Prealgebra Textbook

Second Edition

Chapter 4 Odd Solutions

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Chapter 4

Fractions

4.1 Equivalent Fractions

1. List the divisors of 72.

$$1,\ 2,\ 3,\ 4,\ 6,\ 8,\ 9,\ 12,\ 18,\ 24,\ 36,\ 72$$

List the divisiors of 8.

$$1,\ 2,\ 4,\ 8$$

The common divisors of 72 and 8 are:

$$1,\ 2,\ 4,\ 8$$

The greatest of these common divisors is the GCD of 72 and 8; that is, the GCD is 8.

3. List the divisors of 52.

$$1,\ 2,\ 4,\ 13,\ 26,\ 52$$

List the divisiors of 20.

$$1,\ 2,\ 4,\ 5,\ 10,\ 20$$

The common divisors of 52 and 20 are:

$$1,\ 2,\ 4$$

The greatest of these common divisors is the GCD of 52 and 20; that is, the GCD is 4.

5. List the divisors of 36.

$$1,\ 2,\ 3,\ 4,\ 6,\ 9,\ 12,\ 18,\ 36$$

List the divisiors of 63.

$$1,\ 3,\ 7,\ 9,\ 21,\ 63$$

The common divisors of 36 and 63 are:

$$1,\ 3,\ 9$$

The greatest of these common divisors is the GCD of 36 and 63; that is, the GCD is 9.

7. List the divisors of 72.

$$1,\ 2,\ 3,\ 4,\ 6,\ 8,\ 9,\ 12,\ 18,\ 24,\ 36,\ 72$$

List the divisiors of 44.

$$1,\ 2,\ 4,\ 11,\ 22,\ 44$$

The common divisors of 72 and 44 are:

$$1,\ 2,\ 4$$

The greatest of these common divisors is the GCD of 72 and 44; that is, the GCD is 4.

9. List the divisors of 16.

$$1,\ 2,\ 4,\ 8,\ 16$$

List the divisiors of 56.

$$1,\ 2,\ 4,\ 7,\ 8,\ 14,\ 28,\ 56$$

The common divisors of 16 and 56 are:

$$1,\ 2,\ 4,\ 8$$

The greatest of these common divisors is the GCD of 16 and 56; that is, the GCD is 8.

11. List the divisors of 84.

$$1,\ 2,\ 3,\ 4,\ 6,\ 7,\ 12,\ 14,\ 21,\ 28,\ 42,\ 84$$

List the divisiors of 24.

$$1,\ 2,\ 3,\ 4,\ 6,\ 8,\ 12,\ 24$$

The common divisors of 84 and 24 are:

$$1,\ 2,\ 3,\ 4,\ 6,\ 12$$

The greatest of these common divisors is the GCD of 84 and 24; that is, the GCD is 12.

13. The greatest common divisor of 22 and 98 is 2. Therefore,

$$\begin{aligned} \frac{22}{98} &= \frac{11 \cdot 2}{49 \cdot 2} && \text{Factor out 2 in numerator and denominator.} \\ &= \frac{11}{49} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{22}{98} &= \frac{2 \cdot 11}{2 \cdot 7 \cdot 7} && \text{Prime factorization.} \\ &= \frac{11}{7 \cdot 7} && \text{Cancel common factors.} \\ &= \frac{11}{49} && \text{Simplify numerator and denominator.} \end{aligned}$$

15. The greatest common divisor of 93 and 15 is 3. Therefore,

$$\begin{aligned} \frac{93}{15} &= \frac{31 \cdot 3}{5 \cdot 3} && \text{Factor out 3 in numerator and denominator.} \\ &= \frac{31}{5} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{93}{15} &= \frac{3 \cdot 31}{3 \cdot 5} && \text{Prime factorization.} \\ &= \frac{31}{5} && \text{Cancel common factors.} \end{aligned}$$

17. The greatest common divisor of 69 and 21 is 3. Therefore,

$$\begin{aligned} \frac{69}{21} &= \frac{23 \cdot 3}{7 \cdot 3} && \text{Factor out 3 in numerator and denominator.} \\ &= \frac{23}{7} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{69}{21} &= \frac{3 \cdot 23}{3 \cdot 7} && \text{Prime factorization.} \\ &= \frac{23}{7} && \text{Cancel common factors.} \end{aligned}$$

19. The greatest common divisor of 74 and 12 is 2. Therefore,

$$\begin{aligned} \frac{74}{12} &= \frac{37 \cdot 2}{6 \cdot 2} && \text{Factor out 2 in numerator and denominator.} \\ &= \frac{37}{6} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{74}{12} &= \frac{2 \cdot 37}{2 \cdot 2 \cdot 3} && \text{Prime factorization.} \\ &= \frac{37}{2 \cdot 3} && \text{Cancel common factors.} \\ &= \frac{37}{6} && \text{Simplify numerator and denominator.} \end{aligned}$$

21. The greatest common divisor of 66 and 57 is 3. Therefore,

$$\begin{aligned} \frac{66}{57} &= \frac{22 \cdot 3}{19 \cdot 3} && \text{Factor out 3 in numerator and denominator.} \\ &= \frac{22}{19} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{66}{57} &= \frac{2 \cdot 3 \cdot 11}{3 \cdot 19} && \text{Prime factorization.} \\ &= \frac{2 \cdot 11}{19} && \text{Cancel common factors.} \\ &= \frac{22}{19} && \text{Simplify numerator and denominator.} \end{aligned}$$

23. The greatest common divisor of 33 and 99 is 33. Therefore,

$$\begin{aligned} \frac{33}{99} &= \frac{1 \cdot 33}{3 \cdot 33} && \text{Factor out 33 in numerator and denominator.} \\ &= \frac{1}{3} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{33}{99} &= \frac{3 \cdot 11}{3 \cdot 3 \cdot 11} && \text{Prime factorization.} \\ &= \frac{1}{3} && \text{Cancel common factors.} \end{aligned}$$

25. The greatest common divisor of 69 and 24 is 3. Therefore,

$$\begin{aligned} \frac{69}{24} &= \frac{23 \cdot 3}{8 \cdot 3} && \text{Factor out 3 in numerator and denominator.} \\ &= \frac{23}{8} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{69}{24} &= \frac{3 \cdot 23}{2 \cdot 2 \cdot 2 \cdot 3} && \text{Prime factorization.} \\ &= \frac{23}{2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\ &= \frac{23}{8} && \text{Simplify numerator and denominator.} \end{aligned}$$

27. The greatest common divisor of 46 and 44 is 2. Therefore,

$$\begin{aligned} \frac{46}{44} &= \frac{23 \cdot 2}{22 \cdot 2} && \text{Factor out 2 in numerator and denominator.} \\ &= \frac{23}{22} && \text{Cancel common factors.} \end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{46}{44} &= \frac{2 \cdot 23}{2 \cdot 2 \cdot 11} && \text{Prime factorization.} \\ &= \frac{23}{2 \cdot 11} && \text{Cancel common factors.} \\ &= \frac{23}{22} && \text{Simplify numerator and denominator.} \end{aligned}$$

29. Both numerator and denominator must be multiplied by 24:

$$\begin{aligned} 3 &= \frac{3}{1} && 3 = 3/1. \\ &= \frac{3 \cdot 24}{1 \cdot 24} && \text{Multiply numerator and denominator by 24.} \\ &= \frac{72}{24} && \text{Simplify numerator and denominator.} \end{aligned}$$

31. Since $57 = 19 \cdot 3$, both numerator and denominator must be multiplied by 3:

$$\begin{aligned} \frac{25}{19} &= \frac{25 \cdot 3}{19 \cdot 3} && \text{Multiply numerator and denominator by 3.} \\ &= \frac{75}{57} && \text{Simplify numerator and denominator.} \end{aligned}$$

33. Both numerator and denominator must be multiplied by 2:

$$\begin{aligned} 2 &= \frac{2}{1} && 2 = 2/1. \\ &= \frac{2 \cdot 2}{1 \cdot 2} && \text{Multiply numerator and denominator by 2.} \\ &= \frac{4}{2} && \text{Simplify numerator and denominator.} \end{aligned}$$

35. Since $95 = 19 \cdot 5$, both numerator and denominator must be multiplied by 5:

$$\begin{aligned} \frac{18}{19} &= \frac{18 \cdot 5}{19 \cdot 5} && \text{Multiply numerator and denominator by 5.} \\ &= \frac{90}{95} && \text{Simplify numerator and denominator.} \end{aligned}$$

37. Since $24 = 3 \cdot 8$, both numerator and denominator must be multiplied by 8:

$$\begin{aligned} \frac{1}{3} &= \frac{1 \cdot 8}{3 \cdot 8} && \text{Multiply numerator and denominator by 8.} \\ &= \frac{8}{24} && \text{Simplify numerator and denominator.} \end{aligned}$$

39. Both numerator and denominator must be multiplied by 4:

$$\begin{aligned} 16 &= \frac{16}{1} && 16 = 16/1. \\ &= \frac{16 \cdot 4}{1 \cdot 4} && \text{Multiply numerator and denominator by 4.} \\ &= \frac{64}{4} && \text{Simplify numerator and denominator.} \end{aligned}$$

41. The greatest common divisor of 34 and 86 is 2. Therefore,

$$\begin{aligned}\frac{34}{-86} &= -\frac{34}{86} && \text{Unlike signs give a negative result.}\\ &= -\frac{17\cdot 2}{43\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\ &= -\frac{17}{43} && \text{Cancel common factors.}\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}\frac{34}{-86} &= -\frac{34}{86} && \text{Unlike signs give a negative result.}\\ &= -\frac{2\cdot 17}{2\cdot 43} && \text{Prime factorization.}\\ &= -\frac{17}{43} && \text{Cancel common factors.}\end{aligned}$$

43. The greatest common divisor of 72 and 92 is 4. Therefore,

$$\begin{aligned}\frac{-72}{-92} &= \frac{72}{92} && \text{Like signs give a positive result.}\\ &= \frac{18\cdot 4}{23\cdot 4} && \text{Factor out 4 in numerator and denominator.}\\ &= \frac{18}{23} && \text{Cancel common factors.}\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}\frac{-72}{-92} &= \frac{72}{92} && \text{Like signs give a positive result.}\\ &= \frac{2\cdot 2\cdot 2\cdot 3\cdot 3}{2\cdot 2\cdot 23} && \text{Prime factorization.}\\ &= \frac{2\cdot 3\cdot 3}{23} && \text{Cancel common factors.}\\ &= \frac{18}{23} && \text{Simplify numerator and denominator.}\end{aligned}$$

45. The greatest common divisor of 92 and 82 is 2. Therefore,

$$\begin{aligned}\frac{-92}{82} &= -\frac{92}{82} && \text{Unlike signs give a negative result.}\\ &= -\frac{46\cdot 2}{41\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\ &= -\frac{46}{41} && \text{Cancel common factors.}\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-92}{82} &= -\frac{92}{82} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 23}{2\cdot 41} && \text{Prime factorization.}\\
&= -\frac{2\cdot 23}{41} && \text{Cancel common factors.}\\
&= -\frac{46}{41} && \text{Simplify numerator and denominator.}
\end{aligned}$$

47. The greatest common divisor of 21 and 33 is 3. Therefore,

$$\begin{aligned}
\frac{-21}{33} &= -\frac{21}{33} && \text{Unlike signs give a negative result.}\\
&= -\frac{7\cdot 3}{11\cdot 3} && \text{Factor out 3 in numerator and denominator.}\\
&= -\frac{7}{11} && \text{Cancel common factors.}
\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-21}{33} &= -\frac{21}{33} && \text{Unlike signs give a negative result.}\\
&= -\frac{3\cdot 7}{3\cdot 11} && \text{Prime factorization.}\\
&= -\frac{7}{11} && \text{Cancel common factors.}
\end{aligned}$$

49. The greatest common divisor of 22 and 98 is 2. Therefore,

$$\begin{aligned}
\frac{22}{-98} &= -\frac{22}{98} && \text{Unlike signs give a negative result.}\\
&= -\frac{11\cdot 2}{49\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\
&= -\frac{11}{49} && \text{Cancel common factors.}
\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common

factors:

$$\begin{aligned}
\frac{22}{-98} &= -\frac{22}{98} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 11}{2\cdot 7\cdot 7} && \text{Prime factorization.}\\
&= -\frac{11}{7\cdot 7} && \text{Cancel common factors.}\\
&= -\frac{11}{49} && \text{Simplify numerator and denominator.}
\end{aligned}$$

51. The greatest common divisor of 42 and 88 is 2. Therefore,

$$\begin{aligned}
\frac{42}{-88} &= -\frac{42}{88} && \text{Unlike signs give a negative result.}\\
&= -\frac{21\cdot 2}{44\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\
&= -\frac{21}{44} && \text{Cancel common factors.}
\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{42}{-88} &= -\frac{42}{88} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 3\cdot 7}{2\cdot 2\cdot 2\cdot 11} && \text{Prime factorization.}\\
&= -\frac{3\cdot 7}{2\cdot 2\cdot 11} && \text{Cancel common factors.}\\
&= -\frac{21}{44} && \text{Simplify numerator and denominator.}
\end{aligned}$$

53. The greatest common divisor of 94 and 6 is 2. Therefore,

$$\begin{aligned}
\frac{94}{-6} &= -\frac{94}{6} && \text{Unlike signs give a negative result.}\\
&= -\frac{47\cdot 2}{3\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\
&= -\frac{47}{3} && \text{Cancel common factors.}
\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}\frac{94}{-6} &= -\frac{94}{6} && \text{Unlike signs give a negative result.}\\ &= -\frac{2\cdot 47}{2\cdot 3} && \text{Prime factorization.}\\ &= -\frac{47}{3} && \text{Cancel common factors.}\end{aligned}$$

55. The greatest common divisor of 10 and 86 is 2. Therefore,

$$\begin{aligned}\frac{10}{-86} &= -\frac{10}{86} && \text{Unlike signs give a negative result.}\\ &= -\frac{5\cdot 2}{43\cdot 2} && \text{Factor out 2 in numerator and denominator.}\\ &= -\frac{5}{43} && \text{Cancel common factors.}\end{aligned}$$

Alternatively, factor the numerator and denominator and cancel common factors:

$$\begin{aligned}\frac{10}{-86} &= -\frac{10}{86} && \text{Unlike signs give a negative result.}\\ &= -\frac{2\cdot 5}{2\cdot 43} && \text{Prime factorization.}\\ &= -\frac{5}{43} && \text{Cancel common factors.}\end{aligned}$$

57. Since $62 = 2\cdot 31$, both numerator and denominator must be multiplied by $31n$:

$$\begin{aligned}\frac{3}{2} &= \frac{3\cdot 31n}{2\cdot 31n} && \text{Multiply numerator and denominator by } 31n.\\ &= \frac{93n}{62n} && \text{Simplify numerator and denominator.}\end{aligned}$$

59. Since $60 = 10\cdot 6$, both numerator and denominator must be multiplied by $6m$:

$$\begin{aligned}\frac{13}{10} &= \frac{13\cdot 6m}{10\cdot 6m} && \text{Multiply numerator and denominator by } 6m.\\ &= \frac{78m}{60m} && \text{Simplify numerator and denominator.}\end{aligned}$$

61. Since $50 = 2 \cdot 25$, both numerator and denominator must be multiplied by $25n$:

$$\begin{aligned} \frac{3}{2} &= \frac{3 \cdot 25n}{2 \cdot 25n} && \text{Multiply numerator and denominator by } 25n. \\ &= \frac{75n}{50n} && \text{Simplify numerator and denominator.} \end{aligned}$$

63. Both numerator and denominator must be multiplied by $4m$:

$$\begin{aligned} 11 &= \frac{11}{1} && 11 = 11/1. \\ &= \frac{11 \cdot 4m}{1 \cdot 4m} && \text{Multiply numerator and denominator by } 4m. \\ &= \frac{44m}{4m} && \text{Simplify numerator and denominator.} \end{aligned}$$

65. Both numerator and denominator must be multiplied by $10m$:

$$\begin{aligned} 3 &= \frac{3}{1} && 3 = 3/1. \\ &= \frac{3 \cdot 10m}{1 \cdot 10m} && \text{Multiply numerator and denominator by } 10m. \\ &= \frac{30m}{10m} && \text{Simplify numerator and denominator.} \end{aligned}$$

67. Both numerator and denominator must be multiplied by $5n$:

$$\begin{aligned} 6 &= \frac{6}{1} && 6 = 6/1. \\ &= \frac{6 \cdot 5n}{1 \cdot 5n} && \text{Multiply numerator and denominator by } 5n. \\ &= \frac{30n}{5n} && \text{Simplify numerator and denominator.} \end{aligned}$$

69. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned} \frac{82y^5}{-48y} &= -\frac{82y^5}{48y} && \text{Unlike signs give a negative result.} \\ &= -\frac{2 \cdot 41 \cdot y \cdot y \cdot y \cdot y \cdot y}{2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot y} && \text{Prime factorization.} \\ &= -\frac{41 \cdot y \cdot y \cdot y \cdot y}{2 \cdot 2 \cdot 2 \cdot 3} && \text{Cancel common factors.} \\ &= -\frac{41y^4}{24} && \text{Simplify numerator and denominator.} \end{aligned}$$

71. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-77x^5}{44x^4} &= -\frac{77x^5}{44x^4} && \text{Unlike signs give a negative result.}\\
&= -\frac{7\cdot 11\cdot x\cdot x\cdot x\cdot x\cdot x}{2\cdot 2\cdot 11\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{7\cdot x}{2\cdot 2} && \text{Cancel common factors.}\\
&= -\frac{7x}{4} && \text{Simplify numerator and denominator.}
\end{aligned}$$

73. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-14y^5}{54y^2} &= -\frac{14y^5}{54y^2} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 7\cdot y\cdot y\cdot y\cdot y\cdot y}{2\cdot 3\cdot 3\cdot 3\cdot y\cdot y} && \text{Prime factorization.}\\
&= -\frac{7\cdot y\cdot y\cdot y}{3\cdot 3\cdot 3} && \text{Cancel common factors.}\\
&= -\frac{7y^3}{27} && \text{Simplify numerator and denominator.}
\end{aligned}$$

75. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{42x}{81x^3} &= \frac{2\cdot 3\cdot 7\cdot x}{3\cdot 3\cdot 3\cdot 3\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= \frac{2\cdot 7}{3\cdot 3\cdot 3\cdot x\cdot x} && \text{Cancel common factors.}\\
&= \frac{14}{27x^2} && \text{Simplify numerator and denominator.}
\end{aligned}$$

77. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-12x^5}{14x^6} &= -\frac{12x^5}{14x^6} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 3\cdot x\cdot x\cdot x\cdot x\cdot x}{2\cdot 7\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{2\cdot 3}{7\cdot x} && \text{Cancel common factors.}\\
&= -\frac{6}{7x} && \text{Simplify numerator and denominator.}
\end{aligned}$$

79. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-74x}{22x^2} &= -\frac{74x}{22x^2} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 37\cdot x}{2\cdot 11\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{37}{11\cdot x} && \text{Cancel common factors.}\\
&= -\frac{37}{11x} && \text{Simplify numerator and denominator.}
\end{aligned}$$

81. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-12y^5}{98y^6} &= -\frac{12y^5}{98y^6} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 3\cdot y\cdot y\cdot y\cdot y\cdot y}{2\cdot 7\cdot 7\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y} && \text{Prime factorization.}\\
&= -\frac{2\cdot 3}{7\cdot 7\cdot y} && \text{Cancel common factors.}\\
&= -\frac{6}{49y} && \text{Simplify numerator and denominator.}
\end{aligned}$$

83. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{18x^6}{-54x^2} &= -\frac{18x^6}{54x^2} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 3\cdot 3\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x}{2\cdot 3\cdot 3\cdot 3\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{x\cdot x\cdot x\cdot x}{3} && \text{Cancel common factors.}\\
&= -\frac{x^4}{3} && \text{Simplify numerator and denominator.}
\end{aligned}$$

85. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{26y^2x^4}{-62y^6x^2} &= -\frac{26y^2x^4}{62y^6x^2} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 13\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x}{2\cdot 31\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{13\cdot x\cdot x}{31\cdot y\cdot y\cdot y\cdot y} && \text{Cancel common factors.}\\
&= -\frac{13x^2}{31y^4} && \text{Simplify numerator and denominator.}
\end{aligned}$$

87. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-2y^6x^4}{-94y^2x^5} &= \frac{2y^6x^4}{94y^2x^5} && \text{Like signs give a positive result.}\\
&= \frac{2\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x}{2\cdot 47\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= \frac{y\cdot y\cdot y\cdot y}{47\cdot x} && \text{Cancel common factors.}\\
&= \frac{y^4}{47x} && \text{Simplify numerator and denominator.}
\end{aligned}$$

89. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{30y^5x^5}{-26yx^4} &= -\frac{30y^5x^5}{26yx^4} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 3\cdot 5\cdot y\cdot y\cdot y\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x}{2\cdot 13\cdot y\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{3\cdot 5\cdot y\cdot y\cdot y\cdot y\cdot x}{13} && \text{Cancel common factors.}\\
&= -\frac{15y^4x}{13} && \text{Simplify numerator and denominator.}
\end{aligned}$$

91. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{36x^3y^2}{-98x^4y^5} &= -\frac{36x^3y^2}{98x^4y^5} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 3\cdot 3\cdot x\cdot x\cdot x\cdot y\cdot y}{2\cdot 7\cdot 7\cdot x\cdot x\cdot x\cdot x\cdot y\cdot y\cdot y\cdot y\cdot y} && \text{Prime factorization.}\\
&= -\frac{2\cdot 3\cdot 3}{7\cdot 7\cdot x\cdot y\cdot y\cdot y} && \text{Cancel common factors.}\\
&= -\frac{18}{49xy^3} && \text{Simplify numerator and denominator.}
\end{aligned}$$

93. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-8x^6y^3}{54x^3y^5} &= -\frac{8x^6y^3}{54x^3y^5} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 2\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x\cdot y\cdot y\cdot y}{2\cdot 3\cdot 3\cdot 3\cdot x\cdot x\cdot x\cdot y\cdot y\cdot y\cdot y\cdot y} && \text{Prime factorization.}\\
&= -\frac{2\cdot 2\cdot x\cdot x\cdot x}{3\cdot 3\cdot 3\cdot y\cdot y} && \text{Cancel common factors.}\\
&= -\frac{4x^3}{27y^2} && \text{Simplify numerator and denominator.}
\end{aligned}$$

95. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{34yx^6}{-58y^5x^4} &= -\frac{34yx^6}{58y^5x^4} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 17\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x}{2\cdot 29\cdot y\cdot y\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{17\cdot x\cdot x}{29\cdot y\cdot y\cdot y\cdot y} && \text{Cancel common factors.}\\
&= -\frac{17x^2}{29y^4} && \text{Simplify numerator and denominator.}
\end{aligned}$$

97. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{-36y^3x^5}{51y^2x} &= -\frac{36y^3x^5}{51y^2x} && \text{Unlike signs give a negative result.}\\
&= -\frac{2\cdot 2\cdot 3\cdot 3\cdot y\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x}{3\cdot 17\cdot y\cdot y\cdot x} && \text{Prime factorization.}\\
&= -\frac{2\cdot 2\cdot 3\cdot y\cdot x\cdot x\cdot x\cdot x}{17} && \text{Cancel common factors.}\\
&= -\frac{12yx^4}{17} && \text{Simplify numerator and denominator.}
\end{aligned}$$

99. Factor the numerator and denominator and cancel common factors:

$$\begin{aligned}
\frac{91y^3x^2}{-28y^5x^5} &= -\frac{91y^3x^2}{28y^5x^5} && \text{Unlike signs give a negative result.}\\
&= -\frac{7\cdot 13\cdot y\cdot y\cdot y\cdot x\cdot x}{2\cdot 2\cdot 7\cdot y\cdot y\cdot y\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x} && \text{Prime factorization.}\\
&= -\frac{13}{2\cdot 2\cdot y\cdot y\cdot x\cdot x\cdot x} && \text{Cancel common factors.}\\
&= -\frac{13}{4y^2x^3} && \text{Simplify numerator and denominator.}
\end{aligned}$$

101. i) To find the fraction of named storms that grew into hurricanes, find the number of storms that grew into hurricanes for the numerator, with the total number of named storms in the denominator. Then, reduce the fraction if possible.

