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Chapter 2

FRACTIONS

2.1 Factors and Prime Numbers

Exercises

2. A composite number is a whole number that has more than two factors.

4. The least common multiple of two or more numbers is the smallest nonzero number that is a multiple of each number.

6. The divisibility test for 10 is to check if the ones digit is 0.

8. $\frac{10}{1} = 10$ R0

$$\frac{10}{2} = 5$$
 R0

The factors of 10 are 1, 2, 5, and 10.

10. $\frac{9}{1} = 9$ R0

$$\frac{9}{3} = 3$$
 R0

20. $\frac{98}{1} = 98$ R0

$$\frac{98}{2} = 49$$
 R0

$$\frac{98}{7} = 14$$
 R0

The factors of 98 are 1, 2, 7, 14, 49, and 98.

22. $\frac{48}{1} = 48$ R0

$$\frac{48}{2} = 24$$
 R0

$$\frac{48}{3} = 16$$
 R0

$$\frac{48}{4} = 12$$
 R0

$$\frac{48}{6} = 8$$
 R0

The factors of 48 are 1, 2, 3, 4, 6, 8, 12, 16, 24, and 48.

$\frac{9}{3} = 3$
The factors of 9 are 1, 3, and 9.

12. $\frac{15}{1} = 15$ R0

$$\frac{15}{3} = 5 \text{ R}0$$

The factors of 15 are 1, 3, 5, and 15.

14. $\frac{47}{1} = 47 \text{ R}0$

The factors of 47 are 1 and 47.

16. $\frac{35}{1} = 35 \text{ R}0$

$$\frac{35}{5} = 7 \text{ R}0$$

The factors of 35 are 1, 5, 7, and 35.

18. $\frac{73}{1} = 73 \text{ R}0$

The factors of 73 are 1 and 73.

24. 7 is prime.

26. 24 is composite; 2, 3, 4, 6, 8, and 12 are factors.

28. 75 is composite; 3, 5, 15, and 25 are factors.

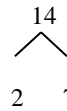
30. 31 is prime.

32. 45 is composite; 3, 5, 9 and 15 are factors.

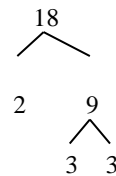
34. $10 = 2 \times 5$



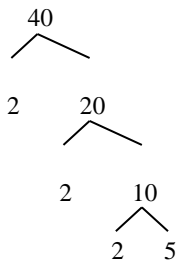
36. $14 = 2 \times 7$



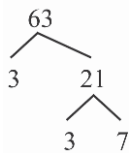
38. $18 = 2 \times 3 \times 3 = 2 \times 3^2$



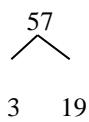
40. $40 = 2 \times 2 \times 2 \times 5 = 2^3 \times 5$



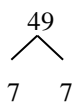
42. $63 = 3 \times 3 \times 7 = 3^2 \times 7$



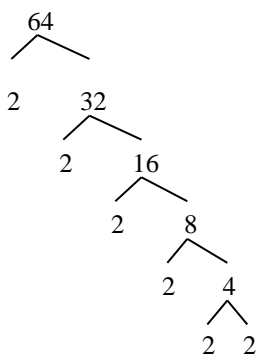
44. $57 = 3 \times 19$



46. $49 = 7 \times 7 = 7^2$



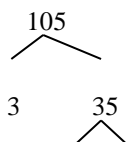
48. $64 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6$



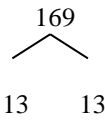
50. $22 = 2 \times 11$



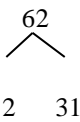
52. $105 = 3 \times 5 \times 7$



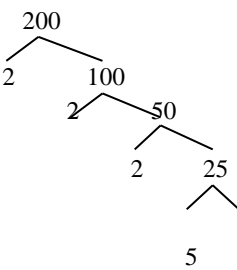
54. $169 = 13 \times 13 = 13^2$



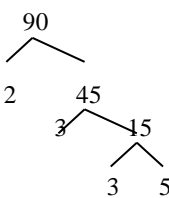
56. $62 = 2 \times 31$



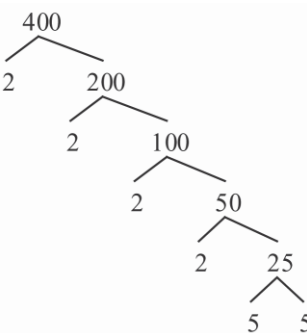
58. $200 = 2 \times 2 \times 2 \times 5 \times 5 = 2^3 \times 5^2$



