$

$5+3=-2$

$8=-2$ false

Check: $n=10$

$\sqrt{2n+29}+3=n$

$\sqrt{2(10)+29}+3=10$

$\sqrt{49}+3=10$

$7+3=10$

$10=10$ ✓ true

$\{10\}$; The value $-2$ does not check.

**63.** $-4\sqrt[3]{2x-5}+6=10$

$-4\sqrt[3]{2x-5}=4$

$\sqrt[3]{2x-5}=-1$

$\left(\sqrt[3]{2x-5}\right)^3=(-1)^3$

$2x-5=-1$

$2x=4$

$x=2$

$\{2\}$

**64.** $-3\sqrt[5]{4x-1}+2=8$

$-3\sqrt[5]{4x-1}=6$

$\sqrt[5]{4x-1}=-2$

$\left(\sqrt[5]{4x-1}\right)^5=(-2)^5$

$4x-1=-32$

$4x=-31$

$x=-\frac{31}{4}$

$\left\{-\frac{31}{4}\right\}$

**65.** $\sqrt[4]{5y-3}-\sqrt[4]{2y+1}=0$

$\sqrt[4]{5y-3}=-\sqrt[4]{2y+1}$

$\left(\sqrt[4]{5y-3}\right)^4=\left(-\sqrt[4]{2y+1}\right)^4$

$5y-3=2y+1$

$3y=4$

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

Check: $y=\frac{4}{3}$

$$\sqrt[4]{5y-3}-\sqrt[4]{2y+1}=0$$
$$\sqrt[4]{5\left(\frac{4}{3}\right)-3}-\sqrt[4]{2\left(\frac{4}{3}\right)+1}=0$$
$$\sqrt[4]{\frac{20}{3}-\frac{9}{3}}-\sqrt[4]{\frac{8}{3}+\frac{3}{3}}=0$$
$$\sqrt[4]{\frac{11}{3}}-\sqrt[4]{\frac{11}{3}}=0$$
$$0=0 \checkmark \text{ true}$$

$\left\{\frac{4}{3}\right\}$

**66.** $\sqrt[6]{y+7}-\sqrt[6]{4y+5}=0$

$$\sqrt[6]{y+7}=\sqrt[6]{4y+5}$$
$$\left(\sqrt[6]{y+7}\right)^6=\left(\sqrt[6]{4y+5}\right)^6$$
$$y+7=4y+5$$
$$2=3y$$
$$\frac{2}{3}=y$$

Check: $y=\frac{2}{3}$

$$\sqrt[6]{y+7}-\sqrt[6]{4y+5}=0$$
$$\sqrt[6]{\left(\frac{2}{3}\right)+7}-\sqrt[6]{4\left(\frac{2}{3}\right)+5}=0$$
$$\sqrt[6]{\frac{2}{3}+\frac{21}{3}}-\sqrt[6]{\frac{8}{3}+\frac{15}{3}}=0$$
$$\sqrt[6]{\frac{23}{3}}-\sqrt[6]{\frac{23}{3}}=0$$
$$0=0 \checkmark \text{ true}$$

$\left\{\frac{2}{3}\right\}$

**67.** $\sqrt{8-p}-\sqrt{p+5}=1$

$$\sqrt{8-p}=1+\sqrt{p+5}$$
$$\left(\sqrt{8-p}\right)^2=\left(1+\sqrt{p+5}\right)^2$$
$$8-p=1+2\sqrt{p+5}+p+5$$
$$-2\sqrt{p+5}=2p-2$$
$$\sqrt{p+5}=-p+1$$
$$\left(\sqrt{p+5}\right)^2=\left(-p+1\right)^2$$
$$p+5=p^2-2p+1$$
$$0=p^2-3p-4$$
$$0=(p+1)(p-4)$$
$$p=-1 \quad \text{or} \quad p=4$$

Check: $p=-1$

$$\sqrt{8-p}-\sqrt{p+5}=1$$
$$\sqrt{8-(-1)}-\sqrt{(-1)+5}=1$$
$$\sqrt{9}-\sqrt{4}=1$$
$$3-2=1 \checkmark \text{ true}$$

Check: $p=4$

$$\sqrt{8-p}-\sqrt{p+5}=1$$
$$\sqrt{8-(4)}-\sqrt{(4)+5}=1$$
$$\sqrt{4}-\sqrt{9}=1$$
$$2-3=1$$
$$-1=1 \text{ false}$$

$\{-1\}$; The value 4 does not check.

**68.** $\sqrt{d+4}-\sqrt{6+2d}=-1$

$$\sqrt{d+4}=\sqrt{6+2d}-1$$
$$\left(\sqrt{d+4}\right)^2=\left(\sqrt{6+2d}-1\right)^2$$
$$d+4=6+2d-2\sqrt{6+2d}+1$$
$$2\sqrt{6+2d}=d+3$$
$$\left(2\sqrt{6+2d}\right)^2=(d+3)^2$$
$$4(6+2d)=d^2+6d+9$$
$$24+8d=d^2+6d+9$$
$$0=d^2-2d-15$$
$$0=(d+3)(d-5)$$
$$d=-3 \quad \text{or} \quad d=5$$

Check: $d=-3$

$$\sqrt{d+4}-\sqrt{6+2d}=-1$$
$$\sqrt{(-3)+4}-\sqrt{6+2(-3)}=-1$$
$$\sqrt{1}-\sqrt{0}=-1$$
$$1=-1 \text{ false}$$

Check: $d=5$

$$\sqrt{d+4}-\sqrt{6+2d}=-1$$
$$\sqrt{(5)+4}-\sqrt{6+2(5)}=-1$$
$$\sqrt{9}-\sqrt{16}=-1$$
$$3-4=-1$$
$$-1=-1 \checkmark \text{ true}$$

$\{5\}$; The value $-3$ does not check.

**69.** $3-\sqrt{y+3}=\sqrt{2-y}$

$$\left(3-\sqrt{y+3}\right)^2=\left(\sqrt{2-y}\right)^2$$
$$9-6\sqrt{y+3}+y+3=2-y$$
$$-6\sqrt{y+3}=-10-2y$$
$$3\sqrt{y+3}=5+y$$
$$\left(3\sqrt{y+3}\right)^2=(5+y)^2$$
$$9y+27=25+10y+y^2$$
$$0=y^2+y-2$$
$$0=(y+2)(y-1)$$
$$y=-2 \quad \text{or} \quad y=1$$

Check: $y=-2$

$$3-\sqrt{y+3}=\sqrt{2-y}$$
$$3-\sqrt{(-2)+3}=\sqrt{2-(-2)}$$
$$3-\sqrt{1}=\sqrt{4}$$
$$3-1=2$$
$$2=2 \checkmark \text{ true}$$

Check: $y=1$

$$3-\sqrt{y+3}=\sqrt{2-y}$$
$$3-\sqrt{(1)+3}=\sqrt{2-(1)}$$
$$3-\sqrt{4}=\sqrt{1}$$
$$3-2=1$$
$$1=1 \checkmark \text{ true}$$

$\{-2,1\}$

**70.** $\sqrt{k-2}=\sqrt{2k+3}-2$

$$\left(\sqrt{k-2}\right)^2=\left(\sqrt{2k+3}-2\right)^2$$
$$k-2=2k+3-4\sqrt{2k+3}+4$$
$$4\sqrt{2k+3}=k+9$$
$$\left(4\sqrt{2k+3}\right)^2=(k+9)^2$$
$$16(2k+3)=k^2+18k+81$$
$$32k+48=k^2+18k+81$$
$$0=k^2-14k+33$$
$$0=(k-3)(k-11)$$
$$k=3 \quad \text{or} \quad k=11$$

Check: $k=3$

$$\sqrt{k-2}=\sqrt{2k+3}-2$$
$$\sqrt{(3)-2}=\sqrt{2(3)+3}-2$$
$$\sqrt{1}=\sqrt{9}-2$$
$$1=3-2$$
$$1=1 \checkmark \text{ true}$$

Check: $k=11$

$$\sqrt{k-2}=\sqrt{2k+3}-2$$
$$\sqrt{(11)-2}=\sqrt{2(11)+3}-2$$
$$\sqrt{9}=\sqrt{25}-2$$
$$3=5-2$$
$$3=3 \checkmark \text{ true}$$

$\{3,11\}$

**71.** $2(x+5)^{\frac{2}{3}}=18$

$$2\sqrt[3]{(x+5)^2}=18$$
$$\sqrt[3]{(x+5)^2}=9$$
$$\left[\sqrt[3]{(x+5)^2}\right]^3=(9)^3$$
$$(x+5)^2=729$$
$$x+5=\pm\sqrt{729}$$
$$x+5=\pm 27$$
$$x=-5+27 \quad \text{or} \quad x=-5-27$$
$$x=22 \qquad x=-32$$

Check: $x=22$

$$2\sqrt[3]{(x+5)^2}=18$$
$$2\sqrt[3]{(22+5)^2}=18$$
$$2\sqrt[3]{729}=18$$
$$18=18 \checkmark \text{ true}$$

Check: $x=-32$

$$2\sqrt[3]{(x+5)^2}=18$$
$$2\sqrt[3]{(-32+5)^2}=18$$
$$2\sqrt[3]{729}=18$$
$$18=18 \checkmark \text{ true}$$

$\{-32, 22\}$

**72.** $3(x-6)^{\frac{2}{3}}=48$

$$3\sqrt[3]{(x-6)^2}=48$$
$$\sqrt[3]{(x-6)^2}=16$$
$$\left[\sqrt[3]{(x-6)^2}\right]^3=(16)^3$$
$$(x-6)^2=4096$$
$$x-6=\pm\sqrt{4096}$$
$$x-6=\pm 64$$
$$x=6+64 \quad \text{or} \quad x=6-64$$
$$x=70 \qquad x=-58$$

Check: $x=-58$

$$3\sqrt[3]{(x-6)^2}=48$$
$$3\sqrt[3]{(-58-6)^2}=48$$
$$3\sqrt[3]{4096}=48$$
$$48=48 \checkmark \text{ true}$$

Check: $x=70$

$$3\sqrt[3]{(x-6)^2}=48$$
$$3\sqrt[3]{(70-6)^2}=48$$
$$3\sqrt[3]{4096}=48$$
$$48=48 \checkmark \text{ true}$$

$\{-58, 70\}$

**73.** $(3x+1)^{\frac{3}{2}}+2=66$

$$\sqrt{(3x+1)^3}+2=66$$
$$\sqrt{(3x+1)^3}=64$$
$$\left[\sqrt{(3x+1)^3}\right]^2=(64)^2$$
$$(3x+1)^3=4096$$
$$3x+1=\sqrt[3]{4096}$$
$$3x+1=16$$
$$x=5$$

Check: $x=5$

$$\sqrt{(3x+1)^3}+2=66$$
$$\sqrt{(15+1)^3}+2=66$$
$$64+2=66$$
$$66=66 \checkmark \text{ true}$$

$\{5\}$

**74.** $(2x-1)^{\frac{3}{2}}-3=122$

$$\sqrt{(2x-1)^3}-3=122$$
$$\sqrt{(2x-1)^3}=125$$
$$\left[\sqrt{(2x-1)^3}\right]^2=(125)^2$$
$$(2x-1)^3=15625$$
$$2x-1=\sqrt[3]{15625}$$
$$2x-1=25$$
$$x=13$$

Check: $x=13$

$$\sqrt{(2x-1)^3}-3=122$$
$$\sqrt{(25)^3}-3=122$$
$$125-3=122$$
$$122=122 \checkmark \text{ true}$$

$\{122\}$

**75.** $m^{3/4}=5$

$$\left(m^{3/4}\right)^{4/3}=(5)^{4/3}$$
$$m=5^{4/3}$$

$\left\{5^{4/3}\right\}$ or $\left\{5\sqrt[3]{5}\right\}$

**76.** $n^{5/6} = 3$

$$\left(n^{5/6}\right)^{6/5} = (3)^{6/5}$$

$$n = 3^{6/5}$$

$$\left\{3^{6/5}\right\} \text{ or } \left\{3\sqrt[5]{3}\right\}$$

**77.** $2p^{4/5} = \frac{1}{8}$

$$p^{4/5} = \frac{1}{16}$$

$$\left(p^{4/5}\right)^{5/4} = \pm\left(\frac{1}{16}\right)^{5/4}$$

$$p = \pm\left(\sqrt[4]{\frac{1}{16}}\right)^5$$

$$= \pm\left(\frac{1}{2}\right)^5 = \pm\frac{1}{32}$$

$$\left\{\pm\frac{1}{32}\right\}$$

**78.** $5t^{2/3} = \frac{1}{5}$

$$t^{2/3} = \frac{1}{25}$$

$$\left(t^{2/3}\right)^{3/2} = \pm\left(\frac{1}{25}\right)^{3/2}$$

$$t = \pm\left(\sqrt{\frac{1}{25}}\right)^3$$

$$= \pm\left(\frac{1}{5}\right)^3 = \pm\frac{1}{125}$$

$$\left\{\pm\frac{1}{125}\right\}$$

**79.** $(2v+7)^{1/3} - (v-3)^{1/3} = 0$

$$(2v+7)^{1/3} = (v-3)^{1/3}$$

$$\left[(2v+7)^{1/3}\right]^3 = \left[(v-3)^{1/3}\right]^3$$

$$2v+7 = v-3$$

$$v = -10$$

$$\{-10\}$$

**80.** $(5u-6)^{1/5} - (3u+1)^{1/5} = 0$

$$(5u-6)^{1/5} = (3u+1)^{1/5}$$

$$\left[(5u-6)^{1/5}\right]^5 = \left[(3u+1)^{1/5}\right]^5$$

$$5u-6 = 3u+1$$

$$2u = 7$$

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

$$\left\{\frac{7}{2}\right\}$$

**81.** Let $u = 2x+5$.

$$(2x+5)^2 - 7(2x+5) - 30 = 0$$

$$u^2 - 7u - 30 = 0$$

$$(u+3)(u-10) = 0$$

| | | |
|---|---|---|
| $u = -3$ | or | $u = 10$ |
| $2x+5 = -3$ | | $2x+5 = 10$ |
| $x = -4$ | | $x = \frac{5}{2}$ |

$$\left\{-4, \frac{5}{2}\right\}$$

**82.** Let $u = 3x-7$.

$$(3x-7)^2 - 6(3x-7) - 16 = 0$$

$$u^2 - 6u - 16 = 0$$

$$(u+2)(u-8) = 0$$

| | | |
|---|---|---|
| $u = -2$ | or | $u = 8$ |
| $3x-7 = -2$ | | $3x-7 = 8$ |
| $x = \frac{5}{3}$ | | $x = 5$ |

$$\left\{\frac{5}{3}, 5\right\}$$

**83.** Let $u = x^2 + 2x$.

$$\left(x^2+2x\right)^2 - 18\left(x^2+2x\right) = -45$$

$$u^2 - 18u + 45 = 0$$

$$(u-15)(u-3) = 0$$

$$u=15 \quad \text{or} \quad u=3$$
$$x^2+2x=15 \quad \text{or} \quad x^2+2x=3$$
$$x^2+2x-15=0 \quad \text{or} \quad x^2+2x-3=0$$
$$(x-3)(x+5)=0 \quad \text{or} \quad (x+3)(x-1)=0$$
$$x=3,-5 \quad \text{or} \quad x=-3,1$$
$$\{-5,-3,1,3\}$$

**84.** Let $u=x^2+3x$.

$$(x^2+3x)^2-14(x^2+3x)=-40$$
$$u^2-14u+40=0$$
$$(u-10)(u-4)=0$$
$$u=10 \quad \text{or} \quad u=4$$
$$x^2+3x=10 \quad \text{or} \quad x^2+3x=4$$
$$x^2+3x-10=0 \quad \text{or} \quad x^2+3x-4=0$$
$$(x-2)(x+5)=0 \quad \text{or} \quad (x+4)(x-1)=0$$
$$x=2,-5 \quad \text{or} \quad x=-4,1$$
$$\{-5,-4,1,2\}$$

**85.** Let $u=x^2+2$.

$$(x^2+2)^2+(x^2+2)-42=0$$
$$u^2+u-42=0$$
$$(u+7)(u-6)=0$$
$$u=-7 \quad \text{or} \quad u=6$$
$$x^2+2=-7 \quad \text{or} \quad x^2+2=6$$
$$x^2=-9 \quad \text{or} \quad x^2=4$$
$$x=\pm 3i \quad \text{or} \quad x=\pm 2$$
$$\{\pm 3i,\pm 2\}$$

**86.** Let $u=y^2-3$.

$$(y^2-3)^2-9(y^2-3)-52=0$$
$$u^2-9u-52=0$$
$$(u+4)(u-13)=0$$
$$u=-4 \quad \text{or} \quad u=13$$
$$y^2-3=-4 \quad \text{or} \quad y^2-3=13$$
$$y^2=-1 \quad \text{or} \quad y^2=16$$
$$y=\pm i \quad \text{or} \quad y=\pm 4$$
$$\{\pm i,\pm 4\}$$

**87.** Let $u=\frac{1}{a}$.

$$\left(-\frac{2}{a^2}\right)+\left(\frac{4}{a}\right)+1=0$$
$$-2\left(\frac{1}{a}\right)^2+4\left(\frac{1}{a}\right)+1=0$$
$$-2u^2+4u+1=0$$
$$2u^2-4u-1=0$$
$$u=\frac{4\pm\sqrt{(-4)^2-4\cdot 2\cdot(-1)}}{4}$$
$$u=1\pm\frac{\sqrt{6}}{2}$$
$$u=1+\frac{\sqrt{6}}{2} \text{ or } u=1-\frac{\sqrt{6}}{2}$$
$$u=1+\frac{\sqrt{6}}{2} \quad \text{or} \quad u=1-\frac{\sqrt{6}}{2}$$
$$\frac{1}{a}=1+\frac{\sqrt{6}}{2} \quad \text{or} \quad \frac{1}{a}=1-\frac{\sqrt{6}}{2}$$
$$a=\frac{1}{1+\frac{\sqrt{6}}{2}} \quad \text{or} \quad a=\frac{1}{1-\frac{\sqrt{6}}{2}}$$
$$a=\frac{2}{2+\sqrt{6}} \quad \text{or} \quad a=\frac{2}{2-\sqrt{6}}$$
$$a=-2+\sqrt{6} \text{ or } a=-2-\sqrt{6}$$
$$\{-2\pm\sqrt{6}\}$$

**88.** Let $u=\frac{2}{x}$.

$$\left(-\frac{4}{x^2}\right)-\left(\frac{4}{x}\right)+1=0$$
$$-\left(\frac{2}{x}\right)^2-2\left(\frac{2}{x}\right)+1=0$$
$$-u^2-2u+1=0$$
$$u^2+2u-1=0$$
$$u=\frac{-2\pm\sqrt{(2)^2-4\cdot 1\cdot(-1)}}{2}$$
$$u=-1\pm\sqrt{2}$$
$$u=-1+\sqrt{2} \text{ or } u=-1-\sqrt{2}$$

$$u=-1+\sqrt{2} \quad \text{or} \quad u=-1-\sqrt{2}$$
$$\frac{2}{a}=-1+\sqrt{2} \quad \text{or} \quad \frac{2}{a}=-1-\sqrt{2}$$
$$a=\frac{2}{-1+\sqrt{2}} \quad \text{or} \quad a=\frac{2}{-1-\sqrt{2}}$$
$$a=2+2\sqrt{2} \quad \text{or} \quad a=2-2\sqrt{2}$$
$$\left\{2\pm 2\sqrt{2}\right\}$$

**89.** Let $u=\frac{1}{n+2}$.

$$\frac{2}{(n+2)^2}-\frac{3}{n+2}=5$$
$$2\left(\frac{1}{n+2}\right)^2-3\left(\frac{1}{n+2}\right)-5=0$$
$$2u^2-3u-5=0$$
$$(u+1)(2u-5)=0$$
$$u=-1 \quad \text{or} \quad u=\frac{5}{2}$$
$$\frac{1}{n+2}=-1 \quad \text{or} \quad \frac{1}{n+2}=\frac{5}{2}$$
$$n+2=-1 \quad \text{or} \quad n+2=\frac{2}{5}$$
$$n=-3 \quad \text{or} \quad n=-\frac{8}{5}$$
$$\left\{-3,-\frac{8}{5}\right\}$$

**90.** Let $u=\frac{1}{m-3}$.

$$\frac{3}{(m-3)^2}-\frac{7}{m-3}=-4$$
$$3\left(\frac{1}{m-3}\right)^2-7\left(\frac{1}{m-3}\right)+4=0$$
$$3u^2-7u+4=0$$
$$(u-1)(3u-4)=0$$
$$u=1 \quad \text{or} \quad u=\frac{4}{3}$$
$$\frac{1}{m-3}=1 \quad \text{or} \quad \frac{1}{m-3}=\frac{4}{3}$$
$$m-3=1 \quad \text{or} \quad m-3=\frac{3}{4}$$
$$m=4 \quad \text{or} \quad m=\frac{15}{4}$$
$$\left\{\frac{15}{4},4\right\}$$

**91.** Let $u=m-\frac{10}{m}$.

$$\left(m-\frac{10}{m}\right)^2-6\left(m-\frac{10}{m}\right)-27=0$$
$$u^2-6u-27=0$$
$$(u-9)(u+3)=0$$
$$u=9 \text{ or } u=-3$$
$$u=9$$
$$m-\frac{10}{m}=9$$
$$m^2-9m-10=0$$
$$(m+1)(m-10)=0$$
$$m=-1,10$$
$$u=-3$$
$$m-\frac{10}{m}=-3$$
$$m^2+3m-10=0$$
$$(m-5)(m+2)=0$$
$$m=5,-2$$
$$\{-5,-1,2,10\}$$