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

Therefore, 1/2 of the named storms from 2008 grew into hurricanes.

ii) To find the fraction of named storms that became major hurricanes, create a fraction with the number of major hurricanes in the numerator and the total

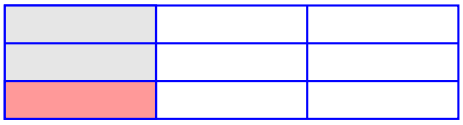
number of named storms in the denominator. Therefore, 5/16 of the named storms from 2008 grew into major hurricanes. Note that this fraction is already in lowest terms.

iii) To find the fraction of hurricanes that were major, create a fraction with the number of major hurricanes in the numerator and the total number of hurricanes in the denominator. Therefore, 5/8 of the hurricanes were major hurricanes. Note that this fraction is already in lowest terms.

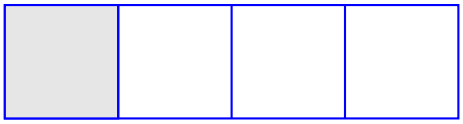
4.2 Multiplying Fractions

1. First, shade 1/3 of the whole. This shaded area represents 1/3.

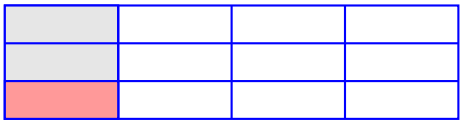
Now shade 1/3 of the shaded area in the previous figure. The result shows that one of nine equally sized rectangles is shaded. This shows that 1/3 of 1/3 is 1/9.



3. First, shade 1/4 of the whole. This shaded area represents 1/4.



Now shade 1/3 of the shaded area in the previous figure. The result shows that one of twelve equally sized rectangles is shaded. This shows that 1/3 of 1/4 is 1/12.



5. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-21}{4} \cdot \frac{22}{19} = -\frac{(3 \cdot 7) \cdot (2 \cdot 11)}{(2 \cdot 2) \cdot (19)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{3 \cdot 7 \cdot 11}{2 \cdot 19}$$ Cancel common factors.

$$= -\frac{231}{38}$$ Multiply numerators and denominators.

7. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{20}{11} \cdot \frac{-17}{22} = -\frac{(2 \cdot 2 \cdot 5) \cdot (17)}{(11) \cdot (2 \cdot 11)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot 5 \cdot 17}{11 \cdot 11}$$ Cancel common factors.

$$= -\frac{170}{121}$$ Multiply numerators and denominators.

9. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{21}{8} \cdot \frac{-14}{15} = -\frac{(3 \cdot 7) \cdot (2 \cdot 7)}{(2 \cdot 2 \cdot 2) \cdot (3 \cdot 5)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{7 \cdot 7}{2 \cdot 2 \cdot 5}$$ Cancel common factors.

$$= -\frac{49}{20}$$ Multiply numerators and denominators.

11. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-5}{11} \cdot \frac{7}{20} = -\frac{(5) \cdot (7)}{(11) \cdot (2 \cdot 2 \cdot 5)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{7}{11 \cdot 2 \cdot 2}$$ Cancel common factors.

$$= -\frac{7}{44}$$ Multiply numerators and denominators.

13. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{8}{13}\cdot\frac{-1}{6} = -\frac{(2\cdot 2\cdot 2)\cdot(1)}{(13)\cdot(2\cdot 3)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2\cdot 2}{13\cdot 3}$$ Cancel common factors.

$$= -\frac{4}{39}$$ Multiply numerators and denominators.

15. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{2}{15}\cdot\frac{-9}{8} = -\frac{(2)\cdot(3\cdot 3)}{(3\cdot 5)\cdot(2\cdot 2\cdot 2)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{3}{5\cdot 2\cdot 2}$$ Cancel common factors.

$$= -\frac{3}{20}$$ Multiply numerators and denominators.

17. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{17}{12}\cdot\frac{3}{4} = \frac{(17)\cdot(3)}{(2\cdot 2\cdot 3)\cdot(2\cdot 2)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{17}{2\cdot 2\cdot 2\cdot 2}$$ Cancel common factors.

$$= \frac{17}{16}$$ Multiply numerators and denominators.

19. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-6}{23}\cdot\frac{9}{10} = -\frac{(2\cdot 3)\cdot(3\cdot 3)}{(23)\cdot(2\cdot 5)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{3\cdot 3\cdot 3}{23\cdot 5}$$ Cancel common factors.

$$= -\frac{27}{115}$$ Multiply numerators and denominators.

21. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-23}{24} \cdot \frac{-6}{17} = \frac{(23) \cdot (2 \cdot 3)}{(2 \cdot 2 \cdot 2 \cdot 3) \cdot (17)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{23}{2 \cdot 2 \cdot 17}$$ Cancel common factors.

$$= \frac{23}{68}$$ Multiply numerators and denominators.

23. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{24}{7} \cdot \frac{5}{2} = \frac{(2 \cdot 2 \cdot 2 \cdot 3) \cdot (5)}{(7) \cdot (2)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2 \cdot 2 \cdot 3 \cdot 5}{7}$$ Cancel common factors.

$$= \frac{60}{7}$$ Multiply numerators and denominators.

25. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{1}{2} \cdot \frac{-8}{11} = -\frac{(1) \cdot (2 \cdot 2 \cdot 2)}{(2) \cdot (11)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot 2}{11}$$ Cancel common factors.

$$= -\frac{4}{11}$$ Multiply numerators and denominators.

27. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-24}{13} \cdot \frac{-7}{18} = \frac{(2 \cdot 2 \cdot 2 \cdot 3) \cdot (7)}{(13) \cdot (2 \cdot 3 \cdot 3)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2 \cdot 2 \cdot 7}{13 \cdot 3}$$ Cancel common factors.

$$= \frac{28}{39}$$ Multiply numerators and denominators.

29. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-12y^3}{13}\cdot\frac{2}{9y^6} = -\frac{(2\cdot 2\cdot 3\cdot y\cdot y\cdot y)\cdot(2)}{(13)\cdot(3\cdot 3\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2\cdot 2\cdot 2}{13\cdot 3\cdot y\cdot y\cdot y}$$ Cancel common factors.

$$= -\frac{8}{39y^3}$$ Multiply numerators and denominators.

31. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{11y^3}{24}\cdot\frac{6}{5y^5} = \frac{(11\cdot y\cdot y\cdot y)\cdot(2\cdot 3)}{(2\cdot 2\cdot 2\cdot 3)\cdot(5\cdot y\cdot y\cdot y\cdot y\cdot y)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{11}{2\cdot 2\cdot 5\cdot y\cdot y}$$ Cancel common factors.

$$= \frac{11}{20y^2}$$ Multiply numerators and denominators.

33. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-8x^2}{21}\cdot\frac{-18}{19x} = \frac{(2\cdot 2\cdot 2\cdot x\cdot x)\cdot(2\cdot 3\cdot 3)}{(3\cdot 7)\cdot(19\cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2\cdot 2\cdot 2\cdot 2\cdot 3\cdot x}{7\cdot 19}$$ Cancel common factors.

$$= \frac{48x}{133}$$ Multiply numerators and denominators.

35. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{13x^6}{15}\cdot\frac{9}{16x^2} = \frac{(13\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x)\cdot(3\cdot 3)}{(3\cdot 5)\cdot(2\cdot 2\cdot 2\cdot 2\cdot x\cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{13\cdot 3\cdot x\cdot x\cdot x\cdot x}{5\cdot 2\cdot 2\cdot 2\cdot 2}$$ Cancel common factors.

$$= \frac{39x^4}{80}$$ Multiply numerators and denominators.

37. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-6y^3}{5}\cdot\frac{-20}{7y^6}=\frac{(2\cdot 3\cdot y\cdot y\cdot y)\cdot(2\cdot 2\cdot 5)}{(5)\cdot(7\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y)}$$

Prime factorization.
Like signs give a positive product.

$$=\frac{2\cdot 3\cdot 2\cdot 2}{7\cdot y\cdot y\cdot y}$$

Cancel common factors.

$$=\frac{24}{7y^3}$$

Multiply numerators and denominators.

39. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-3y^3}{4}\cdot\frac{23}{12y}=-\frac{(3\cdot y\cdot y\cdot y)\cdot(23)}{(2\cdot 2)\cdot(2\cdot 2\cdot 3\cdot y)}$$

Prime factorization.
Unlike signs give a negative product.

$$=-\frac{23\cdot y\cdot y}{2\cdot 2\cdot 2\cdot 2}$$

Cancel common factors.

$$=-\frac{23y^2}{16}$$

Multiply numerators and denominators.

41. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{13y^6}{20x^4}\cdot\frac{2x}{7y^2}=\frac{(13\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y)\cdot(2\cdot x)}{(2\cdot 2\cdot 5\cdot x\cdot x\cdot x\cdot x)\cdot(7\cdot y\cdot y)}$$

Prime factorization.
Like signs give a positive product.

$$=\frac{13\cdot y\cdot y\cdot y\cdot y}{2\cdot 5\cdot 7\cdot x\cdot x\cdot x}$$

Cancel common factors.

$$=\frac{13y^4}{70x^3}$$

Multiply numerators and denominators.

43. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{23y^4}{21x}\cdot\frac{-7x^6}{4y^2}=-\frac{(23\cdot y\cdot y\cdot y\cdot y)\cdot(7\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x)}{(3\cdot 7\cdot x)\cdot(2\cdot 2\cdot y\cdot y)}$$

Prime factorization.
Unlike signs give a negative product.

$$=-\frac{23\cdot y\cdot y\cdot x\cdot x\cdot x\cdot x\cdot x}{3\cdot 2\cdot 2}$$

Cancel common factors.

$$=-\frac{23y^2x^5}{12}$$

Multiply numerators and denominators.

45. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{11y^6}{12x^6}\cdot\frac{-2x^4}{7y^2} = -\frac{(11\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y)\cdot(2\cdot x\cdot x\cdot x\cdot x)}{(2\cdot 2\cdot 3\cdot x\cdot x\cdot x\cdot x\cdot x\cdot x)\cdot(7\cdot y\cdot y)}$$

Prime factorization.
Unlike signs give a negative product.

$$= -\frac{11\cdot y\cdot y\cdot y\cdot y}{2\cdot 3\cdot 7\cdot x\cdot x}$$

Cancel common factors.

$$= -\frac{11y^4}{42x^2}$$

Multiply numerators and denominators.

47. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{x^6}{21y^3}\cdot\frac{-7y^4}{9x^5} = -\frac{(x\cdot x\cdot x\cdot x\cdot x\cdot x)\cdot(7\cdot y\cdot y\cdot y\cdot y)}{(3\cdot 7\cdot y\cdot y\cdot y)\cdot(3\cdot 3\cdot x\cdot x\cdot x\cdot x\cdot x)}$$

Prime factorization.
Unlike signs give a negative product.

$$= -\frac{x\cdot y}{3\cdot 3\cdot 3}$$

Cancel common factors.

$$= -\frac{xy}{27}$$

Multiply numerators and denominators.

49. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{19y^2}{18x}\cdot\frac{10x^3}{7y^3} = \frac{(19\cdot y\cdot y)\cdot(2\cdot 5\cdot x\cdot x\cdot x)}{(2\cdot 3\cdot 3\cdot x)\cdot(7\cdot y\cdot y\cdot y)}$$

Prime factorization.
Like signs give a positive product.

$$= \frac{19\cdot 5\cdot x\cdot x}{3\cdot 3\cdot 7\cdot y}$$

Cancel common factors.

$$= \frac{95x^2}{63y}$$

Multiply numerators and denominators.

51. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-4y^3}{5x^5}\cdot\frac{-10x}{21y^4} = \frac{(2\cdot 2\cdot y\cdot y\cdot y)\cdot(2\cdot 5\cdot x)}{(5\cdot x\cdot x\cdot x\cdot x\cdot x)\cdot(3\cdot 7\cdot y\cdot y\cdot y\cdot y)}$$

Prime factorization.
Like signs give a positive product.

$$= \frac{2\cdot 2\cdot 2}{3\cdot 7\cdot y\cdot x\cdot x\cdot x\cdot x}$$

Cancel common factors.

$$= \frac{8}{21yx^4}$$

Multiply numerators and denominators.

53. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{-16x}{21y^2}\cdot\frac{-7y^3}{5x^2}=\frac{(2\cdot 2\cdot 2\cdot 2\cdot x)\cdot(7\cdot y\cdot y\cdot y)}{(3\cdot 7\cdot y\cdot y)\cdot(5\cdot x\cdot x)}$$ Prime factorization.
Like signs give a positive product.

$$=\frac{2\cdot 2\cdot 2\cdot 2\cdot y}{3\cdot 5\cdot x}$$ Cancel common factors.

$$=\frac{16y}{15x}$$ Multiply numerators and denominators.

55. Factor the numerators and denominators completely, and then cancel common factors:

$$\frac{17x^3}{3y^6}\cdot\frac{-12y^2}{7x^4}=-\frac{(17\cdot x\cdot x\cdot x)\cdot(2\cdot 2\cdot 3\cdot y\cdot y)}{(3\cdot y\cdot y\cdot y\cdot y\cdot y\cdot y)\cdot(7\cdot x\cdot x\cdot x\cdot x)}$$ Prime factorization.
Unlike signs give a negative product.

$$=-\frac{17\cdot 2\cdot 2}{7\cdot x\cdot y\cdot y\cdot y\cdot y}$$ Cancel common factors.

$$=-\frac{68}{7xy^4}$$ Multiply numerators and denominators.

57. To find the area of the parallelogram, find the product of the base and height.

$A=bh$ Area formula for parallelogram.
$=(8\,\text{cm})(7\,\text{cm})$ Substitute: 8 cm for b, 7 cm for h.
$=56\,\text{cm}^2$ Multiply.

Therefore, the area of the parallelogram is 56 square centimeters.

59. To find the area of the parallelogram, find the product of the base and height.

$A=bh$ Area formula for parallelogram.
$=(6\,\text{cm})(13\,\text{cm})$ Substitute: 6 cm for b, 13 cm for h.
$=78\,\text{cm}^2$ Multiply.

Therefore, the area of the parallelogram is 78 square centimeters.

61. To find the area of the parallelogram, find the product of the base and height.

$A=bh$ Area formula for parallelogram.
$=(18\,\text{cm})(14\,\text{cm})$ Substitute: 18 cm for b, 14 cm for h.
$=252\,\text{cm}^2$ Multiply.

Therefore, the area of the parallelogram is 252 square centimeters.

63. To find the area of the triangle, take one-half the product of the base and height.

$$\begin{aligned} A &= \frac{1}{2}bh && \text{Area formula for triangle.} \\ &= \frac{1}{2}(14\,\text{ft})(9\,\text{ft}) && \text{Substitute: } 14\,\text{ft for } b,\ 9\,\text{ft for } h. \\ &= \frac{126\,\text{ft}^2}{2} && \text{Multiply numerators; multiply denominators.} \\ &= 63\,\text{ft}^2. && \text{Divide.} \end{aligned}$$

Therefore, the area of the triangle is 63 square feet.

65. To find the area of the triangle, take one-half the product of the base and height.

$$\begin{aligned} A &= \frac{1}{2}bh && \text{Area formula for triangle.} \\ &= \frac{1}{2}(12\,\text{in})(5\,\text{in}) && \text{Substitute: } 12\,\text{in for } b,\ 5\,\text{in for } h. \\ &= \frac{60\,\text{in}^2}{2} && \text{Multiply numerators; multiply denominators.} \\ &= 30\,\text{in}^2. && \text{Divide.} \end{aligned}$$

Therefore, the area of the triangle is 30 square inches.

67. To find the area of the triangle, take one-half the product of the base and height.

$$\begin{aligned} A &= \frac{1}{2}bh && \text{Area formula for triangle.} \\ &= \frac{1}{2}(5\,\text{cm})(4\,\text{cm}) && \text{Substitute: } 5\,\text{cm for } b,\ 4\,\text{cm for } h. \\ &= \frac{20\,\text{cm}^2}{2} && \text{Multiply numerators; multiply denominators.} \\ &= 10\,\text{cm}^2. && \text{Divide.} \end{aligned}$$

Therefore, the area of the triangle is 10 square centimeters.

69. To find your weight on the moon, take 1/6 of your weight on Earth. In this case, "of" means multiply, so multiply your weight on Earth by 1/6.

$$\begin{aligned}
\frac{1}{6}\cdot 138 &= \frac{1}{6}\cdot\frac{138}{1} && \text{Understood: } 138 = 138/1.\\
&= \frac{138}{6} && \text{Multiply numerators; multiply denominators.}\\
&= \frac{2\cdot 3\cdot 23}{2\cdot 3} && \text{Factor numerator and denominator.}\\
&= \frac{\cancel{2}\cdot\cancel{3}\cdot 23}{\cancel{2}\cdot\cancel{3}} && \text{Cancel common factors.}\\
&= 23 && \text{Remaining factor.}
\end{aligned}$$

Therefore, you would weigh only 23 pounds on the moon.

4.3 Dividing Fractions

1. To find the reciprocal of $-16/5$, we invert (turn upside down) $-16/5$. Thus, the reciprocal of $-16/5$ is $5/(-16) = -5/16$. Since the product of two negatives is positive, the computation

$$\begin{aligned}
-\frac{16}{5}\cdot\left(-\frac{5}{16}\right) &= \frac{16\cdot 5}{5\cdot 16}\\
&= \frac{\cancel{16}\cdot\cancel{5}}{\cancel{5}\cdot\cancel{16}}\\
&= 1,
\end{aligned}$$

confirms that $-5/16$ is the reciprocal of $-16/5$.

3. To find the reciprocal of -17, write $-17 = -17/1$ and invert (turn upside down). Thus, the reciprocal of -17 is $1/(-17) = -1/17$. Since the product of two negatives is positive, the computation

$$\begin{aligned}
-17\cdot\left(-\frac{1}{17}\right) &= -\frac{17}{1}\cdot\left(-\frac{1}{17}\right)\\
&= \frac{17}{17}\\
&= 1,
\end{aligned}$$

confirms that $-1/17$ is the reciprocal of -17.

5. To find the reciprocal of 15/16, we invert (turn upside down) 15/16. Thus, the reciprocal of 15/16 is 16/15. Note that

$$\begin{aligned}\frac{15}{16}\cdot\frac{16}{15} &= \frac{15\cdot 16}{16\cdot 15}\\ &= \frac{\cancel{15}\cdot\cancel{16}}{\cancel{16}\cdot\cancel{15}}\\ &= 1,\end{aligned}$$

confirming that 16/15 is the reciprocal of 15/16.

7. To find the reciprocal of 30, write $30 = 30/1$ and invert (turn upside down). Thus, the reciprocal of 30 is 1/30. Note that

$$\begin{aligned}30\cdot\frac{1}{30} &= \frac{30}{1}\cdot\frac{1}{30}\\ &= \frac{30}{30}\\ &= 1,\end{aligned}$$

confirming that 1/30 is the reciprocal of 30.

9. To find the reciprocal of -46, write $-46 = -46/1$ and invert (turn upside down). Thus, the reciprocal of -46 is $1/(-46) = -1/46$. Since the product of two negatives is positive, the computation

$$\begin{aligned}-46\cdot\left(-\frac{1}{46}\right) &= -\frac{46}{1}\cdot\left(-\frac{1}{46}\right)\\ &= \frac{46}{46}\\ &= 1,\end{aligned}$$

confirms that $-1/46$ is the reciprocal of -46.

11. To find the reciprocal of $-9/19$, we invert (turn upside down) $-9/19$. Thus, the reciprocal of $-9/19$ is $19/(-9) = -19/9$. Since the product of two negatives is positive, the computation

$$\begin{aligned}-\frac{9}{19}\cdot\left(-\frac{19}{9}\right) &= \frac{9\cdot 19}{19\cdot 9}\\ &= \frac{\cancel{9}\cdot\cancel{19}}{\cancel{19}\cdot\cancel{9}}\\ &= 1,\end{aligned}$$

confirms that $-19/9$ is the reciprocal of $-9/19$.

13. To find the reciprocal of 3/17, we invert (turn upside down) 3/17. Thus, the reciprocal of 3/17 is 17/3. Note that

$$\begin{aligned}\frac{3}{17}\cdot\frac{17}{3} &= \frac{3\cdot 17}{17\cdot 3}\\ &= \frac{\cancel{3}\cdot\cancel{17}}{\cancel{17}\cdot\cancel{3}}\\ &= 1,\end{aligned}$$

confirming that 17/3 is the reciprocal of 3/17.

15. To find the reciprocal of 11, write $11 = 11/1$ and invert (turn upside down). Thus, the reciprocal of 11 is 1/11. Note that

$$\begin{aligned}11\cdot\frac{1}{11} &= \frac{11}{1}\cdot\frac{1}{11}\\ &= \frac{11}{11}\\ &= 1,\end{aligned}$$

confirming that 1/11 is the reciprocal of 11.

17. Because the given identity

$$\frac{2}{9}\cdot\frac{9}{2} = 1$$

has the form

$$\frac{a}{b}\cdot\frac{b}{a} = 1,$$

this is an example of the multiplicative inverse property.

19. Because the given identity

$$\frac{-19}{12}\cdot 1 = \frac{-19}{12}$$

has the form

$$\frac{a}{b}\cdot 1 = \frac{a}{b},$$

this is an example of the multiplicative identity property.

21. The given identity

$$-6 \cdot \left(-\frac{1}{6}\right) = 1$$

is equivalent to

$$\frac{-6}{1} \cdot \left(\frac{1}{-6}\right) = 1,$$

which has the form

$$\frac{a}{b} \cdot \frac{b}{a} = 1.$$

Therefore, this is an example of the multiplicative inverse property.

23. Because the given identity

$$\frac{-16}{11} \cdot 1 = \frac{-16}{11}$$

has the form

$$\frac{a}{b} \cdot 1 = \frac{a}{b},$$

this is an example of the multiplicative identity property.

25. Because the given identity

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

has the form

$$\frac{a}{b} \cdot \frac{b}{a} = 1,$$

this is an example of the multiplicative inverse property.

27. Because the given identity

$$\frac{8}{1} \cdot 1 = \frac{8}{1}$$

has the form

$$\frac{a}{b} \cdot 1 = \frac{a}{b},$$

this is an example of the multiplicative identity property.

29. The given identity

$$14 \cdot \frac{1}{14} = 1$$

is equivalent to

$$\frac{14}{1} \cdot \frac{1}{14} = 1,$$

which has the form

$$\frac{a}{b} \cdot \frac{b}{a} = 1.$$

Therefore, this is an example of the multiplicative inverse property.

31. Because the given identity

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

has the form

$$\frac{a}{b} \cdot 1 = \frac{a}{b},$$

this is an example of the multiplicative identity property.

33. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{8}{23} \div \frac{-6}{11} &= \frac{8}{23} \cdot \frac{11}{-6} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 2 \cdot 2) \cdot (11)}{(23) \cdot (2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 2 \cdot 11}{23 \cdot 3} && \text{Cancel common factors.} \\
&= -\frac{44}{69} && \text{Multiply numerators and denominators.}
\end{aligned}$$

35. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{18}{19} \div \frac{-16}{23} &= \frac{18}{19} \cdot \frac{23}{-16} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 3 \cdot 3) \cdot (23)}{(19) \cdot (2 \cdot 2 \cdot 2 \cdot 2)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{3 \cdot 3 \cdot 23}{19 \cdot 2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= -\frac{207}{152} && \text{Multiply numerators and denominators.}
\end{aligned}$$

37. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{4}{21} \div \frac{-6}{5} &= \frac{4}{21} \cdot \frac{5}{-6} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 2) \cdot (5)}{(3 \cdot 7) \cdot (2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 5}{3 \cdot 7 \cdot 3} && \text{Cancel common factors.} \\
&= -\frac{10}{63} && \text{Multiply numerators and denominators.}
\end{aligned}$$

39. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{-1}{9} \div \frac{8}{3} &= \frac{-1}{9} \cdot \frac{3}{8} && \text{Invert the second fraction.} \\
&= -\frac{(1) \cdot (3)}{(3 \cdot 3) \cdot (2 \cdot 2 \cdot 2)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{1}{3 \cdot 2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= -\frac{1}{24} && \text{Multiply numerators and denominators.}
\end{aligned}$$

41. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{-21}{11} \div \frac{3}{10} &= \frac{-21}{11} \cdot \frac{10}{3} && \text{Invert the second fraction.} \\
&= -\frac{(3 \cdot 7) \cdot (2 \cdot 5)}{(11) \cdot (3)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{7 \cdot 2 \cdot 5}{11} && \text{Cancel common factors.} \\
&= -\frac{70}{11} && \text{Multiply numerators and denominators.}
\end{aligned}$$

43. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{-12}{7} \div \frac{2}{3} &= \frac{-12}{7} \cdot \frac{3}{2} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 2 \cdot 3) \cdot (3)}{(7) \cdot (2)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 3 \cdot 3}{7} && \text{Cancel common factors.} \\
&= -\frac{18}{7} && \text{Multiply numerators and denominators.}
\end{aligned}$$

45. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{2}{19} \div \frac{24}{23} &= \frac{2}{19} \cdot \frac{23}{24} && \text{Invert the second fraction.} \\
&= \frac{(2) \cdot (23)}{(19) \cdot (2 \cdot 2 \cdot 2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{23}{19 \cdot 2 \cdot 2 \cdot 3} && \text{Cancel common factors.} \\
&= \frac{23}{228} && \text{Multiply numerators and denominators.}
\end{aligned}$$

47. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{-9}{5} \div \frac{-24}{19} &= \frac{-9}{5} \cdot \frac{19}{-24} && \text{Invert the second fraction.} \\
&= \frac{(3 \cdot 3) \cdot (19)}{(5) \cdot (2 \cdot 2 \cdot 2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{3 \cdot 19}{5 \cdot 2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= \frac{57}{40} && \text{Multiply numerators and denominators.}
\end{aligned}$$

49. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{18}{11} \div \frac{14}{9} &= \frac{18}{11} \cdot \frac{9}{14} && \text{Invert the second fraction.} \\
&= \frac{(2 \cdot 3 \cdot 3) \cdot (3 \cdot 3)}{(11) \cdot (2 \cdot 7)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{3 \cdot 3 \cdot 3 \cdot 3}{11 \cdot 7} && \text{Cancel common factors.} \\
&= \frac{81}{77} && \text{Multiply numerators and denominators.}
\end{aligned}$$

51. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{13}{18} \div \frac{4}{9} &= \frac{13}{18} \cdot \frac{9}{4} && \text{Invert the second fraction.} \\
&= \frac{(13) \cdot (3 \cdot 3)}{(2 \cdot 3 \cdot 3) \cdot (2 \cdot 2)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{13}{2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= \frac{13}{8} && \text{Multiply numerators and denominators.}
\end{aligned}$$

53. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{11}{2} \div \frac{-21}{10} &= \frac{11}{2} \cdot \frac{10}{-21} && \text{Invert the second fraction.} \\
&= -\frac{(11) \cdot (2 \cdot 5)}{(2) \cdot (3 \cdot 7)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{11 \cdot 5}{3 \cdot 7} && \text{Cancel common factors.} \\
&= -\frac{55}{21} && \text{Multiply numerators and denominators.}
\end{aligned}$$

55. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{3}{10} \div \frac{12}{5} &= \frac{3}{10} \cdot \frac{5}{12} && \text{Invert the second fraction.} \\
&= \frac{(3) \cdot (5)}{(2 \cdot 5) \cdot (2 \cdot 2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{1}{2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= \frac{1}{8} && \text{Multiply numerators and denominators.}
\end{aligned}$$

57. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{20}{17} \div 5 &= \frac{20}{17} \div \frac{5}{1} && 5 = 5/1. \\
&= \frac{20}{17} \cdot \frac{1}{5} && \text{Invert the second fraction.} \\
&= \frac{(2 \cdot 2 \cdot 5) \cdot (1)}{(17) \cdot (5)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{2 \cdot 2}{17} && \text{Cancel common factors.} \\
&= \frac{4}{17} && \text{Multiply numerators and denominators.}
\end{aligned}$$

59. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
-7 \div \frac{21}{20} &= \frac{-7}{1} \div \frac{21}{20} && -7 = -7/1. \\
&= \frac{-7}{1} \cdot \frac{20}{21} && \text{Invert the second fraction.} \\
&= -\frac{(7) \cdot (2 \cdot 2 \cdot 5)}{(1) \cdot (3 \cdot 7)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 2 \cdot 5}{3} && \text{Cancel common factors.} \\
&= -\frac{20}{3} && \text{Multiply numerators and denominators.}
\end{aligned}$$

61. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{8}{21} \div 2 &= \frac{8}{21} \div \frac{2}{1} && 2 = 2/1. \\
&= \frac{8}{21} \cdot \frac{1}{2} && \text{Invert the second fraction.} \\
&= \frac{(2 \cdot 2 \cdot 2) \cdot (1)}{(3 \cdot 7) \cdot (2)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{2 \cdot 2}{3 \cdot 7} && \text{Cancel common factors.} \\
&= \frac{4}{21} && \text{Multiply numerators and denominators.}
\end{aligned}$$

63. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
8 \div \frac{-10}{17} &= \frac{8}{1} \div \frac{-10}{17} && 8 = 8/1. \\
&= \frac{8}{1} \cdot \frac{17}{-10} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 2 \cdot 2) \cdot (17)}{(1) \cdot (2 \cdot 5)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 2 \cdot 17}{5} && \text{Cancel common factors.} \\
&= -\frac{68}{5} && \text{Multiply numerators and denominators.}
\end{aligned}$$

65. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
-8 \div \frac{18}{5} &= \frac{-8}{1} \div \frac{18}{5} && -8 = -8/1. \\
&= \frac{-8}{1} \cdot \frac{5}{18} && \text{Invert the second fraction.} \\
&= -\frac{(2 \cdot 2 \cdot 2) \cdot (5)}{(1) \cdot (2 \cdot 3 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 2 \cdot 5}{3 \cdot 3} && \text{Cancel common factors.} \\
&= -\frac{20}{9} && \text{Multiply numerators and denominators.}
\end{aligned}$$

67. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{3}{4} \div (-9) &= \frac{3}{4} \div \frac{-9}{1} && -9 = -9/1. \\
&= \frac{3}{4} \cdot \frac{1}{-9} && \text{Invert the second fraction.} \\
&= -\frac{(3) \cdot (1)}{(2 \cdot 2) \cdot (3 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{1}{2 \cdot 2 \cdot 3} && \text{Cancel common factors.} \\
&= -\frac{1}{12} && \text{Multiply numerators and denominators.}
\end{aligned}$$

69. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{11x^2}{12} \div \frac{8x^4}{3} &= \frac{11x^2}{12} \cdot \frac{3}{8x^4} && \text{Invert the second fraction.} \\
&= \frac{(11 \cdot x \cdot x) \cdot (3)}{(2 \cdot 2 \cdot 3) \cdot (2 \cdot 2 \cdot 2 \cdot x \cdot x \cdot x \cdot x)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{11}{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot x \cdot x} && \text{Cancel common factors.} \\
&= \frac{11}{32x^2} && \text{Multiply numerators and denominators.}
\end{aligned}$$

71. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\begin{aligned}
\frac{17y}{9} \div \frac{10y^6}{3} &= \frac{17y}{9} \cdot \frac{3}{10y^6} && \text{Invert the second fraction.} \\
&= \frac{(17 \cdot y) \cdot (3)}{(3 \cdot 3) \cdot (2 \cdot 5 \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{17}{3 \cdot 2 \cdot 5 \cdot y \cdot y \cdot y \cdot y \cdot y} && \text{Cancel common factors.} \\
&= \frac{17}{30y^5} && \text{Multiply numerators and denominators.}
\end{aligned}$$

73. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-22x^4}{13} \div \frac{12x}{11} = \frac{-22x^4}{13} \cdot \frac{11}{12x}$$ Invert the second fraction.

$$= -\frac{(2 \cdot 11 \cdot x \cdot x \cdot x \cdot x) \cdot (11)}{(13) \cdot (2 \cdot 2 \cdot 3 \cdot x)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{11 \cdot 11 \cdot x \cdot x \cdot x}{13 \cdot 2 \cdot 3}$$ Cancel common factors.

$$= -\frac{121x^3}{78}$$ Multiply numerators and denominators.

75. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-3x^4}{10} \div \frac{-4x}{5} = \frac{-3x^4}{10} \cdot \frac{5}{-4x}$$ Invert the second fraction.

$$= \frac{(3 \cdot x \cdot x \cdot x \cdot x) \cdot (5)}{(2 \cdot 5) \cdot (2 \cdot 2 \cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{3 \cdot x \cdot x \cdot x}{2 \cdot 2 \cdot 2}$$ Cancel common factors.

$$= \frac{3x^3}{8}$$ Multiply numerators and denominators.

77. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-15y^2}{14} \div \frac{-10y^5}{13} = \frac{-15y^2}{14} \cdot \frac{13}{-10y^5}$$ Invert the second fraction.

$$= \frac{(3 \cdot 5 \cdot y \cdot y) \cdot (13)}{(2 \cdot 7) \cdot (2 \cdot 5 \cdot y \cdot y \cdot y \cdot y \cdot y)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{3 \cdot 13}{2 \cdot 7 \cdot 2 \cdot y \cdot y \cdot y}$$ Cancel common factors.

$$= \frac{39}{28y^3}$$ Multiply numerators and denominators.

79. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-15x^5}{13} \div \frac{20x^2}{19} = \frac{-15x^5}{13} \cdot \frac{19}{20x^2}$$ Invert the second fraction.

$$= -\frac{(3 \cdot 5 \cdot x \cdot x \cdot x \cdot x \cdot x) \cdot (19)}{(13) \cdot (2 \cdot 2 \cdot 5 \cdot x \cdot x)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{3 \cdot 19 \cdot x \cdot x \cdot x}{13 \cdot 2 \cdot 2}$$ Cancel common factors.

$$= -\frac{57x^3}{52}$$ Multiply numerators and denominators.

81. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{11y^4}{14x^2} \div \frac{-9y^2}{7x^3} = \frac{11y^4}{14x^2} \cdot \frac{7x^3}{-9y^2}$$ Invert the second fraction.

$$= -\frac{(11 \cdot y \cdot y \cdot y \cdot y) \cdot (7 \cdot x \cdot x \cdot x)}{(2 \cdot 7 \cdot x \cdot x) \cdot (3 \cdot 3 \cdot y \cdot y)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{11 \cdot y \cdot y \cdot x}{2 \cdot 3 \cdot 3}$$ Cancel common factors.

$$= -\frac{11y^2x}{18}$$ Multiply numerators and denominators.

83. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{10x^4}{3y^4} \div \frac{7x^5}{24y^2} = \frac{10x^4}{3y^4} \cdot \frac{24y^2}{7x^5}$$ Invert the second fraction.

$$= \frac{(2 \cdot 5 \cdot x \cdot x \cdot x \cdot x) \cdot (2 \cdot 2 \cdot 2 \cdot 3 \cdot y \cdot y)}{(3 \cdot y \cdot y \cdot y \cdot y) \cdot (7 \cdot x \cdot x \cdot x \cdot x \cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2 \cdot 5 \cdot 2 \cdot 2 \cdot 2}{7 \cdot x \cdot y \cdot y}$$ Cancel common factors.

$$= \frac{80}{7xy^2}$$ Multiply numerators and denominators.

85. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{22y^4}{21x^5} \div \frac{-5y^2}{6x^4} = \frac{22y^4}{21x^5} \cdot \frac{6x^4}{-5y^2}$$ Invert the second fraction.

$$= -\frac{(2 \cdot 11 \cdot y \cdot y \cdot y \cdot y) \cdot (2 \cdot 3 \cdot x \cdot x \cdot x \cdot x)}{(3 \cdot 7 \cdot x \cdot x \cdot x \cdot x \cdot x) \cdot (5 \cdot y \cdot y)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot 11 \cdot 2 \cdot y \cdot y}{7 \cdot 5 \cdot x}$$ Cancel common factors.

$$= -\frac{44y^2}{35x}$$ Multiply numerators and denominators.

87. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-22x^4}{21y^3} \div \frac{-17x^3}{3y^4} = \frac{-22x^4}{21y^3} \cdot \frac{3y^4}{-17x^3}$$ Invert the second fraction.

$$= \frac{(2 \cdot 11 \cdot x \cdot x \cdot x \cdot x) \cdot (3 \cdot y \cdot y \cdot y \cdot y)}{(3 \cdot 7 \cdot y \cdot y \cdot y) \cdot (17 \cdot x \cdot x \cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2 \cdot 11 \cdot x \cdot y}{7 \cdot 17}$$ Cancel common factors.

$$= \frac{22xy}{119}$$ Multiply numerators and denominators.

89. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-16y^2}{3x^3} \div \frac{2y^6}{11x^5} = \frac{-16y^2}{3x^3} \cdot \frac{11x^5}{2y^6}$$ Invert the second fraction.

$$= -\frac{(2 \cdot 2 \cdot 2 \cdot 2 \cdot y \cdot y) \cdot (11 \cdot x \cdot x \cdot x \cdot x \cdot x)}{(3 \cdot x \cdot x \cdot x) \cdot (2 \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot 2 \cdot 2 \cdot 11 \cdot x \cdot x}{3 \cdot y \cdot y \cdot y \cdot y}$$ Cancel common factors.

$$= -\frac{88x^2}{3y^4}$$ Multiply numerators and denominators.

91. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-x}{12y^4} \div \frac{-23x^3}{16y^3} = \frac{-x}{12y^4} \cdot \frac{16y^3}{-23x^3}$$ Invert the second fraction.

$$= \frac{(x) \cdot (2 \cdot 2 \cdot 2 \cdot 2 \cdot y \cdot y \cdot y)}{(2 \cdot 2 \cdot 3 \cdot y \cdot y \cdot y \cdot y) \cdot (23 \cdot x \cdot x \cdot x)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{2 \cdot 2}{3 \cdot 23 \cdot x \cdot x \cdot y}$$ Cancel common factors.

$$= \frac{4}{69x^2y}$$ Multiply numerators and denominators.

93. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{y^2}{4x} \div \frac{-9y^5}{8x^3} = \frac{y^2}{4x} \cdot \frac{8x^3}{-9y^5}$$ Invert the second fraction.

$$= -\frac{(y \cdot y) \cdot (2 \cdot 2 \cdot 2 \cdot x \cdot x \cdot x)}{(2 \cdot 2 \cdot x) \cdot (3 \cdot 3 \cdot y \cdot y \cdot y \cdot y \cdot y)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot x \cdot x}{3 \cdot 3 \cdot y \cdot y \cdot y}$$ Cancel common factors.

$$= -\frac{2x^2}{9y^3}$$ Multiply numerators and denominators.

95. First rewrite as a multiplication problem. Then factor the numererators and denominators completely and cancel common factors:

$$\frac{-18x^6}{13y^4} \div \frac{3x}{y^2} = \frac{-18x^6}{13y^4} \cdot \frac{y^2}{3x}$$ Invert the second fraction.

$$= -\frac{(2 \cdot 3 \cdot 3 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x) \cdot (y \cdot y)}{(13 \cdot y \cdot y \cdot y \cdot y) \cdot (3 \cdot x)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{2 \cdot 3 \cdot x \cdot x \cdot x \cdot x \cdot x}{13 \cdot y \cdot y}$$ Cancel common factors.

$$= -\frac{6x^5}{13y^2}$$ Multiply numerators and denominators.

4.4 Adding and Subtracting Fractions

1. List the multiples of 9:

$$9, 18, 27, 36, 45, 54, 63, 72, 81, 90,$$
$$99, 108, 117, 126, 135, 144, 153, 162, 171, 180, \ldots$$

List the multiples of 15:

$$15, 30, 45, 60, 75, 90, 105, 120, 135, 150,$$
$$165, 180, 195, 210, 225, 240, 255, 270, 285, 300, \ldots$$

List the common multiples of 9 and 15:

$$45, 90, 135, 180, \ldots$$

Therefore, the least common multiple is

$$\text{LCM} = 45.$$

3. List the multiples of 20:

$$20, 40, 60, 80, 100, 120, 140, 160, 180, 200,$$
$$220, 240, 260, 280, 300, 320, 340, 360, 380, 400, \ldots$$

List the multiples of 8:

$$8, 16, 24, 32, 40, 48, 56, 64, 72, 80,$$
$$88, 96, 104, 112, 120, 128, 136, 144, 152, 160, \ldots$$

List the common multiples of 20 and 8:

$$40, 80, 120, 160, \ldots$$

Therefore, the least common multiple is

$$\text{LCM} = 40.$$

5. List the multiples of 16:

$$16, 32, 48, 64, 80, 96, 112, 128, 144, 160,$$
$$176, 192, 208, 224, 240, 256, 272, 288, 304, 320, \ldots$$

List the multiples of 20:

$$20, 40, 60, 80, 100, 120, 140, 160, 180, 200,$$
$$220, 240, 260, 280, 300, 320, 340, 360, 380, 400, \ldots$$

List the common multiples of 16 and 20:

$$80, 160, 240, 320, \ldots$$

Therefore, the least common multiple is

$$\text{LCM} = 80.$$

7. List the multiples of 20:

$$20, 40, 60, 80, 100, 120, 140, 160, 180, 200,$$
$$220, 240, 260, 280, 300, 320, 340, 360, 380, 400, \ldots$$

List the multiples of 12:

$$12, 24, 36, 48, 60, 72, 84, 96, 108, 120,$$
$$132, 144, 156, 168, 180, 192, 204, 216, 228, 240, \ldots$$

List the common multiples of 20 and 12:

$$60, 120, 180, 240, \ldots$$

Therefore, the least common multiple is

$$\text{LCM} = 60.$$

9. List the multiples of 10:

$$10, 20, 30, 40, 50, 60, 70, 80, 90, 100,$$
$$110, 120, 130, 140, 150, 160, 170, 180, 190, 200, \ldots$$

List the multiples of 6:

$$6, 12, 18, 24, 30, 36, 42, 48, 54, 60,$$
$$66, 72, 78, 84, 90, 96, 102, 108, 114, 120, \ldots$$

List the common multiples of 10 and 6:

$$30, 60, 90, 120, \ldots$$

Therefore, the least common multiple is

$$\text{LCM} = 30.$$

11. Prime factor each number and place the result in compact form using exponents.

$$54 = 2^1 \cdot 3^3$$
$$12 = 2^2 \cdot 3^1$$

Write each prime factor that appears above to the highest power that appears above.

$$\text{LCM} = 2^2 \cdot 3^3 \qquad \text{Each factor to highest power.}$$

Expand and simplify.

$$= 4 \cdot 27 \qquad \text{Expand: } 2^2 = 4,\ 3^3 = 27.$$
$$= 108 \qquad \text{Multiply.}$$

Therefore, the LCM of 54 and 12 is 108.

13. Prime factor each number and place the result in compact form using exponents.

$$18 = 2^1 \cdot 3^2$$
$$24 = 2^3 \cdot 3^1$$

Write each prime factor that appears above to the highest power that appears above.

$$\text{LCM} = 2^3 \cdot 3^2 \qquad \text{Each factor to highest power.}$$

Expand and simplify.

$$= 8 \cdot 9 \qquad \text{Expand: } 2^3 = 8,\ 3^2 = 9.$$
$$= 72 \qquad \text{Multiply.}$$

Therefore, the LCM of 18 and 24 is 72.

15. Prime factor each number and place the result in compact form using exponents.

$$72 = 2^3 \cdot 3^2$$
$$108 = 2^2 \cdot 3^3$$

Write each prime factor that appears above to the highest power that appears above.

$$\text{LCM} = 2^3 \cdot 3^3 \qquad \text{Each factor to highest power.}$$

Expand and simplify.

$$= 8 \cdot 27 \qquad \text{Expand: } 2^3 = 8,\ 3^3 = 27.$$
$$= 216 \qquad \text{Multiply.}$$

Therefore, the LCM of 72 and 108 is 216.

17. Prime factor each number and place the result in compact form using exponents.

$$36 = 2^2 \cdot 3^2$$
$$24 = 2^3 \cdot 3^1$$

Write each prime factor that appears above to the highest power that appears above.

$$\text{LCM} = 2^3 \cdot 3^2 \qquad \text{Each factor to highest power.}$$

Expand and simplify.

$$\begin{aligned} &= 8 \cdot 9 && \text{Expand: } 2^3 = 8,\ 3^2 = 9. \\ &= 72 && \text{Multiply.} \end{aligned}$$

Therefore, the LCM of 36 and 24 is 72.

19. Prime factor each number and place the result in compact form using exponents.

$$\begin{aligned} 12 &= 2^2 \cdot 3^1 \\ 18 &= 2^1 \cdot 3^2 \end{aligned}$$

Write each prime factor that appears above to the highest power that appears above.

$$\text{LCM} = 2^2 \cdot 3^2 \qquad \text{Each factor to highest power.}$$

Expand and simplify.

$$\begin{aligned} &= 4 \cdot 9 && \text{Expand: } 2^2 = 4,\ 3^2 = 9. \\ &= 36 && \text{Multiply.} \end{aligned}$$

Therefore, the LCM of 12 and 18 is 36.