60. $90 = 2 \times 3 \times 3 \times 5 = 2 \times 3^2 \times 5$



62. $400 = 2 \times 2 \times 2 \times 2 \times 5 \times 5 = 2^4 \times 5^2$



64. $9 = 3^2$

$12 = 2^2 \cdot 3$

$LCM = 2^2 \cdot 3^2 = 4 \cdot 9 = 36$

5
7

66.

$$4 = 2^2$$

$$6 = 2 \cdot 3$$

$$\text{LCM} = 2^2 \cdot 3 =$$

$$4 \cdot 3 = 12$$

$$68. \begin{aligned} 20 &= 2^2 \cdot 5 \\ 21 &= 3 \cdot 7 \\ \text{LCM} &= 2^2 \cdot 3 \cdot 5 \cdot 7 = 4 \cdot 3 \cdot 5 \cdot 7 = 420 \end{aligned}$$

$$70. \begin{aligned} 15 &= 3 \cdot 5 \\ 60 &= 2^2 \cdot 3 \cdot 5 \\ \text{LCM} &= 2^2 \cdot 3 \cdot 5 = 4 \cdot 3 \cdot 5 = 60 \end{aligned}$$

$$72. \begin{aligned} 30 &= 2 \cdot 3 \cdot 5 \\ 150 &= 2 \cdot 3 \cdot 5^2 \\ \text{LCM} &= 2 \cdot 3 \cdot 5^2 = 2 \cdot 3 \cdot 25 \\ &= 150 \end{aligned}$$

$$74. \begin{aligned} 100 &= 2^2 \cdot 5^2 \\ 90 &= 2 \cdot 3^2 \cdot 5 \\ \text{LCM} &= 2^2 \cdot 3^2 \cdot 5^2 = 4 \cdot 9 \cdot 25 = 900 \end{aligned}$$

$$76. \begin{aligned} 2 &= 2 \\ 8 &= 2^3 \\ 10 &= 2 \cdot 5 \\ \text{LCM} &= 2^3 \cdot 5 = 8 \cdot 5 = 40 \end{aligned}$$

$$78. \begin{aligned} 2 &= 2 \\ 3 &= 3 \\ 5 &= 5 \\ \text{LCM} &= 2 \cdot 3 \cdot 5 = 6 \cdot 5 = \\ &30 \end{aligned}$$

$$80. \begin{aligned} 6 &= 2 \cdot 3 \\ 8 &= 2^3 \\ 12 &= 2^2 \cdot 3 \\ \text{LCM} &= 2^3 \cdot 3 = 8 \cdot 3 = 24 \end{aligned}$$

$$82. \begin{aligned} 8 &= 2^3 \\ 24 &= 2^3 \cdot 3 \\ 56 &= 2^3 \cdot 7 \\ \text{LCM} &= 2^3 \cdot 3 \cdot 7 = 8 \cdot 3 \cdot 7 = 168 \end{aligned}$$

84. 63 is composite; 3, 7, 9, and 21 are factors.

$$86. \begin{aligned} 5 &= 5 \\ 10 &= 2 \cdot 5 \\ 12 &= 2^2 \cdot 3 \\ \text{LCM} &= 2^2 \cdot 3 \cdot 5 = 4 \cdot 15 = 60 \end{aligned}$$

$$\begin{array}{r} 49 \text{ R}0 \\ \overline{) } \end{array}$$

$$88. \text{ b. } \begin{array}{r} 49 \text{ R}2 \\ \overline{4)198} \end{array}$$

No, because 198 is not a multiple of 4.

90. Yes, an oil change would be recommended at 21,000 miles, since 21,000 is divisible by 3,000.

$$92. \begin{aligned} \text{LCM}(4, 3) &= 12 \\ 2006 + 12 &= 2018 \end{aligned}$$

Both prizes will be given in 2018.

$$94. \begin{aligned} 6 &= 2 \cdot 3 \\ 3 &= 3 \\ 4 &= 2 \cdot 2 \\ \text{LCM}(6, 3, 4) &= 2^2 \cdot 3 = 12 \end{aligned}$$

The bills will all fall due again in 12 months.