**92.** Let $u=x+\frac{6}{x}$.

$$\left(x+\frac{6}{x}\right)^2-12\left(x+\frac{6}{x}\right)+35=0$$
$$u^2-12u+35=0$$
$$(u-5)(u-7)=0$$
$$u=5 \text{ or } u=7$$
$$u=5$$
$$x+\frac{6}{x}=5$$
$$x^2-5x+6=0$$
$$(x-2)(x-3)=0$$
$$x=2,3$$
$$u=7$$
$$x+\frac{6}{x}=7$$
$$x^2-7x+6=0$$
$$(x-1)(x-6)=0$$
$$x=1,6$$
$$\{1,2,3,6\}$$

**93.** Let $u=2+\frac{3}{t}$.

$$\left(2+\frac{3}{t}\right)^2-\left(2+\frac{3}{t}\right)=12$$
$$\left(2+\frac{3}{t}\right)^2-\left(2+\frac{3}{t}\right)-12=0$$
$$u^2-u-2=0$$
$$(u+3)(u-4)=0$$
$$u=-3 \quad \text{or} \quad u=4$$
$$2+\frac{3}{t}=-3 \quad \text{or} \quad 2+\frac{3}{t}=4$$
$$\frac{3}{t}=-5 \quad \text{or} \quad \frac{3}{t}=2$$
$$t=-\frac{3}{5} \quad \text{or} \quad t=\frac{3}{2}$$
$$\left\{\frac{3}{2},-\frac{3}{5}\right\}$$

**94.** Let $u=\frac{5}{y}+3$.

$$\left(\frac{5}{y}+3\right)^2+6\left(\frac{5}{y}+3\right)=-8$$
$$\left(\frac{5}{y}+3\right)^2+6\left(\frac{5}{y}+3\right)+8=0$$
$$u^2+6u+8=0$$
$$(u+2)(u+4)=0$$
$$u=-2 \quad \text{or} \quad u=-4$$
$$\frac{5}{y}+3=-2 \quad \text{or} \quad \frac{5}{y}+3=-4$$
$$\frac{5}{y}=-5 \quad \text{or} \quad \frac{5}{y}=-7$$
$$y=-1 \quad \text{or} \quad y=-\frac{5}{7}$$
$$\left\{-1,-\frac{5}{7}\right\}$$

**95.** Let $u=c^{1/5}$.

$$5c^{2/5}-11c^{1/5}+2=0$$
$$5u^2-11u+2=0$$
$$(5u-1)(u-2)=0$$
$$u=\frac{1}{5} \quad \text{or} \quad u=2$$
$$c^{1/5}=\frac{1}{5} \quad \text{or} \quad c^{1/5}=2$$
$$\left(c^{1/5}\right)^5=\left(\frac{1}{5}\right)^5 \quad \text{or} \quad \left(c^{1/5}\right)^5=(2)^5$$
$$c=\frac{1}{3125} \quad \text{or} \quad c=32$$
$$\left\{\frac{1}{3125},32\right\}$$

**96.** Let $u=d^{1/3}$.

$$3d^{2/3}-d^{1/3}-4=0$$
$$3u^2-u-4=0$$
$$(3u-4)(u+1)=0$$
$$u=\frac{4}{3} \quad \text{or} \quad u=-1$$
$$d^{1/3}=\frac{4}{3} \quad \text{or} \quad d^{1/3}=-1$$
$$\left(d^{1/3}\right)^3=\left(\frac{4}{3}\right)^3 \quad \text{or} \left(d^{1/3}\right)^3=(-1)^3$$
$$d=\frac{64}{27} \quad \text{or} \quad d=-1$$
$$\left\{\frac{64}{27},-1\right\}$$

**97.** Let $u=y^{1/4}$.

$$y^{1/2}-y^{1/4}-6=0$$
$$u^2-u-6=0$$
$$(u-3)(u+2)=0$$
$$u=3 \quad \text{or} \quad u=-2$$
$$y^{1/4}=3 \quad \text{or} \quad y^{1/4}=-2$$
$$\left(y^{1/4}\right)^4=(3)^4$$
$$y=81$$
$$\{81\}$$

**98.** Let $u=n^{1/4}$.

$$n^{1/2}+6n^{1/4}-16=0$$
$$u^2+6u-16=0$$
$$(u+8)(u-2)=0$$
$$u=2 \quad \text{or} \quad u=-8$$
$$n^{1/4}=2 \quad \text{or} \quad n^{1/4}=-8$$
$$\left(n^{1/4}\right)^4=(2)^4$$
$$n=16$$
$$\{16\}$$

**99.** Let $u=y^{-2}$.

$$9y^{-4}-10y^{-2}+1=0$$
$$9u^2-10u+1=0$$
$$(9u-1)(u-1)=0$$
$$u=1 \quad \text{or} \quad u=\frac{1}{9}$$
$$y^{-2}=1 \quad \text{or} \quad y^{-2}=\frac{1}{9}$$
$$y^2=1 \qquad y^2=9$$
$$y=1,-1 \qquad y=-3,3$$
$$\{-3,-1,1,3\}$$

**100.** Let $u=x^{-2}$.

$$100x^{-4}-29x^{-2}+1=0$$
$$100u^2-29u+1=0$$
$$(25u-1)(4u-1)=0$$
$$u=\frac{1}{4} \quad \text{or} \quad u=\frac{1}{25}$$
$$x^{-2}=\frac{1}{4} \quad \text{or} \quad x^{-2}=\frac{1}{25}$$
$$x^2=4 \qquad x^2=25$$
$$x=-2,2 \qquad x=-5,5$$
$$\{-5,-2,2,5\}$$

**101.** Let $u=\sqrt{t}$.

$$4t-25\sqrt{t}=0$$
$$4u^2-25u=0$$
$$u(4u-25)=0$$
$$u=0 \quad \text{or} \quad u=\frac{25}{4}$$
$$\sqrt{t}=0 \qquad \sqrt{t}=\frac{25}{4}$$
$$t=0 \qquad \left(\sqrt{t}\right)^2=\left(\frac{25}{4}\right)^2$$
$$t=\frac{625}{16}$$
$$\left\{0,\frac{625}{16}\right\}$$

**102.** Let $u=\sqrt{m}$.

$$9m-16\sqrt{m}=0$$
$$9u^2-16u=0$$
$$u(9u-16)=0$$

$u=0$ or $u=\frac{16}{9}$

$\sqrt{m}=0$ $\qquad$ $\sqrt{m}=\frac{16}{9}$

$m=0$ $\qquad$ $\left(\sqrt{m}\right)^2=\left(\frac{16}{9}\right)^2$

$$m=\frac{256}{81}$$

$$\left\{0,\frac{256}{81}\right\}$$

**103.** $x^2\left(x^2+5\right)=7$

$$x^4+5x^2-7=0$$

Let $u=x^2$.

$$u^2+5u-7=0$$

$$u=\frac{-(5)\pm\sqrt{(5)^2-4(1)(-7)}}{2(1)}$$
$$=\frac{-5\pm\sqrt{53}}{2}$$
$$x^2=\frac{-5\pm\sqrt{53}}{2}$$
$$x=\pm\sqrt{\frac{-5\pm\sqrt{53}}{2}}$$
$$\left\{\pm\sqrt{\frac{-5\pm\sqrt{53}}{2}}\right\}$$

**104.** $x^2\left(x^2-2\right)=x^2+13$

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

Let $u=x^2$.

$$u^4-3u^2-13=0$$
$$u=\frac{-(-3)\pm\sqrt{(-3)^2-4(1)(-13)}}{2(1)}$$
$$=\frac{3\pm\sqrt{61}}{2}$$
$$x^2=\frac{3\pm\sqrt{61}}{2}$$
$$x=\pm\sqrt{\frac{3\pm\sqrt{61}}{2}}$$
$$\left\{\pm\sqrt{\frac{3\pm\sqrt{61}}{2}}\right\}$$

**105.** Let $u=k^{-1}$.

$$30k^{-2}-23k^{-1}+2=0$$
$$30u^2-23u+2=0$$
$$(10u-1)(3u-2)=0$$
$$u=\frac{1}{10} \text{ or } u=\frac{2}{3}$$
$$k^{-1}=\frac{1}{10} \text{ or } k^{-1}=\frac{2}{3}$$
$$k=10 \text{ or } k=\frac{3}{2}$$
$$\left\{\frac{3}{2},10\right\}$$

**106.** Let $u=q^{-1}$.

$$3q^{-2}+16q^{-1}+5=0$$
$$3u^2+16u+5=0$$
$$(3u+1)(u+5)=0$$
$$u=-\frac{1}{3} \text{ or } u=-5$$
$$q^{-1}=-\frac{1}{3} \text{ or } q^{-1}=-5$$
$$q=-3 \text{ or } q=-\frac{1}{5}$$
$$\left\{-\frac{1}{5},-3\right\}$$

**107.**
$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$$
$$fpq\left(\frac{1}{f}\right)=fpq\left(\frac{1}{p}+\frac{1}{q}\right)$$
$$pq=fq+fp$$
$$pq-fp=fq$$
$$p(q-f)=fq$$
$$p=\frac{fq}{q-f}$$

**108.**
$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$$
$$RR_1R_2R_3\left(\frac{1}{R}\right)=\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)$$
$$R_1R_2R_3=RR_2R_3+RR_1R_3+RR_1R_2$$
$$R_1R_2R_3-RR_2R_3-RR_1R_3=RR_1R_2$$
$$R_3\left(R_1R_2-RR_2-RR_1\right)=RR_1R_2$$
$$R_3=\frac{RR_1R_2}{R_1R_2-RR_2-RR_1}$$

**109.**
$$E=kT^4$$
$$\frac{E}{k}=T^4$$
$$\sqrt[4]{\frac{E}{k}}=\sqrt[4]{T^4}$$
$$T=\sqrt[4]{\frac{E}{k}}$$

**110.**
$$V=\frac{4}{3}\pi r^3$$
$$\frac{3V}{4\pi}=r^3$$
$$\sqrt[3]{\frac{3V}{4\pi}}=\sqrt[3]{r^3}$$
$$r=\sqrt[3]{\frac{3V}{4\pi}}$$

**111.**
$$a=\frac{kF}{m}$$
$$m(a)=m\left(\frac{kF}{m}\right)$$
$$ma=kF$$
$$m=\frac{kF}{a}$$

**112.**
$$V=\frac{k}{P}$$
$$P(V)=P\left(\frac{k}{P}\right)$$
$$PV=k$$
$$P=\frac{k}{V}$$

**113.**
$$16+\sqrt{x^2-y^2}=z$$
$$\sqrt{x^2-y^2}=z-16$$
$$\left(\sqrt{x^2-y^2}\right)^2=(z-16)^2$$
$$x^2-y^2=(z-16)^2$$
$$x^2=(z-16)^2+y^2$$
$$x=\pm\sqrt{(z-16)^2+y^2}$$

**114.**
$$4+\sqrt{x^2+y^2}=z$$
$$\sqrt{x^2+y^2}=z-4$$
$$\left(\sqrt{x^2+y^2}\right)^2=(z-4)^2$$
$$x^2+y^2=(z-4)^2$$
$$y^2=(z-4)^2-x^2$$
$$y=\pm\sqrt{(z-4)^2-x^2}$$

**115.**
$$\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$$
$$T_1T_2\left(\frac{P_1V_1}{T_1}\right)=T_1T_2\left(\frac{P_2V_2}{T_2}\right)$$
$$T_2P_1V_1=T_1P_2V_2$$
$$\frac{P_1V_1T_2}{P_2V_2}=T_1$$

**116.**
$$\frac{t_1}{s_1v_1}=\frac{t_2}{s_2v_2}$$
$$s_1v_1s_2v_2\left(\frac{t_1}{s_1v_1}\right)=s_1v_1s_2v_2\left(\frac{t_2}{s_2v_2}\right)$$
$$t_1s_2v_2=t_2s_1v_1$$
$$v_2=\frac{t_2s_1v_1}{t_1s_2}$$

**117.** $T = 2\pi\sqrt{\frac{L}{g}}$

$$(T)^2 = \left(2\pi\sqrt{\frac{L}{g}}\right)^2$$

$$T^2 = \frac{4\pi^2 L}{g}$$

$$g(T^2) = g\left(\frac{4\pi^2 L}{g}\right)$$

$$gT^2 = 4\pi^2 L$$

$$g = \frac{4\pi^2 L}{T^2}$$

**118.** $t = \sqrt{\frac{2s}{g}}$

$$(t)^2 = \left(\sqrt{\frac{2s}{g}}\right)^2$$

$$t^2 = \frac{2s}{g}$$

$$t^2\left(\frac{g}{2}\right) = \left(\frac{2s}{g}\right)\left(\frac{g}{2}\right)$$

$$\frac{t^2 g}{2} = s$$

**119. a.**

$$y + 4\sqrt{y} = 21$$

$$4\sqrt{y} = 21 - y$$

$$\left(4\sqrt{y}\right)^2 = (21 - y)^2$$

$$16y = 441 - 42y + y^2$$

$$0 = 441 - 58y + y^2$$

$$0 = (y - 9)(y - 49)$$

$$y = 9 \quad \text{or} \quad y = 49$$

Check: $y = 9$

$$y + 4\sqrt{y} = 21$$

$$(9) + 4\sqrt{(9)} = 21$$

$$9 + 12 = 21$$

$$21 = 21 \checkmark \text{ true}$$

Check: $y = 49$

$$y + 4\sqrt{y} = 21$$

$$(49) + 4\sqrt{(49)} = 21$$

$$49 + 28 = 21$$

$$77 = 21 \text{ false}$$

$\{9\}$

**b.** Let $u = \sqrt{y}$.

$$y + 4\sqrt{y} = 21$$

$$y + 4\sqrt{y} - 21 = 0$$

$$u^2 + 4u - 21 = 0$$

$$(u + 7)(u - 3) = 0$$

$$u = -7 \quad \text{or} \quad u = 3$$

$$\sqrt{y} = -7 \quad \text{or} \quad \sqrt{y} = 3$$

$$\left(\sqrt{y}\right)^2 = (-7)^2 \text{ or } \left(\sqrt{y}\right)^2 = (3)^2$$

$$y = 49 \quad \text{or} \quad y = 9$$

$\{9\}$; See checks in part (a).

**120. a.**

$$w - 3\sqrt{w} = 10$$

$$w - 10 = 3\sqrt{w}$$

$$(w - 10)^2 = \left(3\sqrt{w}\right)^2$$

$$w^2 - 20w + 100 = 9w$$

$$w^2 - 29w + 100 = 0$$

$$(w - 4)(w - 25) = 0$$

$$w = 4 \quad \text{or} \quad w = 25$$

Check: $w = 4$

$$w - 3\sqrt{w} = 10$$

$$(4) - 3\sqrt{(4)} = 10$$

$$4 - 6 = 10$$

$$-2 = 10 \text{ false}$$

Check: $w = 25$

$$w - 3\sqrt{w} = 10$$

$$(25) - 3\sqrt{(25)} = 10$$

$$25 - 15 = 10$$

$$10 = 10 \checkmark \text{ true}$$

$\{25\}$

**b.** Let $u = \sqrt{w}$.

$$w-3\sqrt{w}=10$$
$$w-3\sqrt{w}-10=0$$
$$u^2-3u-10=0$$
$$(u+2)(u-5)=0$$
$$u=-2 \quad \text{or} \quad u=5$$
$$\sqrt{w}=-2 \quad \text{or} \quad \sqrt{w}=5$$
$$\left(\sqrt{w}\right)^2=(-2)^2 \text{ or } \left(\sqrt{w}\right)^2=(5)^2$$
$$w=4 \quad \text{or} \quad w=25$$

$\{25\}$; See checks in part (a).

**121.** $\sqrt{x+\sqrt{x+2}}=3$

$$\left(\sqrt{x+\sqrt{x+2}}\right)^2=(3)^2$$
$$x+\sqrt{x+2}=9$$
$$\sqrt{x+2}=9-x$$
$$\left(\sqrt{x+2}\right)^2=(9-x)^2$$
$$x+2=x^2-18x+81$$
$$x^2-19x+79=0$$
$$x=\frac{19\pm\sqrt{(-19)^2-4\cdot1\cdot79}}{2}$$
$$x=\frac{19\pm3\sqrt{5}}{2}$$
$$x=\frac{19-3\sqrt{5}}{2} \text{ or } x=\frac{19+3\sqrt{5}}{2}$$

Check: $x=\frac{19-3\sqrt{5}}{2}$

$$\sqrt{x+\sqrt{x+2}}=3$$
$$\sqrt{\frac{19-3\sqrt{5}}{2}+\sqrt{\frac{19-3\sqrt{5}}{2}+2}}=3$$
$$\sqrt{\frac{19-3\sqrt{5}}{2}+\sqrt{\frac{23-3\sqrt{5}}{2}}}=3$$
$$\left(\sqrt{\frac{19-3\sqrt{5}}{2}+\sqrt{\frac{23-3\sqrt{5}}{2}}}\right)^2=(3)^2$$
$$\sqrt{\frac{23-3\sqrt{5}}{2}}=9-\left(\frac{19-3\sqrt{5}}{2}\right)$$
$$\sqrt{\frac{23-3\sqrt{5}}{2}}=\frac{-1+3\sqrt{5}}{2}$$
$$\frac{23-3\sqrt{5}}{2}=\frac{46-6\sqrt{5}}{4}$$
$$\frac{23-3\sqrt{5}}{2}=\frac{23-3\sqrt{5}}{2} \quad \checkmark \text{ true}$$

Check: $x=\frac{19+3\sqrt{5}}{2}$

$$\sqrt{x+\sqrt{x+2}}=3$$
$$\sqrt{\frac{19+3\sqrt{5}}{2}+\sqrt{\frac{19+3\sqrt{5}}{2}+2}}=3$$
$$\sqrt{\frac{19+3\sqrt{5}}{2}+\sqrt{\frac{23+3\sqrt{5}}{2}}}=3$$
$$\left(\sqrt{\frac{19+3\sqrt{5}}{2}+\sqrt{\frac{23+3\sqrt{5}}{2}}}\right)^2=(3)^2$$
$$\sqrt{\frac{23+3\sqrt{5}}{2}}=9-\left(\frac{19+3\sqrt{5}}{2}\right)$$
$$\sqrt{\frac{23+3\sqrt{5}}{2}}=\frac{-1-3\sqrt{5}}{2} \text{ false}$$

$$\left\{\frac{19-3\sqrt{5}}{2}\right\}$$

**122.** $\sqrt{1+\sqrt{x+\sqrt{x+1}}}=2$

$$\left(\sqrt{1+\sqrt{x+\sqrt{x+1}}}\right)^2=(2)^2$$
$$1+\sqrt{x+\sqrt{x+1}}=4$$
$$x+\sqrt{x+1}=9$$

$$\left(\sqrt{x+1}\right)^2 = (9-x)^2$$
$$x+1 = x^2 - 18x + 81$$
$$x^2 - 19x + 80 = 0$$
$$x = \frac{19 \pm \sqrt{(-19)^2 - 4\cdot 1\cdot 80}}{2}$$
$$x = \frac{19 \pm \sqrt{41}}{2}$$
$$x = \frac{19-\sqrt{41}}{2} \quad \text{or} \quad x = \frac{19+\sqrt{41}}{2}$$

Check: $x = \frac{19-\sqrt{41}}{2}$

$$\sqrt{1+\sqrt{x+\sqrt{x+1}}} = 2$$
$$\sqrt{1+\sqrt{\frac{19-\sqrt{41}}{2}+\sqrt{\frac{19-\sqrt{41}}{2}+1}}} = 2$$
$$\sqrt{\frac{19-\sqrt{41}}{2}+\sqrt{\frac{21-\sqrt{41}}{2}}} = 3$$
$$\left(\sqrt{\frac{19-\sqrt{41}}{2}+\sqrt{\frac{21-\sqrt{41}}{2}}}\right)^2 = (3)^2$$
$$\sqrt{\frac{21-\sqrt{41}}{2}} = 9-\left(\frac{19-\sqrt{41}}{2}\right)$$
$$\sqrt{\frac{21-\sqrt{41}}{2}} = \frac{-1+\sqrt{41}}{2}$$
$$\frac{21-\sqrt{41}}{2} = \frac{42-2\sqrt{41}}{4}$$
$$\frac{21-\sqrt{41}}{2} = \frac{21-\sqrt{41}}{2} \ \checkmark \text{ true}$$

Check: $x = \frac{19+\sqrt{41}}{2}$

$$\sqrt{1+\sqrt{x+\sqrt{x+1}}} = 2$$
$$\sqrt{1+\sqrt{\frac{19+\sqrt{41}}{2}+\sqrt{\frac{19+\sqrt{41}}{2}+1}}} = 2$$
$$\sqrt{\frac{19+\sqrt{41}}{2}+\sqrt{\frac{21+\sqrt{41}}{2}}} = 3$$
$$\left(\sqrt{\frac{19+\sqrt{41}}{2}+\sqrt{\frac{21+\sqrt{41}}{2}}}\right)^2 = (3)^2$$
$$\sqrt{\frac{21+\sqrt{41}}{2}} = 9-\left(\frac{19+\sqrt{41}}{2}\right)$$
$$\sqrt{\frac{21-\sqrt{41}}{2}} = \frac{-1-\sqrt{41}}{2} \text{ false}$$

$$\left\{\frac{19-\sqrt{41}}{2}\right\}$$

**123.** $r = \sqrt[3]{\frac{3V}{4\pi}}$

$$(6)^3 = \left(\sqrt[3]{\frac{3V}{4\pi}}\right)^3$$
$$216 = \frac{3V}{4\pi}$$
$$V = 288\pi \text{ in.}^3$$