21. Since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{7}{12} - \frac{1}{12} &= \frac{7-1}{12} && \text{Subtract numerators over common denominator.} \\ &= \frac{6}{12} && \text{Simplify numerator.} \\ &= \frac{1}{2} && \text{Reduce to lowest terms.} \end{aligned}$$

23. Since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{1}{9}+\frac{1}{9} &= \frac{1+1}{9} && \text{Add numerators over common denominator.} \\ &= \frac{2}{9} && \text{Simplify numerator.} \end{aligned}$$

25. Since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{1}{5}-\frac{4}{5} &= \frac{1-4}{5} && \text{Subtract numerators over common denominator.} \\ &= -\frac{3}{5} && \text{Simplify numerator.} \end{aligned}$$

27. Since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{3}{7}-\frac{4}{7} &= \frac{3-4}{7} && \text{Subtract numerators over common denominator.} \\ &= -\frac{1}{7} && \text{Simplify numerator.} \end{aligned}$$

29. Since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{4}{11}+\frac{9}{11} &= \frac{4+9}{11} && \text{Add numerators over common denominator.} \\ &= \frac{13}{11} && \text{Simplify numerator.} \end{aligned}$$

31. Since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{3}{11}+\frac{4}{11} &= \frac{3+4}{11} && \text{Add numerators over common denominator.} \\ &= \frac{7}{11} && \text{Simplify numerator.} \end{aligned}$$

33. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{6}-\frac{1}{8} &= \frac{1\cdot 4}{6\cdot 4}-\frac{1\cdot 3}{8\cdot 3} && \text{Equivalent fractions with LCD} = 24.\\
&= \frac{4}{24}-\frac{3}{24} && \text{Simplify numerators and denominators.}\\
&= \frac{4-3}{24} && \text{Subtract numerators over common denominator.}\\
&= \frac{1}{24} && \text{Simplify numerator.}
\end{aligned}$$

35. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{5}+\frac{2}{3} &= \frac{1\cdot 3}{5\cdot 3}+\frac{2\cdot 5}{3\cdot 5} && \text{Equivalent fractions with LCD} = 15.\\
&= \frac{3}{15}+\frac{10}{15} && \text{Simplify numerators and denominators.}\\
&= \frac{3+10}{15} && \text{Add numerators over common denominator.}\\
&= \frac{13}{15} && \text{Simplify numerator.}
\end{aligned}$$

37. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{2}{3}+\frac{5}{8} &= \frac{2\cdot 8}{3\cdot 8}+\frac{5\cdot 3}{8\cdot 3} && \text{Equivalent fractions with LCD} = 24.\\
&= \frac{16}{24}+\frac{15}{24} && \text{Simplify numerators and denominators.}\\
&= \frac{16+15}{24} && \text{Add numerators over common denominator.}\\
&= \frac{31}{24} && \text{Simplify numerator.}
\end{aligned}$$

39. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the

common denominator and simplify.

$$\begin{aligned}
\frac{4}{7}-\frac{5}{9} &= \frac{4\cdot 9}{7\cdot 9}-\frac{5\cdot 7}{9\cdot 7} && \text{Equivalent fractions with LCD} = 63.\\
&= \frac{36}{63}-\frac{35}{63} && \text{Simplify numerators and denominators.}\\
&= \frac{36-35}{63} && \text{Subtract numerators over common denominator.}\\
&= \frac{1}{63} && \text{Simplify numerator.}
\end{aligned}$$

41. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{2}{3}-\frac{3}{8} &= \frac{2\cdot 8}{3\cdot 8}-\frac{3\cdot 3}{8\cdot 3} && \text{Equivalent fractions with LCD} = 24.\\
&= \frac{16}{24}-\frac{9}{24} && \text{Simplify numerators and denominators.}\\
&= \frac{16-9}{24} && \text{Subtract numerators over common denominator.}\\
&= \frac{7}{24} && \text{Simplify numerator.}
\end{aligned}$$

43. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{6}{7}-\frac{1}{6} &= \frac{6\cdot 6}{7\cdot 6}-\frac{1\cdot 7}{6\cdot 7} && \text{Equivalent fractions with LCD} = 42.\\
&= \frac{36}{42}-\frac{7}{42} && \text{Simplify numerators and denominators.}\\
&= \frac{36-7}{42} && \text{Subtract numerators over common denominator.}\\
&= \frac{29}{42} && \text{Simplify numerator.}
\end{aligned}$$

45. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the com-

mon denominator and simplify.

$$\begin{aligned}
\frac{1}{6}+\frac{2}{3} &= \frac{1}{6}+\frac{2\cdot 2}{3\cdot 2} && \text{Equivalent fractions with LCD} = 6.\\
&= \frac{1}{6}+\frac{4}{6} && \text{Simplify numerators and denominators.}\\
&= \frac{1+4}{6} && \text{Add numerators over common denominator.}\\
&= \frac{5}{6} && \text{Simplify numerator.}
\end{aligned}$$

47. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{7}{9}+\frac{1}{8} &= \frac{7\cdot 8}{9\cdot 8}+\frac{1\cdot 9}{8\cdot 9} && \text{Equivalent fractions with LCD} = 72.\\
&= \frac{56}{72}+\frac{9}{72} && \text{Simplify numerators and denominators.}\\
&= \frac{56+9}{72} && \text{Add numerators over common denominator.}\\
&= \frac{65}{72} && \text{Simplify numerator.}
\end{aligned}$$

49. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{3}+\frac{1}{7} &= \frac{1\cdot 7}{3\cdot 7}+\frac{1\cdot 3}{7\cdot 3} && \text{Equivalent fractions with LCD} = 21.\\
&= \frac{7}{21}+\frac{3}{21} && \text{Simplify numerators and denominators.}\\
&= \frac{7+3}{21} && \text{Add numerators over common denominator.}\\
&= \frac{10}{21} && \text{Simplify numerator.}
\end{aligned}$$

51. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the

common denominator and simplify.

$$\begin{aligned}
\frac{1}{2}-\frac{2}{7} &= \frac{1\cdot 7}{2\cdot 7}-\frac{2\cdot 2}{7\cdot 2} && \text{Equivalent fractions with LCD} = 14.\\
&= \frac{7}{14}-\frac{4}{14} && \text{Simplify numerators and denominators.}\\
&= \frac{7-4}{14} && \text{Subtract numerators over common denominator.}\\
&= \frac{3}{14} && \text{Simplify numerator.}
\end{aligned}$$

53. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{5}{6}-\frac{4}{5} &= \frac{5\cdot 5}{6\cdot 5}-\frac{4\cdot 6}{5\cdot 6} && \text{Equivalent fractions with LCD} = 30.\\
&= \frac{25}{30}-\frac{24}{30} && \text{Simplify numerators and denominators.}\\
&= \frac{25-24}{30} && \text{Subtract numerators over common denominator.}\\
&= \frac{1}{30} && \text{Simplify numerator.}
\end{aligned}$$

55. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{3}+\frac{1}{8} &= \frac{1\cdot 8}{3\cdot 8}+\frac{1\cdot 3}{8\cdot 3} && \text{Equivalent fractions with LCD} = 24.\\
&= \frac{8}{24}+\frac{3}{24} && \text{Simplify numerators and denominators.}\\
&= \frac{8+3}{24} && \text{Add numerators over common denominator.}\\
&= \frac{11}{24} && \text{Simplify numerator.}
\end{aligned}$$

57. Prime factor each denominator and place the result in compact form using exponents.

$$36 = 2^2\cdot 3^2$$
$$54 = 2^1\cdot 3^3$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^2\cdot 3^3 = 108$$

Next, create equivalent fractions with an LCD = 108.

$$\begin{aligned}
\frac{7}{36}+\frac{11}{54} &= \frac{7\cdot 3}{36\cdot 3}+\frac{11\cdot 2}{54\cdot 2} && \text{Equivalent fractions, LCD = 108.}\\
&= \frac{21}{108}+\frac{22}{108} && \text{Simplify numerators and denominators.}\\
&= \frac{21+22}{108} && \text{Add numerators over common denominator.}\\
&= \frac{43}{108} && \text{Simplify numerator.}
\end{aligned}$$

59. Prime factor each denominator and place the result in compact form using exponents.

$$18 = 2^1 \cdot 3^2$$
$$12 = 2^2 \cdot 3^1$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^2 \cdot 3^2 = 36$$

Next, create equivalent fractions with an LCD = 36.

$$\begin{aligned}
\frac{7}{18}-\frac{5}{12} &= \frac{7\cdot 2}{18\cdot 2}-\frac{5\cdot 3}{12\cdot 3} && \text{Equivalent fractions, LCD = 36.}\\
&= \frac{14}{36}-\frac{15}{36} && \text{Simplify numerators and denominators.}\\
&= \frac{14-15}{36} && \text{Subtract numerators over common denominator.}\\
&= \frac{-1}{36} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{1}{36}$$

61. Prime factor each denominator and place the result in compact form using exponents.

$$36 = 2^2 \cdot 3^2$$
$$54 = 2^1 \cdot 3^3$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^2 \cdot 3^3 = 108$$

Next, create equivalent fractions with an LCD = 108.

$$\begin{aligned}
\frac{7}{36}+\frac{7}{54} &= \frac{7\cdot 3}{36\cdot 3}+\frac{7\cdot 2}{54\cdot 2} && \text{Equivalent fractions, LCD = 108.}\\
&= \frac{21}{108}+\frac{14}{108} && \text{Simplify numerators and denominators.}\\
&= \frac{21+14}{108} && \text{Add numerators over common denominator.}\\
&= \frac{35}{108} && \text{Simplify numerator.}
\end{aligned}$$

63. Prime factor each denominator and place the result in compact form using exponents.

$$\begin{aligned}
24 &= 2^3\cdot 3^1\\
36 &= 2^2\cdot 3^2
\end{aligned}$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^3\cdot 3^2 = 72$$

Next, create equivalent fractions with an LCD = 72.

$$\begin{aligned}
\frac{7}{24}-\frac{5}{36} &= \frac{7\cdot 3}{24\cdot 3}-\frac{5\cdot 2}{36\cdot 2} && \text{Equivalent fractions, LCD = 72.}\\
&= \frac{21}{72}-\frac{10}{72} && \text{Simplify numerators and denominators.}\\
&= \frac{21-10}{72} && \text{Subtract numerators over common denominator.}\\
&= \frac{11}{72} && \text{Simplify numerator.}
\end{aligned}$$

65. Prime factor each denominator and place the result in compact form using exponents.

$$\begin{aligned}
12 &= 2^2\cdot 3^1\\
18 &= 2^1\cdot 3^2
\end{aligned}$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^2\cdot 3^2 = 36$$

Next, create equivalent fractions with an LCD = 36.

$$\begin{aligned}
\frac{11}{12}+\frac{5}{18} &= \frac{11\cdot 3}{12\cdot 3}+\frac{5\cdot 2}{18\cdot 2} && \text{Equivalent fractions, LCD = 36.}\\
&= \frac{33}{36}+\frac{10}{36} && \text{Simplify numerators and denominators.}\\
&= \frac{33+10}{36} && \text{Add numerators over common denominator.}\\
&= \frac{43}{36} && \text{Simplify numerator.}
\end{aligned}$$

67. Prime factor each denominator and place the result in compact form using exponents.

$$54 = 2^1\cdot 3^3$$
$$24 = 2^3\cdot 3^1$$

Write each prime factor that appears above to the highest power that appears above, then simplify.

$$\text{LCD} = 2^3\cdot 3^3 = 216$$

Next, create equivalent fractions with an LCD = 216.

$$\begin{aligned}
\frac{11}{54}-\frac{5}{24} &= \frac{11\cdot 4}{54\cdot 4}-\frac{5\cdot 9}{24\cdot 9} && \text{Equivalent fractions, LCD = 216.}\\
&= \frac{44}{216}-\frac{45}{216} && \text{Simplify numerators and denominators.}\\
&= \frac{44-45}{216} && \text{Subtract numerators over common denominator.}\\
&= \frac{-1}{216} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{1}{216}$$

69. First simplify by rewriting as a subtraction problem. Then, since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{3}{7}+\left(-\frac{3}{7}\right) &= -\frac{3}{7}-\frac{3}{7} && \text{Rewrite as a subtraction problem.}\\
&= \frac{-3-3}{7} && \text{Subtract numerators over common denominator.}\\
&= \frac{-6}{7} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{6}{7}$$

71. First simplify by rewriting as a addition problem. Then, since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{7}{9} - \left(-\frac{1}{9}\right) &= \frac{7}{9} + \frac{1}{9} && \text{Rewrite as an addition problem.} \\ &= \frac{7+1}{9} && \text{Add numerators over common denominator.} \\ &= \frac{8}{9} && \text{Simplify numerator.} \end{aligned}$$

73. First simplify by rewriting as a subtraction problem. Then, since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned} \frac{7}{9} + \left(-\frac{2}{9}\right) &= \frac{7}{9} - \frac{2}{9} && \text{Rewrite as a subtraction problem.} \\ &= \frac{7-2}{9} && \text{Subtract numerators over common denominator.} \\ &= \frac{5}{9} && \text{Simplify numerator.} \end{aligned}$$

75. Since the denominators are the same, simply subtract the numerators over the common denominator and simplify.

$$\begin{aligned} -\frac{3}{5} - \frac{4}{5} &= \frac{-3-4}{5} && \text{Subtract numerators over common denominator.} \\ &= \frac{-7}{5} && \text{Simplify numerator.} \end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{7}{5}$$

77. Since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} -\frac{7}{8}+\frac{1}{8} &= \frac{-7+1}{8} && \text{Add numerators over common denominator.} \\ &= \frac{-6}{8} && \text{Simplify numerator.} \\ &= \frac{-3}{4} && \text{Reduce to lowest terms.} \end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

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

79. First simplify by rewriting as a addition problem. Then, since the denominators are the same, simply add the numerators over the common denominator and simplify.

$$\begin{aligned} -\frac{1}{3}-\left(-\frac{2}{3}\right) &= -\frac{1}{3}+\frac{2}{3} && \text{Rewrite as an addition problem.} \\ &= \frac{-1+2}{3} && \text{Add numerators over common denominator.} \\ &= \frac{1}{3} && \text{Simplify numerator.} \end{aligned}$$

81. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned} -\frac{2}{7}+\frac{4}{5} &= -\frac{2\cdot 5}{7\cdot 5}+\frac{4\cdot 7}{5\cdot 7} && \text{Equivalent fractions with LCD} = 35. \\ &= -\frac{10}{35}+\frac{28}{35} && \text{Simplify numerators and denominators.} \\ &= \frac{-10+28}{35} && \text{Add numerators over common denominator.} \\ &= \frac{18}{35} && \text{Simplify numerator.} \end{aligned}$$

83. First simplify by rewriting as an addition problem. Then, since the denominators are different, write equivalent fractions using the least common

denominator. Finally, add the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{1}{4}-\left(-\frac{4}{9}\right) &= -\frac{1}{4}+\frac{4}{9} && \text{Rewrite as an addition problem.}\\
&= -\frac{1\cdot 9}{4\cdot 9}+\frac{4\cdot 4}{9\cdot 4} && \text{Equivalent fractions with LCD = 36.}\\
&= -\frac{9}{36}+\frac{16}{36} && \text{Simplify numerators and denominators.}\\
&= \frac{-9+16}{36} && \text{Add numerators over common denominator.}\\
&= \frac{7}{36} && \text{Simplify numerator.}
\end{aligned}$$

85. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{2}{7}+\frac{3}{4} &= -\frac{2\cdot 4}{7\cdot 4}+\frac{3\cdot 7}{4\cdot 7} && \text{Equivalent fractions with LCD = 28.}\\
&= -\frac{8}{28}+\frac{21}{28} && \text{Simplify numerators and denominators.}\\
&= \frac{-8+21}{28} && \text{Add numerators over common denominator.}\\
&= \frac{13}{28} && \text{Simplify numerator.}
\end{aligned}$$

87. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{4}{9}-\frac{1}{3} &= -\frac{4}{9}-\frac{1\cdot 3}{3\cdot 3} && \text{Equivalent fractions with LCD = 9.}\\
&= -\frac{4}{9}-\frac{3}{9} && \text{Simplify numerators and denominators.}\\
&= \frac{-4-3}{9} && \text{Subtract numerators over common denominator.}\\
&= \frac{-7}{9} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{7}{9}$$

89. First simplify by rewriting as an addition problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, add the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{5}{7}-\left(-\frac{1}{5}\right) &= -\frac{5}{7}+\frac{1}{5} && \text{Rewrite as an addition problem.}\\
&= -\frac{5\cdot 5}{7\cdot 5}+\frac{1\cdot 7}{5\cdot 7} && \text{Equivalent fractions with LCD} = 35.\\
&= -\frac{25}{35}+\frac{7}{35} && \text{Simplify numerators and denominators.}\\
&= \frac{-25+7}{35} && \text{Add numerators over common denominator.}\\
&= \frac{-18}{35} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{18}{35}$$

91. First simplify by rewriting as a subtraction problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{9}+\left(-\frac{1}{3}\right) &= \frac{1}{9}-\frac{1}{3} && \text{Rewrite as a subtraction problem.}\\
&= \frac{1}{9}-\frac{1\cdot 3}{3\cdot 3} && \text{Equivalent fractions with LCD} = 9.\\
&= \frac{1}{9}-\frac{3}{9} && \text{Simplify numerators and denominators.}\\
&= \frac{1-3}{9} && \text{Subtract numerators over common denominator.}\\
&= \frac{-2}{9} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{2}{9}$$

93. First simplify by rewriting as a subtraction problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{2}{3}+\left(-\frac{1}{9}\right) &= \frac{2}{3}-\frac{1}{9} && \text{Rewrite as a subtraction problem.}\\
&= \frac{2\cdot 3}{3\cdot 3}-\frac{1}{9} && \text{Equivalent fractions with LCD} = 9.\\
&= \frac{6}{9}-\frac{1}{9} && \text{Simplify numerators and denominators.}\\
&= \frac{6-1}{9} && \text{Subtract numerators over common denominator.}\\
&= \frac{5}{9} && \text{Simplify numerator.}
\end{aligned}$$

95. First simplify by rewriting as a subtraction problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{1}{2}+\left(-\frac{6}{7}\right) &= -\frac{1}{2}-\frac{6}{7} && \text{Rewrite as a subtraction problem.}\\
&= -\frac{1\cdot 7}{2\cdot 7}-\frac{6\cdot 2}{7\cdot 2} && \text{Equivalent fractions with LCD} = 14.\\
&= -\frac{7}{14}-\frac{12}{14} && \text{Simplify numerators and denominators.}\\
&= \frac{-7-12}{14} && \text{Subtract numerators over common denominator.}\\
&= \frac{-19}{14} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{19}{14}$$

97. First simplify by rewriting as a subtraction problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, subtract the numerators over the common denominator

and simplify.

$$\begin{aligned}
-\frac{1}{2}+\left(-\frac{3}{4}\right) &= -\frac{1}{2}-\frac{3}{4} && \text{Rewrite as a subtraction problem.}\\
&= -\frac{1\cdot 2}{2\cdot 2}-\frac{3}{4} && \text{Equivalent fractions with LCD} = 4.\\
&= -\frac{2}{4}-\frac{3}{4} && \text{Simplify numerators and denominators.}\\
&= \frac{-2-3}{4} && \text{Subtract numerators over common denominator.}\\
&= \frac{-5}{4} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

$$= -\frac{5}{4}$$

99. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator and simplify.

$$\begin{aligned}
-\frac{1}{4}-\frac{1}{2} &= -\frac{1}{4}-\frac{1\cdot 2}{2\cdot 2} && \text{Equivalent fractions with LCD} = 4.\\
&= -\frac{1}{4}-\frac{2}{4} && \text{Simplify numerators and denominators.}\\
&= \frac{-1-2}{4} && \text{Subtract numerators over common denominator.}\\
&= \frac{-3}{4} && \text{Simplify numerator.}
\end{aligned}$$

Although this answer is perfectly acceptable, negative divided by positive gives a negative answer, so we could also write

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

101. First simplify by rewriting as an addition problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, add the numerators over the common denominator and

simplify.

$$\begin{aligned}
\frac{5}{8}-\left(-\frac{3}{4}\right) &= \frac{5}{8}+\frac{3}{4} && \text{Rewrite as an addition problem.}\\
&= \frac{5}{8}+\frac{3\cdot 2}{4\cdot 2} && \text{Equivalent fractions with LCD} = 8.\\
&= \frac{5}{8}+\frac{6}{8} && \text{Simplify numerators and denominators.}\\
&= \frac{5+6}{8} && \text{Add numerators over common denominator.}\\
&= \frac{11}{8} && \text{Simplify numerator.}
\end{aligned}$$

103. First simplify by rewriting as an addition problem. Then, since the denominators are different, write equivalent fractions using the least common denominator. Finally, add the numerators over the common denominator and simplify.

$$\begin{aligned}
\frac{1}{8}-\left(-\frac{1}{3}\right) &= \frac{1}{8}+\frac{1}{3} && \text{Rewrite as an addition problem.}\\
&= \frac{1\cdot 3}{8\cdot 3}+\frac{1\cdot 8}{3\cdot 8} && \text{Equivalent fractions with LCD} = 24.\\
&= \frac{3}{24}+\frac{8}{24} && \text{Simplify numerators and denominators.}\\
&= \frac{3+8}{24} && \text{Add numerators over common denominator.}\\
&= \frac{11}{24} && \text{Simplify numerator.}
\end{aligned}$$

105. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator.

$$\begin{aligned}
\frac{1}{2}+\frac{3q}{5} &= \frac{1\cdot 5}{2\cdot 5}+\frac{3q\cdot 2}{5\cdot 2} && \text{Equivalent fractions with LCD} = 10.\\
&= \frac{5}{10}+\frac{6q}{10} && \text{Simplify numerators and denominators.}\\
&= \frac{5+6q}{10} && \text{Add numerators over common denominator.}
\end{aligned}$$

107. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the

common denominator.

$$\begin{aligned}\frac{4}{9}-\frac{3a}{4} &= \frac{4\cdot 4}{9\cdot 4}-\frac{3a\cdot 9}{4\cdot 9} && \text{Equivalent fractions with LCD} = 36.\\ &= \frac{16}{36}-\frac{27a}{36} && \text{Simplify numerators and denominators.}\\ &= \frac{16-27a}{36} && \text{Add numerators over common denominator.}\end{aligned}$$

109. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator.

$$\begin{aligned}\frac{2}{s}+\frac{1}{3} &= \frac{2\cdot 3}{s\cdot 3}+\frac{1\cdot s}{3\cdot s} && \text{Equivalent fractions with LCD} = 3s.\\ &= \frac{6}{3s}+\frac{s}{3s} && \text{Simplify numerators and denominators.}\\ &= \frac{6+s}{3s} && \text{Add numerators over common denominator.}\end{aligned}$$

111. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator.

$$\begin{aligned}\frac{1}{3}-\frac{7}{b} &= \frac{1\cdot b}{3\cdot b}-\frac{7\cdot 3}{b\cdot 3} && \text{Equivalent fractions with LCD} = 3b.\\ &= \frac{b}{3b}-\frac{21}{3b} && \text{Simplify numerators and denominators.}\\ &= \frac{b-21}{3b} && \text{Add numerators over common denominator.}\end{aligned}$$

113. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator.

$$\begin{aligned}\frac{4b}{7}+\frac{2}{3} &= \frac{4b\cdot 3}{7\cdot 3}+\frac{2\cdot 7}{3\cdot 7} && \text{Equivalent fractions with LCD} = 21.\\ &= \frac{12b}{21}+\frac{14}{21} && \text{Simplify numerators and denominators.}\\ &= \frac{12b+14}{21} && \text{Add numerators over common denominator.}\end{aligned}$$

115. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator.

$$\begin{aligned}\frac{2}{3}-\frac{9}{t} &= \frac{2\cdot t}{3\cdot t}-\frac{9\cdot 3}{t\cdot 3} && \text{Equivalent fractions with LCD} = 3t.\\ &= \frac{2t}{3t}-\frac{27}{3t} && \text{Simplify numerators and denominators.}\\ &= \frac{2t-27}{3t} && \text{Add numerators over common denominator.}\end{aligned}$$

117. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then add the numerators over the common denominator.

$$\begin{aligned}\frac{9}{s}+\frac{7}{8} &= \frac{9\cdot 8}{s\cdot 8}+\frac{7\cdot s}{8\cdot s} && \text{Equivalent fractions with LCD} = 8s.\\ &= \frac{72}{8s}+\frac{7s}{8s} && \text{Simplify numerators and denominators.}\\ &= \frac{72+7s}{8s} && \text{Add numerators over common denominator.}\end{aligned}$$

119. Since the denominators are different, start by writing equivalent fractions using the least common denominator. Then subtract the numerators over the common denominator.

$$\begin{aligned}\frac{7b}{8}-\frac{5}{9} &= \frac{7b\cdot 9}{8\cdot 9}-\frac{5\cdot 8}{9\cdot 8} && \text{Equivalent fractions with LCD} = 72.\\ &= \frac{63b}{72}-\frac{40}{72} && \text{Simplify numerators and denominators.}\\ &= \frac{63b-40}{72} && \text{Add numerators over common denominator.}\end{aligned}$$

121. The least common denominator for 3 and 7 is 21. Make equivalent fractions with an LCD equal to 21:

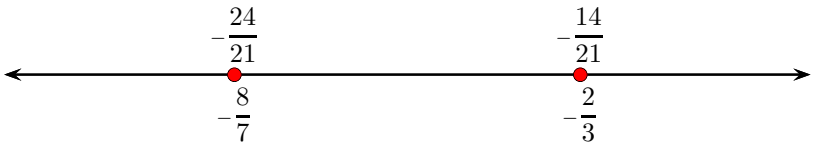
$$-\frac{2}{3}=-\frac{2\cdot 7}{3\cdot 7}=-\frac{14}{21} \qquad \text{and} \qquad -\frac{8}{7}=-\frac{8\cdot 3}{7\cdot 3}=-\frac{24}{21}.$$