Mindstretchers

$$1. \text{ a. } \begin{aligned} 57 &= 7 + 19 + 31 \text{ or} \\ &57 = 3 + 17 + 37 \end{aligned}$$

$$\text{ b. } \begin{aligned} 81 &= 11 + 23 + 47 \text{ or} \\ &81 = 7 + 37 + 37 \end{aligned}$$

$$2. \begin{aligned} 1 &= 1 \\ 2 &= 2 \\ 3 &= 3 \\ 4 &= 2^2 \\ 5 &= 5 \\ 6 &= 2 \times 3 \\ 7 &= 7 \\ 8 &= 2^3 \\ 9 &= 3^2 \\ 10 &= 2 \times 5 \end{aligned}$$

$$\text{LCM} = 1 \times 2^3 \times 3^2 \times 5 \times 7 = 2,520$$

The smallest whole number divisible by every whole number from 1 to 10 is 2,520.

$$3. 715 \times 7 \times 11 \times 13 = 715,715$$

88. a. 4 196

Yes, because 196 is a multiple of 4.

2.2 Introduction to Fractions

Exercises

2. The improper fraction $\frac{5}{2}$ can be expressed as a

mixed number.

4. Divide the numerator and denominator of a fraction by the same whole number in order to simplify it.

6. The least common denominator of two or more fractions is the least common multiple of their denominators.

8. There are 4 equal parts of which 1 part is shaded. The fraction is $\frac{1}{4}$.

10. There are 5 equal parts of which 4 parts are shaded. The fraction is $\frac{4}{5}$.

12. There are 2 wholes and $\frac{2}{5}$ of a whole shaded. The mixed number is $2\frac{2}{5}$.

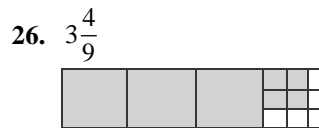
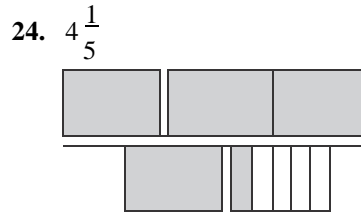
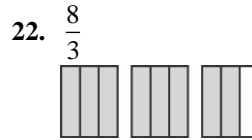
14. There is 1 whole shaded and $\frac{6}{8}$ of a whole shaded. The mixed number is $1\frac{6}{8}$.