**124.** $d = \frac{49}{40}\sqrt{h}$

$$(24.5)^2 = \left(\frac{49}{40}\sqrt{h}\right)^2$$
$$600.25 = \frac{2401}{1600}h$$
$$400 = h$$
400 ft

**125.a.** $P = 48t^{1/5}$

$$P = 48(2)^{1/5}$$
$$\approx 55\%$$

**b.** $P = 48t^{1/5}$

$$75 = 48t^{1/5}$$
$$\frac{25}{16} = t^{1/5}$$
$$\left(\frac{25}{16}\right)^5 = \left(t^{1/5}\right)^5$$
$$t \approx 9.3 \text{ hr}$$

**126. a.** $h = 16(t+4)^{1/3}$

$$h = 16\left[(14)+4\right]^{1/3}$$
$$h = 16(18)^{1/3}$$
$$\approx 42 \text{ in.}$$

**b.** $h = 16\left(t+4\right)^{1/3}$

$$60 = 16\left(t+4\right)^{1/3}$$

$$\frac{15}{4} = \left(t+4\right)^{1/3}$$

$$\left(\frac{15}{4}\right)^3 = \left[\left(t+4\right)^{1/3}\right]^3$$

$$t+4 = \left(\frac{15}{4}\right)^3$$

$$t = \left(\frac{15}{4}\right)^3 - 4$$

$$\approx 49 \text{ days}$$

**127. a.** $v = \sqrt{2gh} = \sqrt{19.6h}$

$$v = \sqrt{19.6\left(10\right)} = 14 \text{ m/sec}$$

**b.** $v = \sqrt{19.6h}$

$$26.8 = \sqrt{19.6h}$$

$$26.8 = \sqrt{19.6} \cdot \sqrt{h}$$

$$\frac{26.8}{\sqrt{19.6}} = \sqrt{h}$$

$$\left(\frac{26.8}{\sqrt{19.6}}\right)^2 = \left(\sqrt{h}\right)^2$$

$$h = \frac{26.8^2}{19.6} \approx 36.6 \text{ m}$$

**128. a.**

$$r = 1 - \left(\frac{V}{C}\right)^{1/n}$$

$$r = 1 - \left(\frac{12{,}000}{18{,}000}\right)^{1/3}$$

$$r = 1 - \left(\frac{2}{3}\right)^{1/3}$$

$$\approx 0.126 \text{ or } 12.6\% \text{ per year}$$

**b.** $r = 1 - \left(\frac{V}{C}\right)^{1/n}$

$$0.15 = 1 - \left(\frac{11{,}000}{C}\right)^{1/5}$$

$$\left(\frac{11{,}000}{C}\right)^{1/5} = 0.85$$

$$\left[\left(\frac{11{,}000}{C}\right)^{1/5}\right]^5 = (0.85)^5$$

$$\frac{11{,}000}{C} = (0.85)^5$$

$$C = \frac{11{,}000}{(0.85)^5}$$

$$\approx \$24{,}800$$

**129. a.** $|x-4| = 6$ or equivalently

$|4-x| = 6$

**b.** $|x-4| = 6$

$(x-4) = 6 \quad \text{or} \quad (x-4) = -6$

$x = 10 \qquad x = -2$

$\{-2, 10\}$

**130. a.** $|x-3| = 8$ or equivalently

$|3-x| = 8$

**b.** $|x-3| = 8$

$(x-3) = 8 \text{ or } (x-3) = -8$

$x = 11 \qquad x = -5$

$\{-5, 11\}$

**131.** An equation is in quadratic form if,
after a suitable substitution, the equation can be written in the form
$au^2 + bu + c = 0$, where *u* is a variable expression.

**132.** When solving a radical equation, if
both sides of the equation are raised to an even power, then the potential solutions must be checked. This is because some or all of the solutions may be extraneous solutions.

**133.** Let *t* represent the time Joan takes to fill 100 orders by herself. Then $(t+1)$ is the time it takes Henry to fill 100 orders.

$$\frac{1 \text{ job}}{t \text{ hr}} + \frac{1 \text{ job}}{(t+1) \text{ hr}} = \frac{1 \text{ job}}{3 \text{ hr}}$$

$$\frac{1}{t} + \frac{1}{(t+1)} = \frac{1}{3}$$

$$3t(t+1)\left(\frac{1}{t} + \frac{1}{t+1}\right) = 3t(t+1)\left(\frac{1}{3}\right)$$

$$3(t+1) + 3t = t(t+1)$$

$$3t + 3 + 3t = t^2 + t$$

$$0 = t^2 - 5t - 3$$

$$t = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(-3)}}{2(1)}$$

$$= \frac{5 \pm \sqrt{37}}{2}$$

$$\approx 5.5 \text{ or } \cancel{-0.5}$$

$t + 1 = 5.5 + 1 = 6.5$

It would take Joan approximately 5.5 hr working alone, and it would take Henry approximately 6.5 hr.

**134.** Let *t* represent the time it takes Antonio to complete one bathroom.
Then $(t+4)$ is the time it takes Jeremy to complete one

bathroom.

$$\frac{1\text{ job}}{t\text{ hr}}+\frac{1\text{ job}}{(t+4)\text{ hr}}=\frac{1\text{ job}}{8\text{ hr}}$$

$$\frac{1}{t}+\frac{1}{(t+4)}=\frac{1}{8}$$

$$8t(t+4)\left(\frac{1}{t}+\frac{1}{t+4}\right)=8t(t+4)\left(\frac{1}{8}\right)$$

$$8(t+4)+8t=t(t+4)$$

$$8t+32+8t=t^2+4t$$

$$0=t^2-12t-32$$

$$t=\frac{-(-12)\pm\sqrt{(-12)^2-4(1)(-32)}}{2(1)}$$

$$=\frac{12\pm\sqrt{272}}{2}$$

$$\approx 14.2 \text{ or } \cancel{-2.2}$$

$$t+4=14.2+4=18.2$$

It would take Antonio approximately 14.2 hr working alone, and it would take Jeremy approximately 18.2 hr.

**135.** Let $x$ represent the distance along the shoreline as shown in the figure.

| | Distance | Rat | Time |
|---|---|---|---|
| **Row** | $\sqrt{400^2+x^2}$ | 2.5 | $\frac{\sqrt{400^2+x^2}}{2.5}$ |
| **Walk** | $800-x$ | 5 | $\frac{800-x}{5}$ |

$$\frac{\sqrt{400^2+x^2}}{2.5}+\frac{800-x}{5}=300$$

$$5\left(\frac{\sqrt{400^2+x^2}}{2.5}+\frac{800-x}{5}\right)=5(300)$$

$$2\sqrt{400^2+x^2}+800-x=1500$$

$$2\sqrt{400^2+x^2}=x+700$$

$$(x+700)^2=\left(2\sqrt{400^2+x^2}\right)^2$$

$$x^2+1400x+490{,}000=4(400^2+x^2)$$

$$x^2+1400x+490{,}000=4x^2+640{,}000$$

$$3x^2-1400x+150{,}000=0$$

$$(3x-500)(x-300)=0$$

$$x=\frac{500}{3} \quad \text{or} \quad x=300$$

Pam can row to a point $166\frac{2}{3}$ ft down the beach or to a point 300 ft down the beach to be home in 5 min.

**136.** Let $x$ represent the distance along the shoreline as shown in the figure.

| | Distanc | Rate | Time |
|---|---|---|---|
| **Boat** | $\sqrt{48^2+x^2}$ | 20 | $\frac{\sqrt{48^2+x^2}}{20}$ |
| **Car** | $96-x$ | 60 | $\frac{96-x}{60}$ |

$$\frac{\sqrt{48^2+x^2}}{20}+\frac{96-x}{60}=4$$

$$60\left(\frac{\sqrt{48^2+x^2}}{20}+\frac{96-x}{60}\right)=60(4)$$

$$3\sqrt{48^2+x^2}+96-x=240$$

$$3\sqrt{48^2+x^2}=x+144$$

$$\left(3\sqrt{48^2+x^2}\right)^2=(x+144)^2$$

$$x^2+288x+20{,}736=9\left(48^2+x^2\right)$$

$$x^2+288x+20{,}736=9x^2+20{,}736$$

$$8x^2-288x=0$$

$$8x(x-36)=0$$

$$x=0 \quad \text{or} \quad x=36$$

The marina is 36 mi up the coast.

## Section 1.7 Linear Inequalities and Compound Inequalities

**1.** inequality
**2.** intersection
**3.** $a<x<b$

**4.** union
**5.** $-k;k$
**6.** $-k;>$
**7.** □

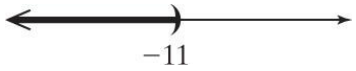
**8.** $\{\ \}$

**9.** $-2x-5>17$

$-2x>22$

$x<-11$

$\{x\,|x<-11\};(-\infty,-11)$

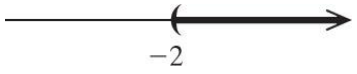



**10.** $-8t+1<17$

$-8t<16$

$t>-2$

$\{t\,|t>-2\};(-2,\infty)$

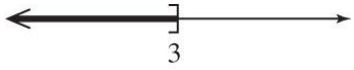



**11.** $-3\le -\frac{4}{3}w+1$

$-4\le -\frac{4}{3}w$

$3\ge w \text{ or } w\le 3$

$\{w\,|w\le 3\};(-\infty,3]$

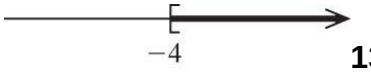



**12.** $8\ge -\frac{5}{2}y-2$

$10\ge -\frac{5}{2}y$

$-4\le y \text{ or } y\ge -4$

$\{y\,|y\ge -4\};[-4,\infty)$



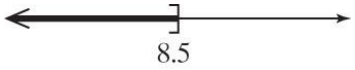

**13.** $-1.2+0.6a\le 0.4a+0.5$

$0.2a\le 1.7$

$a\le \frac{1.7}{0.2}$

$a\le 8.5$

$\{a\,|a\le 8.5\};(-\infty,8.5]$



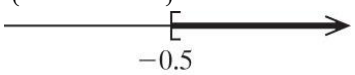

**14.** $-0.7+0.3x\le 0.9x-0.4$

$-0.6x\le 0.3$

$x\ge -\frac{0.3}{0.6}$

$x\ge -0.5$

$\{x\,|x\ge -0.5\};[-0.5,\infty)$




**15.** $-5>6(c-4)+7$

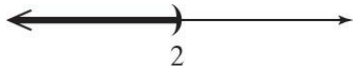
$-5>6c-24+7$

$-5>6c-17$

$12>6c$

$2>c \text{ or } c<2$

$\{c\,|c<2\};(-\infty,2)$




**16.** $-14<3(m-7)+7$

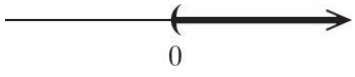
$-14<3m-21+7$

$-14<3m-14$

$0<3m$

$0<m \text{ or } m>0$

$\{m\,|m>0\};(0,\infty)$




**17.** $\frac{4+x}{2}-\frac{x-3}{5}<-\frac{x}{10}$

$10\left(\frac{4+x}{2}-\frac{x-3}{5}\right)<10\left(-\frac{x}{10}\right)$

$5(4+x)-2(x-3)<-x$

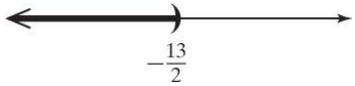
$20+5x-2x+6<-x$

$4x<-26$

$x<-\frac{26}{4}$

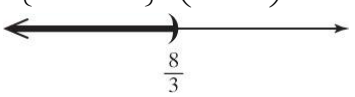
$x<-\frac{13}{2}$

$\left\{x\,|x<-\frac{13}{2}\right\};\left(-\infty,-\frac{13}{2}\right)$

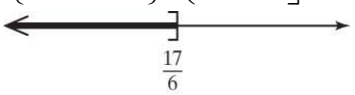



**18.** $\frac{y+3}{4}-\frac{3y+1}{6}>-\frac{1}{12}$

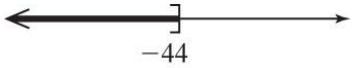
$$12\left(\frac{y+3}{4}-\frac{3y+1}{6}\right)>12\left(-\frac{1}{12}\right)$$
$$3(y+3)-2(3y+1)>-1$$
$$3y+9-6y-2>-1$$
$$-3y>-8$$
$$y<\frac{8}{3}$$
$$\left\{y\mid y<\frac{8}{3}\right\};\left(-\infty,\frac{8}{3}\right)$$




**19.** $$\frac{1}{3}(x+4)-\frac{5}{6}(x-3)\ge\frac{1}{2}x+1$$
$$6\left[\frac{1}{3}(x+4)-\frac{5}{6}(x-3)\right]\ge 6\left(\frac{1}{2}x+1\right)$$
$$2(x+4)-5(x-3)\ge 3x+6$$
$$2x+8-5x+15\ge 3x+6$$
$$-6x\ge -17$$
$$x\le\frac{17}{6}$$
$$\left\{x\mid x\le\frac{17}{6}\right\};\left(-\infty,\frac{17}{6}\right]$$



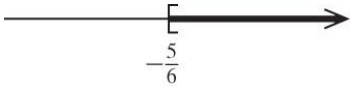

**20.** $$\frac{1}{2}(t-6)-\frac{4}{3}(t+2)\ge-\frac{3}{4}t-2$$
$$12\left[\frac{1}{2}(t-6)-\frac{4}{3}(t+2)\right]\ge 12\left(-\frac{3}{4}t-2\right)$$
$$6(t-6)-16(t+2)\ge -9t-24$$
$$6t-36-16t-32\ge -9t-24$$
$$-t\ge 44$$
$$t\le -44$$
$$\{t\mid t\le -44\};(-\infty,-44]$$



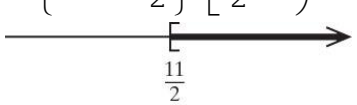

**21.** $$5(7-x)+2x<6x-2-9x$$
$$35-5x+2x<6x-2-9x$$
$$35<-2$$
$$\{\ \}$$

**22.** $$2(3x+1)-4x>2(x+8)-5$$
$$6x+2-4x>2x+16-5$$
$$2>9$$
$$\{\ \}$$

**23.** $$5-3\left[2-4(x-2)\right]\ge 6\left\{2-\left[4-(x-3)\right]\right\}$$
$$5-3\left[2-4x+8\right]\ge 6\left\{2-\left[4-x+3\right]\right\}$$
$$5-3\left[-4x+10\right]\ge 6\left\{2-\left[-x+7\right]\right\}$$
$$5+12x-30\ge 6\left\{2+x-7\right\}$$
$$12x-25\ge 6\left\{x-5\right\}$$
$$12x-25\ge 6x-30$$
$$6x\ge -5$$
$$x\ge -\frac{5}{6}$$
$$\left\{x\mid x\ge -\frac{5}{6}\right\};\left[-\frac{5}{6},\infty\right)$$




**24.** $$8-\left[6-10(x-1)\right]\ge 2\left\{1-3\left[2-(x+4)\right]\right\}$$
$$8-\left[6-10x+10\right]\ge 2\left\{1-3\left[2-x-4\right]\right\}$$
$$8-\left[-10x+16\right]\ge 2\left\{1-3\left[-x-2\right]\right\}$$
$$8+10x-16\ge 2\left\{1+3x+6\right\}$$
$$10x-8\ge 2\left\{3x+7\right\}$$
$$10x-8\ge 6x+14$$
$$4x\ge 22$$
$$x\ge\frac{11}{2}$$
$$\left\{x\mid x\ge\frac{11}{2}\right\};\left[\frac{11}{2},\infty\right)$$




**25.** $$4-3k>-2(k+3)-k$$
$$4-3k>-2k-6-k$$
$$4>-6$$
$$\square\ ;(-\infty,\infty)$$

**26.** $2x-9<6(x-1)-4x$

$2x-9<6x-6-4x$

$-9<-6$

$\square$ ; $(-\infty,\infty)$

**27. a.** $x<4$ and $x\geq -2$

$[-2,4)$


**b.** $x<4$ or $x\geq -2$

$(-\infty,\infty)$

**28. a.** $y\leq -2$ and $y>-5$

$(-5,-2]$


**b.** $y\leq -2$ or $y>-5$

$(-\infty,\infty)$

**29. a.** $m+1\leq 6$ or $\frac{1}{3}m<-2$

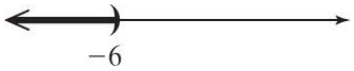
$m\leq 5$ or $m<-6$

$(-\infty,5]$


**b.** $m+1\leq 6$ and $\frac{1}{3}m<-2s$

$m\leq 5$ and $m<-6$

$(-\infty,-6)$




**30. a.** $n-6>1$ or $\frac{3}{4}n\geq 6$

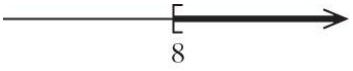
$n>7$ or $n\geq 8$

$(7,\infty)$


**b.** $n-6>1$ and $\frac{3}{4}n\geq 6$

$n>7$ and $n\geq 8$

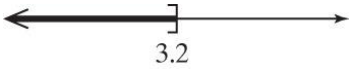
$[8,\infty)$




**31. a.** $-\frac{2}{3}y>-12$ and $2.08\geq 0.65y$

$y>18$ and $y\leq 3.2$

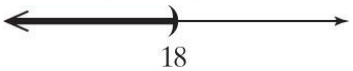
$(-\infty,3.2]$




**b.** $-\frac{2}{3}y>-12$ or $2.08\geq 0.65y$

$y>18$ or $y\leq 3.2$

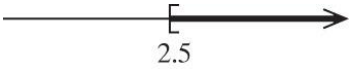
$(-\infty,18)$




**32. a.** $-\frac{4}{5}m<8$ and $0.85\leq 0.34m$

$m>-10$ and $m\geq 2.5$

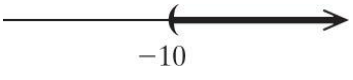
$[2.5,\infty)$




**b.** $-\frac{4}{5}m<8$ or $0.85\leq 0.34m$

$m>-10$ or $m\geq 2.5$

$(-10,\infty)$



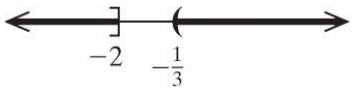

**33. a.** $3(x-2)+2\leq x-8$ or $4(x+1)+2>-2x+4$

$3x-6+2\leq x-8$ or $4x+4+2>-2x+4$

$2x\leq -4$ or $6x>-2$

$x\leq -2$ or $x>-\frac{1}{3}$

$\left(-\infty,-2\right]\cup\left(-\frac{1}{3},\infty\right)$




**b.** $3(x-2)+2 \le x-8$ and $4(x+1)+2 > -2x+4$

$x \le -2$ and $x > -\frac{1}{3}$

$\{\ \}$

**34. a.** $5(t-4)+2 > 3(t+1)-3$ or $2t-6 > 3(t-4)-2$

$5t-20+2 > 3t+3-3$ or $2t-6 > 3t-12-2$

$2t > 18$ or $-t > -8$

$t > 9$ or $t < 8$

$(-\infty,-8) \cup (9,\infty)$


**b.** $5(t-4)+2 > 3(t+1)-3$ and $2t-6 > 3(t-4)-2$

$t > 9$ and $t < 8$

$\{\ \}$

**35.** $-2.8 < y$ and $y \le 5$

**36.** $-\frac{1}{2} \le z$ and $z < 2.4$

**37.** $-3 < -2x+1 \le 9$

$-4 < -2x \le 8$

$2 > x \ge -4$ or $-4 \le x < 2$

$[-4,2)$


**38.** $-6 \le -3x+9 < 0$

$-15 \le -3x < -9$

$5 \ge x > 3$ or $3 < x \le 5$

$(3,5]$


**39.** $1 \le \frac{5x-4}{2} < 3$

$2 \le 5x-4 < 6$

$6 \le 5x < 10$

$\frac{6}{5} \le x < 2$

$\left[\frac{6}{5},2\right)$


**40.** $-2 \le \frac{4x-1}{3} \le 5$

$-6 \le 4x-1 \le 15$

$-5 \le 4x \le 16$

$-\frac{5}{4} \le x \le 4$

$\left[-\frac{5}{4},4\right]$


**41.** $-2 \le \frac{-2x+1}{-3} \le 4$

$6 \ge -2x+1 \ge -12$

$5 \ge -2x \ge -13$

$-\frac{5}{2} \le x \le \frac{13}{2}$

$\left[-\frac{5}{2},\frac{13}{2}\right]$

**42.** $-4 < \dfrac{-5x-2}{-2} < 4$

$-4 < \dfrac{5x+2}{2} < 4$

$-8 < 5x+2 < 8$

$-10 < 5x < 6$

$-2 < x < \dfrac{6}{5}$

$\left(-2, \dfrac{6}{5}\right)$


**43. a.** $|x| = 7$

$x = 7 \text{ or } x = -7$

$\{7, -7\}$

**b.** $|x| < 7$

$-7 < x < 7$

$(-7, 7)$

**c.** $|x| > 7$

$x < -7 \text{ or } x > 7$

$(-\infty, -7) \cup (7, \infty)$

**44. a.** $|y| = 8$

$y = 8 \text{ or } y = -8$

$\{8, -8\}$

**b.** $|y| < 8$

$-8 < y < 8$

$(-8, 8)$

**c.** $|y| > 8$

$y < -8 \text{ or } y > 8$

$(-\infty, -8) \cup (8, \infty)$

**45. a.** $|a+9| + 2 = 6$

$|a+9| = 4$

$a+9 = 4 \quad \text{or} \quad a+9 = -4$

$a = -5 \quad \text{or} \quad a = -13$

$\{-13, -5\}$

**b.** $|a+9| + 2 \le 6$

$|a+9| \le 4$

$-4 \le a+9 \le 4$

$-13 \le a \le -5$

$[-13, -5]$

**c.** $|a+9| + 2 \ge 6$

$|a+9| \ge 4$

$a+9 \le -4 \quad \text{or} \quad a+9 \ge 4$

$a \le -13 \quad \text{or} \quad a \ge -5$

$(-\infty, -13] \cup [-5, \infty)$

**46. a.** $|b+1| - 4 = 1$

$|b+1| = 5$

$b+1 = 5 \quad \text{or} \quad b+1 = -5$

$b = 4 \quad \text{or} \quad b = -6$

$\{-6, 4\}$

**b.** $|b+1| - 4 \le 1$

$|b+1| \le 5$

$-5 \le b+1 \le 5$

$-6 \le b \le 4$

$[-6, -4]$

**c.** $|b+1| - 4 \ge 1$

$|b+1| \ge 5$

$b+1 \le -5 \quad \text{or} \quad b+1 \ge 5$

$b \le -6 \quad \text{or} \quad b \ge 4$

$(-\infty, -6] \cup [4, \infty)$

**47.** $3|4-x| - 2 < 16$

$3|4-x| < 18$

$|4-x| < 6$

$-6 < 4-x < 6$

$-10 < -x < 2$

$10 > x > -2 \text{ or } -2 < x < 10$

$(-2, 10)$

**48.** $2|7-y|+1<17$

$2|7-y|<16$

$|7-y|<8$

$-8<7-y<8$

$-15<-y<1$

$15>y>-1 \text{ or } -1<y<15$

$(-1,15)$

**49.** $2|x+3|-4\geq 6$

$2|x+3|\geq 10$

$|x+3|\geq 5$

$x+3\leq -5 \text{ or } x+3\geq 5$

$x\leq -8 \text{ or } x\geq 2$

$(-\infty,-8]\cup[2,\infty)$

**50.** $5|x+1|-9\geq -4$

$5|x+1|\geq 5$

$|x+1|\geq 1$

$x+1\leq -1 \text{ or } x+1\geq 1$

$x\leq -2 \text{ or } x\geq 0$

$(-\infty,-2]\cup[0,\infty)$

**51.** $|4w-5|+6\leq 2$

$|4w-5|\leq -4$

$\{\ \}$

**52.** $|2x+7|+5<1$

$|2x+7|<-4$

$\{\ \}$

**53.** $|5-p|+13>6$

$|5-p|>-7$

$\square$ ; $(-\infty,\infty)$

An absolute value of any real number is greater than or equal to zero. Therefore, it is also greater than every negative number. This inequality is true for all real numbers, *p*.