Now compare numerators (including the negative sign): since $-14 > -24$, it follows that

$$-\frac{14}{21} > -\frac{24}{21},$$

and therefore

$$-\frac{2}{3} > -\frac{8}{7}$$



123. The least common denominator for 7 and 3 is 21. Make equivalent fractions with an LCD equal to 21:

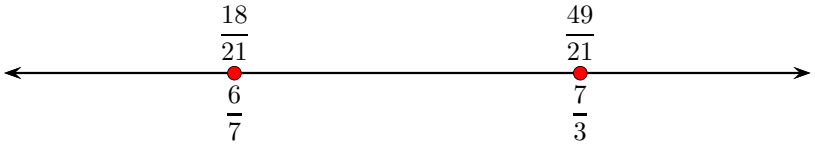
$$\frac{6}{7} = \frac{6 \cdot 3}{7 \cdot 3} = \frac{18}{21} \qquad \text{and} \qquad \frac{7}{3} = \frac{7 \cdot 7}{3 \cdot 7} = \frac{49}{21}.$$

Now compare numerators: since $18 < 49$, it follows that

$$\frac{18}{21} < \frac{49}{21},$$

and therefore

$$\frac{6}{7} < \frac{7}{3}$$



125. The least common denominator for 4 and 3 is 12. Make equivalent fractions with an LCD equal to 12:

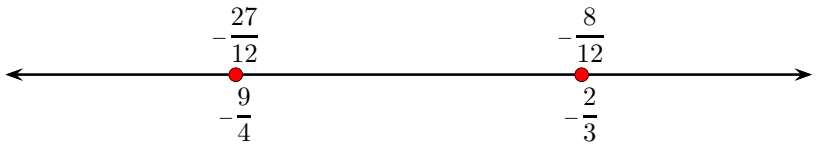
$$-\frac{9}{4} = -\frac{9 \cdot 3}{4 \cdot 3} = -\frac{27}{12} \qquad \text{and} \qquad -\frac{2}{3} = -\frac{2 \cdot 4}{3 \cdot 4} = -\frac{8}{12}.$$

Now compare numerators (including the negative sign): since $-27 < -8$, it follows that

$$-\frac{27}{12} < -\frac{8}{12},$$

and therefore

$$-\frac{9}{4} < -\frac{2}{3}$$



127. The least common denominator for 7 and 9 is 63. Make equivalent fractions with an LCD equal to 63:

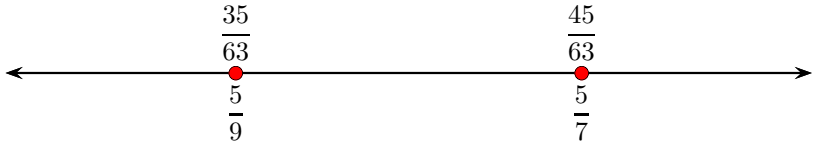
$$\frac{5}{7} = \frac{5 \cdot 9}{7 \cdot 9} = \frac{45}{63} \qquad \text{and} \qquad \frac{5}{9} = \frac{5 \cdot 7}{9 \cdot 7} = \frac{35}{63}.$$

Now compare numerators: since $45 > 35$, it follows that

$$\frac{45}{63} > \frac{35}{63},$$

and therefore

$$\frac{5}{7} > \frac{5}{9}$$



129. The least common denominator for 2 and 5 is 10. Make equivalent fractions with an LCD equal to 10:

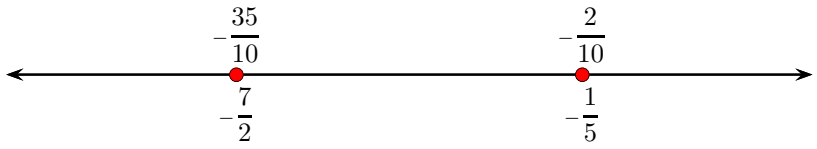
$$-\frac{7}{2} = -\frac{7 \cdot 5}{2 \cdot 5} = -\frac{35}{10} \qquad \text{and} \qquad -\frac{1}{5} = -\frac{1 \cdot 2}{5 \cdot 2} = -\frac{2}{10}.$$

Now compare numerators (including the negative sign): since $-35 < -2$, it follows that

$$-\frac{35}{10} < -\frac{2}{10},$$

and therefore

$$-\frac{7}{2} < -\frac{1}{5}$$



131. The least common denominator for 9 and 5 is 45. Make equivalent fractions with an LCD equal to 45:

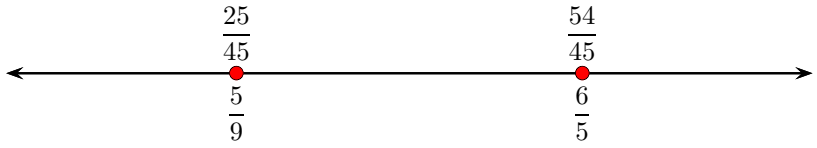
$$\frac{5}{9} = \frac{5 \cdot 5}{9 \cdot 5} = \frac{25}{45} \qquad \text{and} \qquad \frac{6}{5} = \frac{6 \cdot 9}{5 \cdot 9} = \frac{54}{45}.$$

Now compare numerators: since $25 < 54$, it follows that

$$\frac{25}{45} < \frac{54}{45},$$

and therefore

$$\frac{5}{9} < \frac{6}{5}$$



4.5 Multiplying and Dividing Mixed Fractions

1. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$2\frac{1}{3} = \frac{2 \cdot 3 + 1}{3} \qquad \text{Convert to an improper fraction.}$$

$$= \frac{7}{3} \qquad \text{Simplify numerator.}$$

3. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$1\frac{1}{19} = \frac{1 \cdot 19 + 1}{19} \qquad \text{Convert to an improper fraction.}$$
$$= \frac{20}{19} \qquad \text{Simplify numerator.}$$

5. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$-1\frac{3}{7} = -\frac{1 \cdot 7 + 3}{7} \qquad \text{Convert to an improper fraction.}$$
$$= -\frac{10}{7} \qquad \text{Simplify numerator.}$$

7. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$1\frac{1}{9} = \frac{1 \cdot 9 + 1}{9} \qquad \text{Convert to an improper fraction.}$$
$$= \frac{10}{9} \qquad \text{Simplify numerator.}$$

9. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$-1\frac{1}{2} = -\frac{1 \cdot 2 + 1}{2} \qquad \text{Convert to an improper fraction.}$$
$$= -\frac{3}{2} \qquad \text{Simplify numerator.}$$

11. Multiply the whole number part by the denominator, add the numerator, then place the result over the denominator.

$$1\frac{1}{3} = \frac{1 \cdot 3 + 1}{3} \qquad \text{Convert to an improper fraction.}$$
$$= \frac{4}{3} \qquad \text{Simplify numerator.}$$

13. 13 divided by 7 is 1, with a remainder of 6. Therefore,

$$\frac{13}{7} = 1\frac{6}{7}$$

15. 13 divided by 5 is 2, with a remainder of 3. Therefore,

$$-\frac{13}{5} = -2\frac{3}{5}$$

17. 16 divided by 5 is 3, with a remainder of 1. Therefore,

$$-\frac{16}{5} = -3\frac{1}{5}$$

19. 9 divided by 8 is 1, with a remainder of 1. Therefore,

$$\frac{9}{8} = 1\frac{1}{8}$$

21. 6 divided by 5 is 1, with a remainder of 1. Therefore,

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

23. 3 divided by 2 is 1, with a remainder of 1. Therefore,

$$-\frac{3}{2} = -1\frac{1}{2}$$

25. Convert the mixed fractions to improper fractions, then multiply.

$$\begin{aligned}
1\frac{1}{7} \cdot 2\frac{1}{2} &= \frac{8}{7} \cdot \frac{5}{2} && \text{Convert to improper fractions.} \\
&= \frac{(2 \cdot 2 \cdot 2) \cdot (5)}{(7) \cdot (2)} && \text{Prime factorization.} \\
&= \frac{2 \cdot 2 \cdot 5}{7} && \text{Cancel common factors.} \\
&= \frac{20}{7} && \text{Simplify.} \\
&= 2\frac{6}{7} && \text{Convert to a mixed fraction.}
\end{aligned}$$

27. Convert the numbers to improper fractions, then multiply.

$$\begin{aligned}
4 \cdot 1\frac{1}{6} &= \frac{4}{1} \cdot \frac{7}{6} && \text{Convert to improper fractions.} \\
&= \frac{(2 \cdot 2) \cdot (7)}{(1) \cdot (2 \cdot 3)} && \text{Prime factorization.} \\
&= \frac{2 \cdot 7}{3} && \text{Cancel common factors.} \\
&= \frac{14}{3} && \text{Simplify.} \\
&= 4\frac{2}{3} && \text{Convert to a mixed fraction.}
\end{aligned}$$

29. Convert the mixed fractions to improper fractions, then multiply.

$$\begin{aligned}
\left(-1\frac{1}{12}\right)\left(3\frac{3}{4}\right) &= \left(-\frac{13}{12}\right) \cdot \left(\frac{15}{4}\right) && \text{Convert to improper fractions.} \\
&= -\frac{(13) \cdot (3 \cdot 5)}{(2 \cdot 2 \cdot 3) \cdot (2 \cdot 2)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{13 \cdot 5}{2 \cdot 2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= -\frac{65}{16} && \text{Simplify.} \\
&= -4\frac{1}{16} && \text{Convert to a mixed fraction.}
\end{aligned}$$

31. Convert the mixed fractions to improper fractions, then multiply.

$$\begin{aligned}
7\frac{1}{2} \cdot 1\frac{1}{13} &= \frac{15}{2} \cdot \frac{14}{13} && \text{Convert to improper fractions.} \\
&= \frac{(3 \cdot 5) \cdot (2 \cdot 7)}{(2) \cdot (13)} && \text{Prime factorization.} \\
&= \frac{3 \cdot 5 \cdot 7}{13} && \text{Cancel common factors.} \\
&= \frac{105}{13} && \text{Simplify.} \\
&= 8\frac{1}{13} && \text{Convert to a mixed fraction.}
\end{aligned}$$

33. Convert the mixed fractions to improper fractions, then multiply.

$$\left(1\frac{2}{13}\right)\left(-4\frac{2}{3}\right) = \left(\frac{15}{13}\right)\cdot\left(-\frac{14}{3}\right)$$ Convert to improper fractions.

$$= -\frac{(3\cdot 5)\cdot(2\cdot 7)}{(13)\cdot(3)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{5\cdot 2\cdot 7}{13}$$ Cancel common factors.

$$= -\frac{70}{13}$$ Simplify.

$$= -5\frac{5}{13}$$ Convert to a mixed fraction.

35. Convert the mixed fractions to improper fractions, then multiply.

$$\left(1\frac{3}{7}\right)\left(-3\frac{3}{4}\right) = \left(\frac{10}{7}\right)\cdot\left(-\frac{15}{4}\right)$$ Convert to improper fractions.

$$= -\frac{(2\cdot 5)\cdot(3\cdot 5)}{(7)\cdot(2\cdot 2)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{5\cdot 3\cdot 5}{7\cdot 2}$$ Cancel common factors.

$$= -\frac{75}{14}$$ Simplify.

$$= -5\frac{5}{14}$$ Convert to a mixed fraction.

37. Convert the numbers to improper fractions, then multiply.

$$9\cdot\left(-1\frac{2}{15}\right) = \left(\frac{9}{1}\right)\cdot\left(-\frac{17}{15}\right)$$ Convert to improper fractions.

$$= -\frac{(3\cdot 3)\cdot(17)}{(1)\cdot(3\cdot 5)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{3\cdot 17}{5}$$ Cancel common factors.

$$= -\frac{51}{5}$$ Simplify.

$$= -10\frac{1}{5}$$ Convert to a mixed fraction.

39. Convert the numbers to improper fractions, then multiply.

$$\begin{aligned}
\left(-2\frac{1}{8}\right)(-6) &= \left(-\frac{17}{8}\right)\left(-\frac{6}{1}\right) && \text{Convert to improper fractions.}\\
&= \frac{(17)\cdot(2\cdot 3)}{(2\cdot 2\cdot 2)\cdot(1)} && \text{Prime factorization.}\\
& && \text{Like signs give a positive product.}\\
&= \frac{17\cdot 3}{2\cdot 2} && \text{Cancel common factors.}\\
&= \frac{51}{4} && \text{Simplify.}\\
&= 12\frac{3}{4} && \text{Convert to a mixed fraction.}
\end{aligned}$$

41. Convert the mixed fractions to improper fractions, then multiply.

$$\begin{aligned}
\left(-4\frac{1}{2}\right)\left(-2\frac{2}{5}\right) &= \left(-\frac{9}{2}\right)\cdot\left(-\frac{12}{5}\right) && \text{Convert to improper fractions.}\\
&= \frac{(3\cdot 3)\cdot(2\cdot 2\cdot 3)}{(2)\cdot(5)} && \text{Prime factorization.}\\
& && \text{Like signs give a positive product.}\\
&= \frac{3\cdot 3\cdot 2\cdot 3}{5} && \text{Cancel common factors.}\\
&= \frac{54}{5} && \text{Simplify.}\\
&= 10\frac{4}{5} && \text{Convert to a mixed fraction.}
\end{aligned}$$

43. Convert the numbers to improper fractions, then multiply.

$$\begin{aligned}
\left(-2\frac{1}{6}\right)\cdot 4 &= \left(-\frac{13}{6}\right)\cdot\left(\frac{4}{1}\right) && \text{Convert to improper fractions.}\\
&= -\frac{(13)\cdot(2\cdot 2)}{(2\cdot 3)\cdot(1)} && \text{Prime factorization.}\\
& && \text{Unlike signs give a negative product.}\\
&= -\frac{13\cdot 2}{3} && \text{Cancel common factors.}\\
&= -\frac{26}{3} && \text{Simplify.}\\
&= -8\frac{2}{3} && \text{Convert to a mixed fraction.}
\end{aligned}$$

45. Convert the mixed fractions to improper fractions, then multiply.

$$\left(-1\frac{4}{15}\right)\left(2\frac{1}{2}\right) = \left(-\frac{19}{15}\right)\cdot\left(\frac{5}{2}\right)$$ Convert to improper fractions.

$$= -\frac{(19)\cdot(5)}{(3\cdot 5)\cdot(2)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{19}{3\cdot 2}$$ Cancel common factors.

$$= -\frac{19}{6}$$ Simplify.

$$= -3\frac{1}{6}$$ Convert to a mixed fraction.

47. Convert the mixed fractions to improper fractions, then multiply.

$$\left(-2\frac{1}{2}\right)\left(-1\frac{7}{11}\right) = \left(-\frac{5}{2}\right)\cdot\left(-\frac{18}{11}\right)$$ Convert to improper fractions.

$$= \frac{(5)\cdot(2\cdot 3\cdot 3)}{(2)\cdot(11)}$$ Prime factorization. Like signs give a positive product.

$$= \frac{5\cdot 3\cdot 3}{11}$$ Cancel common factors.

$$= \frac{45}{11}$$ Simplify.

$$= 4\frac{1}{11}$$ Convert to a mixed fraction.

49. Convert the mixed fractions to improper fractions, then divide.

$$8 \div 2\frac{2}{9} = \frac{8}{1} \div \frac{20}{9}$$ Convert to improper fractions.

$$= \frac{8}{1}\cdot\frac{9}{20}$$ Invert the second fraction and multiply.

$$= \frac{(2\cdot 2\cdot 2)\cdot(3\cdot 3)}{(1)\cdot(2\cdot 2\cdot 5)}$$ Prime factorization.

$$= \frac{2\cdot 3\cdot 3}{5}$$ Cancel common factors.

$$= \frac{18}{5}$$ Simplify.

$$= 3\frac{3}{5}$$ Convert to a mixed fraction.

51. Convert the mixed fractions to improper fractions, then divide.

$$\left(-3\frac{1}{2}\right) \div \left(1\frac{1}{16}\right) = \left(-\frac{7}{2}\right) \div \left(\frac{17}{16}\right)$$ Convert to improper fractions.

$$= \left(-\frac{7}{2}\right) \cdot \left(\frac{16}{17}\right)$$ Invert the second fraction and multiply.

$$= -\frac{(7) \cdot (2 \cdot 2 \cdot 2 \cdot 2)}{(2) \cdot (17)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{7 \cdot 2 \cdot 2 \cdot 2}{17}$$ Cancel common factors.

$$= -\frac{56}{17}$$ Simplify.

$$= -3\frac{5}{17}$$ Convert to a mixed fraction.

53. Convert the mixed fractions to improper fractions, then divide.

$$6\frac{1}{2} \div 1\frac{7}{12} = \frac{13}{2} \div \frac{19}{12}$$ Convert to improper fractions.

$$= \frac{13}{2} \cdot \frac{12}{19}$$ Invert the second fraction and multiply.

$$= \frac{(13) \cdot (2 \cdot 2 \cdot 3)}{(2) \cdot (19)}$$ Prime factorization.

$$= \frac{13 \cdot 2 \cdot 3}{19}$$ Cancel common factors.

$$= \frac{78}{19}$$ Simplify.

$$= 4\frac{2}{19}$$ Convert to a mixed fraction.

55. Convert the mixed fractions to improper fractions, then divide.

$$
\begin{aligned}
(-4) \div \left(1\frac{5}{9}\right) &= \left(-\frac{4}{1}\right) \div \left(\frac{14}{9}\right) && \text{Convert to improper fractions.} \\
&= \left(-\frac{4}{1}\right) \cdot \left(\frac{9}{14}\right) && \text{Invert the second fraction and multiply.} \\
&= -\frac{(2 \cdot 2) \cdot (3 \cdot 3)}{(1) \cdot (2 \cdot 7)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{2 \cdot 3 \cdot 3}{7} && \text{Cancel common factors.} \\
&= -\frac{18}{7} && \text{Simplify.} \\
&= -2\frac{4}{7} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

57. Convert the mixed fractions to improper fractions, then divide.

$$
\begin{aligned}
\left(-5\frac{2}{3}\right) \div \left(-2\frac{1}{6}\right) &= \left(-\frac{17}{3}\right) \div \left(-\frac{13}{6}\right) && \text{Convert to improper fractions.} \\
&= \left(-\frac{17}{3}\right) \cdot \left(-\frac{6}{13}\right) && \text{Invert the second fraction and multiply.} \\
&= \frac{(17) \cdot (2 \cdot 3)}{(3) \cdot (13)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{17 \cdot 2}{13} && \text{Cancel common factors.} \\
&= \frac{34}{13} && \text{Simplify.} \\
&= 2\frac{8}{13} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

59. Convert the mixed fractions to improper fractions, then divide.

$$\begin{aligned}
\left(-6\frac{1}{2}\right) \div \left(4\frac{1}{4}\right) &= \left(-\frac{13}{2}\right) \div \left(\frac{17}{4}\right) && \text{Convert to improper fractions.} \\
&= \left(-\frac{13}{2}\right) \cdot \left(\frac{4}{17}\right) && \text{Invert the second fraction and multiply.} \\
&= -\frac{(13) \cdot (2 \cdot 2)}{(2) \cdot (17)} && \text{Prime factorization.} \\
& && \text{Unlike signs give a negative product.} \\
&= -\frac{13 \cdot 2}{17} && \text{Cancel common factors.} \\
&= -\frac{26}{17} && \text{Simplify.} \\
&= -1\frac{9}{17} && \text{Convert to a mixed fraction.}
\end{aligned}$$

61. Convert the mixed fractions to improper fractions, then divide.

$$\begin{aligned}
(-6) \div \left(-1\frac{3}{11}\right) &= \left(-\frac{6}{1}\right) \div \left(-\frac{14}{11}\right) && \text{Convert to improper fractions.} \\
&= \left(-\frac{6}{1}\right) \cdot \left(-\frac{11}{14}\right) && \text{Invert the second fraction and multiply.} \\
&= \frac{(2 \cdot 3) \cdot (11)}{(1) \cdot (2 \cdot 7)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{3 \cdot 11}{7} && \text{Cancel common factors.} \\
&= \frac{33}{7} && \text{Simplify.} \\
&= 4\frac{5}{7} && \text{Convert to a mixed fraction.}
\end{aligned}$$

63. Convert the mixed fractions to improper fractions, then divide.

$$\left(4\frac{2}{3}\right) \div (-4) = \left(\frac{14}{3}\right) \div \left(-\frac{4}{1}\right) \quad \text{Convert to improper fractions.}$$

$$= \left(\frac{14}{3}\right) \cdot \left(-\frac{1}{4}\right) \quad \text{Invert the second fraction and multiply.}$$

$$= -\frac{(2 \cdot 7) \cdot (1)}{(3) \cdot (2 \cdot 2)} \quad \text{Prime factorization. Unlike signs give a negative product.}$$

$$= -\frac{7}{3 \cdot 2} \quad \text{Cancel common factors.}$$

$$= -\frac{7}{6} \quad \text{Simplify.}$$

$$= -1\frac{1}{6} \quad \text{Convert to a mixed fraction.}$$

65. Convert the mixed fractions to improper fractions, then divide.

$$\left(1\frac{3}{4}\right) \div \left(-1\frac{1}{12}\right) = \left(\frac{7}{4}\right) \div \left(-\frac{13}{12}\right) \quad \text{Convert to improper fractions.}$$

$$= \left(\frac{7}{4}\right) \cdot \left(-\frac{12}{13}\right) \quad \text{Invert the second fraction and multiply.}$$

$$= -\frac{(7) \cdot (2 \cdot 2 \cdot 3)}{(2 \cdot 2) \cdot (13)} \quad \text{Prime factorization. Unlike signs give a negative product.}$$

$$= -\frac{7 \cdot 3}{13} \quad \text{Cancel common factors.}$$

$$= -\frac{21}{13} \quad \text{Simplify.}$$

$$= -1\frac{8}{13} \quad \text{Convert to a mixed fraction.}$$

67. Convert the mixed fractions to improper fractions, then divide.

$$
\begin{aligned}
5\frac{2}{3} \div 1\frac{1}{9} &= \frac{17}{3} \div \frac{10}{9} && \text{Convert to improper fractions.} \\
&= \frac{17}{3} \cdot \frac{9}{10} && \text{Invert the second fraction and multiply.} \\
&= \frac{(17) \cdot (3 \cdot 3)}{(3) \cdot (2 \cdot 5)} && \text{Prime factorization.} \\
&= \frac{17 \cdot 3}{2 \cdot 5} && \text{Cancel common factors.} \\
&= \frac{51}{10} && \text{Simplify.} \\
&= 5\frac{1}{10} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

69. Convert the mixed fractions to improper fractions, then divide.

$$
\begin{aligned}
\left(-7\frac{1}{2}\right) \div \left(-2\frac{2}{5}\right) &= \left(-\frac{15}{2}\right) \div \left(-\frac{12}{5}\right) && \text{Convert to improper fractions.} \\
&= \left(-\frac{15}{2}\right) \cdot \left(-\frac{5}{12}\right) && \text{Invert the second fraction and multiply.} \\
&= \frac{(3 \cdot 5) \cdot (5)}{(2) \cdot (2 \cdot 2 \cdot 3)} && \text{Prime factorization.} \\
& && \text{Like signs give a positive product.} \\
&= \frac{5 \cdot 5}{2 \cdot 2 \cdot 2} && \text{Cancel common factors.} \\
&= \frac{25}{8} && \text{Simplify.} \\
&= 3\frac{1}{8} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

71. Convert the mixed fractions to improper fractions, then divide.

$$\left(3\frac{2}{3}\right) \div \left(-1\frac{1}{9}\right) = \left(\frac{11}{3}\right) \div \left(-\frac{10}{9}\right)$$ Convert to improper fractions.

$$= \left(\frac{11}{3}\right) \cdot \left(-\frac{9}{10}\right)$$ Invert the second fraction and multiply.

$$= -\frac{(11) \cdot (3 \cdot 3)}{(3) \cdot (2 \cdot 5)}$$ Prime factorization. Unlike signs give a negative product.

$$= -\frac{11 \cdot 3}{2 \cdot 5}$$ Cancel common factors.

$$= -\frac{33}{10}$$ Simplify.

$$= -3\frac{3}{10}$$ Convert to a mixed fraction.