18. $\frac{4}{10}$



20. $\frac{11}{11}$



28. $\frac{7}{12}$; proper fraction

30. $\frac{11}{10}$; improper fraction

32. $12\frac{1}{2}$; mixed number

34. $\frac{4}{4}$; improper fraction

36. $\frac{5}{6}$; proper fraction

38. $10\frac{3}{4}$; mixed number

40. $1\frac{1}{3} = \frac{(3 \times 1) + 1}{3} = \frac{4}{3}$

42. $10\frac{2}{3} = \frac{(3 \times 10) + 2}{3} = \frac{32}{3}$

44. $12\frac{3}{4} = \frac{(4 \times 12) + 3}{4} = \frac{51}{4}$

46. $8 = \frac{8}{1}$

1

$$6\frac{5}{6} = \frac{(6 \times 6) + 5}{6} = \frac{41}{6}$$

$$50. 10\frac{1}{2} = \frac{(2 \times 10) + 1}{2} = \frac{21}{2}$$

$$52. 20\frac{1}{8} = \frac{(8 \times 20) + 1}{8} = \frac{161}{8}$$

$$54. 11\frac{5}{7} = \frac{(7 \times 11) + 5}{7} = \frac{82}{7}$$

$$56. 10 = \frac{10}{1}$$

$$58. 2\frac{7}{13} = \frac{(13 \times 2) + 7}{13} = \frac{33}{13}$$

$$60. 4\frac{1}{6} = \frac{(6 \times 4) + 1}{6} = \frac{25}{6}$$

$$62. 14\frac{1}{10} = \frac{(10 \times 14) + 1}{10} = \frac{141}{10}$$

$$64. \frac{6}{5} = 5\frac{1}{5} \quad \frac{6}{5} = 1\frac{1}{5}$$

$$66. \frac{12}{5} = 5\frac{2}{5} \quad \frac{12}{5} = 2\frac{2}{5}$$

$$68. \frac{12}{12} = 12\frac{1}{12} \quad \frac{12}{12} = 1$$

$$70. \frac{100}{100} = 100\frac{1}{100} \quad \frac{100}{100} = 1$$

$$72. \frac{31}{2} = 2\frac{15}{2} \quad \frac{31}{2} = 15\frac{1}{2}$$

$$\frac{38}{3} = 12\frac{2}{3}$$

$$82. \frac{38}{3} = 3\frac{2}{3}$$

$$84. \frac{72}{9} = 9\frac{8}{9} \quad \frac{72}{9} = 8$$

$$86. \frac{19}{19} = 1\frac{19}{19} \quad \frac{19}{19} = 19$$

88. Possible answers:

$$\frac{3}{10} = \frac{3 \cdot 2}{10 \cdot 2} = \frac{6}{20}$$

$$\frac{3}{10} = \frac{3 \cdot 3}{10 \cdot 3} = \frac{9}{30}$$

$$10 \quad 10 \cdot 3 \quad 30$$

90. Possible answers:

$$\frac{1}{10} = \frac{1 \cdot 2}{10 \cdot 2} = \frac{2}{20}$$

$$\frac{1}{10} = \frac{1 \cdot 3}{10 \cdot 3} = \frac{3}{30}$$

92. Possible answers:

$$\frac{5}{6} = \frac{5 \cdot 2}{6 \cdot 2} = \frac{10}{12}$$

$$\frac{5}{6} = \frac{5 \cdot 3}{6 \cdot 3} = \frac{15}{18}$$

$$6 \quad 6 \cdot 3 \quad 18$$

94. Possible answers:

$$\frac{3}{5} = \frac{3 \cdot 2}{5 \cdot 2} = \frac{6}{10}$$

$$\frac{3}{5} = \frac{3 \cdot 3}{5 \cdot 3} = \frac{9}{15}$$

$$5 \quad 5 \cdot 2 \quad 10$$

$$5 \quad 5 \cdot 3 \quad 15$$

$$96. \frac{2}{9} = \frac{2 \cdot 2}{9 \cdot 2} = \frac{4}{18}$$

$$98. \frac{7}{10} = \frac{7 \cdot 2}{10 \cdot 2} = \frac{14}{20}$$

$$74. \frac{62}{3} = 3 \overline{) 20} \text{ R}2 \quad \frac{62}{3} = 20 \frac{2}{3}$$

$$76. \frac{40}{3} = 3 \overline{) 13} \text{ R}1 \quad \frac{40}{3} = 13 \frac{1}{3}$$

$$78. \frac{41}{8} = 8 \overline{) 5} \text{ R}1 \quad \frac{41}{8} = 5 \frac{1}{8}$$

$$80. \frac{58}{11} = 11 \overline{) 5} \text{ R}3 \quad \frac{58}{11} = 5 \frac{3}{11}$$

$$100. 5 = \frac{5}{1} = \frac{5 \cdot 15}{1 \cdot 15} = \frac{75}{15}$$

$$\frac{4}{9} = \frac{4 \cdot 7}{9 \cdot 7} = \frac{28}{63}$$

$$102. \frac{4}{9} = \frac{4 \cdot 7}{9 \cdot 7} = \frac{28}{63}$$

$$104. \frac{3}{10} = \frac{3 \cdot 4}{10 \cdot 4} = \frac{12}{40}$$

$$106. 2 = \frac{2}{1} = \frac{2 \cdot 21}{1 \cdot 21} = \frac{42}{21}$$

108. $\frac{7}{8} = \frac{7 \cdot 3}{8 \cdot 3} = \frac{21}{24}$

110. $\frac{5}{6} = \frac{5 \cdot 8}{6 \cdot 8} = \frac{40}{48}$

112. $\frac{1}{3} = \frac{1 \cdot 30}{3 \cdot 30} = \frac{30}{90}$

114. $\frac{1}{4} = \frac{1 \cdot 25}{4 \cdot 25} = \frac{25}{100}$

116. $\frac{7}{8} = \frac{7 \cdot 7}{8 \cdot 7} = \frac{49}{56}$

118. $\frac{5}{6} = \frac{5 \cdot 24}{6 \cdot 24} = \frac{120}{144}$

120. $\frac{9}{12} = \frac{\cancel{3} \cdot 3}{\cancel{3} \cdot 4} = \frac{3}{4}$

122. $\frac{21}{21} = \frac{\cancel{7} \cdot 7}{\cancel{7} \cdot 7} = 1$

124. $\frac{4}{24} = \frac{\cancel{2} \cdot \cancel{2} \cdot 2 \cdot 3}{\cancel{2} \cdot \cancel{2} \cdot 2 \cdot 3} = \frac{1}{6}$

126. $\frac{25}{49} = \frac{5 \cdot 5}{7 \cdot 7} = \frac{25}{49}$

128. $\frac{75}{100} = \frac{\cancel{3} \cdot \cancel{25}}{4 \cdot \cancel{25}} = \frac{3}{4}$

130. $\frac{1}{2} = \frac{1 \cdot 1 \cdot 1}{2 \cdot 1 \cdot 1} = \frac{1}{2}$

132. $\frac{1}{2} = \frac{1 \cdot 1}{2 \cdot 1} = \frac{1}{2}$

136. $\frac{36}{45} = \frac{\cancel{9} \cdot 4}{\cancel{9} \cdot 5} = \frac{4}{5}$