**54.** $|12-7x|+5\geq 4$

$|12-7x|\geq -1$

$\square$ ; $(-\infty,\infty)$

An absolute value of any real number is greater than or equal to zero. Therefore, it is also greater than every negative number. This inequality is true for all real numbers, *x*.

**55.** $-11\leq 5-|2p+4|$

$-16\leq -|2p+4|$

$16\geq |2p+4|$

$|2p+4|\leq 16$

$-16\leq 2p+4\leq 16$

$-20\leq 2p\leq 12$

$-10\leq p\leq 6$

$[-10,6]$

**56.** $-18\leq 6-|3z+3|$

$-24\leq -|3z+3|$

$24\geq |3z+3|$

$|3z+3|\leq 24$

$-24\leq 3z+3\leq 24$

$-27\leq 3z\leq 21$

$-9\leq z\leq 7$

$[-9,7]$

**57.** $10<|-5c-4|+2$

$8<|-5c-4|$

$|-5c-4|>8$

$-5c-4<-8 \text{ or } -5c-4>8$

$-5c<-4 \text{ or } -5c>12$

$c>\frac{4}{5} \text{ or } c<-\frac{12}{5}$

$\left(-\infty,-\frac{12}{5}\right)\cup\left(\frac{4}{5},\infty\right)$

**58.** $15<|-2d-3|+6$

$9<|-2d-3|$

$|-2d-3|>9$

$-2d-3<-9 \text{ or } -2d-3>9$

$-2d<-6 \text{ or } -2d>12$

$d>3 \text{ or } d<-6$

$(-\infty,-6)\cup(3,\infty)$

**59.** $\left|\frac{y+3}{6}\right|<2$

$-2<\frac{y+3}{6}<2$

$-12<y+3<12$

$-15<y<9$

$(-15,9)$

**60.** $\left|\frac{m-4}{2}\right|<14$

$-14<\frac{m-4}{2}<14$

$-28<m-4<28$

$-24<m<32$

$(-24,32)$

**61. a.** $|x|=-9$

$\{\ \}$

**b.** $|x|<-9$

$\{\ \}$

**c.** $|x|>-9$

$\square\ ;\{-\infty,\infty\}$

**62. a.** $|y|=-2$

$\{\ \}$

**b.** $|y|<-2$

$\{\ \}$

**c.** $|y|>-2$

$\square\ ;\{-\infty,\infty\}$

**63. a.** $18=4-|y-7|$

$14=-|y-7|$

$-14=|y-7|$

$\{\ \}$

**b.** $18\le 4-|y-7|$

$14\le -|y-7|$

$-14\ge |y-7|$

$\{\ \}$

**c.** $18\ge 4-|y-7|$

$14\ge -|y-7|$

$-14\le |y-7|$

$\square\ ;\{-\infty,\infty\}$

**64. a.** $15=2-|p-3|$

$13=-|p-3|$

$-13=|p-3|$

$\{\ \}$

**b.** $15\le 2-|p-3|$

$13\le -|p-3|$

$-13\ge |p-3|$

$\{\ \}$

**c.** $15\ge 2-|p-3|$

$13\ge -|p-3|$

$-13\le |p-3|$

$\square\ ;\{-\infty,\infty\}$

**65. a.** $|z|=0$

$z=0$ or $z=-0$

$\{\ \}$

**b.** $|z|<0$

$\{\ \}$

**c.** $|z|\le 0$

$z=0$

$\{0\}$

**d.** $|z|>0$

$\{z\,|\,z<0 \text{ or } z>0\}$;

$(-\infty,0)\cup(0,\infty)$

**e.** $|z|\ge 0$

$\square$ ; $(-\infty,\infty)$

**66. a.** $|2w|=0$

$2w=0$ or $2w=-0$

$w=0$ or $w=-0$

$\{0\}$

**b.** $|2w| < 0$

$\{\ \}$

**c.** $|2w| \le 0$

$2w = 0$

$w = 0$

$\{0\}$

**d.** $|2w| > 0$

$2w < -0 \quad \text{or} \quad 2w > 0$

$w < 0 \quad \text{or} \quad w > 0$

$\{w \mid w < 0 \text{ or } w > 0\}$;

$(-\infty, 0) \cup (0, \infty)$

**e.** $|2w| \ge 0$

$\square$; $(-\infty, \infty)$

**67. a.** $|k+4| = 0$

$k+4 = 0 \quad \text{or} \quad k+4 = -0$

$k = -4 \quad \text{or} \quad k = -4$

$\{-4\}$

**b.** $|k+4| < 0$

$\{\ \}$

**c.** $|k+4| \le 0$

$k+4 = 0$

$k = -4$

$\{-4\}$

**d.** $|k+4| > 0$

$k+4 < -0 \quad \text{or} \quad k+4 > 0$

$k < -4 \quad \text{or} \quad k > -4$

$\{k \mid k < -4 \text{ or } k > -4\}$;

$(-\infty, -4) \cup (-4, \infty)$

**e.** $|k+4| \ge 0$

$\square$; $(-\infty, \infty)$

**68. a.** $|c-3| = 0$

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

$c = 3 \quad \text{or} \quad c = 3$

$\{3\}$

**b.** $|c-3| < 0$

$\{\ \}$

**c.** $|c-3| \le 0$

$c-3 = 0$

$c = 3$

$\{3\}$

**d.** $|c-3| > 0$

$c-3 < -0 \quad \text{or} \quad c-3 > 0$

$c < 3 \quad \text{or} \quad c > 3$

$\{c \mid c < 3 \text{ or } c > 3\}$;

$(-\infty, 3) \cup (3, \infty)$

**e.** $|c-3| \ge 0$

$\square$; $(-\infty, \infty)$

**69.** $12.0 \le x \le 15.2$ g/dL

**70.** $18 < a < 25$ yr

**71.** $90 \le d \le 110$ yd

**72.** $220 \le s \le 410$ mph

**73.** $\dfrac{88+92+100+80+90+2.5x}{7.5} \ge 92$

$\dfrac{450+2.5x}{7.5} \ge 92$

$450+2.5x \ge 690$

$2.5x \ge 240$

$x \ge 96$

Marilee needs to score at least 96 on the final exam.

**74.** $\dfrac{36+36.9+37.1+37.4+x}{5} \ge 37$

$\dfrac{147.4+x}{5} \ge 37$

$147.4+x \ge 185$

$x \ge 37.6$

The child needs a score of at least 37.6.

**75.** Let $x$ be the score of Rita in the final exam.

$$80 \le \left( \frac{78+82+90+80+75}{5} \times 60\% \right) + \left( 85 \times 10\% \right) + \left( x \times 30\% \right) \le 90$$

$$80 \le \left( 81 \times \frac{60}{100} \right) + \left( 85 \times \frac{10}{100} \right) + \left( x \times \frac{30}{100} \right) \le 90$$

$$80 \le \left( 48.6 + 8.5 + 0.3x \right) \le 90$$

$$22.9 \le 0.3x \le 32.9$$

$$76.33 \le x \le 109.66$$

$$77 \le x \le 100$$

Because 100 is the highest score that can be earned on the final exam and only whole- number scores are given.

**76.** Let $x$ be the score of Trent in the final exam.

$$70 \le \left( \frac{66+84+72}{3} \times 50\% \right) + \left( 60 \times 20\% \right) + \left( 85 + 10\% \right) + \left( x \times 20\% \right) \le 100$$

$$70 \le \left( 74 \times \frac{50}{100} \right) + \left( 60 \times \frac{20}{100} \right) + \left( 85 \times \frac{10}{100} \right) + \left( x \times \frac{20}{100} \right) \le 100$$

$$70 \le \left( 37 + 12 + 8.5 + 0.2x \right) \le 100$$

$$12.5 \le 0.2x \le 42.5$$

$$62.5 \le x \le 212.5$$

$$63 \le x \le 100$$

Because 100 is the highest score that can be earned on the final exam and that whole-number scores are given.

**77.** Let $t$ represent the time it takes for the car to be more than 16 miles ahead of the truck.

$$50t > 40t + 16$$

$$10t > 16$$

$$t > 1.6 \bigcup_{i=1}^{n} X_i$$

It will take more than 1.6 hr or 1 hr 36 min.

**78.** Let $t$ represent the time it takes for a tutor to make over \$500 more than a student working in the library.

$$16.25t > 10.75t + 500$$

$$5.5t > 500$$

$$t > 91$$

It would take 91 or more hours.

**79.** Let $l$ represent the length of the garden. Then the perimeter of the garden is $\left( 2l + 200 \right)$.

$$200 + 2l \le 800$$

$$2l \le 600$$

$$l \le 300$$

The length must be 300 ft or less.

**80.** Let $x$ represent the length of the shortest side. Then the lengths of the other two sides are $\left( x+1 \right)$ and $\left( x+2 \right)$.

$$x + \left( x+1 \right) + \left( x+2 \right) \le 24$$

$$3x + 3 \le 24$$

$$3x \le 21$$

$$x \le 7$$

The shortest side may be 2 ft, 3 ft, 4 ft, 5 ft, 6 ft, or 7 ft.

**81.** Let $x$ represent the average scores that would produce a nonnegative handicap of 72 or less.

$$0 \le 0.9(220 - x) \le 72$$
$$0 \le 220 - x \le 80$$
$$-220 \le -x \le -140$$
$$220 \ge x \ge 140 \text{ or } 140 \le x \le 220$$

An average score in league play between 140 and 220, inclusive, would produce a handicap of 72 or less.

**82.** $C = \frac{5}{9}(F - 32)$

$$36.5 \le \frac{5}{9}(F - 32) \le 37.5$$
$$65.7 \le F - 32 \le 67.5$$
$$97.7 \le F \le 99.5$$

Normal body temperature is between $97.7°\text{F}$ and $99.5°\text{F}$, inclusive.

**83. a.** Let $s$ represent the amount of sales.

$$25{,}000 + 0.1s > 30{,}000 + 0.08s$$
$$0.02s > 5000$$
$$s > 250{,}000$$

**b.** Job A

**84.** Let $x$ represent the number of nights.

$$40 + 1.18x(169) < 1.14x(179)$$
$$40 + 199.42x < 204.06x$$
$$40 < 4.64x$$
$$8.62 < x \text{ or } x > 8.62$$

After 8 nights (9 or more), Hotel B will be less expensive.

**85. a.** $|v - 16| < 0.01$ or $|16 - v| < 0.01$

**b.** $|v - 16| < 0.01$

$$-0.01 < v - 16 < 0.01$$
$$15.99 < v < 16.01$$
$$(15.99, 16.01)$$

**86. a.** $|t - 60| < 0.2$ or $|60 - t| < 0.2$

**b.** $|t - 60| < 0.2$

$$-0.2 < t - 60 < 0.2$$
$$59.8 < t < 60.2$$
$$(59.8, 60.2)$$

**87. a.** $|x - 4| > 1$ or $|4 - x| > 1$

**b.** $|x - 4| > 1$

$$x - 4 < -1 \quad \text{or} \quad x - 4 > 1$$
$$x < 3 \quad \text{or} \quad x > 5$$
$$(-\infty, 3) \cup (5, \infty)$$

**88. a.** $|y - 10| > 2$ or $|10 - y| > 2$

**b.** $|y - 10| > 2$

$$y - 10 < -2 \quad \text{or} \quad y - 10 > 2$$
$$y < 8 \quad \text{or} \quad y > 12$$
$$(-\infty, 8) \cup (12, \infty)$$

**89. a.** $|t - 36.5| \le 1.5$ or $|36.5 - t| \le 1.5$

**b.** $|t - 36.5| \le 1.5$

$$-1.5 \le t - 36.5 \le 1.5$$
$$35 \le t \le 38$$
$$[35, 38]$$

If the refrigerator is set to $36.5°\text{F}$, the actual temperature would be between $35°\text{F}$ and $38°\text{F}$, inclusive.

**90. a.** $|x - 16| \le 0.5$ or $|16 - x| \le 0.5$

**b.** $|x - 16| \le 0.5$

$$-0.5 \le x - 16 \le 0.5$$
$$15.5 \le x \le 16.5$$
$$[15.5, 16.5]$$

The boxes of cereal vary in weight between 15.5 oz and 16.5 oz, inclusive.

**91. a.** $|x - 0.51| \le 0.03$ or $|0.51 - x| \le 0.03$

**b.** $|x - 0.51| \le 0.03$

$$-0.03 \le x - 0.51 \le 0.03$$
$$0.48 \le x \le 0.54$$
$$[0.48, 0.54]$$

The candidate is expected to receive between 48% of the vote and 54% of the vote, inclusive.

**92. a.** $|x-34| \le 3$ or $|34-x| \le 3$

**b.** $|x-34| \le 3$

$-3 \le x-34 \le 3$

$31 \le x \le 37$

$[31, 37]$; The motorist was traveling between 31 mph and 37 mph, inclusive. The motorist should receive a ticket because even at the lower end of the interval, the speed of 31 mph still exceeds the posted speed limit.

**93. a.** $x-2 \ge 0$

$x \ge 2$

$\{x \mid x \ge 2\}$

**b.** $2-x \ge 0$

$2 \ge x$ or $x \le 2$

$\{x \mid x \le 2\}$

**94. a.** $x-6 \ge 0$

$x \ge 6$

$\{x \mid x \ge 6\}$

**b.** $6-x \ge 0$

$6 \ge x$ or $x \le 6$

$\{x \mid x \le 6\}$

**95. a.** $x+4 \ge 0$

$x \ge -4$

$\{x \mid x \ge -4\}$

**b.** 

**96. a.** $x+7 \ge 0$

$x \ge -7$

$\{x \mid x \ge -7\}$

**b.** 

**97. a.** $2x-9 \ge 0$

$2x \ge 9$

$x \ge \frac{9}{2}$

$\left\{x \middle| x \ge \frac{9}{2}\right\}$

**b.** $2x-9 \ge 0$

$2x \ge 9$

$x \ge \frac{9}{2}$

$\left\{x \middle| x \ge \frac{9}{2}\right\}$

**98. a.** $3x-7 \ge 0$

$3x \ge 7$

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

$\left\{x \middle| x \ge \frac{7}{3}\right\}$

**b.** $3x-7 \ge 0$

$3x \ge 7$

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

$\left\{x \middle| x \ge \frac{7}{3}\right\}$

**99.** $cd > a$ False

**100.** $ab < c$ True

**101.** If $a > c$, then $ad < cd$. True

**102.** If $a < c$, then $ab < bc$. False

**103.** $-3 \le x \le 7$

$-3-2 \le x-2 \le 7-2$

$-5 \le x \le 5$

$|x-2| \le 5$

**104.** $2 < x < 6$

$2-4 < x-4 < 6-4$

$-2 < x < 2$

$|x-4| < 2$

**105.** $x < 4$ or $x > 10$

$x-7 < 4-7$ or $x-7 > 10-7$

$x-7 < -3$ or $x-7 > 3$

$|x-7| > 3$

**106.** $x < -1$ or $x > 11$

$x-5 < -1-5$ or $x-5 > 11-5$

$x-5 < -6$ or $x-5 > 6$

$|x-5| > 6$

**107.** The steps are the same with the following exception. If both sides

of
an inequality are multiplied or divided by a negative real number,
then the direction of the inequality
sign must be reversed.

**108.** The statement $8 < x < 2$ is equivalent to $8 < x$ and $x < 2$. No real number is greater than 8 and simultaneously less than 2.

**109.** The inequality $|x-3| \le 0$ will be true only for values of *x* for which $x - 3 = 0$ (the absolute value will never be less than 0). The solution set is {3}. The inequality $|x-3| > 0$ is true for all values of *x* excluding 3. The solution set is $\{x \mid x < 3 \text{ or } x > 3\}$.

**110.** Taking the square root of both sides of the equation $x^2 = 4$ results in $\sqrt{x^2} = \sqrt{4}$ or equivalently $|x| = 2$. The solution set for each equation is $\{2, -2\}$, indicating that the equations are equivalent.