73. *Quarter-acre* means $\frac{1}{4}$ of an acre. To find the number of quarter-acres in $6\frac{1}{2}$ acres, divide the $6\frac{1}{2}$ by $\frac{1}{4}$.

$$6\frac{1}{2} \div \frac{1}{4} = \frac{13}{2} \div \frac{1}{4}$$ Convert to an improper fraction.

$$= \frac{13}{2} \cdot \frac{4}{1}$$ Multiply by the reciprocal.

$$= \frac{13 \cdot 4}{2}$$ Multiply numerators; multilply denominators.

$$= \frac{13 \cdot (2 \cdot 2)}{2}$$ Factor numerator.

$$= 26$$ Cancel common factor. Simplify.

Therefore, there are 26 quarter-acre lots in $6\frac{1}{2}$ acres of land.

75. To find how many silver pieces $\frac{1}{12}$ inch long are contained in a bar $4\frac{1}{2}$ inches long, divide the $4\frac{1}{2}$ by $\frac{1}{12}$.

$$4\frac{1}{2} \div \frac{1}{12} = \frac{9}{2} \div \frac{1}{12}$$ Convert to an improper fraction.

$$= \frac{9}{2} \cdot \frac{12}{1}$$ Multiply by the reciprocal.

$$= \frac{9 \cdot 12}{2}$$ Multiply numerators; multiply denominators.

$$= \frac{(3 \cdot 3) \cdot (2 \cdot 2 \cdot 3)}{2}$$ Factor the numerator and denominator.

$$= 54$$ Cancel common factors and simplify.

Therefore, 54 pieces were made from the silver bar.

4.6 Adding and Subtracting Mixed Fractions

1. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$\begin{aligned}
9\frac{1}{4}+9\frac{1}{2} &= \frac{37}{4}+\frac{19}{2} && \text{Convert to improper fractions.}\\
&= \frac{37}{4}+\frac{19\cdot 2}{2\cdot 2} && \text{Equivalent fractions with LCD} = 4.\\
&= \frac{37}{4}+\frac{38}{4} && \text{Simplify numerators and denominators.}\\
&= \frac{75}{4} && \text{Add numerators over common denominator.}\\
&= 18\frac{3}{4} && \text{Convert to a mixed fraction.}
\end{aligned}$$

3. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$\begin{aligned}
6\frac{1}{2}-1\frac{1}{3} &= \frac{13}{2}-\frac{4}{3} && \text{Convert to improper fractions.}\\
&= \frac{13\cdot 3}{2\cdot 3}-\frac{4\cdot 2}{3\cdot 2} && \text{Equivalent fractions with LCD} = 6.\\
&= \frac{39}{6}-\frac{8}{6} && \text{Simplify numerators and denominators.}\\
&= \frac{31}{6} && \text{Subtract numerators over common denominator.}\\
&= 5\frac{1}{6} && \text{Convert to a mixed fraction.}
\end{aligned}$$

5. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$\begin{aligned}
9\frac{1}{2}+7\frac{1}{4} &= \frac{19}{2}+\frac{29}{4} && \text{Convert to improper fractions.}\\
&= \frac{19\cdot 2}{2\cdot 2}+\frac{29}{4} && \text{Equivalent fractions with LCD} = 4.\\
&= \frac{38}{4}+\frac{29}{4} && \text{Simplify numerators and denominators.}\\
&= \frac{67}{4} && \text{Add numerators over common denominator.}\\
&= 16\frac{3}{4} && \text{Convert to a mixed fraction.}
\end{aligned}$$

7. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$
\begin{aligned}
5\frac{2}{3}+4\frac{1}{2} &= \frac{17}{3}+\frac{9}{2} && \text{Convert to improper fractions.}\\
&= \frac{17\cdot 2}{3\cdot 2}+\frac{9\cdot 3}{2\cdot 3} && \text{Equivalent fractions with LCD} = 6.\\
&= \frac{34}{6}+\frac{27}{6} && \text{Simplify numerators and denominators.}\\
&= \frac{61}{6} && \text{Add numerators over common denominator.}\\
&= 10\frac{1}{6} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

9. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$
\begin{aligned}
3\frac{1}{3}-1\frac{1}{4} &= \frac{10}{3}-\frac{5}{4} && \text{Convert to improper fractions.}\\
&= \frac{10\cdot 4}{3\cdot 4}-\frac{5\cdot 3}{4\cdot 3} && \text{Equivalent fractions with LCD} = 12.\\
&= \frac{40}{12}-\frac{15}{12} && \text{Simplify numerators and denominators.}\\
&= \frac{25}{12} && \text{Subtract numerators over common denominator.}\\
&= 2\frac{1}{12} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

11. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$
\begin{aligned}
8\frac{1}{2}-1\frac{1}{3} &= \frac{17}{2}-\frac{4}{3} && \text{Convert to improper fractions.}\\
&= \frac{17\cdot 3}{2\cdot 3}-\frac{4\cdot 2}{3\cdot 2} && \text{Equivalent fractions with LCD} = 6.\\
&= \frac{51}{6}-\frac{8}{6} && \text{Simplify numerators and denominators.}\\
&= \frac{43}{6} && \text{Subtract numerators over common denominator.}\\
&= 7\frac{1}{6} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

13. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$\begin{aligned}
4\frac{1}{2} - 1\frac{1}{8} &= \frac{9}{2} - \frac{9}{8} && \text{Convert to improper fractions.}\\
&= \frac{9\cdot 4}{2\cdot 4} - \frac{9}{8} && \text{Equivalent fractions with LCD} = 8.\\
&= \frac{36}{8} - \frac{9}{8} && \text{Simplify numerators and denominators.}\\
&= \frac{27}{8} && \text{Subtract numerators over common denominator.}\\
&= 3\frac{3}{8} && \text{Convert to a mixed fraction.}
\end{aligned}$$

15. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$\begin{aligned}
4\frac{7}{8} + 1\frac{3}{4} &= \frac{39}{8} + \frac{7}{4} && \text{Convert to improper fractions.}\\
&= \frac{39}{8} + \frac{7\cdot 2}{4\cdot 2} && \text{Equivalent fractions with LCD} = 8.\\
&= \frac{39}{8} + \frac{14}{8} && \text{Simplify numerators and denominators.}\\
&= \frac{53}{8} && \text{Add numerators over common denominator.}\\
&= 6\frac{5}{8} && \text{Convert to a mixed fraction.}
\end{aligned}$$

17. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$\begin{aligned}
2\frac{1}{3} - 1\frac{1}{4} &= \frac{7}{3} - \frac{5}{4} && \text{Convert to improper fractions.}\\
&= \frac{7\cdot 4}{3\cdot 4} - \frac{5\cdot 3}{4\cdot 3} && \text{Equivalent fractions with LCD} = 12.\\
&= \frac{28}{12} - \frac{15}{12} && \text{Simplify numerators and denominators.}\\
&= \frac{13}{12} && \text{Subtract numerators over common denominator.}\\
&= 1\frac{1}{12} && \text{Convert to a mixed fraction.}
\end{aligned}$$

19. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then subtract:

$$
\begin{aligned}
9\frac{1}{2} - 1\frac{3}{4} &= \frac{19}{2} - \frac{7}{4} && \text{Convert to improper fractions.}\\
&= \frac{19\cdot 2}{2\cdot 2} - \frac{7}{4} && \text{Equivalent fractions with LCD} = 4.\\
&= \frac{38}{4} - \frac{7}{4} && \text{Simplify numerators and denominators.}\\
&= \frac{31}{4} && \text{Subtract numerators over common denominator.}\\
&= 7\frac{3}{4} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

21. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$
\begin{aligned}
4\frac{2}{3} + 1\frac{1}{4} &= \frac{14}{3} + \frac{5}{4} && \text{Convert to improper fractions.}\\
&= \frac{14\cdot 4}{3\cdot 4} + \frac{5\cdot 3}{4\cdot 3} && \text{Equivalent fractions with LCD} = 12.\\
&= \frac{56}{12} + \frac{15}{12} && \text{Simplify numerators and denominators.}\\
&= \frac{71}{12} && \text{Add numerators over common denominator.}\\
&= 5\frac{11}{12} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

23. Change the mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add:

$$
\begin{aligned}
9\frac{1}{2} + 3\frac{1}{8} &= \frac{19}{2} + \frac{25}{8} && \text{Convert to improper fractions.}\\
&= \frac{19\cdot 4}{2\cdot 4} + \frac{25}{8} && \text{Equivalent fractions with LCD} = 8.\\
&= \frac{76}{8} + \frac{25}{8} && \text{Simplify numerators and denominators.}\\
&= \frac{101}{8} && \text{Add numerators over common denominator.}\\
&= 12\frac{5}{8} && \text{Convert to a mixed fraction.}
\end{aligned}
$$

25. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 3\frac{1}{2} & = & 3\frac{1\cdot 2}{2\cdot 2} & = & 3\frac{2}{4} \\ +3\frac{3}{4} & = & +3\frac{3}{4} & = & +3\frac{3}{4} \\ \hline & & & & 6\frac{5}{4} \end{array}$$

Since 5/4 is an improper fraction, we must convert it to a mixed fraction and then add:

$$\begin{aligned} 6\frac{5}{4} &= 6 + 1\frac{1}{4} \\ &= 7\frac{1}{4} \end{aligned}$$

27. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 1\frac{3}{8} & = & 1\frac{3}{8} & = & 1\frac{3}{8} \\ +1\frac{1}{4} & = & +1\frac{1\cdot 2}{4\cdot 2} & = & +1\frac{2}{8} \\ \hline & & & & 2\frac{5}{8} \end{array}$$

29. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 1\frac{7}{8} & = & 1\frac{7}{8} & = & 1\frac{7}{8} \\ +1\frac{1}{2} & = & +1\frac{1\cdot 4}{2\cdot 4} & = & +1\frac{4}{8} \\ \hline & & & & 2\frac{11}{8} \end{array}$$

Since 11/8 is an improper fraction, we must convert it to a mixed fraction and then add:

$$\begin{aligned} 2\frac{11}{8} &= 2 + 1\frac{3}{8} \\ &= 3\frac{3}{8} \end{aligned}$$

31. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 8\frac{1}{2} & = & 8\frac{1\cdot 3}{2\cdot 3} & = & 8\frac{3}{6} \\ -5\frac{2}{3} & = & -5\frac{2\cdot 2}{3\cdot 2} & = & -5\frac{4}{6} \\ \hline & & & & 2\frac{5}{6} \end{array}$$

Since $3/6 < 4/6$, we cannot subtract $4/6$ from $3/6$. Therefore, we must borrow 1 from 8 in the form of $6/6$ and add it to the $3/6$:

$$\begin{array}{rcrcr} 8\frac{3}{6} & = & 7+\frac{6}{6}+\frac{3}{6} & = & 7\frac{9}{6} \\ -5\frac{4}{6} & = & -5\frac{4}{6} & = & -5\frac{4}{6} \\ \hline & & & & 2\frac{5}{6} \end{array}$$

33. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 7\frac{1}{2} & = & 7\frac{1\cdot 8}{2\cdot 8} & = & 7\frac{8}{16} \\ -1\frac{3}{16} & = & -1\frac{3}{16} & = & -1\frac{3}{16} \\ \hline & & & & 6\frac{5}{16} \end{array}$$

35. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 9\frac{1}{2} & = & 9\frac{1\cdot 3}{2\cdot 3} & = & 9\frac{3}{6} \\ -1\frac{1}{3} & = & -1\frac{1\cdot 2}{3\cdot 2} & = & -1\frac{2}{6} \\ \hline & & & & 8\frac{1}{6} \end{array}$$

37. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 5\frac{1}{3} & = & 5\frac{1\cdot 2}{3\cdot 2} & = & 5\frac{2}{6} \\ -2\frac{1}{2} & = & -2\frac{1\cdot 3}{2\cdot 3} & = & -2\frac{3}{6} \\ \hline & & & & 2\frac{5}{6} \end{array}$$

Since $2/6 < 3/6$, we cannot subtract $3/6$ from $2/6$. Therefore, we must borrow 1 from 5 in the form of $6/6$ and add it to the $2/6$:

$$\begin{array}{rcrcr} 5\frac{2}{6} & = & 4+\frac{6}{6}+\frac{2}{6} & = & 4\frac{8}{6} \\ -2\frac{3}{6} & = & -2\frac{3}{6} & = & -2\frac{3}{6} \\ \hline & & & & 2\frac{5}{6} \end{array}$$

39. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 9\frac{1}{2} & = & 9\frac{1\cdot 3}{2\cdot 3} & = & 9\frac{3}{6} \\ -2\frac{2}{3} & = & -2\frac{2\cdot 2}{3\cdot 2} & = & -2\frac{4}{6} \\ \hline & & & & 6\frac{5}{6} \end{array}$$

Since $3/6 < 4/6$, we cannot subtract $4/6$ from $3/6$. Therefore, we must borrow 1 from 9 in the form of $6/6$ and add it to the $3/6$:

$$\begin{array}{rcrcr} 9\frac{3}{6} & = & 8+\frac{6}{6}+\frac{3}{6} & = & 8\frac{9}{6} \\ -2\frac{4}{6} & = & -2\frac{4}{6} & = & -2\frac{4}{6} \\ \hline & & & & 6\frac{5}{6} \end{array}$$

41. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 1\,\frac{1}{16} & = & 1\,\frac{1}{16} & = & 1\,\frac{1}{16} \\ +1\,\frac{3}{4} & = & +1\,\frac{3\cdot 4}{4\cdot 4} & = & +1\,\frac{12}{16} \\ \hline & & & & 2\,\frac{13}{16} \end{array}$$

43. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 8\,\frac{1}{2} & = & 8\,\frac{1\cdot 3}{2\cdot 3} & = & 8\,\frac{3}{6} \\ +3\,\frac{2}{3} & = & +3\,\frac{2\cdot 2}{3\cdot 2} & = & +3\,\frac{4}{6} \\ \hline & & & & 11\,\frac{7}{6} \end{array}$$

Since 7/6 is an improper fraction, we must convert it to a mixed fraction and then add:

$$\begin{aligned} 11\,\frac{7}{6} &= 11 + 1\,\frac{1}{6} \\ &= 12\,\frac{1}{6} \end{aligned}$$

45. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 6\,\frac{1}{2} & = & 6\,\frac{1\cdot 8}{2\cdot 8} & = & 6\,\frac{8}{16} \\ -1\,\frac{3}{16} & = & -1\,\frac{3}{16} & = & -1\,\frac{3}{16} \\ \hline & & & & 5\,\frac{5}{16} \end{array}$$

47. Working in vertical format, first make equivalent fractions with a common denominator, and then add the whole number and fractional parts:

$$\begin{array}{rcrcr} 2\,\frac{2}{3} & = & 2\,\frac{2\cdot 4}{3\cdot 4} & = & 2\,\frac{8}{12} \\ +1\,\frac{1}{4} & = & +1\,\frac{1\cdot 3}{4\cdot 3} & = & +1\,\frac{3}{12} \\ \hline & & & & 3\,\frac{11}{12} \end{array}$$

4.7 Order of Operations

1. Apply exponents first, then multiply.

$$\begin{aligned} \left(-\frac{7}{3}\right)^3 &= \left(-\frac{7}{3}\right)\left(-\frac{7}{3}\right)\left(-\frac{7}{3}\right) && a^3 = a\cdot a\cdot a. \\ &= -\frac{7\cdot 7\cdot 7}{3\cdot 3\cdot 3} && \text{Multiply numerators and denominators.} \\ & && \text{An odd number of negative factors is negative.} \\ &= -\frac{343}{27} && \text{Simplify.} \end{aligned}$$

3. Apply exponents first, then multiply.

$$\begin{aligned} \left(\frac{5}{3}\right)^4 &= \left(\frac{5}{3}\right)\left(\frac{5}{3}\right)\left(\frac{5}{3}\right)\left(\frac{5}{3}\right) && a^4 = a\cdot a\cdot a\cdot a. \\ &= \frac{5\cdot 5\cdot 5\cdot 5}{3\cdot 3\cdot 3\cdot 3} && \text{Multiply numerators and denominators.} \\ &= \frac{625}{81} && \text{Simplify.} \end{aligned}$$

5. Apply exponents first, then multiply.

$$\begin{aligned} \left(\frac{1}{2}\right)^5 &= \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right) && a^5 = a\cdot a\cdot a\cdot a\cdot a. \\ &= \frac{1\cdot 1\cdot 1\cdot 1\cdot 1}{2\cdot 2\cdot 2\cdot 2\cdot 2} && \text{Multiply numerators and denominators.} \\ &= \frac{1}{32} && \text{Simplify.} \end{aligned}$$

7. Apply exponents first, then multiply.

$$\begin{aligned}\left(\frac{4}{3}\right)^2 &= \left(\frac{4}{3}\right)\left(\frac{4}{3}\right) && a^2 = a \cdot a.\\ &= \frac{4 \cdot 4}{3 \cdot 3} && \text{Multiply numerators and denominators.}\\ &= \frac{16}{9} && \text{Simplify.}\end{aligned}$$

9. Substitute $a = 7/6$ in the expression a^3, then simplify.

$$\begin{aligned}a^3 &= \left(\frac{7}{6}\right)^3 && \text{Substitute } a = 7/6.\\ &= \left(\frac{7}{6}\right)\left(\frac{7}{6}\right)\left(\frac{7}{6}\right) && \left(\frac{7}{6}\right)^3 = \left(\frac{7}{6}\right)\left(\frac{7}{6}\right)\left(\frac{7}{6}\right).\\ &= \frac{7 \cdot 7 \cdot 7}{6 \cdot 6 \cdot 6} && \text{Multiply numerators and denominators.}\\ &= \frac{343}{216} && \text{Simplify.}\end{aligned}$$

11. Substitute $e = -2/3$ in the expression $-e^2$, then simplify. Note that order of operations demands that we evaluate the exponent before negating.

$$\begin{aligned}-e^2 &= -\left(-\frac{2}{3}\right)^2 && \text{Substitute } e = -2/3.\\ &= -\left[\left(-\frac{2}{3}\right)\left(-\frac{2}{3}\right)\right] && \left(-\frac{2}{3}\right)^2 = \left(-\frac{2}{3}\right)\left(-\frac{2}{3}\right).\\ &= -\left[\frac{2 \cdot 2}{3 \cdot 3}\right] && \text{Multiply numerators and denominators.}\\ & && \text{An even number of negative factors is positive.}\\ &= -\frac{4}{9} && \text{Simplify.}\end{aligned}$$

13. Substitute $b = -5/9$ in the expression b^2, then simplify.

$$\begin{aligned}b^2 &= \left(-\frac{5}{9}\right)^2 && \text{Substitute } b = -5/9.\\ &= \left(-\frac{5}{9}\right)\left(-\frac{5}{9}\right) && \left(-\frac{5}{9}\right)^2 = \left(-\frac{5}{9}\right)\left(-\frac{5}{9}\right).\\ &= \frac{5 \cdot 5}{9 \cdot 9} && \text{Multiply numerators and denominators.}\\ & && \text{An even number of negative factors is positive.}\\ &= \frac{25}{81} && \text{Simplify.}\end{aligned}$$

15. Substitute $b = -1/2$ in the expression $-b^3$, then simplify. Note that order of operations demands that we evaluate the exponent before negating.

$$\begin{aligned}
-b^3 &= -\left(-\frac{1}{2}\right)^3 && \text{Substitute } b = -1/2.\\
&= -\left[\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\right] && \left(-\frac{1}{2}\right)^3 = \left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right).\\
&= -\left[-\frac{1\cdot 1\cdot 1}{2\cdot 2\cdot 2}\right] && \text{Multiply numerators and denominators.}\\
& && \text{An odd number of negative factors is negative.}\\
&= \frac{1}{8} && \text{Simplify.}
\end{aligned}$$

17. Multiply first, then add or subtract as needed.

$$\begin{aligned}
\left(-\frac{1}{2}\right)\left(\frac{1}{6}\right) - \left(\frac{7}{8}\right)\left(-\frac{7}{9}\right) &= \left(-\frac{1}{12}\right) - \left(-\frac{49}{72}\right) && \text{Multiply.}\\
&= -\frac{6}{72} + \frac{49}{72} && \text{Rewrite with a common denominator.}\\
&= \frac{43}{72} && \text{Add over common denominator.}
\end{aligned}$$

19. First evaluate exponents and multiply, then add or subtract as needed.

$$\begin{aligned}
\left(-\frac{9}{8}\right)^2 - \left(-\frac{3}{2}\right)\left(\frac{7}{3}\right) &= \frac{81}{64} - \left(-\frac{7}{2}\right) && \text{Evaluate exponents and multiply.}\\
&= \frac{81}{64} + \frac{224}{64} && \text{Rewrite with a common denominator.}\\
&= \frac{305}{64} && \text{Add over common denominator.}
\end{aligned}$$

21. First evaluate exponents and multiply, then subtract.

$$\begin{aligned}
\left(-\frac{1}{2}\right)\left(-\frac{7}{4}\right) - \left(-\frac{1}{2}\right)^2 &= \frac{7}{8} - \frac{1}{4} && \text{Evaluate exponents and multiply.}\\
&= \frac{7}{8} - \frac{2}{8} && \text{Rewrite with a common denominator.}\\
&= \frac{5}{8} && \text{Subtract over common denominator.}
\end{aligned}$$

23. Multiply first, then subtract.

$$\begin{aligned} -\frac{7}{6} - \frac{1}{7} \cdot \frac{7}{9} &= -\frac{7}{6} - \frac{1}{9} && \text{Multiply.} \\ &= -\frac{21}{18} - \frac{2}{18} && \text{Rewrite with a common denominator.} \\ &= -\frac{23}{18} && \text{Subtract over common denominator.} \end{aligned}$$

25. Multiply first, then add or subtract as needed.

$$\begin{aligned} \frac{3}{4} + \frac{9}{7}\left(-\frac{7}{6}\right) &= \frac{3}{4} + \left(-\frac{3}{2}\right) && \text{Multiply.} \\ &= \frac{3}{4} - \frac{6}{4} && \text{Rewrite with a common denominator.} \\ &= -\frac{3}{4} && \text{Subtract over common denominator.} \end{aligned}$$

27. First evaluate exponents and multiply, then add or subtract as needed.

$$\begin{aligned} \left(-\frac{1}{3}\right)^2 + \left(\frac{7}{8}\right)\left(-\frac{1}{3}\right) &= \frac{1}{9} + \left(-\frac{7}{24}\right) && \text{Evaluate exponents and multiply.} \\ &= \frac{8}{72} - \frac{21}{72} && \text{Rewrite with a common denominator.} \\ &= -\frac{13}{72} && \text{Subtract over common denominator.} \end{aligned}$$

29. Multiply first, then add.

$$\begin{aligned} \frac{5}{9} + \frac{5}{9} \cdot \frac{7}{9} &= \frac{5}{9} + \frac{35}{81} && \text{Multiply.} \\ &= \frac{45}{81} + \frac{35}{81} && \text{Rewrite with a common denominator.} \\ &= \frac{80}{81} && \text{Add over common denominator.} \end{aligned}$$

31. Multiply first, then add or subtract as needed.

$$\begin{aligned} \left(-\frac{5}{6}\right)\left(\frac{3}{8}\right) + \left(-\frac{7}{9}\right)\left(-\frac{3}{4}\right) &= \left(-\frac{5}{16}\right) + \frac{7}{12} && \text{Multiply.} \\ &= -\frac{15}{48} + \frac{28}{48} && \text{Rewrite with a common denominator.} \\ &= \frac{13}{48} && \text{Add over common denominator.} \end{aligned}$$

33. Multiply first, then add or subtract as needed.

$$\begin{aligned}
\frac{4}{3}-\frac{2}{9}\left(-\frac{3}{4}\right) &= \frac{4}{3}-\left(-\frac{1}{6}\right) && \text{Multiply.}\\
&= \frac{8}{6}+\frac{1}{6} && \text{Rewrite with a common denominator.}\\
&= \frac{9}{6} && \text{Add over common denominator.}\\
&= \frac{3}{2} && \text{Simplify.}
\end{aligned}$$