138. $\frac{19}{51} = \frac{19}{51}$

140. $\frac{36}{144} = \frac{\cancel{9} \cdot \cancel{4}}{\cancel{9} \cdot \cancel{4} \cdot 4} = \frac{1}{4}$

142. $\frac{21}{36} = \frac{\cancel{3} \cdot 7}{\cancel{3} \cdot 12} = \frac{7}{12}$

144. $11 \frac{51}{102} = 11 \frac{\cancel{1} \cdot \cancel{51}}{2 \cdot \cancel{51}} = 11 \frac{1}{2}$

146. $1 \frac{144}{144} = 1 + 1 = 2$

148. $\frac{5}{6} > \frac{3}{8}$ because $5 > 3$

150. $\frac{5}{6} < \frac{7}{8}$ because $\frac{20}{24} < \frac{21}{24}$

152. $\frac{9}{12} = \frac{3}{4}$ because $9 \cdot 4 = 12 \cdot 3$, $36 = 36$

154. $2 \frac{3}{7} > 1 \frac{1}{2}$ because $\frac{17}{7} > \frac{3}{2}$ since $\frac{34}{14} > \frac{21}{14}$

156. $2 = 2$
 $3 = 3$
 $4 = 2^2$
 LCM = $2^2 \cdot 3 = 4 \cdot 3 = 12$

$\frac{875}{1,000} = \frac{5 \cdot 5 \cdot 5 \cdot 7}{5 \cdot 5 \cdot 5 \cdot 8} = \frac{7}{8}$

$\frac{30}{6} = \frac{5}{1}$
 $\frac{6}{3} = \frac{2}{1}$
 $\frac{18}{6} = \frac{3}{1}$

$\frac{15}{9} = \frac{3 \cdot 5}{3 \cdot 3} = \frac{5}{3} = 1 \frac{2}{3}$

$$\frac{3}{3 \cdot 6}$$

$$\frac{18}{2 \cdot 6}$$

$$\frac{3}{3 \cdot 4} = \frac{\frac{3}{4} \cdot \frac{3}{3} \cdot \frac{3}{2}}{\frac{3}{4} \cdot \frac{3}{3} \cdot \frac{3}{2}}$$

$$\frac{12}{3 \cdot 4}$$

$$\frac{3}{3 \cdot 4}$$

$$\frac{3}{9}$$

$$\frac{4}{4 \cdot 3}$$

In increasing order, the fractions are



158. $4 = 2^2$
 $6 = 2 \cdot 3$
 $8 = 2^3$
 $\text{LCM} = 2^3 \cdot 3 = 8 \cdot 3$
 $= 24$

$$\frac{3}{18} = \frac{3 \cdot 6}{18} =$$

$$\frac{4}{24} = \frac{4 \cdot 6}{24} =$$

$$\frac{5}{20} = \frac{5 \cdot 4}{20} =$$

$$\frac{6}{8} = \frac{6 \cdot 4}{8 \cdot 4} = \frac{24}{32}$$

$$\frac{7}{8} = \frac{7 \cdot 3}{8 \cdot 3} = \frac{21}{24}$$

In increasing order, the fractions are $\frac{3}{4}, \frac{5}{6}, \frac{7}{8}$.

160. $8 = 2^3$
 $2 = 2$
 $11 = 11$
 $\text{LCM} = 2^3 \cdot 11 = 8 \cdot 11 =$
 88

$$\frac{5}{8} = \frac{5 \cdot 11}{8 \cdot 11} = \frac{55}{88}$$

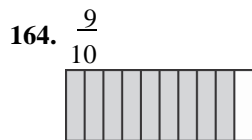
$$\frac{1}{2} = \frac{1 \cdot 44}{2 \cdot 44} = \frac{44}{88}$$

$$\frac{4}{11} = \frac{4 \cdot 8}{11 \cdot 8} = \frac{32}{88}$$

In increasing order, the fractions are $\frac{4}{11}, \frac{1}{2}, \frac{5}{8}$.

162.
$$\begin{array}{r} 5 \text{ R}2 \\ 6 \overline{) 32} \end{array}$$

$$\frac{32}{6} = 5 \frac{2}{6} = 5 \frac{1}{3}$$



166. $2 \frac{3}{8} = \frac{(8 \times 2) + 3}{8} = \frac{19}{8}$

168.
$$\begin{array}{r} 1 \text{ R}2 \\ 4 \overline{) 6} \end{array}$$

$$\frac{6}{4} = 1 \frac{2}{4} = 1 \frac{1}{2}$$

170. b. The fraction of therapists who are respiratory therapists is $\frac{94,000}{276,000} = \frac{94}{276} = \frac{47}{138}$.