**111.** $|x| + x < 11$

$x + x < 11$ or $-x + x < 11$

$2x < 11$ or $0 < 11$

$x < \frac{11}{2}$

$\left(-\infty, \frac{11}{2}\right)$

**112.** $|x| - x > 10$

$x - x > -10$ or $-x - x > 10$

$0 > -10$ or $-2x > 10$

$x < -5$

$(-\infty, -5)$

**113.** $1 < |x| < 9$

$1 < x < 9$ or $1 < -x < 9$

$-1 > x > -9$

$-9 < x < -1$

$(-9, -1) < (1, 9)$

**114.** $2 < |y| < 11$

$2 < y < 11$ or $2 < -y < 11$

or $-2 > y > -11$

or $-11 < y < -2$

$(-11, -2) < (2, 11)$

**115.** $5 \le |2x+1| \le 7$

$5 \le 2x+1 \le 7$ or $5 \le -2x-1 \le 7$

$4 \le 2x \le 6$ or $6 \le -2x \le 8$

$2 \le x \le 3$ or $-3 \ge x \ge -4$

or $-4 \le x \le -3$

$(-4, -3) < (2, 3)$

**116.** $7 \le |3x-5| \le 13$

$$7 \le 3x-5 \le 13 \quad \text{or} \quad 7 \le -3x+5 \le 13$$
$$12 \le 3x \le 18 \quad \text{or} \quad 2 \le -3x \le 8$$
$$4 \le x \le 6 \quad \text{or} \quad -\frac{2}{3} \ge x \ge -\frac{8}{3}$$
$$\text{or} \quad -\frac{8}{3} \le x \le -\frac{2}{3}$$
$$\left(-\frac{8}{3}, -\frac{2}{3}\right) < (4, 6)$$

**117.** $$\left|p-\hat{p}\right| < z\sqrt{\frac{\hat{p}\hat{q}}{n}}$$
$$-z\sqrt{\frac{\hat{p}\hat{q}}{n}} < p-\hat{p} < z\sqrt{\frac{\hat{p}\hat{q}}{n}}$$
$$\hat{p}-z\sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p}+z\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

**118.** $$\left|\mu-\bar{x}\right| < \frac{z\sigma}{\sqrt{n}}$$
$$-\frac{z\sigma}{\sqrt{n}} < \mu-\bar{x} < \frac{z\sigma}{\sqrt{n}}$$
$$\bar{x}-\frac{z\sigma}{\sqrt{n}} < \mu < \bar{x}+\frac{z\sigma}{\sqrt{n}}$$

## Problem Recognition Exercises: Recognizing and Solving Equations and Inequalities

**1. a.** Equation in quadratic form and a polynomial equation

**b.** Let $u = x^2 - 5$

$$\left(x^2-5\right)^2 - 5\left(x^2-5\right) + 4 = 0$$
$$u^2 - 5u + 4 = 0$$
$$(u-4)(u-1) = 0$$
$$u = 4 \quad \text{or} \quad u = 1$$
$$x^2 - 5 = 4 \quad \text{or} \quad x^2 - 5 = 1$$
$$x^2 = 9 \quad \text{or} \quad x^2 = 6$$
$$x = \pm 3 \quad \text{or} \quad x = \pm\sqrt{6}$$
$$\left\{\pm 3, \pm\sqrt{6}\right\}$$

**2. a.** Absolute value inequality

**b.**
$$2 \le \left|3t-1\right| - 6$$
$$8 \le \left|3t-1\right|$$
$$\left|3t-1\right| \ge 8$$
$$3t-1 \le -8 \quad \text{or} \quad 3t-1 \ge 8$$
$$3t \le -7 \quad \text{or} \quad 3t \ge 9$$
$$t \le -\frac{7}{3} \quad \text{or} \quad t \ge 3$$
$$\left(-\infty, -\frac{7}{3}\right] < \left[3, \infty\right)$$

**5. a.** Rational equation

**3. a.** Radical equation

**b.**
$$\sqrt[3]{2y-5} - 4 = -1$$
$$\sqrt[3]{2y-5} = 3$$
$$\left(\sqrt[3]{2y-5}\right)^3 = (3)^3$$
$$2y-5 = 27$$
$$2y = 32$$
$$y = 16$$
$$\{16\}$$

**4. a.** Absolute value equation

b.
$$-9\left|3z-7\right| + 1 = 4$$
$$-9\left|3z-7\right| = 3$$
$$\left|3z-7\right| = -\frac{1}{3}$$
$$\{\ \}$$

**b.** $\dfrac{2}{w-3}+\dfrac{5}{w+1}=1$

$$(w-3)(w+1)\left(\frac{2}{w-3}+\frac{5}{w+1}\right)=(w-3)(w+1)(1)$$
$$2(w+1)+5(w-3)=(w-3)(w+1)$$
$$2w+2+5w-15=w^2-2w-3$$
$$7w-13=w^2-2w-3$$
$$0=w^2-9w+10$$
$$w=\frac{-(-9)\pm\sqrt{(-9)^2-4(1)(10)}}{2(1)}=\frac{9\pm\sqrt{41}}{2}$$

$\left\{\dfrac{9\pm\sqrt{41}}{2}\right\}$

**6. a.** Polynomial equation

**b.** $48x^3+80x^2-3x-5=0$

$$48x^3-3x+80x^2-5=0$$
$$3x(16x^2-1)+5(16x^2-1)=0$$
$$(3x+5)(16x^2-1)=0$$
$$(3x+5)(4x+1)(4x-1)=0$$
$$x=-\frac{5}{3}\text{ or }x=-\frac{1}{4}\text{ or }x=\frac{1}{4}$$

$\left\{-\dfrac{5}{3},\pm\dfrac{1}{4}\right\}$

**7. a.** Compound inequality

**b.** $-2(m+2)<-m+5$ and $6\geq m+3$

$$-2m-4<-m+5 \text{ and } 3\geq m$$
$$-m<9 \text{ and } m\leq 3$$
$$m>-9$$

$(-9,3]$

**8. a.** Compound inequality

**b.** $6\leq -2c+8$ or $\dfrac{1}{3}c-2<2$

$$-2\leq -2c \text{ or } \frac{1}{3}c<4$$
$$1\geq c \text{ or } c<12$$

$(-\infty,12)$

**9. a.** Quadratic equation

**b.** $(2p+1)(p+5)=2p+40$

$$2p^2+11p+5=2p+40$$
$$2p^2+9p-35=0$$
$$(2p-5)(p+7)=0$$
$$p=\frac{5}{2} \text{ or } p=-7$$

$\left\{\dfrac{5}{2},-7\right\}$

**10. a.** Linear equation

**b.** $2x(x-4)+7=2x^2-3[x+5-(2+x)]$

$$2x^2-8x+7=2x^2-3[x+5-2-x]$$
$$-8x+7=-3[3]$$
$$-8x+7=-9$$
$$-8x=-16$$
$$x=2$$

$\{2\}$

**11. a.** Linear inequality

**b.** $\frac{a-4}{2}-\frac{3a+1}{4}\le -\frac{a}{8}$

$8\left(\frac{a-4}{2}-\frac{3a+1}{4}\right)\le 8\left(-\frac{a}{8}\right)$

$4(a-4)-2(3a+1)\le -a$

$4a-16-6a-2\le -a$

$-a\le 18$

$a\ge -18$

$[-18,\infty)$

**12. a.** Quadratic equation

**b.** $3x^2+11=4$

$3x^2=-7$

$x^2=-\frac{7}{3}$

$x=\pm\sqrt{-\frac{7}{3}}$

$=\pm i\frac{\sqrt{7}}{\sqrt{3}}$

$=\pm i\frac{\sqrt{7}\cdot\sqrt{3}}{\sqrt{3}\cdot\sqrt{3}}$

$=\pm\frac{\sqrt{21}}{3}i$

$\left\{\pm\frac{\sqrt{21}}{3}i\right\}$

**13. a.** Compound inequality

**b.** $-1\le\frac{6-x}{-5}\le 7$

$-1\le\frac{x-6}{5}\le 7$

$-5\le x-6\le 35$

$1\le x\le 41$

$[1,41]$

**14. a.** Radical equation

**b.** $5=\sqrt{5+2n}+\sqrt{2+n}$

$5-\sqrt{2+n}=\sqrt{5+2n}$

$\left(5-\sqrt{2+n}\right)^2=\left(\sqrt{5+2n}\right)^2$

$25-10\sqrt{2+n}+2+n=5+2n$

$-10\sqrt{2+n}=n-22$

$\left(10\sqrt{2+n}\right)^2=(22-n)^2$

$100(2+n)=484-44n+n^2$

$200+100n=484-44n+n^2$

$n^2-144n+284=0$

$(n-142)(n-2)=0$

$n=142$ or $n=2$

Check: $n=142$

$5=\sqrt{5+2n}+\sqrt{2+n}$

$5=\sqrt{5+2(142)}+\sqrt{2+(142)}$

$5=\sqrt{289}+\sqrt{144}$

$5=17+12$

$5=29$ false

Check: $n=2$

$5=\sqrt{5+2n}+\sqrt{2+n}$

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

$5=\sqrt{9}+\sqrt{4}$

$5=3+2$

$5=5$ ✓ true

$\{2\}$; The value 142 does not check.

**15. a.** Absolute value equation

**b.** $|4x-5|=|3x-2|$

$4x-5=3x-2$ or $4x-5=-3x+2$

$x=3$ or $7x=7$

$x=1$

$\{1,3\}$

**16. a.** Rational equation

**b.** $\frac{1}{d}-\frac{1}{2d-1}+\frac{2d}{2d-1}=0$

$$\frac{1}{d}+\frac{2d-1}{2d-1}=0$$
$$\frac{1}{d}+1=0$$
$$\frac{1}{d}=-1$$
$$d=-1$$

$\{-1\}$

**17. a.** Absolute value inequality

**b.** $-|x+4|+8>3$

$$-|x+4|>-5$$
$$|x+4|<5$$
$$-5<x+4<5$$
$$-9<x<1$$

$(-9,1)$

**18. a.** Radical equation and an equation in quadratic form

**b.** Let $u=\sqrt{y}$

$$y-4\sqrt{y}-12=0$$
$$u^2-4u-12=0$$
$$(u+2)(u-6)=0$$
$$u=-2 \quad \text{or} \quad u=6$$
$$\sqrt{y}=-2 \quad \text{or} \quad \sqrt{y}=6$$
$$\left(\sqrt{y}\right)^2=(-2)^2 \text{ or } \left(\sqrt{y}\right)^2=(6)^2$$
$$y=4 \quad \text{or} \quad y=36$$

Check: $y=4$

$$y-4\sqrt{y}-12=0$$
$$(4)-4\sqrt{(4)}-12=0$$
$$4-8-12=0$$
$$-16=0 \text{ false}$$

Check: $y=36$

$$y-4\sqrt{y}-12=0$$
$$(36)-4\sqrt{(36)}-12=0$$
$$36-24-12=0$$
$$0=0 \checkmark \text{ true}$$

$\{36\}$; The value 4 does not check.

**19. a.** Radical equation

**b.** $c^{2/3}=16$

$$\left(c^{2/3}\right)^{3/2}=\pm(16)^{3/2}$$
$$c=\pm 64$$

$\{\pm 64\}$

**20. a.** Absolute value inequality

**b.** $2|z-14|+8>4$

$$2|z-14|>-4$$
$$|z-14|>-2$$

$(-\infty,\infty)$

## Equations and Inequalities for Calculus

**1.** $\frac{2x}{25}+\frac{2y}{9}y'=0$

$$\frac{2y}{9}y'=-\frac{2x}{25}$$
$$y'=-\frac{9x}{25y}$$

**2.** $2xy^3+3x^2y^2y'-y'=1$

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

**3.** $3y^2y' + 6xy + 3x^2y' = 2y^2 + 4xyy'$

$3y^2y' - 4xyy' + 3x^2y' = 2y^2 - 6xy$

$y'\left(3y^2 - 4xy + 3x^2\right) = 2y\left(y - 3x\right)$

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

**4.** $3\left(x+y\right)^2 + 3\left(x+y\right)^2 y' - 3y^2y' = 3x^2$

$3\left(x+y\right)^2 y' - 3y^2y' = 3x^2 - 3\left(x+y\right)^2$

$y'\left\{\left(x+y\right)^2 - y^2\right\} = x^2 - \left(x+y\right)^2$

$y'\left(x^2 + 2xy\right) = -\left(y^2 + 2xy\right)$

$$y' = -\frac{\left(y^2+2xy\right)}{\left(x^2+2xy\right)}$$

$$y' = -\frac{y\left(y+2x\right)}{x\left(x+2y\right)}$$

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

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

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

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

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

**6.** $$\frac{2x\left(2x-7\right)^{\frac{1}{2}} - x^2\left(\frac{1}{2}\right)\left(2x-7\right)^{-\frac{1}{2}}\left(2\right)}{\left[\left(2x-7\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{x\left(2x-7\right)^{-\frac{1}{2}}\left\{2\left(2x-7\right) - x\right\}}{\left[\left(2x-7\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{x\left(2x-7\right)^{-\frac{1}{2}}\left\{3x-14\right\}}{\left[\left(2x-7\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{x\left(3x-14\right)}{\left(2x-7\right)^{\frac{3}{2}}}$$

**7.** $$\frac{\left(1\right)\left(x^2-9\right)^{\frac{1}{2}} - x\left(\frac{1}{2}\right)\left(x^2-9\right)^{-\frac{1}{2}}\left(2x\right)}{\left[\left(x^2-9\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{\left(x^2-9\right)^{-\frac{1}{2}}\left\{\left(x^2-9\right) - x\left(\frac{1}{2}\right)\left(2x\right)\right\}}{\left[\left(x^2-9\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{\left(x^2-9\right)^{-\frac{1}{2}}\left\{\left(x^2-9\right) - x^2\right\}}{\left[\left(x^2-9\right)^{\frac{1}{2}}\right]^2}$$

$$= \frac{\left(x^2-9\right)^{-\frac{1}{2}}\left(-9\right)}{\left[\left(x^2-9\right)^{\frac{1}{2}}\right]^2}$$

$$= -\frac{9}{\left(x^2-9\right)^{\frac{3}{2}}}$$

**8. a.** $$\frac{4x\left(4x-5\right) - 2x^2\left(4\right)}{\left(4x-5\right)^2}$$

$$= \frac{4x\left\{\left(4x-5\right) - 2x\right\}}{\left(4x-5\right)^2}$$

$$= \frac{4x\left(2x-5\right)}{\left(4x-5\right)^2}$$

**b.** $\frac{4x\left(2x-5\right)}{\left(4x-5\right)^2} = 0$

$4x = 0 \quad \text{or} \quad 2x - 5 = 0$

$x = 0 \quad \text{or} \quad x = \frac{5}{2}$

**c.** $\frac{4x\left(2x-5\right)}{\left(4x-5\right)^2}$

undefined for $\left(4x-5\right)^2 = 0$

$4x - 5 = 0$

$x = \frac{5}{4}$

**9. a.** $\dfrac{-6x(6x+1)-(-3x^2)(6)}{(6x+1)^2}$

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

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

**b.** $-\dfrac{6x(3x+1)}{(6x+1)^2}=0$

$6x=0$ or $3x+1=0$

$x=0$ $\qquad$ $x=-\dfrac{1}{3}$

**c.** $-\dfrac{6x(3x+1)}{(6x+1)^2}$

undefined for $(6x+1)^2=0$

$6x+1=0$

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

**10. a.** $\sqrt{4-x^2}-x\left(\dfrac{1}{2}\right)\dfrac{1}{\sqrt{4-x^2}}(2x)$

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

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

**b.** $\dfrac{2(2-x^2)}{\sqrt{4-x^2}}=0$

$2-x^2=0$

$x=\pm\sqrt{2}$

**c.** $\dfrac{2(2-x^2)}{\sqrt{4-x^2}}$

undefined for $(4-x^2)^2=0$

$4-x^2=0$

$x=\pm\sqrt{2}$

**11.** $\left|\dfrac{x+1}{2}\right|<1$

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

$x+1<2$ $\qquad$ $-(x+1)<2$

$x<1$ $\qquad$ $-x<3$

$x>-3$

$(-3,1)$

**12.** $\left|-\dfrac{x}{2}\right|<1$

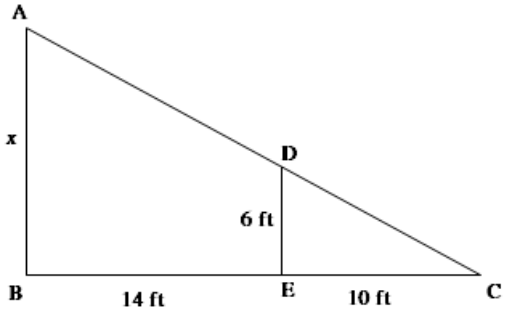
$-\dfrac{x}{2}<1$ or $-\left(-\dfrac{x}{2}\right)<1$

$-x<2$ $\qquad$ $x<2$

$x>-2$ $\qquad$ $x<2$

$(-2,2)$

**13.** Let *x* be the height of the lamppost. In two similar triangles, the ratio of corresponding sides is equal.




Hence,

$\dfrac{x}{6}=\dfrac{(10+14)}{10}$

$\dfrac{x}{6}=\dfrac{24}{10}$

$x=\dfrac{144}{10}$

$x=14.4$ ft

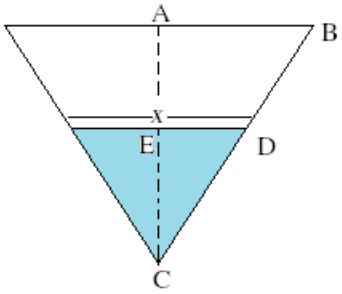
The height of the lamppost is 14.4 ft.

**14.** The perpendicular of an equivalent triangle divide its base in two halves.

Therefore $AB=\dfrac{1}{2}$ m .

The height of the equivalent triangle is calculated using Pythagorean theorem

as $\frac{\sqrt{3}}{2}$ m . $\Delta$ ABC and $\Delta$ EDC are similar triangles.




$$\frac{x}{1}=\frac{\left(\frac{1}{2}\right)}{\left(\frac{\sqrt{3}}{2}\right)}$$

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

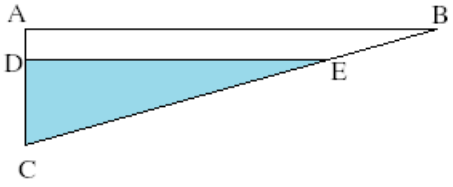
$$V=Ah$$

$$V=\frac{1}{2}bh(1)$$

$$V=\frac{1}{2}\left(\frac{1}{\sqrt{3}}\right)\left(\frac{1}{2}\right)(3)$$

$$V=\frac{\sqrt{3}}{4}\text{ m}^3$$

**15.** Let DE be *x* ft. $\Delta$ ABC is similar to $\Delta$ DCE.




$$\frac{x}{4}=\frac{50}{5}$$

$$x=40\text{ ft}$$

$$V=Ah$$

$$V=\frac{1}{2}bx(20)$$

$$V=\frac{1}{2}(4)(40)(20)$$

$$V=1600\text{ ft}^3$$

## Chapter 1 Review Exercises

**1.** $$\frac{3}{x^2-4}+\frac{4}{2x-7}=\frac{2}{3}$$

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

$$x\neq 2, x\neq 2, x\neq\frac{7}{2}$$

**2.** $$-8(t-4)+7=4\left[t-3(1-t)\right]+6$$

$$-8t+32+7=4(t-3+3t)+6$$

$$-8t+39=4(4t-3)+6$$

$$-8t+39=16t-12+6$$

$$-8t+39=16t-6$$

$$45=24t$$

$$t=\frac{45}{24}=\frac{15}{8}$$

**3.** $$\frac{4}{5}x-\frac{2}{3}=\frac{7}{10}x-2$$

$$30\left(\frac{4}{5}x-\frac{2}{3}\right)=30\left(\frac{7}{10}x-2\right)$$

$$24x-20=21x-60$$

$$3x=-40$$

$$x=-\frac{40}{3}$$

$$\left\{-\frac{40}{3}\right\}$$

**4.** $\frac{m+2}{3}-\frac{m-4}{4}=\frac{m+1}{6}-1$

$12\left(\frac{m+2}{3}-\frac{m-4}{4}\right)=12\left(\frac{m+1}{6}-1\right)$

$4(m+2)-3(m-4)=2(m+1)-12$

$4m+8-3m+12=2m+2-12$

$m+20=2m-10$

$30=m$

$\{30\}$

**5.** $x-5+2(x-4)=3(x+1)-5$

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

$3x-13=3x-2$

$-13=-2$

$\{\ \}$

**6.** $0.2x+1.6=x-0.8(x-2)$

$0.2x+1.6=x-0.8x+1.6$

$0.2x+1.6=0.2x+1.6$

$0=0$

□

**7.** $(y-4)^2=(y+3)^2$

$y^2-8y+16=y^2+6y+9$

$7=14y$

$\frac{7}{14}=y$

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

$\left\{\frac{1}{2}\right\}$

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

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

$x+3+10x=5x-20$

$11x+3=5x-20$

$6x=-23$

$x=-\frac{23}{6}$

$\left\{-\frac{23}{6}\right\}$

**9.** $\frac{1}{m-1}=\frac{5m}{m^2+3m-4}-\frac{3}{m+4}$

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

$(m-1)(m+4)\left(\frac{1}{m-1}\right)=\left[\begin{array}{l}(m-1)(m+4)\\ \left(\frac{5m}{(m-1)(m+4)}-\frac{3}{m+4}\right)\end{array}\right]$

$1(m+4)=5m-3(m-1)$

$m+4=5m-3m+3$

$1=m$

$\{\ \}$; The value 1 does not check.

**10.** $4x-3y=6$

$-3y=-4x+6$

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

**11.** $t_a=\frac{t_1+t_2}{2}$

$2t_a=t_1+t_2$

$2t_a-t_1=t_2$ or $t_2=2t_a-t_1$

**12.** $4x+6y=ax+c$

$4x-ax=c-6y$

$x(4-a)=c-6y$

$x=\dfrac{c-6y}{4-a}$ or $x=\dfrac{6y-c}{a-4}$

**13.** $A=\dfrac{1}{41}c+\dfrac{1}{36}h$

$11=\dfrac{1}{41}c+\dfrac{1}{36}(288)$

$11=\dfrac{1}{41}c+8$

$3=\dfrac{1}{41}c$

$123=c$ or $c=123$ mi

**14.** Let *x* represent the amount invested in the international fund. Then, $(12{,}000-x)$ is the amount invested in the real estate fund.

| | International Fund | Real Estate Fund | Total |
|---|---|---|---|
| **Principal** | *x* | $12{,}000-x$ | |
| **Interest (*I* = *Prt*)** | $x(0.082)(1)$ | $(12{,}000-x)(0.015)(1)$ | 749.50 |

$x(0.082)+(12{,}000-x)(0.015)=749.50$

$0.082x+180-0.015x=749.50$

$0.067x+180=749.50$

$0.067x=569.50$

$x=8500$

$12{,}000-x=12{,}000-8500$

$=3500$

Shawna invested $8500 in the international fund and $3500 in the real estate fund.

**15.** Let *x* represent the amount invested in the 10-yr Treasury note. Then, $(x+4000)$ is the amount invested in the 15-yr bond.

| | 10-yr Note | 15-yr Bond | Total |
|---|---|---|---|
| **Principal** | *x* | $x+4000$ | |
| **Interest (*I* = *Prt*)** | $x(0.035)(10)$ | $(x+4000)(0.041)(15)$ | 10,180 |

$x(0.035)(10)+(x+4000)(0.041)(15)=10{,}180$

$0.35x+0.615x+2460=10{,}180$

$0.965x+2460=10{,}180$

$0.965x=7720$

$x=8000$

$x+4000=8000+4000$

$=12{,}000$

Cassandra invested $8000 in the Treasury note and $12,000 in the bond.

**16.** Let *x* represent the amount of the 20% acid solution (in cubic centimetres). 100 cc is the amount of the 60% acid solution. Therefore, $(x+100)$ is the amount of the

resulting 25% acid solution.

| | 20% Solution | 60% Solution | 25% Solution |
|---|---|---|---|
| **Amount of Solution** | $x$ | 100 | $x+100$ |
| **Pure Acid** | $0.2x$ | $0.6(100)$ | $0.25(x+100)$ |

$$\begin{aligned} 0.2x+0.6(100) &= 0.25(x+100) \\ 0.2x+60 &= 0.25x+25 \\ 35 &= 0.05x \\ 700 &= x \end{aligned}$$

700 cc of 20% acid solution should be mixed with the 60% acid solution.