35. First evaluate exponents and multiply, then add.

$$\begin{aligned}
\left(-\frac{5}{9}\right)\left(\frac{1}{2}\right)+\left(-\frac{1}{6}\right)^2 &= \left(-\frac{5}{18}\right)+\frac{1}{36} && \text{Evaluate exponents and multiply.}\\
&= -\frac{10}{36}+\frac{1}{36} && \text{Rewrite with a common denominator.}\\
&= -\frac{9}{36} && \text{Add over common denominator.}\\
&= -\frac{1}{4} && \text{Simplify.}
\end{aligned}$$

37. Substitute $a=-5/4$, $b=1/2$, and $c=3/8$. To evaluate the resulting expression, multiply first, then add.

$$\begin{aligned}
a+bc &= -\frac{5}{4}+\left(\frac{1}{2}\right)\left(\frac{3}{8}\right) && \text{Substitute.}\\
&= -\frac{5}{4}+\frac{3}{16} && \text{Multiply.}\\
&= -\frac{20}{16}+\frac{3}{16} && \text{Rewrite with a common denominator.}\\
&= -\frac{17}{16} && \text{Add over common denominator.}
\end{aligned}$$

39. Substitute $x=-1/8$, $y=5/2$, and $z=-1/2$. In the resulting expression, multiply first, then add or subtract as needed.

$$\begin{aligned}
x+yz &= -\frac{1}{8}+\left(\frac{5}{2}\right)\left(-\frac{1}{2}\right) && \text{Substitute.}\\
&= -\frac{1}{8}+\left(-\frac{5}{4}\right) && \text{Multiply.}\\
&= -\frac{1}{8}-\frac{10}{8} && \text{Rewrite with a common denominator.}\\
&= -\frac{11}{8} && \text{Subtract over common denominator.}
\end{aligned}$$

41. Substitute $a = 3/4$, $b = 5/7$, and $c = 1/2$. In the resulting expression, multiply first, then subtract.

$$\begin{aligned} a - bc &= \frac{3}{4} - \frac{5}{7} \cdot \frac{1}{2} && \text{Substitute.} \\ &= \frac{3}{4} - \frac{5}{14} && \text{Multiply.} \\ &= \frac{21}{28} - \frac{10}{28} && \text{Rewrite with a common denominator.} \\ &= \frac{11}{28} && \text{Subtract over common denominator.} \end{aligned}$$

43. Substitute $x = -3/2$, $y = 1/4$, and $z = -5/7$. In the resulting expression, first evaluate exponents and multiply, then add or subtract as needed.

$$\begin{aligned} x^2 - yz &= \left(-\frac{3}{2}\right)^2 - \left(\frac{1}{4}\right)\left(-\frac{5}{7}\right) && \text{Substitute.} \\ &= \frac{9}{4} - \left(-\frac{5}{28}\right) && \text{Evaluate exponents and multiply.} \\ &= \frac{63}{28} + \frac{5}{28} && \text{Rewrite with a common denominator.} \\ &= \frac{68}{28} && \text{Add over common denominator.} \\ &= \frac{17}{7} && \text{Simplify.} \end{aligned}$$

45. Substitute $a = 6/7$, $b = 2/3$, $c = -8/9$, and $d = -6/7$. In the resulting expression, multiply first, then add or subtract as needed.

$$\begin{aligned} ab + cd &= \left(\frac{6}{7}\right)\left(\frac{2}{3}\right) + \left(-\frac{8}{9}\right)\left(-\frac{6}{7}\right) && \text{Substitute.} \\ &= \frac{4}{7} + \frac{16}{21} && \text{Multiply.} \\ &= \frac{12}{21} + \frac{16}{21} && \text{Rewrite with a common denominator.} \\ &= \frac{28}{21} && \text{Add over common denominator.} \\ &= \frac{4}{3} && \text{Simplify.} \end{aligned}$$

47. Substitute $w = -1/8$, $x = -2/7$, $y = -1/2$, and $z = 8/7$. In the resulting expression, multiply first, then add or subtract as needed.

$$\begin{aligned} wx - yz = &= \left(-\frac{1}{8}\right)\left(-\frac{2}{7}\right) - \left(-\frac{1}{2}\right)\left(\frac{8}{7}\right) && \text{Substitute.} \\ &= \frac{1}{28} - \left(-\frac{4}{7}\right) && \text{Multiply.} \\ &= \frac{1}{28} + \frac{16}{28} && \text{Rewrite with a common denominator.} \\ &= \frac{17}{28} && \text{Add over common denominator.} \end{aligned}$$

49. Substitute $x = 3/8$, $y = 3/5$, and $z = -3/2$. In the resulting expression, first evaluate exponents and multiply, then add.

$$\begin{aligned} xy + z^2 &= \left(\frac{3}{8}\right)\left(\frac{3}{5}\right) + \left(-\frac{3}{2}\right)^2 && \text{Substitute.} \\ &= \frac{9}{40} + \frac{9}{4} && \text{Evaluate exponents and multiply.} \\ &= \frac{9}{40} + \frac{90}{40} && \text{Rewrite with a common denominator.} \\ &= \frac{99}{40} && \text{Add over common denominator.} \end{aligned}$$

51. Substitute $u = 9/7$, $v = 2/3$, and $w = -3/7$. In the resulting expression, first evaluate exponents and multiply, then subtract.

$$\begin{aligned} uv - w^2 &= \left(\frac{9}{7}\right)\left(\frac{2}{3}\right) - \left(-\frac{3}{7}\right)^2 && \text{Substitute.} \\ &= \frac{6}{7} - \frac{9}{49} && \text{Evaluate exponents and multiply.} \\ &= \frac{42}{49} - \frac{9}{49} && \text{Rewrite with a common denominator.} \\ &= \frac{33}{49} && \text{Subtract over common denominator.} \end{aligned}$$

53. Substitute $a = 7/8$, $b = -1/4$, and $c = -3/2$. In the resulting expression,

first evaluate exponents and multiply, then add or subtract as needed.

$$\begin{aligned} a^2+bc &= \left(\frac{7}{8}\right)^2+\left(-\frac{1}{4}\right)\left(-\frac{3}{2}\right) && \text{Substitute.}\\ &= \frac{49}{64}+\frac{3}{8} && \text{Evaluate exponents and multiply.}\\ &= \frac{49}{64}+\frac{24}{64} && \text{Rewrite with a common denominator.}\\ &= \frac{73}{64} && \text{Add over common denominator.} \end{aligned}$$

55. Substitute $u = 1/3$, $v = 5/2$, and $w = -2/9$. In the resulting expression, multiply first, then add or subtract as needed.

$$\begin{aligned} u-vw &= \frac{1}{3}-\left(\frac{5}{2}\right)\left(-\frac{2}{9}\right) && \text{Substitute.}\\ &= \frac{1}{3}-\left(-\frac{5}{9}\right) && \text{Multiply.}\\ &= \frac{3}{9}+\frac{5}{9} && \text{Rewrite with a common denominator.}\\ &= \frac{8}{9} && \text{Add over common denominator.} \end{aligned}$$

57. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the numerator and denominator.

$$\begin{aligned} \frac{\frac{8}{3}+\frac{7}{6}}{-\frac{9}{2}-\frac{1}{4}} &= \frac{12\left(\frac{8}{3}+\frac{7}{6}\right)}{12\left(-\frac{9}{2}-\frac{1}{4}\right)} && \text{Multiply numerator and denominator by the LCD} = 12.\\ &= \frac{12\left(\frac{8}{3}\right)+12\left(\frac{7}{6}\right)}{12\left(-\frac{9}{2}\right)-12\left(\frac{1}{4}\right)} && \text{Distribute.}\\ &= \frac{32+14}{-54-3} && \text{Multiply.}\\ &= \frac{46}{-57} && \text{Simplify numerator and denominator.}\\ &= -\frac{46}{57} && \text{Simplify.} \end{aligned}$$

59. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the numerator and denominator.

$$\begin{aligned}
\frac{\frac{3}{4}+\frac{4}{3}}{\frac{1}{9}+\frac{5}{3}} &= \frac{36\left(\frac{3}{4}+\frac{4}{3}\right)}{36\left(\frac{1}{9}+\frac{5}{3}\right)} && \text{Multiply numerator and denominator by the LCD} = 36.\\
&= \frac{36\left(\frac{3}{4}\right)+36\left(\frac{4}{3}\right)}{36\left(\frac{1}{9}\right)+36\left(\frac{5}{3}\right)} && \text{Distribute.}\\
&= \frac{27+48}{4+60} && \text{Multiply.}\\
&= \frac{75}{64} && \text{Simplify numerator and denominator.}
\end{aligned}$$

61. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the numerator and denominator.

$$\begin{aligned}
\frac{\frac{7}{5}+\frac{5}{2}}{-\frac{1}{4}+\frac{1}{2}} &= \frac{20\left(\frac{7}{5}+\frac{5}{2}\right)}{20\left(-\frac{1}{4}+\frac{1}{2}\right)} && \text{Multiply numerator and denominator by the LCD} = 20.\\
&= \frac{20\left(\frac{7}{5}\right)+20\left(\frac{5}{2}\right)}{20\left(-\frac{1}{4}\right)+20\left(\frac{1}{2}\right)} && \text{Distribute.}\\
&= \frac{28+50}{-5+10} && \text{Multiply.}\\
&= \frac{78}{5} && \text{Simplify numerator and denominator.}
\end{aligned}$$

63. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the

numerator and denominator.

$$\begin{aligned}
\frac{-\frac{3}{2}-\frac{2}{3}}{-\frac{7}{4}-\frac{2}{3}} &= \frac{12\left(-\frac{3}{2}-\frac{2}{3}\right)}{12\left(-\frac{7}{4}-\frac{2}{3}\right)} && \text{Multiply numerator and denominator by the LCD} = 12.\\
&= \frac{12\left(-\frac{3}{2}\right)-12\left(\frac{2}{3}\right)}{12\left(-\frac{7}{4}\right)-12\left(\frac{2}{3}\right)} && \text{Distribute.}\\
&= \frac{-18-8}{-21-8} && \text{Multiply.}\\
&= \frac{-26}{-29} && \text{Simplify numerator and denominator.}\\
&= \frac{26}{29} && \text{Simplify.}
\end{aligned}$$

65. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the numerator and denominator.

$$\begin{aligned}
\frac{-\frac{1}{2}-\frac{4}{7}}{-\frac{5}{7}+\frac{1}{6}} &= \frac{42\left(-\frac{1}{2}-\frac{4}{7}\right)}{42\left(-\frac{5}{7}+\frac{1}{6}\right)} && \text{Multiply numerator and denominator by the LCD} = 42.\\
&= \frac{42\left(-\frac{1}{2}\right)-42\left(\frac{4}{7}\right)}{42\left(-\frac{5}{7}\right)+42\left(\frac{1}{6}\right)} && \text{Distribute.}\\
&= \frac{-21-24}{-30+7} && \text{Multiply.}\\
&= \frac{-45}{-23} && \text{Simplify numerator and denominator.}\\
&= \frac{45}{23} && \text{Simplify.}
\end{aligned}$$

67. Start by multiplying the main numerator and denominator by the least common denominator (LCD) of the four small fractions. Then simplify the

numerator and denominator.

$$\begin{aligned}
\frac{-\frac{3}{7}-\frac{1}{3}}{\frac{1}{3}-\frac{6}{7}} &= \frac{21\left(-\frac{3}{7}-\frac{1}{3}\right)}{21\left(\frac{1}{3}-\frac{6}{7}\right)} && \text{Multiply numerator and denominator by the LCD} = 21.\\
&= \frac{21\left(-\frac{3}{7}\right)-21\left(\frac{1}{3}\right)}{21\left(\frac{1}{3}\right)-21\left(\frac{6}{7}\right)} && \text{Distribute.}\\
&= \frac{-9-7}{7-18} && \text{Multiply.}\\
&= \frac{-16}{-11} && \text{Simplify numerator and denominator.}\\
&= \frac{16}{11} && \text{Simplify.}
\end{aligned}$$

69. The formula for the area of a trapezoid is

$$A = \frac{1}{2}h\left(b_1 + b_2\right)$$

Substituting the given bases and height, we get

$$A = \frac{1}{2}(7)\left(3\frac{3}{8}+5\frac{1}{2}\right).$$

Simplify the expression inside the parentheses first. Change mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add.

$$\begin{aligned}
A &= \frac{1}{2}(7)\left(\frac{27}{8}+\frac{11}{2}\right)\\
&= \frac{1}{2}(7)\left(\frac{27\cdot 1}{8\cdot 1}+\frac{11\cdot 4}{2\cdot 4}\right)\\
&= \frac{1}{2}(7)\left(\frac{27}{8}+\frac{44}{8}\right)\\
&= \frac{1}{2}\left(\frac{7}{1}\right)\left(\frac{71}{8}\right)
\end{aligned}$$

Multiply numerators and denominators.

$$= \frac{497}{16}$$

This improper fraction is a perfectly good answer, but let's change this result to a mixed fraction (497 divided by 16 is 31 with a remainder of 1). Thus, the area of the trapezoid is

$$A = 31\,\frac{1}{16}\,\text{square feet.}$$

71. The formula for the area of a trapezoid is

$$A = \frac{1}{2}h\,(b_1 + b_2)$$

Substituting the given bases and height, we get

$$A = \frac{1}{2}(7)\left(2\frac{1}{4} + 7\frac{3}{8}\right).$$

Simplify the expression inside the parentheses first. Change mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add.

$$\begin{aligned} A &= \frac{1}{2}(7)\left(\frac{9}{4} + \frac{59}{8}\right) \\ &= \frac{1}{2}(7)\left(\frac{9\cdot 2}{4\cdot 2} + \frac{59\cdot 1}{8\cdot 1}\right) \\ &= \frac{1}{2}(7)\left(\frac{18}{8} + \frac{59}{8}\right) \\ &= \frac{1}{2}\left(\frac{7}{1}\right)\left(\frac{77}{8}\right) \end{aligned}$$

Multiply numerators and denominators.

$$= \frac{539}{16}$$

This improper fraction is a perfectly good answer, but let's change this result to a mixed fraction (539 divided by 16 is 33 with a remainder of 11). Thus, the area of the trapezoid is

$$A = 33\,\frac{11}{16}\,\text{square feet.}$$

73. The formula for the area of a trapezoid is

$$A = \frac{1}{2}h\,(b_1 + b_2)$$

Substituting the given bases and height, we get

$$A = \frac{1}{2}(3)\left(2\frac{3}{4} + 6\frac{5}{8}\right).$$

Simplify the expression inside the parentheses first. Change mixed fractions to improper fractions, make equivalent fractions with a common denominator, then add.

$$\begin{aligned} A &= \frac{1}{2}(3)\left(\frac{11}{4}+\frac{53}{8}\right) \\ &= \frac{1}{2}(3)\left(\frac{11\cdot 2}{4\cdot 2}+\frac{53\cdot 1}{8\cdot 1}\right) \\ &= \frac{1}{2}(3)\left(\frac{22}{8}+\frac{53}{8}\right) \\ &= \frac{1}{2}\left(\frac{3}{1}\right)\left(\frac{75}{8}\right) \end{aligned}$$

Multiply numerators and denominators.

$$= \frac{225}{16}$$

This improper fraction is a perfectly good answer, but let's change this result to a mixed fraction (225 divided by 16 is 14 with a remainder of 1). Thus, the area of the trapezoid is

$$A = 14\,\frac{1}{16}\,\text{square feet.}$$

4.8 Solving Equations with Fractions

1. To see if $1/4$ is a solution, we substitute $1/4$ for x in the equation and check to see if this results in a true or false statement.

$$\begin{aligned} x+\frac{5}{8} &= \frac{5}{8} && \text{Original equation.} \\ \frac{1}{4}+\frac{5}{8} &= \frac{5}{8} && \text{Substitute } x = 1/4. \\ \frac{1\cdot 2}{4\cdot 2}+\frac{5}{8} &= \frac{5}{8} && \text{Equivalent fractions on the left with LCD} = 8. \\ \frac{2}{8}+\frac{5}{8} &= \frac{5}{8} && \text{Simplify numerators and denominators.} \\ \frac{2+5}{8} &= \frac{5}{8} && \text{Add numerators over common denominator.} \\ \frac{7}{8} &= \frac{5}{8} && \text{Simplify numerator.} \end{aligned}$$

This last statement is a false statement. Therefore, $1/4$ is **not** a solution of the equation.

3. To see if $-8/15$ is a solution, we substitute $-8/15$ for x in the equation and check to see if this results in a true or false statement.

$$\left(\frac{1}{4}\right)\left(-\frac{8}{15}\right) = -\frac{1}{15} \qquad \text{Original equation.}$$

$$-\frac{(1)\cdot(2\cdot 2\cdot 2)}{(2\cdot 2)\cdot(3\cdot 5)} = -\frac{1}{15} \qquad \text{Prime factorization. Unlike signs give a negative product.}$$

$$-\frac{2}{3\cdot 5} = -\frac{1}{15} \qquad \text{Cancel common factors.}$$

$$-\frac{2}{15} = -\frac{1}{15} \qquad \text{Multiply numerators and denominators.}$$

This last statement is a false statement. Therefore, $1/4$ is **not** a solution of the equation.

5. To see if $1/2$ is a solution, we substitute $1/2$ for x in the equation and check to see if this results in a true or false statement.

$$x + \frac{4}{9} = \frac{17}{18} \qquad \text{Original equation.}$$

$$\frac{1}{2} + \frac{4}{9} = \frac{17}{18} \qquad \text{Substitute } x = 1/2.$$

$$\frac{1\cdot 9}{2\cdot 9} + \frac{4\cdot 2}{9\cdot 2} = \frac{17}{18} \qquad \text{Equivalent fractions on the left with LCD} = 18.$$

$$\frac{9}{18} + \frac{8}{18} = \frac{17}{18} \qquad \text{Simplify numerators and denominators.}$$

$$\frac{9+8}{18} = \frac{17}{18} \qquad \text{Add numerators over common denominator.}$$

$$\frac{17}{18} = \frac{17}{18} \qquad \text{Simplify numerator.}$$

This last statement is a true statement. Therefore, $1/2$ is a solution of the equation.

7. To see if $3/8$ is a solution, we substitute $3/8$ for x in the equation and check to see if this results in a true or false statement.

$$\begin{aligned}
x - \frac{5}{9} &= -\frac{13}{72} && \text{Original equation.}\\
\frac{3}{8} - \frac{5}{9} &= -\frac{13}{72} && \text{Substitute } x = 3/8.\\
\frac{3\cdot 9}{8\cdot 9} - \frac{5\cdot 8}{9\cdot 8} &= -\frac{13}{72} && \text{Equivalent fractions on the left with LCD} = 72.\\
\frac{27}{72} - \frac{40}{72} &= -\frac{13}{72} && \text{Simplify numerators and denominators.}\\
\frac{27-40}{72} &= -\frac{13}{72} && \text{Subtract numerators over common denominator.}\\
\frac{-13}{72} &= -\frac{13}{72} && \text{Simplify numerator.}
\end{aligned}$$

This last statement is a true statement. Therefore, $3/8$ is a solution of the equation.

9. To see if $2/7$ is a solution, we substitute $2/7$ for x in the equation and check to see if this results in a true or false statement.

$$\begin{aligned}
x - \frac{4}{9} &= -\frac{8}{63} && \text{Original equation.}\\
\frac{2}{7} - \frac{4}{9} &= -\frac{8}{63} && \text{Substitute } x = 2/7.\\
\frac{2\cdot 9}{7\cdot 9} - \frac{4\cdot 7}{9\cdot 7} &= -\frac{8}{63} && \text{Equivalent fractions on the left with LCD} = 63.\\
\frac{18}{63} - \frac{28}{63} &= -\frac{8}{63} && \text{Simplify numerators and denominators.}\\
\frac{18-28}{63} &= -\frac{8}{63} && \text{Subtract numerators over common denominator.}\\
\frac{-10}{63} &= -\frac{8}{63} && \text{Simplify numerator.}
\end{aligned}$$

This last statement is a false statement. Therefore, $2/7$ is **not** a solution of the equation.

11. To see if $8/5$ is a solution, we substitute $8/5$ for x in the equation and check to see if this results in a true or false statement.

$$\left(\frac{11}{14}\right)\left(\frac{8}{5}\right) = \frac{44}{35}$$ Original equation.

$$\frac{(11)\cdot(2\cdot 2\cdot 2)}{(2\cdot 7)\cdot(5)} = \frac{44}{35}$$ Prime factorization. Like signs give a positive product.

$$\frac{11\cdot 2\cdot 2}{7\cdot 5} = \frac{44}{35}$$ Cancel common factors.

$$\frac{44}{35} = \frac{44}{35}$$ Multiply numerators and denominators.

This last statement is a true statement. Therefore, $8/5$ is a solution of the equation.

13.

$$2x - 3 = 6x + 7$$ Original equation.

$$2x - 6x - 3 = 7$$ Add $-6x$ to both sides.

$$-4x - 3 = 7$$ Combine like terms on the left side.

$$-4x = 7 + 3$$ Add 3 to both sides.

$$-4x = 10$$ Combine like terms on the right side.

$$x = -\frac{10}{4}$$ Divide both sides by -4.

$$x = -\frac{5}{2}$$ Simplify.

15.

$$-7x + 4 = 3x$$ Original equation.

$$4 = 3x + 7x$$ Add $7x$ to both sides.

$$4 = 10x$$ Combine like terms on the right side.

$$\frac{4}{10} = x$$ Divide both sides by 10.

$$\frac{2}{5} = x$$ Simplify.

17.

$$-2x = 9x - 4$$ Original equation.

$$-2x - 9x = -4$$ Add $-9x$ to both sides.

$$-11x = -4$$ Combine like terms on the left side.

$$x = \frac{4}{11}$$ Divide both sides by -11.