172. The Lakers did not win $82 - 65 = 17$ games.

This is $\frac{17}{82}$ of the games played.

— —

174. $\frac{1}{9} = \frac{1 \cdot 4}{9 \cdot 4} = \frac{4}{36}$

There is a greater probability of rolling a 6, because $\frac{5}{36}$ is greater than $\frac{1}{9}$.

176. The LCM of 2, 8, and 16 is 16.

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

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

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

a. Newark had the best visibility at $\frac{1}{2}$ mi.

b. JFK had the worst visibility at $\frac{1}{16}$ mi.

178. $\frac{57+61+57+57+58+57}{6} = \frac{347}{6} = 57 \frac{5}{6}$

Their average age at inauguration was $57 \frac{5}{6}$ yr.

Mindstretchers

1. The shaded center triangle is equivalent to 4 of the smaller shaded triangles, so there are 7 shaded triangles. There are 9 unshaded triangles, so there are 16 triangles in total.

$\frac{7}{16}$ of the triangle is shaded.

4 4 2

There are $1\frac{1}{2}$ cloves per serving.

170. a. $182,000 + 94,000 = 276,000$

There are 276,000 physical therapists.

The fraction of therapists who are physical

therapists is $\frac{182,000}{276,000} = \frac{182}{276} = \frac{91}{138}$.

2. There are an infinite number of fractions

$$\left(\frac{3}{2} = 1\frac{1}{2}, \frac{4}{3} = 1\frac{1}{3}, \frac{5}{4} = 1\frac{1}{4}, \dots \right)$$

3. a. $3 \cdot 14 = 6 \cdot 7 = 42$

$$3 \cdot 58 = 6 \cdot 29 = 174$$

$$7 \cdot 58 = 14 \cdot 29 = 406$$

$$\frac{2}{3} = \frac{79}{118}$$

b. $\frac{1}{4} = \frac{1}{6} = \frac{1}{12}$

2.3 Adding and Subtracting Fractions

Exercises

2. To subtract unlike fractions, rewrite them as equivalent fractions with the same denominator.

4. Fractions with equal numerators and denominators are equivalent to 1.

$$6. \frac{7}{10} + \frac{9}{10} = \frac{16}{10} = 1\frac{6}{10} \text{ or } 1\frac{3}{5}$$

$$8. \frac{71}{100} + \frac{79}{100} = \frac{150}{100} = 1\frac{50}{100} \text{ or } 1\frac{1}{2}$$

$$10. \frac{1}{7} + \frac{3}{7} + \frac{2}{7} = \frac{6}{7}$$

$$12. \frac{1}{10} + \frac{3}{10} + \frac{1}{10} = \frac{5}{10} = \frac{1}{2}$$

$$14. \frac{1}{5} = \frac{5}{25}$$

$$\begin{array}{r} 4 \quad 20 \\ + \frac{2}{5} = + \frac{8}{20} \\ \hline \frac{13}{20} \end{array}$$

$$16. \frac{1}{6} = \frac{1}{6}$$

$$\begin{array}{r} 6 \quad 6 \\ + \frac{2}{6} = + \frac{4}{6} \\ \hline \frac{3}{6} = \frac{1}{2} \end{array}$$

$$18. \frac{5}{12} = \frac{10}{24}$$

$$\begin{array}{r} 6 \quad 12 \\ + \frac{1}{12} = + \frac{1}{12} \\ \hline \frac{11}{12} \end{array}$$

$$22. \frac{9}{10} = \frac{9}{10}$$

$$\begin{array}{r} 10 \quad 10 \\ + \frac{4}{5} = + \frac{8}{10} \\ \hline \frac{17}{10} = 1\frac{7}{10} \end{array}$$

$$24. \frac{7}{20} = \frac{7}{20}$$

$$\begin{array}{r} 3 \quad 15 \\ + \frac{3}{4} = + \frac{15}{20} \\ \hline \frac{22}{20} = 1\frac{2}{20} = 1\frac{1}{10} \end{array}$$

$$26. \frac{1}{5} + \frac{1}{6} + \frac{1}{3} = \frac{6}{30} + \frac{5}{30} + \frac{10}{30} = \frac{21}{30} = \frac{7}{10}$$

$$28. \frac{3}{10} + \frac{1}{3} + \frac{1}{9} = \frac{27}{90} + \frac{30}{90} + \frac{10}{90} = \frac{67}{90}$$