**17.** Let $x$ represent the amount of the pure sand (in cubic feet). 250 ft$^2$ is the amount of the concrete mix that is 50% sand. Therefore, $(x+250)$ is the amount of the resulting 70% sand mixture.

| | 100% Sand | 50% Sand | 70% Sand |
|---|---|---|---|
| **Amount of Mixture** | $x$ | 250 | $x+250$ |
| **Pure Sand** | $x$ | $0.5(250)$ | $0.7(x+250)$ |

$$\begin{aligned} x+0.5(250) &= 0.7(x+250) \\ x+125 &= 0.7x+175 \\ 0.3x &= 50 \\ x &= 166\frac{2}{3} \end{aligned}$$

$166\frac{2}{3}$ ft$^2$ of sand should be mixed with the 50% sand mixture.

**18.** Let $x$ represent the distance from Kevin's place of work to his home.

| | Distance | Rate | Time |
|---|---|---|---|
| **To Work** | $x$ | 45 | $\frac{x}{45}$ |
| **To Home** | $x$ | 30 | $\frac{x}{30}$ |

$$\begin{aligned} \frac{x}{45}+\frac{x}{30} &= \frac{50}{60} \\ 180\left(\frac{x}{45}+\frac{x}{30}\right) &= 180\left(\frac{50}{60}\right) \\ 4x+6x &= 150 \\ 10x &= 150 \\ x &= 15 \end{aligned}$$

The distance is 15 mi.

**19.** Let *x* represent the speed of the boat traveling north. Then, $(x+6)$ is the speed of the boat traveling south.

| | Distan | Rat | Time |
|---|---|---|---|
| **Northbound** | $3x$ | $x$ | 3 |
| **Southboun** | $3(x+6)$ | $x+6$ | 3 |

$$3x+3(x+6)=66$$
$$3x+3x+18=66$$
$$6x+18=66$$
$$6x=48$$
$$x=8$$
$$x+6=8+6=14$$

The northbound boat travels 8 mph and the southbound boat travels 14 mph.

**20. a.** $C_A=300+4x$

**b.** $C_A=360+2x$

**c.** $C_A=C_B$

$$300+4x=360+2x$$
$$2x=60$$
$$x=30$$

If Monique takes 30 classes during the year, the cost for each gym will be the same.

**21. a.** $C=5x$

**b.** $C=80$

$$5x=80$$
$$x=16$$

The dancer will save money on the 17th dance during a 3-month period.

**22.** Let *t* represent the time it takes Petra and Dawn to typeset the 150-page manuscript (which is equivalent to three 50-page manuscripts) if they work together.

**23.** Let *t* represent the time it takes the second pump to drain the pond by itself.

$$\frac{1\text{ job}}{22\text{ hr}}+\frac{1\text{ job}}{t\text{ hr}}=\frac{1\text{ job}}{10\text{ hr}}$$
$$110t\left(\frac{1}{22}+\frac{1}{t}\right)=110t\left(\frac{1}{10}\right)$$
$$5t+110=11t$$
$$110=6t$$
$$t=\frac{55}{3}\approx 18.\overline{3}\text{ hr}$$

**24.** Let *x* represent the number of female officers. Then, $(x+60)$ represents the number of male officers.

$$\frac{x+60}{x}=\frac{10}{7}$$
$$7x\left(\frac{x+60}{x}\right)=7x\left(\frac{10}{7}\right)$$
$$7(x+60)=10x$$
$$7x+420=10x$$
$$420=3x$$
$$140=x$$
$$x+60=140+60=200$$

There are 140 females and 200 males.

**25.** Let *x* represent the number of turtles in the pond.

$$\frac{12}{x}=\frac{3}{36}$$
$$3x=432$$
$$x=144$$

There are approximately 144 turtles in the pond.

**26.** $-\sqrt{-169}=-i\sqrt{169}=-13i$

**27.** $\sqrt{-12}=i\sqrt{12}=2i\sqrt{3}$

**28.** $\sqrt{-16}\cdot\sqrt{-4}=i\sqrt{16}\cdot i\sqrt{4}$
$=4i\cdot 2i$
$=8i^2$
$=8(-1)$
$=-8$

**29. a.** Real part: 3; Imaginary part: $-7$
**b.** Real part: 0; Imaginary part: **2**

**30. a.** $i^{35}=i^{32}\cdot i^3$
$=(1)\cdot i^3$
$=-i$

**b.** $i^{56}=1$

**c.** $i^{62}=i^{60}\cdot i^2$
$=(1)\cdot i^2$
$=-1$

**d.** $i^{17}=i^{16}\cdot i^1$
$=(1)\cdot i^1$
$=i$

**e.** $i^{-5}=i^{-8}\cdot i^3=(1)\cdot i^3=-i$

**31.** $\left(\frac{2}{3}+\frac{3}{5}i\right)-\left(\frac{1}{6}+\frac{2}{5}i\right)$
$=\left(\frac{20}{30}+\frac{18}{30}i\right)-\left(\frac{5}{30}+\frac{12}{30}i\right)$
$=\left(\frac{20}{30}-\frac{5}{30}\right)+\left(\frac{18}{30}-\frac{12}{30}\right)i$
$=\frac{15}{30}+\frac{6}{30}i=\frac{1}{2}+\frac{1}{5}i$

**32.** $3i(7+2i)=21i+6i^2$
$=21i+6(-1)$
$=-6+21i$

**33.** $\sqrt{-5}\left(\sqrt{11}+\sqrt{-3}\right)=i\sqrt{5}\left(\sqrt{11}+i\sqrt{3}\right)$
$=i\sqrt{55}+i^2\sqrt{15}$
$=i\sqrt{55}+(-1)\sqrt{15}$
$=-\sqrt{15}+i\sqrt{55}$

**34.** $(4-7i)(5+i)$
$=20+4i-35i-7i^2$
$=20-31i-7(-1)$
$=20-31i+7$
$=27-31i$

**35.** $(4-6i)^2=(4)^2-2(4)(6i)+(6i)^2$
$=16-48i+36i^2$
$=16-48i+36(-1)$
$=16-48i-36$
$=-20-48i$

**36.** $\left(2+\sqrt{-2}\right)\left(4+\sqrt{-2}\right)$
$=\left(2+i\sqrt{2}\right)\left(4+i\sqrt{2}\right)$
$=8+2i\sqrt{2}+4i\sqrt{2}+2i^2$
$=8+6i\sqrt{2}+2(-1)$
$=6+6i\sqrt{2}$

**37.** $(8-3i)(8+3i)=(8)^2+(3)^2$
$=64+9$
$=73$

**38.** $\frac{4+3i}{3-i}=\frac{(4+3i)(3+i)}{(3-i)(3+i)}$
$=\frac{12+4i+9i+3i^2}{3^2+1^2}$
$=\frac{12+13i-3}{9+1}$
$=\frac{9+13i}{10}$
$=\frac{9}{10}+\frac{13}{10}i$

**39.** $\left(6-\sqrt{5}i\right)^{-1}=\frac{1}{6-\sqrt{5}i}$

$$= \frac{1\left(6+\sqrt{5}i\right)}{\left(6-\sqrt{5}i\right)\left(6+\sqrt{5}i\right)}$$
$$= \frac{6+\sqrt{5}i}{6^2+5}$$
$$= \frac{6+\sqrt{5}i}{36+5}$$
$$= \frac{6+\sqrt{5}i}{41}$$
$$= \frac{6}{41}+\frac{\sqrt{5}}{41}i$$

**40.** $\frac{7}{4i} = \frac{7\cdot i}{4i\cdot i}$
$$= \frac{7i}{4i^2}$$
$$= \frac{7i}{4(-1)}$$
$$= -\frac{7}{4}i$$

**41.** $3y^2 - 4y = 8 - 6y$
$$3y^2 + 2y - 8 = 0$$
$$(3y-4)(y+2) = 0$$
$3y-4=0$ or $y+2=0$
$3y=4$ $\quad y=-2$
$y=\frac{4}{3}$
$$\left\{\frac{4}{3}, -2\right\}$$

**42.** $(2v+3)^2 - 1 = 6$
$$(2v+3)^2 = 7$$
$$2v+3 = \pm\sqrt{7}$$
$$2v = -3\pm\sqrt{7}$$
$$v = \frac{-3\pm\sqrt{7}}{2}$$
$$\left\{\frac{-3\pm\sqrt{7}}{2}\right\}$$

**43.** $10t^2 + 1210 = 0$
$$\frac{10t^2}{10} + \frac{1210}{10} = \frac{0}{10}$$
$$t^2 + 121 = 0$$
$$t^2 = -121$$
$$t = \pm\sqrt{-121} = \pm 11i$$
$$\{\pm 11i\}$$

**44.** $2d(d-3) = 1 + 4d$
$$2d^2 - 6d = 1 + 4d$$
$$2d^2 - 10d - 1 = 0$$
$a=2, b=-10, c=-1$
$$d = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$= \frac{-(-10)\pm\sqrt{(-10)^2-4(2)(-1)}}{2(2)}$$
$$= \frac{10\pm\sqrt{100+8}}{4} = \frac{10\pm\sqrt{108}}{4}$$
$$= \frac{10\pm 6\sqrt{3}}{4} = \frac{5\pm 3\sqrt{3}}{2}$$
$$\left\{\frac{5\pm 3\sqrt{3}}{2}\right\}$$

**45.** $x^2 - 5 = (x+2)(x-4)$
$$x^2 - 5 = x^2 - 4x + 2x - 8$$
$$x^2 - 5 = x^2 - 2x - 8$$
$$2x = -3$$
$$x = -\frac{3}{2}$$
$$\left\{-\frac{3}{2}\right\}$$

**46.** $\frac{1}{5}x^2-\frac{2}{3}=\frac{7}{15}x$

$15\left(\frac{1}{5}x^2-\frac{2}{3}\right)=15\left(\frac{7}{15}x\right)$

$3x^2-10=7x$

$3x^2-7x-10=0$

$(3x-10)(x+1)=0$

$3x-10=0 \quad \text{or} \quad x+1=0$

$3x=10 \qquad x=-1$

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

$\left\{\frac{10}{3},-1\right\}$

**47.** $x^2+18x+n=x^2+18x+\left[\frac{1}{2}(18)\right]^2$

$=x^2+18x+(9)^2$

$=x^2+18x+81=(x+9)^2$

$n=81;(x+9)^2$

**48.** $x^2+\frac{2}{7}x+n$

$=x^2+\frac{2}{7}x+\left[\frac{1}{2}\left(\frac{2}{7}\right)\right]^2$

$=x^2+\frac{2}{7}x+\left(\frac{1}{7}\right)^2$

$=x^2+\frac{2}{7}x+\frac{1}{49}=\left(x+\frac{1}{7}\right)^2$

$n=\frac{1}{49};\left(x+\frac{1}{7}\right)^2$

**49. a.** $x^2-10x=-9$

$x^2-10x+9=0$

$(x-1)(x-9)=0$

$x-1=0 \quad \text{or} \quad x-9=0$

$x=1 \qquad x=9$

$\{1,9\}$

**b.** $x^2-10x=-9$

$x^2-10x+\left[\frac{1}{2}(-10)\right]^2=-9+\left[\frac{1}{2}(-10)\right]^2$

$x^2-10x+25=-9+25$

$(x-5)^2=16$

$x-5=\pm\sqrt{16}$

$x=5\pm 4$

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

$x=1 \qquad x=9$

$\{1,9\}$

**c.** $x^2-10x=-9$

$x^2-10x+9=0$

$a=1, b=-10, c=9$

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

$=\frac{-(-10)\pm\sqrt{(-10)^2-4(1)(9)}}{2(1)}$

$=\frac{10\pm\sqrt{100-36}}{2}=\frac{10\pm\sqrt{64}}{2}=\frac{10\pm 8}{2}$

$=5\pm 4=1 \text{ or } 9$

$\{1,9\}$

**50. a.** $2x^2-3x-5=0$

$(2x-5)(x+1)=0$

$2x-5=0 \quad \text{or} \quad x+1=0$

$2x=5 \qquad x=-1$

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

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

**b.** $2x^2-3x-5=0$

$$\frac{2x^2}{2}-\frac{3x}{2}-\frac{5}{2}=\frac{0}{2}$$
$$x^2-\frac{3}{2}x=\frac{5}{2}$$
$$x^2-\frac{3}{2}x+\left[\frac{1}{2}\left(-\frac{3}{2}\right)\right]^2=\frac{5}{2}+\left[\frac{1}{2}\left(-\frac{3}{2}\right)\right]^2$$
$$x^2-\frac{3}{2}x+\frac{9}{16}=\frac{40}{16}+\frac{9}{16}$$
$$\left(x-\frac{3}{4}\right)^2=\frac{49}{16}$$
$$x-\frac{3}{4}=\pm\sqrt{\frac{49}{16}}$$
$$x=\frac{3}{4}\pm\frac{7}{4}$$
$$x=\frac{3}{4}+\frac{7}{4} \quad \text{or} \quad x=\frac{3}{4}-\frac{7}{4}$$
$$x=\frac{10}{4} \qquad x=\frac{-4}{4}$$
$$x=\frac{5}{2} \qquad x=-1$$
$$\left\{\frac{5}{2},-1\right\}$$

**c.** $2x^2-3x-5=0$

$a=2, b=-3, c=-5$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-3)\pm\sqrt{(-3)^2-4(2)(-5)}}{2(2)}$$
$$=\frac{3\pm\sqrt{9+40}}{4}=\frac{3\pm\sqrt{49}}{4}=\frac{3\pm 7}{4}$$
$$x=\frac{3}{4}+\frac{7}{4} \quad \text{or} \quad x=\frac{3}{4}-\frac{7}{4}$$
$$x=\frac{10}{4} \qquad x=\frac{-4}{4}$$
$$x=\frac{5}{2} \qquad x=-1$$
$$\left\{\frac{5}{2},-1\right\}$$

**51.** False

**52.** True

**53. a.** $4x^2-20x+25=0$

$$b^2-4ac=(-20)^2-4(4)(25)$$
$$=400-400$$
$$=0$$

**b.** The discriminant is 0; there is one real solution.

**54. a.** $-2y^2=5y-1$

$$-2y^2-5y+1=0$$
$$b^2-4ac=(-5)^2-4(-2)(1)$$
$$=25+8$$
$$=33$$

**b.** $33>0$ ; there are two real solutions.

**55. a.** $5t(t+1)=4t-11$

$$5t^2+5t=4t-11$$
$$5t^2+t+11=0$$
$$b^2-4ac=(1)^2-4(5)(11)$$
$$=1-220$$
$$=-219$$

**b.** $-219<0$ ; there are two nonreal solutions.

**56.** $H=kI^2Rt$

$$\frac{H}{kRt}=\frac{kI^2Rt}{kRt}$$
$$\frac{H}{kRt}=I^2$$
$$I=\sqrt{\frac{H}{kRt}} \text{ or } I=\frac{\sqrt{HkRt}}{kRt}$$

**57.**

$$(x-h)^2+(y-k)^2=r^2$$
$$(y-k)^2=r^2-(x-h)^2$$
$$y-k=\pm\sqrt{r^2-(x-h)^2}$$
$$y=k\pm\sqrt{r^2-(x-h)^2}$$

**58.** $s=a_0t^2+v_0t+s_0$

$$a_0t^2+v_0t+s_0=s$$
$$a_0t^2+v_0t+s_0-s=0$$
$$a=a_0, b=v_0, c=s_0-s$$

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

$$t=\frac{-(v_0)\pm\sqrt{(v_0)^2-4(a_0)(s_0-s)}}{2(a_0)}$$

$$t=\frac{-v_0\pm\sqrt{v_0{}^2-4a_0(s_0-s)}}{2a_0}$$

**59.** Let *x* represents the height of the triangular plot. Then $x+5$ is the base of the triangular plot.

$$A=\frac{1}{2}bh$$
$$52=\frac{1}{2}(x+5)x$$
$$104=x^2+5x$$
$$x^2+5x-104=0$$
$$(x-8)(x+13)=0$$
$$x-8=0 \quad \text{or} \quad x+13=0$$
$$x=8 \qquad \cancel{x=-13}$$
$$x+5=8+5=13$$

**60.** Let *x* and $(x-2)$ represent the width

and length of the finished tablecloth.

Then $(x+0.5)$ and $(x-1.5)$ are the width and length of the cloth.

$$A=lw$$
$$19.25=(x+0.5)(x-1.5)$$
$$19.25=x^2-1.5x+0.5x-0.75$$
$$0=x^2-x-20$$
$$0=(x-5)(x+4)$$
$$x-5=0 \quad \text{or} \quad x+4=0$$
$$x=5 \qquad \cancel{x=-4}$$
$$x+0.5=5+0.5=5.5$$
$$x-1.5=5-1.5=3.5$$

The cloth is 3.5 ft by 5.5 ft.

**61.** Let *x* and $(1.6x)$ represent the width

and length of the screen.

$$a^2+b^2=c^2$$
$$(x)^2+(1.6x)^2=(50)^2$$
$$x^2+2.56x^2=2500$$
$$3.56x^2=2500$$
$$x^2=\frac{2500}{3.56}$$
$$x=\pm\sqrt{\frac{2500}{3.56}}\approx\pm26.5$$
$$1.6x=1.6(26.5)=42.4$$

The width is 26.5 in. and the length is

42.4 in.

**62.** Let *x* and $(x+2.7)$ represent the width

and length of the screen.

$$a^2+b^2=c^2$$
$$(x)^2+(x+2.7)^2=(7)^2$$
$$x^2+x^2+5.4x+7.29=49$$
$$2x^2+5.4x-41.71=0$$
$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(5.4)\pm\sqrt{(5.4)^2-4(2)(-41.71)}}{2(2)}$$
$$=\frac{-5.4\pm\sqrt{362.84}}{4}$$
$$\approx 3.4 \text{ or } \cancel{-6.1}$$
$$x+2.7=3.4+2.7=6.1$$

The length is 6.1 in. and the width is

3.4 in.

**63. a.** $d=0.048v^2+2.2v$

$$=0.048(50)^2+2.2(50)$$
$$=0.048(2500)+110$$
$$=120+110$$
$$=230 \text{ ft}$$

**b.** $d=0.048v^2+2.2v$

$$390=0.048v^2+2.2v$$
$$d=0.048v^2+2.2v-390$$

$$v = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(2.2) \pm \sqrt{(2.2)^2 - 4(0.048)(-390)}}{2(0.048)}$$
$$= \frac{-2.2 \pm \sqrt{79.72}}{0.096}$$
$$\approx 70 \text{ or } \cancel{-116}$$

The car was traveling 70 mph.

**64. a.** $s = -\frac{1}{2}gt^2 + v_0 t + s_0$

$$s = -\frac{1}{2}(32)t^2 + (200)t + 2$$
$$s = -16t^2 + 200t + 2$$

**b.** $s = -16t^2 + 200t + 2$

$$80 = -16t^2 + 200t + 2$$
$$-40 = 8t^2 - 100t - 1$$
$$0 = 8t^2 - 100t + 39$$
$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(-100) \pm \sqrt{(-100)^2 - 4(8)(39)}}{2(8)}$$
$$= \frac{100 \pm \sqrt{8752}}{16}$$
$$\approx 0.4 \text{ or } 12.1$$

The mortar will be at an 80-ft height 0.4 sec after launch.

**65.** $4x^3 - 6x^2 - 20x + 30 = 0$

$$4x^3 - 20x - 6x^2 + 30 = 0$$
$$4x(x^2 - 5) - 6(x^2 - 5) = 0$$
$$(x^2 - 5)(4x - 6) = 0$$
$$(x^2 - 5)(2x - 3) = 0$$
$$x^2 = 5 \quad \text{or} \quad 2x - 3 = 0$$
$$x = \pm\sqrt{5} \text{ or } \quad x = \frac{3}{2}$$
$$\left\{\pm\sqrt{5}, \frac{3}{2}\right\}$$

**66.** $3x^2(x^2 + 2) = 20 - x^2$

$$3x^4 + 6x^2 = 20 - x^2$$
$$3x^4 + 7x^2 - 20 = 0$$

Let $u = x^2$.

$$3u^2 + 7u - 20 = 0$$
$$(3u - 5)(x + 4) = 0$$
$$u = \frac{5}{3} \quad \text{or} \quad u = -4$$
$$x^2 = \frac{5}{3} \quad \text{or} \quad x^2 = -4$$
$$x = \pm\sqrt{\frac{5}{3}} \quad \text{or} \quad x = \pm\sqrt{-4}$$
$$x = \pm\frac{\sqrt{15}}{3} \quad \text{or} \quad x = \pm 2i$$

**67.** $\sqrt{k+7} - \sqrt{3-k} = 2$

$$\sqrt{k+7} = \sqrt{3-k} + 2$$
$$\left(\sqrt{k+7}\right)^2 = \left(\sqrt{3-k} + 2\right)^2$$
$$k + 7 = 3 - k + 4\sqrt{3-k} + 4$$
$$2k = 4\sqrt{3-k}$$
$$(2k)^2 = \left(4\sqrt{3-k}\right)^2$$
$$4k^2 = 16(3-k)$$
$$4k^2 = 48 - 16k$$
$$4k^2 + 16k - 48 = 0$$
$$k^2 + 4k - 12 = 0$$
$$(k-2)(k+6) = 0$$
$$k = 2 \quad \text{or} \quad k = -6$$

Check: $k = 2$

$$\sqrt{k+7} - \sqrt{3-k} = 2$$
$$\sqrt{(2)+7} - \sqrt{3-(2)} = 2$$
$$\sqrt{9} - \sqrt{1} = 2$$
$$3 - 1 = 2$$
$$2 = 2 \checkmark \text{ true}$$

Check: $k = -6$

$$\sqrt{k+7}-\sqrt{3-k}=2$$
$$\sqrt{(-6)+7}-\sqrt{3-(-6)}=2$$
$$\sqrt{1}-\sqrt{9}=2$$
$$1-3=2$$
$$-2=2 \text{ false}$$

$\{2\}$; The value $-6$ does not check.