19.

$$\begin{aligned} -8x &= 7x - 7 && \text{Original equation.} \\ -8x - 7x &= -7 && \text{Add } -7x \text{ to both sides.} \\ -15x &= -7 && \text{Combine like terms on the left side.} \\ x &= \frac{7}{15} && \text{Divide both sides by } -15. \end{aligned}$$

21.

$$\begin{aligned} -7x + 8 &= 2x && \text{Original equation.} \\ 8 &= 2x + 7x && \text{Add } 7x \text{ to both sides.} \\ 8 &= 9x && \text{Combine like terms on the right side.} \\ \frac{8}{9} &= x && \text{Divide both sides by 9.} \end{aligned}$$

23.

$$\begin{aligned} -9x + 4 &= 4x - 6 && \text{Original equation.} \\ -9x - 4x + 4 &= -6 && \text{Add } -4x \text{ to both sides.} \\ -13x + 4 &= -6 && \text{Combine like terms on the left side.} \\ -13x &= -6 - 4 && \text{Add } -4 \text{ to both sides.} \\ -13x &= -10 && \text{Combine like terms on the right side.} \\ x &= \frac{10}{13} && \text{Divide both sides by } -13. \end{aligned}$$

25.

$$\begin{aligned} x + \frac{3}{2} &= \frac{1}{2} && \text{Original equation.} \\ 2\left(x + \frac{3}{2}\right) &= 2\left(\frac{1}{2}\right) && \text{Multiply both sides by the LCD} = 2. \\ 2x + 2\left(\frac{3}{2}\right) &= 2\left(\frac{1}{2}\right) && \text{On the left, distribute 2.} \\ 2x + 3 &= 1 && \text{Cancel and simplify.} \\ 2x &= -2 && \text{Add } -3 \text{ to both sides.} \\ x &= -\frac{2}{2} && \text{Divide both sides by 2.} \\ x &= -1 && \text{Simplify.} \end{aligned}$$

27.

$$\begin{aligned} -\frac{9}{5}x &= \frac{1}{2} && \text{Original equation.} \\ 10\left(-\frac{9}{5}\right) &= 10\left(\frac{1}{2}\right) && \text{Multiply both sides by the LCD} = 10. \\ -18x &= 5 && \text{Cancel and simplify.} \\ x &= -\frac{5}{18} && \text{Divide both sides by } -18. \end{aligned}$$

29.

$$\begin{aligned} \frac{3}{8}x &= \frac{8}{7} && \text{Original equation.} \\ 56\left(\frac{3}{8}\right) &= 56\left(\frac{8}{7}\right) && \text{Multiply both sides by the LCD} = 56. \\ 21x &= 64 && \text{Cancel and simplify.} \\ x &= \frac{64}{21} && \text{Divide both sides by } 21. \end{aligned}$$

31.

$$\begin{aligned} \frac{2}{5}x &= -\frac{1}{6} && \text{Original equation.} \\ 30\left(\frac{2}{5}\right) &= 30\left(-\frac{1}{6}\right) && \text{Multiply both sides by the LCD} = 30. \\ 12x &= -5 && \text{Cancel and simplify.} \\ x &= -\frac{5}{12} && \text{Divide both sides by } 12. \end{aligned}$$

33.

$$\begin{aligned} -\frac{3}{2}x &= \frac{8}{7} && \text{Original equation.} \\ 14\left(-\frac{3}{2}\right) &= 14\left(\frac{8}{7}\right) && \text{Multiply both sides by the LCD} = 14. \\ -21x &= 16 && \text{Cancel and simplify.} \\ x &= -\frac{16}{21} && \text{Divide both sides by } -21. \end{aligned}$$

35.

$$\begin{aligned}
x + \frac{3}{4} &= \frac{5}{9} && \text{Original equation.}\\
36\left(x + \frac{3}{4}\right) &= 36\left(\frac{5}{9}\right) && \text{Multiply both sides by the LCD} = 36.\\
36x + 36\left(\frac{3}{4}\right) &= 36\left(\frac{5}{9}\right) && \text{On the left, distribute 36.}\\
36x + 27 &= 20 && \text{Cancel and simplify.}\\
36x &= -7 && \text{Add } -27 \text{ to both sides.}\\
x &= -\frac{7}{36} && \text{Divide both sides by 36.}
\end{aligned}$$

37.

$$\begin{aligned}
x - \frac{4}{7} &= \frac{7}{8} && \text{Original equation.}\\
56\left(x - \frac{4}{7}\right) &= 56\left(\frac{7}{8}\right) && \text{Multiply both sides by the LCD} = 56.\\
56x - 56\left(\frac{4}{7}\right) &= 56\left(\frac{7}{8}\right) && \text{On the left, distribute 56.}\\
56x - 32 &= 49 && \text{Cancel and simplify.}\\
56x &= 81 && \text{Add 32 to both sides.}\\
x &= \frac{81}{56} && \text{Divide both sides by 56.}
\end{aligned}$$

39.

$$\begin{aligned}
x + \frac{8}{9} &= \frac{2}{3} && \text{Original equation.}\\
9\left(x + \frac{8}{9}\right) &= 9\left(\frac{2}{3}\right) && \text{Multiply both sides by the LCD} = 9.\\
9x + 9\left(\frac{8}{9}\right) &= 9\left(\frac{2}{3}\right) && \text{On the left, distribute 9.}\\
9x + 8 &= 6 && \text{Cancel and simplify.}\\
9x &= -2 && \text{Add } -8 \text{ to both sides.}\\
x &= -\frac{2}{9} && \text{Divide both sides by 9.}
\end{aligned}$$

41.

$$\begin{aligned}
x + \frac{5}{2} &= -\frac{9}{8} && \text{Original equation.}\\
8\left(x + \frac{5}{2}\right) &= 8\left(-\frac{9}{8}\right) && \text{Multiply both sides by the LCD} = 8.\\
8x + 8\left(\frac{5}{2}\right) &= 8\left(-\frac{9}{8}\right) && \text{On the left, distribute 8.}\\
8x + 20 &= -9 && \text{Cancel and simplify.}\\
8x &= -29 && \text{Add } -20 \text{ to both sides.}\\
x &= -\frac{29}{8} && \text{Divide both sides by 8.}
\end{aligned}$$

43.

$$\begin{aligned}
-\frac{8}{5}x &= \frac{7}{9} && \text{Original equation.}\\
45\left(-\frac{8}{5}\right) &= 45\left(\frac{7}{9}\right) && \text{Multiply both sides by the LCD} = 45.\\
-72x &= 35 && \text{Cancel and simplify.}\\
x &= -\frac{35}{72} && \text{Divide both sides by } -72.
\end{aligned}$$

45.

$$\begin{aligned}
x - \frac{1}{4} &= -\frac{1}{8} && \text{Original equation.}\\
8\left(x - \frac{1}{4}\right) &= 8\left(-\frac{1}{8}\right) && \text{Multiply both sides by the LCD} = 8.\\
8x - 8\left(\frac{1}{4}\right) &= 8\left(-\frac{1}{8}\right) && \text{On the left, distribute 8.}\\
8x - 2 &= -1 && \text{Cancel and simplify.}\\
8x &= 1 && \text{Add 2 to both sides.}\\
x &= \frac{1}{8} && \text{Divide both sides by 8.}
\end{aligned}$$

47.

$$\begin{aligned}
-\frac{1}{4}x &= \frac{1}{2} && \text{Original equation.}\\
4\left(-\frac{1}{4}\right) &= 4\left(\frac{1}{2}\right) && \text{Multiply both sides by the LCD} = 4.\\
-x &= 2 && \text{Cancel and simplify.}\\
x &= -\frac{2}{1} && \text{Divide both sides by } -1.\\
x &= 2 && \text{Simplify.}
\end{aligned}$$

49.

$$\begin{aligned}
-\frac{7}{3}x - \frac{2}{3} &= \frac{3}{4}x + \frac{2}{3} && \text{Original equation.}\\
12\left(-\frac{7}{3}x - \frac{2}{3}\right) &= 12\left(\frac{3}{4}x + \frac{2}{3}\right) && \text{Multiply both sides by the LCD} = 12.\\
12\left(-\frac{7}{3}x\right) - 12\left(\frac{2}{3}\right) &= 12\left(\frac{3}{4}x\right) + 12\left(\frac{2}{3}\right) && \text{On both sides, distribute 12.}\\
-28x - 8 &= 9x + 8 && \text{Cancel and simplify.}\\
-37x - 8 &= 8 && \text{Add } -9x \text{ to both sides.}\\
-37x &= 16 && \text{Add 8 to both sides.}\\
x &= -\frac{16}{37} && \text{Divide both sides by } -37.
\end{aligned}$$

51.

$$\begin{aligned}
-\frac{7}{2}x - \frac{5}{4} &= \frac{4}{5} && \text{Original equation.}\\
20\left(-\frac{7}{2}x - \frac{5}{4}\right) &= 20\left(\frac{4}{5}\right) && \text{Multiply both sides by the LCD} = 20.\\
20\left(-\frac{7}{2}x\right) - 20\left(\frac{5}{4}\right) &= 20\left(\frac{4}{5}\right) && \text{On the left, distribute 20.}\\
-70x - 25 &= 16 && \text{Cancel and simplify.}\\
-70x &= 41 && \text{Add 25 to both sides.}\\
x &= -\frac{41}{70} && \text{Divide both sides by } -70.
\end{aligned}$$

53.

$$\begin{aligned}
-\frac{9}{7}x+\frac{9}{2} &= -\frac{5}{2} && \text{Original equation.}\\
14\left(-\frac{9}{7}x+\frac{9}{2}\right) &= 14\left(-\frac{5}{2}\right) && \text{Multiply both sides by the LCD = 14.}\\
14\left(-\frac{9}{7}x\right)+14\left(\frac{9}{2}\right) &= 14\left(-\frac{5}{2}\right) && \text{On the left, distribute 14.}\\
-18x+63 &= -35 && \text{Cancel and simplify.}\\
-18x &= -98 && \text{Add } -63 \text{ to both sides.}\\
x &= \frac{98}{18} && \text{Divide both sides by } -18.\\
x &= \frac{49}{9} && \text{Simplify.}
\end{aligned}$$

55.

$$\begin{aligned}
\frac{1}{4}x-\frac{4}{3} &= -\frac{2}{3} && \text{Original equation.}\\
12\left(\frac{1}{4}x-\frac{4}{3}\right) &= 12\left(-\frac{2}{3}\right) && \text{Multiply both sides by the LCD = 12.}\\
12\left(\frac{1}{4}x\right)-12\left(\frac{4}{3}\right) &= 12\left(-\frac{2}{3}\right) && \text{On the left, distribute 12.}\\
3x-16 &= -8 && \text{Cancel and simplify.}\\
3x &= 8 && \text{Add 16 to both sides.}\\
x &= \frac{8}{3} && \text{Divide both sides by 3.}
\end{aligned}$$

57.

$$\begin{aligned}
\frac{5}{3}x+\frac{3}{2} &= -\frac{1}{4} && \text{Original equation.}\\
12\left(\frac{5}{3}x+\frac{3}{2}\right) &= 12\left(-\frac{1}{4}\right) && \text{Multiply both sides by the LCD = 12.}\\
12\left(\frac{5}{3}x\right)+12\left(\frac{3}{2}\right) &= 12\left(-\frac{1}{4}\right) && \text{On the left, distribute 12.}\\
20x+18 &= -3 && \text{Cancel and simplify.}\\
20x &= -21 && \text{Add } -18 \text{ to both sides.}\\
x &= -\frac{21}{20} && \text{Divide both sides by 20.}
\end{aligned}$$

59.

$$-\frac{1}{3}x+\frac{4}{5}=-\frac{9}{5}x-\frac{5}{6}$$ Original equation.

$$30\left(-\frac{1}{3}x+\frac{4}{5}\right)=30\left(-\frac{9}{5}x-\frac{5}{6}\right)$$ Multiply both sides by the LCD = 30.

$$30\left(-\frac{1}{3}x\right)+30\left(\frac{4}{5}\right)=30\left(-\frac{9}{5}x\right)-30\left(-\frac{5}{6}\right)$$ On both sides, distribute 30.

$$-10x+24=-54x-25$$ Cancel and simplify.

$$44x+24=-25$$ Add $54x$ to both sides.

$$44x=-49$$ Add -24 to both sides.

$$x=-\frac{49}{44}$$ Divide both sides by 44.

61.

$$-\frac{4}{9}x-\frac{8}{9}=\frac{1}{2}x-\frac{1}{2}$$ Original equation.

$$18\left(-\frac{4}{9}x-\frac{8}{9}\right)=18\left(\frac{1}{2}x-\frac{1}{2}\right)$$ Multiply both sides by the LCD = 18.

$$18\left(-\frac{4}{9}x\right)-18\left(\frac{8}{9}\right)=18\left(\frac{1}{2}x\right)-18\left(-\frac{1}{2}\right)$$ On both sides, distribute 18.

$$-8x-16=9x-9$$ Cancel and simplify.

$$-17x-16=-9$$ Add $-9x$ to both sides.

$$-17x=7$$ Add 16 to both sides.

$$x=-\frac{7}{17}$$ Divide both sides by -17.

63.

$$\frac{1}{2}x-\frac{1}{8}=-\frac{1}{8}x+\frac{5}{7}$$ Original equation.

$$56\left(\frac{1}{2}x-\frac{1}{8}\right)=56\left(-\frac{1}{8}x+\frac{5}{7}\right)$$ Multiply both sides by the LCD = 56.

$$56\left(\frac{1}{2}x\right)-56\left(\frac{1}{8}\right)=56\left(-\frac{1}{8}x\right)+56\left(\frac{5}{7}\right)$$ On both sides, distribute 56.

$$28x-7=-7x+40$$ Cancel and simplify.

$$35x-7=40$$ Add $7x$ to both sides.

$$35x=47$$ Add 7 to both sides.

$$x=\frac{47}{35}$$ Divide both sides by 35.

65.

$$-\frac{3}{7}x-\frac{1}{3}=-\frac{1}{9}$$ Original equation.

$$63\left(-\frac{3}{7}x-\frac{1}{3}\right)=63\left(-\frac{1}{9}\right)$$ Multiply both sides by the LCD = 63.

$$63\left(-\frac{3}{7}x\right)-63\left(\frac{1}{3}\right)=63\left(-\frac{1}{9}\right)$$ On the left, distribute 63.

$$-27x-21=-7$$ Cancel and simplify.

$$-27x=14$$ Add 21 to both sides.

$$x=-\frac{14}{27}$$ Divide both sides by -27.

67.

$$-\frac{3}{4}x+\frac{2}{7}=\frac{8}{7}x-\frac{1}{3}$$ Original equation.

$$84\left(-\frac{3}{4}x+\frac{2}{7}\right)=84\left(\frac{8}{7}x-\frac{1}{3}\right)$$ Multiply both sides by the LCD = 84.

$$84\left(-\frac{3}{4}x\right)+84\left(\frac{2}{7}\right)=84\left(\frac{8}{7}x\right)-84\left(-\frac{1}{3}\right)$$ On both sides, distribute 84.

$$-63x+24=96x-28$$ Cancel and simplify.

$$-159x+24=-28$$ Add $-96x$ to both sides.

$$-159x=-52$$ Add -24 to both sides.

$$x=\frac{52}{159}$$ Divide both sides by -159.

69.

$$-\frac{3}{4}x-\frac{2}{3}=-\frac{2}{3}x-\frac{1}{2}$$ Original equation.

$$12\left(-\frac{3}{4}x-\frac{2}{3}\right)=12\left(-\frac{2}{3}x-\frac{1}{2}\right)$$ Multiply both sides by the LCD = 12.

$$12\left(-\frac{3}{4}x\right)-12\left(\frac{2}{3}\right)=12\left(-\frac{2}{3}x\right)-12\left(-\frac{1}{2}\right)$$ On both sides, distribute 12.

$$-9x-8=-8x-6$$ Cancel and simplify.

$$-x-8=-6$$ Add $8x$ to both sides.

$$-x=2$$ Add 8 to both sides.

$$x=-\frac{2}{1}$$ Divide both sides by -1.

$$x=-2$$ Simplify.

71.

$$\begin{aligned}
-\frac{5}{2}x+\frac{9}{5}&=\frac{5}{8} && \text{Original equation.}\\
40\left(-\frac{5}{2}x+\frac{9}{5}\right)&=40\left(\frac{5}{8}\right) && \text{Multiply both sides by the LCD = 40.}\\
40\left(-\frac{5}{2}x\right)+40\left(\frac{9}{5}\right)&=40\left(\frac{5}{8}\right) && \text{On the left, distribute 40.}\\
-100x+72&=25 && \text{Cancel and simplify.}\\
-100x&=-47 && \text{Add } -72 \text{ to both sides.}\\
x&=\frac{47}{100} && \text{Divide both sides by } -100.
\end{aligned}$$

73. We are told that 2/9 of full seating capacity is 4,302.

1. *Set up a Variable Dictionary.* Let F represent the full seating capacity.
2. *Set up an Equation.* 2/9 of the full seating capacity is 4,302.

$\frac{2}{9}$	of	Full Seating Capacity	is	4,302
$\frac{2}{9}$	$\cdot$	F	$=$	4,302

   Hence, the equation is

$$\frac{2}{9}F=4302.$$

3. *Solve the Equation.* Multiply both sides by 9 to clear fractions, then solve.

$$\begin{aligned}
\frac{2}{9}F&=4302 && \text{Original equation.}\\
9\left(\frac{2}{9}F\right)&=9(4302) && \text{Multiply both sides by 9.}\\
2F&=38718 && \text{Simplify both sides.}\\
\frac{2F}{2}&=\frac{38718}{2} && \text{Divide both sides by 2.}\\
F&=19359 && \text{Simplify both sides.}
\end{aligned}$$

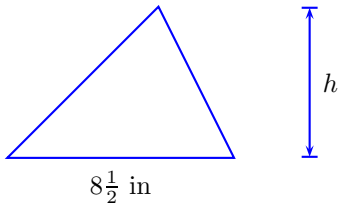
4. *Answer the Question.* The full seating capacity is 19,359.
5. *Look Back.* The words of the problem state that 2/9 of the seating capacity is 4,302. Let's take 2/9 of our answer and see what we get.

$$\frac{2}{9}\cdot 19,359=4,302$$

   This is the correct attendance, so our solution is correct.

75. We follow the requirements for word problems in our solution.

1. *Set up a Variable Dictionary.* Our variable dictionary will take the form of a well labeled diagram.



2. *Set up an Equation.* The area A of a triangle with base b and height h is

$$A = \frac{1}{2}bh.$$

Substitute $A = 51$ and $b = 8\frac{1}{2}$.

$$51 = \frac{1}{2}\left(8\frac{1}{2}\right)h.$$

3. *Solve the Equation.* Change the mixed fraction to an improper fraction, then simplify.

$$\begin{aligned}
51 &= \frac{1}{2}\left(8\frac{1}{2}\right)h && \text{Original equation.}\\
51 &= \frac{1}{2}\left(\frac{17}{2}\right)h && \text{Mixed to improper: } 8\frac{1}{2} = \frac{17}{2}.\\
51 &= \left(\frac{1}{2}\cdot\frac{17}{2}\right)h && \text{Associative property.}\\
51 &= \frac{17}{4}h && \text{Multiply: } \frac{1}{2}\cdot\frac{17}{2} = \frac{17}{4}.
\end{aligned}$$

Now, multiply both sides by 4/17 and solve.

$$\begin{aligned}
\frac{4}{17}(51) &= \frac{4}{17}\left(\frac{17}{4}h\right) && \text{Multiply both sides by } 4/17.\\
12 &= h && \text{Simplify: } \frac{4}{17}(51) = 12
\end{aligned}$$

4. *Answer the Question.* The height of the triangle is 12 inches.

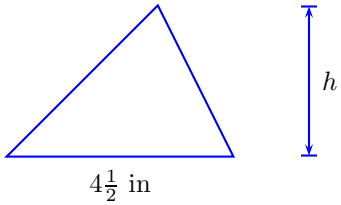
5. *Look Back.* If the height is 12 inches and the base is $8\frac{1}{2}$ inches, then the area is

$$\begin{aligned} A &= \frac{1}{2}\left(8\frac{1}{2}\right)(12) \\ &= \frac{1}{2}\cdot\frac{17}{2}\cdot\frac{12}{1} \\ &= 51 \end{aligned}$$

This is the correct area (51 square inches), so our solution is correct.

77. We follow the requirements for word problems in our solution.

1. *Set up a Variable Dictionary.* Our variable dictionary will take the form of a well labeled diagram.



2. *Set up an Equation.* The area A of a triangle with base b and height h is

$$A = \frac{1}{2}bh.$$

Substitute $A = 18$ and $b = 4\frac{1}{2}$.

$$18 = \frac{1}{2}\left(4\frac{1}{2}\right)h.$$

3. *Solve the Equation.* Change the mixed fraction to an improper fraction, then simplify.

$$\begin{aligned} 18 &= \frac{1}{2}\left(4\frac{1}{2}\right)h && \text{Original equation.} \\ 18 &= \frac{1}{2}\left(\frac{9}{2}\right)h && \text{Mixed to improper: } 4\frac{1}{2} = \frac{9}{2}. \\ 18 &= \left(\frac{1}{2}\cdot\frac{9}{2}\right)h && \text{Associative property.} \\ 18 &= \frac{9}{4}h && \text{Multiply: } \frac{1}{2}\cdot\frac{9}{2} = \frac{9}{4}. \end{aligned}$$

Now, multiply both sides by 4/9 and solve.

$$\begin{aligned} \frac{4}{9}(18) &= \frac{4}{9}\left(\frac{9}{4}h\right) && \text{Multiply both sides by } 4/9. \\ 8 &= h && \text{Simplify: } \frac{4}{9}(18) = 8 \end{aligned}$$

4. *Answer the Question.* The height of the triangle is 8 inches.
5. *Look Back.* If the height is 8 inches and the base is $4\frac{1}{2}$ inches, then the area is

$$\begin{aligned} A &= \frac{1}{2}\left(4\frac{1}{2}\right)(8) \\ &= \frac{1}{2}\cdot\frac{9}{2}\cdot\frac{8}{1} \\ &= 18 \end{aligned}$$

This is the correct area (18 square inches), so our solution is correct.

79. We are told that 2/11 of full seating capacity is 4,536.

1. *Set up a Variable Dictionary.* Let F represent the full seating capacity.
2. *Set up an Equation.* 2/11 of the full seating capacity is 4,536.

$\frac{2}{11}$	of	Full Seating Capacity	is	4,536
$\frac{2}{11}$	$\cdot$	F	$=$	4,536

Hence, the equation is

$$\frac{2}{11}F = 4536.$$

3. *Solve the Equation.* Multiply both sides by 11 to clear fractions, then solve.

$$\begin{aligned} \frac{2}{11}F &= 4536 && \text{Original equation.} \\ 11\left(\frac{2}{11}F\right) &= 11(4536) && \text{Multiply both sides by 11.} \\ 2F &= 49896 && \text{Simplify both sides.} \\ \frac{2F}{2} &= \frac{49896}{2} && \text{Divide both sides by 2.} \\ F &= 24948 && \text{Simplify both sides.} \end{aligned}$$

4. *Answer the Question.* The full seating capacity is 24,948.

5. *Look Back.* The words of the problem state that 2/11 of the seating capacity is 4,536. Let's take 2/11 of our answer and see what we get.

$$\frac{2}{11} \cdot 24,948 = 4,536$$

This is the correct attendance, so our solution is correct.

81. In our solution, we will carefully address each step of the *Requirements for Word Problem Solutions*.

1. *Set up a Variable Dictionary.* We can satisfy this requirement by simply stating "Let x represent the number of pirate attacks worldwide in 2008."

2. *Set up an Equation.* "One-third of number of pirate attacks worldwide were off the Somali coast" becomes

one-third	of	number pirate attacks worldwide	were	number attacks off Somali coast
$\frac{1}{3}$	$\cdot$	x	$=$	111

3. *Solve the Equation.* To "undo" the multiplication of a fraction, multiply both sides of the equation by the reciprocal.

$$\begin{aligned} \frac{1}{3} \cdot x &= 111 && \text{Original equation.} \\ \frac{3}{1} \cdot \frac{1}{3} \cdot x &= 111 \cdot \frac{3}{1} && \text{Multiply both sides of the equation by } \frac{3}{1}. \\ x &= 333 && \text{On the left, multiplying by 3/1 "undoes" the effect of multiplying by 1/3 and returns } x. \text{ On the right, } 111 \cdot \frac{3}{1} = 333. \end{aligned}$$

4. *Answer the Question.* In 2008, the number of pirate attacks worldwide was 333.

5. *Look Back.* Do 333 pirate attacks worldwide satisfy the words in the original problem? We were told that "About one-third of the number of pirate attacks worldwide were off the Somali coast." Well, one-third of 333 is 111.

83. In our solution, we will carefully address each step of the *Requirements for Word Problem Solutions*.

1. *Set up a Variable Dictionary.* We can satisfy this requirement by simply stating "Let x represent the total number of the world's crop seeds."

2. *Set up an Equation.* "One-third of the world's crop seeds is half a million" becomes

one-third	of	number of world's crop seeds	is	number of seeds in seed vault
$\frac{1}{3}$	$\cdot$	x	$=$	500,000

3. *Solve the Equation.* To "undo" the multiplication of a fraction, multiply both sides of the equation by the reciprocal.

$$\begin{aligned}
\frac{1}{3} \cdot x &= 500000 && \text{Original equation.} \\
\frac{3}{1} \cdot \frac{1}{3} \cdot x &= 500000 \cdot \frac{3}{1} && \text{Multiply both sides of the equation by } \frac{3}{1}. \\
x &= 1500000 && \text{On the left, multiplying by } 3/1 \text{ "undoes" the effect of multiplying by } 1/3 \text{ and returns } x. \text{ On the right, } 500000 \cdot \frac{3}{1} = 1500000.
\end{aligned}$$

4. *Answer the Question.* The number of crop seeds in the world is estimated at $1,500,000$.

5. *Look Back.* Does $1,500,000$ crop seeds worldwide make sense? We were told that "At least one-third of the world's crop seeds are $500,000$." Well, one-third of $1,500,000$ is $500,000$.