$$30. \frac{1}{2} = \frac{6}{12}$$

$$\frac{1}{3} = \frac{4}{12}$$

$$\begin{array}{r} 1 \quad 3 \\ + \frac{1}{4} = + \frac{3}{12} \\ \hline \frac{13}{12} = 1\frac{1}{12} \end{array}$$

$$32. \frac{1}{10} = \frac{3}{30}$$

$$\frac{2}{5} = \frac{12}{30}$$

$$\begin{array}{r} -5 \quad - \\ + \frac{5}{25} = + \frac{1}{5} \end{array}$$

$$\frac{6}{30} = \frac{10}{50} = 1\frac{10}{30} = 1\frac{1}{3}$$

$$34. \frac{4}{5} = \frac{8}{10}$$

$$\begin{array}{r} 1 \quad 2 \\ + 2 \\ \hline \frac{11}{5} \end{array}$$

$$\text{Check: } 4\frac{1}{5} + 2$$

$$\begin{array}{r} 20. \quad \frac{3}{4} = \frac{21}{28} \\ + \frac{3}{7} = + \frac{12}{28} \\ \hline \frac{33}{28} = 1\frac{5}{28} \end{array}$$

$$\begin{array}{r} 5 \\ \downarrow \quad \downarrow \\ 4 + 2 = 6 \end{array}$$

36. $6\frac{1}{12}$

$$\begin{array}{r} 12 \\ +4\frac{1}{12} \\ \hline 12 \\ 10\frac{2}{12} = 10\frac{1}{6} \end{array}$$

Check: $6\frac{1}{12} + 4\frac{1}{12}$

$$\begin{array}{r} 12 \quad 12 \\ \downarrow \quad \downarrow \\ 6 + 4 = 10 \end{array}$$

38. $8\frac{2}{3}$

$$\begin{array}{r} 3 \\ +6\frac{2}{3} \\ \hline 3 \\ 14\frac{4}{3} = 15\frac{1}{3} \end{array}$$

Check: $8\frac{2}{3} + 6\frac{2}{3}$

$$\begin{array}{r} \square \quad \square \\ 9 + 7 = 16 \end{array}$$

40. $2\frac{3}{10}$

$$\begin{array}{r} 10 \\ +7\frac{9}{10} \\ \hline 10 \end{array}$$

$$9\frac{12}{10} = 10\frac{2}{10} = 10\frac{1}{5}$$

Check: $2\frac{3}{10} + 7\frac{9}{10}$

$$\begin{array}{r} \square \quad \square \\ 21 \\ 2 + 8 = 10 \end{array}$$

42. $17\frac{3}{5} = 17\frac{15}{25}$

$$\begin{array}{r} 8 \quad 40 \\ +20\frac{1}{5} = +20\frac{8}{25} \\ \hline 40 \\ 37\frac{23}{25} \\ 40 \end{array}$$

Check: $17\frac{3}{5} + 20\frac{1}{5}$

46. $4\frac{1}{7} = 4\frac{10}{70}$

$$\begin{array}{r} 9 \quad 90 \\ +20\frac{1}{7} = +20\frac{30}{70} \\ \hline 10 \quad 90 \\ 24\frac{73}{90} \end{array}$$

Check: $4\frac{1}{7} + 20\frac{30}{70}$

$$\begin{array}{r} 9 \quad 10 \\ \square \quad \square \\ 4 + 21 = 25 \end{array}$$

48. $\frac{1}{6} = \frac{5}{30}$

$$\begin{array}{r} 2 \quad 12 \\ +3\frac{2}{5} = +3\frac{12}{30} \\ \hline 30 \\ 3\frac{17}{30} \end{array}$$

Check: $\frac{1}{6} + 3\frac{2}{5}$

$$\begin{array}{r} \square \quad \square \\ 0 + 3 = 3 \end{array}$$

50. $20\frac{3}{5} = 20\frac{6}{10}$

$$\begin{array}{r} 1 \quad 10 \\ +4\frac{1}{2} = +4\frac{5}{10} \\ \hline 10 \\ 24\frac{11}{10} = 25\frac{1}{10} \end{array}$$

Check: $20\frac{3}{5} + 4\frac{1}{2}$

$$\begin{array}{r} \square \quad \square \\ + 5 = 26 \end{array}$$

52. $4\frac{8}{9} = 4\frac{8}{9}$

$$\begin{array}{r} 1 \quad 3 \\ +5\frac{1}{3} = +5\frac{2}{9} \\ \hline 9 \\ 9\frac{11}{9} = 10\frac{2}{9} \end{array}$$