**68.**
$$\frac{n}{3n+2}+1=\frac{4}{n-2}$$
$$(3n+2)(n-2)\left(\frac{n}{3n+2}+1\right)=(3n+2)(n-2)\left(\frac{4}{n-2}\right)$$
$$n(n-2)+1(3n+2)(n-2)=4(3n+2)$$
$$n^2-2n+3n^2-4n-4=12n+8$$
$$4n^2-18n-12=0$$
$$2n^2-9n-6=0$$
$$n=\frac{-(-9)\pm\sqrt{(-9)^2-4(2)(-6)}}{2(2)}=\frac{9\pm\sqrt{129}}{4}$$
$$\left\{\frac{9\pm\sqrt{129}}{4}\right\}$$

**69.** Let $u=v^{-1}$.
$$11v^{-2}+23v^{-1}+2=0$$
$$11u^2+23u+2=0$$
$$(11u+1)(u+2)=0$$
$$u=-\frac{1}{11} \quad \text{or} \quad u=-2$$
$$v^{-1}=-\frac{1}{11} \quad \text{or} \quad v^{-1}=-2$$
$$v=-11 \quad \text{or} \quad v=-\frac{1}{2}$$
$$\left\{-\frac{1}{2},-11\right\}$$

**70.**
$$\sqrt[3]{4-x}-\sqrt[3]{2x+1}=0$$
$$\sqrt[3]{4-x}=\sqrt[3]{2x+1}$$
$$\left(\sqrt[3]{4-x}\right)^3=\left(\sqrt[3]{2x+1}\right)^3$$
$$4-x=2x+1$$
$$3=3x$$
$$1=x$$
$\{1\}$

**71.**
$$-2\sqrt{3m+4}-3=5$$
$$-2\sqrt{3m+4}=8$$
$$\sqrt{3m+4}=-4$$
$\{\ \}$

**72.**
$$\sqrt{51-14x}+4=x-2$$
$$\sqrt{51-14x}=x-6$$
$$\left(\sqrt{51-14x}\right)^2=(x-6)^2$$
$$51-14x=x^2-12x+36$$
$$0=x^2+2x-15$$
$$0=(x+5)(x-3)$$
$$x=-5 \quad \text{or} \quad x=3$$

Check: $x=-5$
$$\sqrt{51-14x}+4=x-2$$
$$\sqrt{51-14(-5)}+4=(-5)-2$$
$$\sqrt{51-70}=-11$$
$$\sqrt{-19}=-11 \text{ false}$$

Check: $x=3$
$$\sqrt{51-14x}+4=x-2$$
$$\sqrt{51-14(3)}+4=(3)-2$$
$$\sqrt{51-42}=-3$$
$$\sqrt{9}=-3$$
$$3=-3 \text{ false}$$

$\{\ \}$; The values $-5$ and 3 do not check.

**73.**
$$(x-11)^{2/3}=9$$
$$\left((x-11)^{2/3}\right)^{3/2}=\pm(9)^{3/2}$$
$$x-11=\pm 27$$
$$x=27+11 \quad \text{or} \quad x=-27+11$$
$$x=38 \qquad\qquad x=-16$$
$\{-16,38\}$

**74.** $(2x+1)^{3/4}=27$

$\left((2x+1)^{3/4}\right)^{4/3}=(27)^{4/3}$

$2x+1=81$

$x=\frac{81-1}{2}$

$x=40$

$\{40\}$

**75.**

$-2|3y-10|+4=-6$

$-2|3y-10|=-10$

$|3y-10|=5$

$3y-10=5 \quad \text{or} \quad 3y-10=-5$

$y=5 \quad \text{or} \quad y=\frac{5}{3}$

$\left\{\frac{5}{3},5\right\}$

**76.** $|6-w|+7=2$

$|6-w|=-5$

$\{\ \}$

**77.**

$|p-4|=|2p-3|$

$(p-4)=(2p-3) \quad \text{or} \quad (p-4)=-(2p-3)$

$-p=1 \qquad\qquad 3p=7$

$p=-1 \qquad\qquad p=\frac{7}{3}$

$\left\{-1,\frac{7}{3}\right\}$

**78.** $10w^{2/3}=\frac{1}{10}$

$10w^{2/3}=10^{-1}$

$w^{2/3}=10^{-2}$

$\left(w^{2/3}\right)^{3/2}=\pm\left(10^{-2}\right)^{3/2}$

$w=\pm10^{-3}=\pm\frac{1}{1000}$

$\left\{\pm\frac{1}{1000}\right\}$

**79.** Let $u=d^{1/3}$.

$6d^{2/3}-7d^{1/3}-3=0$

$6u^2-7u-3=0$

$(3u+1)(2u-3)=0$

$u=-\frac{1}{3} \quad \text{or} \quad u=\frac{3}{2}$

$d^{1/3}=-\frac{1}{3} \quad \text{or} \quad d^{1/3}=\frac{3}{2}$

$\left(d^{1/3}\right)^3=\left(-\frac{1}{3}\right)^3 \quad \text{or} \left(d^{1/3}\right)^3=\left(\frac{3}{2}\right)^3$

$d=-\frac{1}{27} \quad \text{or} \quad d=\frac{27}{8}$

$\left\{-\frac{1}{27},\frac{27}{8}\right\}$

**80.** Let $v=2u^2-1$.

$\left(2u^2-1\right)^2-10\left(2u^2-1\right)+9=0$

$v^2-10v+9=0$

$(v-1)(v-9)=0$

$v=1 \quad \text{or} \quad v=9$

$2u^2-1=1 \quad \text{or} \quad 2u^2-1=9$

$2u^2=2 \quad \text{or} \quad 2u^2=10$

$u^2=1 \quad \text{or} \quad u^2=5$

$u=\pm1 \quad \text{or} \quad u=\pm\sqrt{5}$

$\left\{\pm\sqrt{5},\pm1\right\}$

**81.** Let $u=\frac{4}{w}+1$.

$2\left(\frac{4}{w}+1\right)^2-10\left(\frac{4}{w}+1\right)=0$

$2u^2-10u=0$

$2u(u-5)=0$

$u=0 \quad \text{or} \quad u=5$

$\frac{4}{w}+1=0 \quad \text{or} \quad \frac{4}{w}+1=5$

$\frac{4}{w}=-1 \quad \text{or} \quad \frac{4}{w}=4$

$w=-4 \quad \text{or} \quad w=1$

$\{1,-4\}$

**82.** $\dfrac{4v}{5v-25}-\dfrac{10}{v-5}=v+\dfrac{4}{5}$

$\dfrac{4v}{5(v-5)}-\dfrac{10}{v-5}=v+\dfrac{4}{5}$

$5(v-5)\left(\dfrac{4v}{5(v-5)}-\dfrac{10}{v-5}\right)=5(v-5)\left(v+\dfrac{4}{5}\right)$

$4v-5(10)=(v-5)(5v+4)$

$4v-50=5v^2+4v-25v-20$

$-5v^2+25v-30=0$

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

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

$v=2 \text{ or } v=3$

**83.** $m=\dfrac{1}{2}\sqrt{2a^2+2b^2-2c^2}$

$2m=\sqrt{2a^2+2b^2-2c^2}$

$(2m)^2=\left(\sqrt{2a^2+2b^2-2c^2}\right)^2$

$4m^2=2a^2+2b^2-2c^2$

$2m^2=a^2+b^2-c^2$

$a^2=2m^2-b^2+c^2$

$a=\pm\sqrt{2m^2-b^2+c^2}$

**84.** $\dfrac{1}{a}=\dfrac{1}{b}+\dfrac{1}{c}$

$abc\left(\dfrac{1}{a}\right)=abc\left(\dfrac{1}{b}+\dfrac{1}{c}\right)$

$bc=ac+ab$

$bc-ab=ac$

$b(c-a)=ac$

$b=\dfrac{ac}{c-a} \text{ or } b=-\dfrac{ac}{a-c}$

**85.** $\dfrac{a_1t_1}{v_1}=\dfrac{a_2t_2}{v_2}$

$v_1v_2\left(\dfrac{a_1t_1}{v_1}\right)=v_1v_2\left(\dfrac{a_2t_2}{v_2}\right)$

$v_2a_1t_1=v_1a_2t_2$

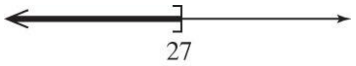
$v_2=\dfrac{v_1a_2t_2}{a_1t_1}$

**86.** $-4\le-\dfrac{2}{3}p+14$

$-18\le-\dfrac{2}{3}p$

$27\ge p \text{ or } p\le 27$

$\{p \mid p\le 27\};\ (-\infty,27]$

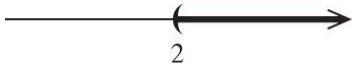



**87.** $-0.6+0.2x<0.8x-1.8$

$1.2<0.6x$

$2<x \text{ or } x>2$

$\{x \mid x>2\};\ (2,\infty)$




**88.** $\dfrac{2+y}{3}-\dfrac{y-1}{4}<\dfrac{y}{6}$

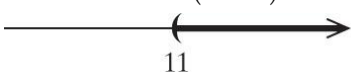
$12\left(\dfrac{2+y}{3}-\dfrac{y-1}{4}\right)<12\left(\dfrac{y}{6}\right)$

$4(2+y)-3(y-1)<2y$

$8+4y-3y+3<2y$

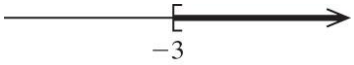
$11<y \text{ or } y>11$

$\{y \mid y>11\};\ (11,\infty)$



**89.**

$$9-\left[5-4\left(t-1\right)\right]\geq 3\left\{2-\left[5-\left(t+2\right)\right]\right\}$$
$$9-\left[5-4t+4\right]\geq 3\left\{2-\left[5-t-2\right]\right\}$$
$$9-\left[-4t+9\right]\geq 3\left\{2-\left[-t+3\right]\right\}$$
$$9+4t-9\geq 3\left\{2+t-3\right\}$$
$$4t\geq 3\left\{t-1\right\}$$
$$4t\geq 3t-3$$
$$t\geq -3$$
$$\left\{t\,|\,t\geq -3\right\};\ \left[-3,\infty\right)$$




**90. a.** $x-12\geq 0$

$$x\geq 12$$
$$\left\{x\,|\,x\geq 12\right\}$$

**b.** $12-x\geq 0$

$$12\geq x \text{ or } x\leq 12$$
$$\left\{x\,|\,x\leq 12\right\}$$

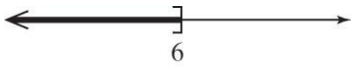
**91. a.** $5x+7\geq 0$

$$5x\geq -7$$
$$x\geq -\frac{7}{5}$$
$$\left\{x\,|\,x\geq -\frac{7}{5}\right\}$$

**b.** □

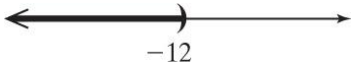
**92. a.** $t+2\leq 8 \quad \text{or} \quad \frac{1}{3}t<-4$

$$t\leq 6 \quad \text{or} \quad t<-12$$
$$\left(-\infty,6\right];$$



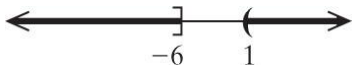

**b.** $t+2\leq 8 \quad \text{and} \quad \frac{1}{3}t<-4$

$$t\leq 6 \quad \text{and} \quad t<-12$$
$$\left(-\infty,-12\right);$$




**93. a.**

$$-2\left(x-1\right)+4<x+3 \quad \text{or} \quad 5\left(x+2\right)-3\leq 4x+1$$
$$-2x+2+4<x+3 \quad \text{or} \quad 5x+10-3\leq 4x+1$$
$$-3x<-3 \quad \text{or} \quad x\leq -6$$
$$x>1 \quad \text{or} \quad x\leq -6$$
$$\left(-\infty,-6\right]<\left(1,\infty\right);$$




**b.** $-2\left(x-1\right)+4<x+3$

and $5\left(x+2\right)-3\leq 4x+1$

$x>1$ and $x\leq -6$

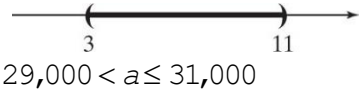
$\left\{\ \right\}$

**94.** $-11\leq -4x-1\leq 7$

$$-10\leq -4x\leq 8$$
$$\frac{10}{4}\geq x\geq -2$$
$$-2\leq x\leq \frac{5}{2}$$
$$\left[-2,\frac{5}{2}\right];$$


**95.** $0<\frac{-3x+9}{-4}<6$

$$0<\frac{3x-9}{4}<6$$
$$0<3x-9<24$$
$$9<3x<33$$
$$3<x<11$$
$$\left(3,11\right);$$




**96.** $29{,}000<a\leq 31{,}000$

**97.** Let *x* represent the September rainfall.

$$\frac{8.54+5.79+8.63+x}{4}>7.83$$
$$\frac{22.96+x}{4}>7.83$$
$$22.96+x>31.32$$
$$x>8.36$$

More than 8.36 in. is needed.

**98.** Let $p$ represent the price of sod.

$$400 + 2000t \le 850$$
$$2000t \le 450$$
$$t \le 0.225$$

She can afford sod that is \$0.225/ft$^2$ or less.

**99. a.** $|w+2|+1=6$

$$|w+2|=5$$
$$w+2=5 \quad \text{or} \quad w+2=-5$$
$$w=3 \quad \text{or} \quad w=-7$$
$$\{-7,3\}$$

**b.** $|w+2|+1<6$

$$|w+2|<5$$
$$-5<w+2<5$$
$$-7<w<3$$
$$(-7,3)$$

**c.** $|w+2|+1\ge 6$

$$|w+2|\ge 5$$
$$w+2\le -5 \quad \text{or} \quad w+2\ge 5$$
$$w\le -7 \quad \text{or} \quad w\ge 3$$
$$(-\infty,-7]\cup[3,\infty)$$

**100. a.** $3=|7x+1|+4$

$$-1=|7x+1|$$
$$\{\ \}$$

**b.** $3<|7x+1|+4$

$$-1<|7x+1|$$
$$(-\infty,\infty)$$

**c.** $3\ge|7x+1|+4$

$$-1\ge|7x+1|$$
$$\{\ \}$$

**101. a.** $|y+5|-3=-3$

$$|y+5|=0$$
$$y+5=0$$
$$y=-5$$
$$\{-5\}$$

**b.** $|y+5|-3<-3$

$$|y+5|<0$$
$$\{\ \}$$

**c.** $|y+5|-3\le -3$

$$|y+5|\le 0$$
$$y+5=0$$
$$y=-5$$
$$\{-5\}$$

**d.** $|y+5|-3>-3$

$$|y+5|>0$$
$$y+5<0 \quad \text{or} \quad y+5>0$$
$$y<-5 \quad \text{or} \quad y>-5$$
$$(-\infty,-5)\cup(-5,\infty)$$

**e.** $|y+5|-3\ge -3$

$$|y+5|\ge 0$$
$$(-\infty,\infty)$$

**102. a.**

$$|x-1|=|3x+5|$$
$$x-1=3x+5 \text{ or } x-1=-3x-5$$
$$-2x=6 \quad \text{or} \quad 4x=-4$$
$$x=-3 \quad \text{or} \quad x=-1$$
$$\{-3,-1\}$$

**b.**

$$|x-1|=|x+5|$$
$$x-1=x+5 \quad \text{or} \quad x-1=-x-5$$
$$-1=5 \quad \text{or} \quad 2x=-4$$
$$\text{or} \quad x=-2$$
$$\{-2\}$$

**c.**

$$|x-1|=|1-x|$$
$$x-1=1-x \quad \text{or} \quad x-1=-1+x$$
$$2x=x \quad \text{or} \quad 0=0$$
$$x=1$$
$$(-\infty,\infty)$$

**103.** $4|x+2|-10\geq -6$

$$4|x+2|\geq 4$$
$$|x+2|\geq 1$$
$$x+2\leq -1 \quad \text{or} \quad x+2\geq 1$$
$$x\leq -3 \quad \text{or} \quad x\geq -1$$
$$(-\infty,-3]\cup[-1,\infty)$$

**104.** $|0.5x-8|<0.01$

$$-0.01<0.5x-8<0.01$$
$$7.99<0.5x<8.01$$
$$15.98<x<16.02$$
$$(15.98,16.02)$$

**105.** $-9\leq 4-|2k-1|$

$$-13\leq -|2k-1|$$
$$13\geq |2k-1|$$
$$|2k-1|\leq 13$$
$$-13\leq 2k-1\leq 13$$
$$-12\leq 2k\leq 14$$
$$-6\leq k\leq 7$$
$$[-6,7]$$

**106. a.** $|x-3|\leq 0.5$ or $|3-x|\leq 0.5$

**b.** $|x-3|\leq 0.5$

$$-0.5\leq (x-3)\leq 0.5$$
$$2.5\leq x\leq 3.5$$
$$[2.5,3.5]$$

**107. a.**

$$|t-(-2)|>0.01$$
$$|t+2|>0.01 \text{ or } |-2-t|>0.01$$

**b.**

$$|t+2|>0.01$$
$$t+2>0.01 \text{ or } -(t+2)>0.01$$
$$t>-1.99 \text{ or } t<-2.01$$
$$(-\infty,-2.01)\cup(-1.99,\infty)$$

## Chapter 1 Test

**1.** $\sqrt{-25}\cdot\sqrt{-4}=5i\cdot 2i$

$$=10i^2$$
$$=10(-1)$$
$$=-10$$

**2. a.** $i^{89}=i^{88}\cdot i^1$

$$=(1)\cdot i^1$$
$$=i$$

**b.** $i^{46}=i^{44}\cdot i^2$

$$=(1)\cdot i^2$$
$$=-1$$

**c.** $i^{35}=i^{32}\cdot i^3$

$$=(1)\cdot i^3$$
$$=-i$$

**d.** $i^{120}=1$

**e.** $i^{-11}=i^{-12}\cdot i^1$

$$=(1)\cdot i^1$$
$$=i$$

**3.** $(4-7i)(6+2i)=24+8i-42i-14i^2$

$$=24-34i-14(-1)$$
$$=24-34i+14$$
$$=38-34i$$

**4.** $(3-5i)^2=(3)^3-2(3)(5i)+(5i)^2$

$$=9-30i+25i^2$$
$$=9-30i+25(-1)$$
$$=-16-30i$$

**5.** $\dfrac{4+3i}{2-5i}=\dfrac{(4+3i)(2+5i)}{(2-5i)(2+5i)}$

$$= \frac{8+20i+6i+15i^2}{2^2+5^2}$$
$$= \frac{8+26i+15(-1)}{4+25}$$
$$= \frac{-7+26i}{29}$$
$$= -\frac{7}{29}+\frac{26}{29}i$$

**6. a.** $b^2-4ac=(-4)^2-4(2)(7)$
$=16-56$
$=-40$

**b.** Because $-40<0$, there are two non-real solutions.

**7. a.** $x^2+25=10x$
$x^2-10x+25=0$
$b^2-4ac=(-10)^2-4(1)(25)$
$=100-100$
$=0$

**b.** Because the discriminant is 0, there is one real solution.

**8. a.** $3x(x+4)=2x-2$
$3x^2+12x=2x-2$
$3x^2+10x+2=0$
$b^2-4ac=(10)^2-4(3)(2)$
$=100-24$
$=76$

**b.** Because $76>0$, there are two real solutions.

**9.** $3y+2[5(y-4)-2]$
$=5y+6(7+y)-3$
$3y+2(5y-20-2)=5y+42+6y-3$
$3y+2(5y-22)=11y+39$
$3y+10y-44=11y+39$
$13y-44=11y+39$
$2y=83$
$y=\frac{83}{2}$

$\left\{\frac{83}{2}\right\}$

**10.** $\frac{2+t}{6}-\frac{3t-1}{4}=1-\frac{2t-5}{3}$
$12\left(\frac{2+t}{6}-\frac{3t-1}{4}\right)=12\left(1-\frac{2t-5}{3}\right)$
$2(2+t)-3(3t-1)=12-4(2t-5)$
$4+2t-9t+3=12-8t+20$
$-7t+7=-8t+32$
$t=25$

$\{25\}$

**11.** $0.4(w+1)+0.8$
$=0.1w+0.3(4+w)$
$0.4w+0.4+0.8=0.1w+1.2+0.3w$
$0.4w+1.2=0.4w+1.2$
$0=0$

$\square$

**12.** $\dfrac{-11}{2x^2+x-15}-\dfrac{2}{2x-5}=\dfrac{1}{x+3}$

$$(2x-5)(x+3)\left[\frac{-11}{(2x-5)(x+3)}-\frac{2}{2x-5}\right]=(2x-5)(x+3)\left(\frac{1}{x+3}\right)$$

$$-11-2(x+3)=1(2x-5)$$
$$-11-2x-6=2x-5$$
$$-2x-17=2x-5$$
$$-12=4x$$
$$-3=x$$

$\{\ \}$; The value $-3$ does not check.

**13.** $(3x-4)^2-2=11$

$$(3x-4)^2=13$$
$$3x-4=\pm\sqrt{13}$$
$$3x=4\pm\sqrt{13}$$
$$x=\frac{4\pm\sqrt{13}}{3}$$

$$\left\{\frac{4\pm\sqrt{13}}{3}\right\}$$

**14.** $y^2+10y=4$

$$y^2+10y+\left[\frac{1}{2}(10)\right]^2=4+\left[\frac{1}{2}(10)\right]^2$$
$$y^2+10y+25=4+25$$
$$(y+5)^2=29$$
$$y+5=\pm\sqrt{29}$$
$$y=-5\pm\sqrt{29}$$

$$\left\{-5\pm\sqrt{29}\right\}$$

**15.** $6t(2t+1)=5-5t$

$$12t^2+11t-5=0$$
$$(3t-1)(4t+5)=0$$
$$3t-1=0 \quad \text{or} \quad 4t+5=0$$
$$3t=1 \qquad\qquad 4t=-5$$
$$t=\frac{1}{3} \qquad\qquad t=-\frac{5}{4}$$

$$\left\{\frac{1}{3},-\frac{5}{4}\right\}$$

**16.** $\dfrac{3x^2}{4}-x=-\dfrac{1}{2}$

$$4\left(\frac{3x^2}{4}-x\right)=4\left(-\frac{1}{2}\right)$$
$$3x^2-4x=-2$$
$$3x^2-4x+2=0$$
$$a=3, b=-4, c=2$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-4)\pm\sqrt{(-4)^2-4(3)(2)}}{2(3)}$$
$$=\frac{4\pm\sqrt{16-24}}{6}$$
$$=\frac{4\pm\sqrt{-8}}{6}=\frac{4\pm 2i\sqrt{2}}{6}$$
$$=\frac{2\pm i\sqrt{2}}{3}$$

$$\left\{\frac{2\pm i\sqrt{2}}{3}\right\}$$

**17.** $12y^3+24y^2=3y+6$

$$12y^3+24y^2-3y-6=0$$
$$12y^3-3y+24y^2-6=0$$
$$3y(4y^2-1)+6(4y^2-1)=0$$
$$y(4y^2-1)+2(4y^2-1)=0$$
$$(4y^2-1)(y+2)=0$$
$$(2y+1)(2y-1)(y+2)=0$$

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

$2y=-1 \qquad 2y=1 \qquad y=-2$

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

$\left\{\pm\frac{1}{2},-2\right\}$

**18.**

$$(2y-3)^{1/3}-(4y+5)^{1/3}=0$$
$$(2y-3)^{1/3}=(4y+5)^{1/3}$$
$$\left[(2y-3)^{1/3}\right]^3=\left[(4y+5)^{1/3}\right]^3$$
$$2y-3=4y+5$$
$$-8=2y$$
$$-4=y$$

$\{-4\}$

**19.** $\sqrt{2d}=1-\sqrt{d+7}$

$$\left(\sqrt{2d}\right)^2=\left(1-\sqrt{d+7}\right)^2$$
$$2d=1-2\sqrt{d+7}+d+7$$
$$2\sqrt{d+7}=8-d$$
$$\left(2\sqrt{d+7}\right)^2=(8-d)^2$$
$$4(d+7)=64-16d+d^2$$
$$4d+28=d^2-16d+64$$
$$0=d^2-20d+36$$
$$0=(d-2)(d-18)$$
$$d=2 \text{ or } d=18$$

Check: $d=2$

$$\sqrt{2d}=1-\sqrt{d+7}$$
$$\sqrt{2(2)}=1-\sqrt{(2)+7}$$
$$\sqrt{4}=1-\sqrt{9}$$
$$2=1-3$$
$$2=-2 \text{ false}$$

Check: $d=18$

$$\sqrt{2d}=1-\sqrt{d+7}$$
$$\sqrt{2(18)}=1-\sqrt{(18)+7}$$
$$\sqrt{36}=1-\sqrt{25}$$
$$6=1-5$$
$$6=-4 \text{ false}$$

$\{\ \}$; The values 2 and 18 do not check.

**20.** $\frac{c}{c+6}-4=\frac{72}{c^2-36}$

$$\frac{c}{c+6}-4=\frac{72}{(c-6)(c+6)}$$
$$(c-6)(c+6)\left(\frac{c}{c+6}-4\right)=(c-6)(c+6)\left[\frac{72}{(c-6)(c+6)}\right]$$
$$c(c-6)-4(c-6)(c+6)=72$$
$$c^2-6c-4c^2+144=72$$
$$-3c^2-6c+72=0$$
$$c^2+2c-24=0$$
$$(c+6)(c-4)=0$$
$$\cancel{c=-6} \quad \text{or} \quad c=4$$

$\{4\}$; The value $-6$ does not check.

**21.** $w^{4/5}-11=0$

$w^{4/5}=11$

$\left(w^{4/5}\right)^{5/4}=\pm(11)^{5/4}$

$w=\pm 11^{5/4}$

$\left\{\pm 11^{5/4}\right\}$

**22.** Let $u=5-\frac{2}{k}$.

$\left(5-\frac{2}{k}\right)^2-6\left(5-\frac{2}{k}\right)-27=0$

$u^2-6u-27=0$

$(u+3)(u-9)=0$

$u=-3 \quad \text{or} \quad u=9$

$5-\frac{2}{k}=-3 \quad \text{or} \quad 5-\frac{2}{k}=9$

$-\frac{2}{k}=-8 \quad \text{or} \quad -\frac{2}{k}=4$

$-2=-8k \quad \text{or} \quad -2=4k$

$k=\frac{1}{4} \quad \text{or} \quad k=-\frac{1}{2}$

$\left\{\frac{1}{4},-\frac{1}{2}\right\}$

**23.** $-2=|x-3|-6$

$4=|x-3|$

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

$x=7 \quad \text{or} \quad x=-1$

$\{-1,7\}$

**24.** $|2v+5|=|2v-1|$

$2v+5=2v-1 \quad \text{or} \quad 2v+5=-2v+1$

$5=-1 \quad \text{or} \quad 4v=-4$

$\text{or} \quad v=-1$

$\{-1\}$

**25.** $aP-4=Pt+2$

$aP-Pt=6$

$P(a-t)=6$

$P=\frac{6}{a-t} \text{ or } P=-\frac{6}{t-a}$

**26.** $\sqrt{a^2-b^2}=c$

$\left(\sqrt{a^2-b^2}\right)^2=(c)^2$

$a^2-b^2=c^2$

$-b^2=-a^2+c^2$

$b^2=a^2-c^2$

$b=\sqrt{a^2-c^2}$

**27.** $-16t^2+v_0t+2=0$

$16t^2-v_0t-2=0$

$a=16, b=-v_0, c=-2$

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

$t=\frac{-(-v_0)\pm\sqrt{(-v_0)^2-4(16)(-2)}}{2(16)}$

$t=\frac{v_0\pm\sqrt{v_0^2+128}}{32}$

**28.** $a^2+b^2+c^2=49$

$c^2=49-a^2-b^2$

$c=\sqrt{49-a^2-b^2}$

**29.** $-2\le\frac{4-x}{3}\le 6$

$-6\le 4-x\le 18$

$-10\le -x\le 14$

$10\ge x\ge -14 \text{ or } -14\le x\le 10$

$[-14,10]$

**30.** $-\frac{4}{3}y<-24 \quad \text{or} \quad y+7\le 2y-3$

$y>18 \quad \text{or} \quad 10\le y$

$[10,\infty)$

**31.** $3(x-5)+1\le 4(x+2)+6$ and $0.3x-1.6>0.2$

$3x-15+1\le 4x+8+6 \quad \text{and} \quad 0.3x>1.8$

$0\le x \quad \text{and} \quad x>6$

$(6,\infty)$

**32.** $2 < -1 + |4w - 3|$

$3 < |4w - 3|$

$|4w - 3| > 3$

$4w - 3 < -3 \quad \text{or} \quad 4w - 3 > 3$

$4w < 0 \quad \text{or} \quad 4w > 6$

$w < 0 \quad \text{or} \quad w > \frac{3}{2}$

$(-\infty, 0) \cup \left(\frac{3}{2}, \infty\right)$

**33.** $-|8 - v| \geq -6$

$|8 - v| \leq 6$

$-6 \leq 8 - v \leq 6$

$-14 \leq -v \leq -2$

$14 \geq v \geq 2$

$2 \leq v \leq 14$

$[2, 14]$

**34. a.** $|7x + 4| + 11 = 2$

$|7x + 4| = -9$

$\{\ \}$

**b.** $|7x + 4| + 11 < 2$

$|7x + 4| < -9$

$\{\ \}$

**c.** $|7x + 4| + 11 > 2$

$|7x + 4| > -9$

$\square$

**35. a.** $|x - 13| + 4 = 4$

$|x - 13| = 0$

$x - 13 = 0$

$x = 13$

$\{13\}$

**b.** $|x - 13| + 4 < 4$

$|x - 13| < 0$

$\{\ \}$

**c.** $|x - 13| + 4 \leq 4$

$|x - 13| \leq 0$

$x - 13 = 0$

$x = 13$

$\{13\}$

**d.** $|x - 13| + 4 > 4$

$|x - 13| > 0$

$x - 13 < -0 \quad \text{or} \quad x - 13 > 0$

$x < 13 \quad \text{or} \quad x > 13$

$(-\infty, 13) \cup (13, \infty)$

**e.** $|x - 13| + 4 \geq 4$

$|x - 13| \geq 0$

$x - 13 \leq -0 \quad \text{or} \quad x - 13 \geq 0$

$x \leq 13 \quad \text{or} \quad x \geq 13$

$(-\infty, \infty)$

**36.** Let *x* represent the amount of 80% antifreeze solution (in gallons) to be mixed. 2 gal is the amount of the 50% antifreeze solution to be mixed. Therefore, $(x + 2)$ is the amount of the resulting 60% antifreeze solution.

| | **80% Sol.** | **50% Sol.** | **60% Sol.** |
|---|---|---|---|
| **Amount of Sol.** | *x* | 2 | $x + 2$ |
| **Pure Anti-freeze** | $0.8(x)$ | $0.5(2)$ | $0.6(x + 2)$ |

$0.8(x) + 0.5(2) = 0.6(x + 2)$

$0.8x + 1 = 0.6x + 1.2$

$0.2x = 0.2$

$x = 1$

1 gal of 80% antifreeze should be used.

**37.** Let *x* represent the speed of the plane flying to Seattle. Then, $(x + 60)$ is the speed of the plane flying to New York City.

| | Distance | Rate | Tim |
|---|---|---|---|
| **Seattle Flight** | $2.3x$ | $x$ | 2.3 |
| **New York Flight** | $3.3(x+60)$ | $x+60$ | 3.3 |

$$2.3x+3.3(x+60)=2662$$
$$2.3x+3.3x+198=2662$$
$$5.6x+198=2662$$
$$5.6x=2464$$
$$x=440$$
$$x+60=440+60$$
$$=500$$

The plane flying to Seattle flies 440 mph, and the plane flying to New York flies 500 mph.

**38.** Let $t$ represent the time it would take the second hose to fill the pool if it worked alone.

$$\frac{1\text{ job}}{3\text{ hr}}+\frac{1\text{ job}}{t\text{ hr}}=\frac{1\text{ job}}{12\text{ hr}}$$
$$6t\left(\frac{1}{3}+\frac{1}{t}\right)=6t\left(\frac{1}{12}\right)$$
$$2t+6=5t$$
$$6=3t$$
$$t=2$$

The second hose can fill the pool in 2 hr.

**39.** Let $x$ represent the patient's LDL cholesterol level. The HDL cholesterol level is 70 mg/dL, and the total cholesterol is $(x+70)$.

$$\frac{x+70}{70}=3.8$$
$$70\left(\frac{x+70}{70}\right)=70(3.8)$$
$$x+70=266$$
$$x=196$$
$$x+70=196+70$$
$$=266$$

The LDL level is 196 mg/dL and the total cholesterol is 266 mg/dL.

**40.** Let $x$ represent the base of the triangular portions and $(x+7)$ represent the height.

$$A=2\left(\frac{1}{2}bh\right)+lw$$
$$276=2\left[\frac{1}{2}(x)(x+7)\right]+18(x+7)$$
$$276=x^2+7x+18x+126$$
$$0=x^2+25x-150$$
$$0=(x+30)(x-5)$$
$$\cancel{x=-30} \quad \text{or} \quad x=5$$
$$x+7=5+7$$
$$=12$$

The base of the triangular portions is 5 ft and the height is 12 ft.

**41. a.** $s=-\frac{1}{2}gt^2+v_0t+s_0$
$$=-\frac{1}{2}(32)t^2+(60)t+2$$
$$=-16t^2+60t+2$$

**b.** $52=-16t^2+60t+2$
$$0=-16t^2+60t-50$$
$$0=8t^2-30t+25$$
$$t=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-30)\pm\sqrt{(-30)^2-4(8)(25)}}{2(8)}$$
$$=\frac{30\pm\sqrt{100}}{16}$$
$$=\frac{30\pm10}{16}$$

$$t=\frac{40}{16}=\frac{5}{2}=2.5 \text{ or } t=\frac{20}{16}=\frac{5}{4}=1.25$$

The ball will be at a height of 52 ft at

times 1.25 sec and 2.5 sec after being kicked.

**42.** Let $s$ represent the score on the sixth round.

$$\frac{92+88+85+90+89+s}{6} < 88$$

$$\frac{444+s}{6} < 88$$

$$444+s < 528$$

$$s < 84$$

The golfer would need to score less than 84.

**43.**

$$r = \sqrt{\frac{3V}{\pi h}}$$

$$9 = \sqrt{\frac{3\times 54\pi}{\pi h}}$$

$$(9)^2 = \left(\sqrt{\frac{3\times 54\pi}{\pi h}}\right)^2$$

$$81 = \frac{162}{h}$$

$$h = \frac{162}{81}$$

$$h = 2 \text{ in.}$$

## Chapter 1 Cumulative Review Exercises

**1.** $\left[(5x+3)^2-(5x-3)^2\right]^2$

$$=\left[25x^2+30x+9-\left(25x^2-30x+9\right)\right]^2$$

$$=\left(25x^2+30x+9-25x^2+30x-9\right)^2$$

$$=(60x)^2 = 3600x^2$$

**2.** $\left(4\sqrt{3}+2\sqrt{2}\right)\left(4\sqrt{3}-2\sqrt{2}\right)$

$$=\left(4\sqrt{3}\right)^2-\left(2\sqrt{2}\right)^2$$

$$=16(3)-4(2)$$

$$=48-8=40$$

**3.** $\dfrac{3x^2-x-4}{4x^2-8x-12} \div \dfrac{3x-4}{6x^2-54}$

$$= \frac{3x^2-x-4}{4\left(x^2-2x-3\right)} \cdot \frac{6\left(x^2-9\right)}{3x-4}$$

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

$$= \frac{\cancel{(3x-4)}\,\cancel{(x+1)}}{\cancel{4}\,\cancel{(x-3)}\,\cancel{(x+1)}} \cdot \frac{\overset{3}{\cancel{6}}\,(x+3)\,\cancel{(x-3)}}{\cancel{3x-4}}$$

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

**4.** $\dfrac{6}{x+2}-\dfrac{5}{x-2}+\dfrac{x}{x^2-4}$

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

$$=\left(\frac{x-2}{x-2}\right)\left(\frac{6}{x+2}\right)-\left(\frac{x+2}{x+2}\right)\left(\frac{5}{x-2}\right)+\frac{x}{(x+2)(x-2)}$$

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

$$=\frac{6x-12-5x-10+x}{(x+2)(x-2)}$$

$$=\frac{2x-22}{(x+2)(x-2)}$$

**5.** $$\frac{\frac{1}{5x}-\frac{3}{5}}{\frac{2}{x}+\frac{1}{5}}=\frac{5x\cdot\left(\frac{1}{5x}-\frac{3}{5}\right)}{5x\cdot\left(\frac{2}{x}+\frac{1}{5}\right)}$$
$$=\frac{1-3x}{10+x}$$

**6.** $$\frac{2}{\sqrt{7}+\sqrt{3}}=\frac{2\left(\sqrt{7}-\sqrt{3}\right)}{\left(\sqrt{7}+\sqrt{3}\right)\left(\sqrt{7}-\sqrt{3}\right)}$$
$$=\frac{2\left(\sqrt{7}-\sqrt{3}\right)}{\left(\sqrt{7}\right)^2-\left(\sqrt{3}\right)^2}$$
$$=\frac{2\left(\sqrt{7}-\sqrt{3}\right)}{7-3}$$
$$=\frac{2\left(\sqrt{7}-\sqrt{3}\right)}{4}$$
$$=\frac{\sqrt{7}-\sqrt{3}}{2}$$

**11.** Let *x* represent the amount borrowed at 4%. Then, $(8000-x)$ is the amount borrowed at 5%.

| | 4% | 5% | To |
|---|---|---|---|
| **Prin** | $x$ | $8000-x$ | |
| **Inter** | $x(0.04)$ | $(8000-x)(0.05)$ | |

**12.** $$(4x-1)^2+3=6$$
$$(4x-1)^2=3$$
$$4x-1=\pm\sqrt{3}$$
$$4x=1\pm\sqrt{3}$$
$$x=\frac{1\pm\sqrt{3}}{4}$$
$$\left\{\frac{1\pm\sqrt{3}}{4}\right\}$$

**7.** $$\sqrt[3]{81y^5z^2w^{12}}=\sqrt[3]{27y^3w^{12}\cdot 3y^2z^2}$$
$$=3yw^4\sqrt[3]{3y^2z^2}$$

**8. a.** $|4\pi-11|$ or $|11-4\pi|$

**b.** $|4\pi-11|=4\pi-11$

**9.** $$4x^3-32y^6$$
$$=4\left(x^3-8y^6\right)$$
$$=4\left[x^3-\left(2y^2\right)^3\right]$$
$$=4\left[\left(x-2y^2\right)\left(x^2+2xy^2+4y^4\right)\right]$$

**10.** $$\frac{3-7i}{2+5i}=\frac{(3-7i)(2-5i)}{(2+5i)(2-5i)}$$
$$=\frac{6-15i-14i+35i^2}{4+25}$$
$$=\frac{6-29i+35(-1)}{29}$$
$$=\frac{-29-29i}{29}$$
$$=-1-i$$

$$x(0.04)+(8000-x)(0.05)=380$$
$$0.04x+400-0.05x=380$$
$$-0.01x+400=380$$
$$-0.01x=-20$$
$$x=2000$$

$$8000-x=8000-2000$$
$$=6000$$

Stephan borrowed \$6000 at 5% and \$2000 at 4%.

**13.** $$2x(x-4)=2x+5$$
$$2x^2-8x=2x+5$$
$$2x^2-10x-5=0$$
$$a=2, b=-10, c=-5$$

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$
$$=\frac{-(-10)\pm\sqrt{(-10)^2-4(2)(-5)}}{2(2)}$$
$$=\frac{10\pm\sqrt{100+40}}{4}$$
$$=\frac{10\pm\sqrt{140}}{4}$$
$$=\frac{10\pm2\sqrt{35}}{4}=\frac{5\pm\sqrt{35}}{2}$$
$$\left\{\frac{5\pm\sqrt{35}}{2}\right\}$$

**14.** Let $u=\frac{x}{3}+1$.

$$2\left(\frac{x}{3}+1\right)^2+5\left(\frac{x}{3}+1\right)-12=0$$
$$2u^2+5u-12=0$$
$$(2u-3)(u+4)=0$$
$$u=\frac{3}{2} \quad \text{or} \quad u=-4$$
$$\frac{x}{3}+1=\frac{3}{2} \quad \text{or} \quad \frac{x}{3}+1=-4$$
$$\frac{x}{3}=\frac{1}{2} \quad \text{or} \quad \frac{x}{3}=-5$$
$$x=\frac{3}{2} \quad \text{or} \quad x=-15$$
$$\left\{\frac{3}{2},-15\right\}$$

**15.** $\sqrt{x+4}-2=x$

$$\sqrt{x+4}=x+2$$
$$\left(\sqrt{x+4}\right)^2=(x+2)^2$$
$$x+4=x^2+4x+4$$
$$x^2+3x=0$$
$$x(x+3)=0$$
$$x=0 \quad \text{or} \quad x=-3$$

Check: $x=0$

$$\sqrt{x+4}-2=x$$
$$\sqrt{(0)+4}-2=(0)$$
$$2-2=0$$
$$0=0 \ \checkmark \text{ true}$$

Check: $x=-3$

$$\sqrt{x+4}-2=x$$
$$\sqrt{(-3)+4}-2=(-3)$$
$$1-2=-3$$
$$-1=-3 \text{ false}$$

$\{0\}$

**16.** $-|5-x|+6=4$

$$-|5-x|=-2$$
$$|5-x|=2$$
$$5-x=-2 \quad \text{or} \quad 5-x=2$$
$$-x=-7 \quad \text{or} \quad -x=-3$$
$$x=7 \quad \text{or} \quad x=3$$
$$\{3,7\}$$

**17.** $x-9=\frac{72}{x-8}$

$$(x-8)(x-9)=(x-8)\left(\frac{72}{x-8}\right)$$
$$x^2-17x+72=72$$
$$x^2-17x=0$$
$$x(x-17)=0$$
$$x=0 \quad \text{or} \quad x=17$$
$$\{0,17\}$$

**18. a.** $A\cup B=\square$

**b.** $A\cap B=\{x\mid 4\le x<11\}$

**c.** $A\cup C=\{x\mid x<11\}$

**d.** $A\cap C=\{x\mid x<2\}$

**e.** $B\cup C=\{x\mid x<2 \text{ or } x\ge 4\}$

**f.** $B\cap C=\{\ \}$

**19.** $|2x-11|+1\le 12$

$$|2x-11|\le 11$$
$$-11\le 2x-11\le 11$$
$$0\le 2x\le 22$$
$$0\le x\le 11$$

$[0,11]$ $(-25,\infty)$

**20.** $-\frac{3}{5}y<15$

$y>-25$