Check: $4\frac{8}{9} + 5\frac{1}{3}$

$$\begin{array}{r} \square \quad \square \end{array}$$

$$\begin{array}{r} \square \quad \square \\ 5 \\ 17 + 20 = 37 \end{array}$$

44. $4\frac{7}{20} = 4\frac{14}{20}$

$$\begin{array}{r} 10 \quad 20 \\ + \frac{7}{20} = + \frac{7}{20} \\ \hline 4\frac{21}{20} = 5\frac{1}{20} \end{array}$$

Check: $4\frac{7}{10} + \frac{7}{20}$

$$\begin{array}{r} \square \quad \square \\ + \\ 5 + 0 = 5 \end{array}$$

$$+ 5 = 10$$

54. $10\frac{5}{6} = 10\frac{10}{12}$

$$\begin{array}{r} \overline{+8\frac{1}{4}} = \overline{+8\frac{3}{12}} \\ 18\frac{13}{12} \text{ or } 19\frac{1}{12} \end{array}$$

Check: $10\frac{5}{6} + 8\frac{1}{4}$

$$\begin{array}{r} \square \quad \square \\ 11 \quad 8 = 19 \end{array}$$

56. $8\frac{3}{10} = 8\frac{300}{1,000}$

$$+2\frac{321}{1,000} = +2\frac{321}{1,000}$$

$$1,000 \quad 1,000$$

$$10\frac{621}{1,000}$$

Check: $8\frac{3}{10} + 2\frac{321}{1,000}$

$$8 + 2 = 10$$

58. $\frac{1}{3} = \frac{8}{24}$

$$25\frac{7}{24} = 25\frac{7}{24}$$

$$+100\frac{1}{24} = +100\frac{12}{24}$$

$$125\frac{27}{24} = 126\frac{3}{24} = 126\frac{1}{8}$$

Check: $\frac{1}{3} + 25\frac{7}{24} + 100\frac{1}{24}$

$$0 + 25 + 101 = 126$$

60. $4\frac{1}{8} = 4\frac{2}{16}$

$$4\frac{3}{16} = 4\frac{3}{16}$$

$$+ \frac{5}{16} = + \frac{20}{16}$$

$$8\frac{25}{16} = 9\frac{9}{16}$$

Check: $4\frac{1}{8} + 4\frac{3}{16} + \frac{5}{16}$

$$4 + 4 + 1 = 9$$

62.

64. $4\frac{2}{3} = 4\frac{24}{36}$

$$2\frac{11}{36} = 2\frac{11}{36}$$

$$+1\frac{1}{2} = +1\frac{9}{18} = +1\frac{18}{36}$$

$$7\frac{53}{36} = 8\frac{17}{36}$$

Check: $4\frac{2}{3} + 2\frac{11}{36} + 1\frac{1}{2}$

$$5 + 2 + 2 = 9$$

$\frac{7}{9} - \frac{5}{9} = \frac{2}{9}$

66. $\frac{7}{9} - \frac{5}{9} = \frac{2}{9}$

68. $\frac{11}{12} - \frac{5}{12} = \frac{6}{12} = \frac{1}{2}$

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

72. $\frac{7}{9} - \frac{4}{9} = \frac{3}{9} = \frac{1}{3}$

74. $\frac{1}{8} - \frac{1}{8} = 0$

76. $\frac{2}{5} = \frac{12}{30}$

$$\frac{1}{6} = \frac{5}{30}$$

$$-\frac{1}{6} = -\frac{5}{30}$$

78. $\frac{9}{9} = \frac{90}{90}$

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

$$\begin{array}{r}
 10 \\
 10 \\
 0 \\
 3 \\
 \hline
 = \\
 \frac{20}{3} = \\
 \frac{100}{3} = 5\frac{10}{3} \\
 \frac{100}{3} = 5\frac{10}{3} \\
 \frac{100}{3} = 5\frac{10}{3} \\
 + 3\frac{1}{4} = + 3\frac{3}{4} \\
 \hline
 \frac{100}{3} + 3\frac{3}{4} = 10\frac{10}{3} + 3\frac{3}{4}
 \end{array}$$

$$9\frac{21}{12} = 10\frac{9}{12} = 10\frac{3}{4}$$

Check: $1\frac{2}{3} + 5\frac{5}{6} + 3\frac{1}{4}$

$$2 + 6 + 3 = 11$$

— —

$$\frac{87}{100}$$

100

80. $\frac{5}{6} = \frac{20}{24}$

$$\frac{6}{1} = \frac{24}{3}$$

$$\frac{8}{17} = \frac{24}{24}$$

$$82. \quad \frac{2}{5} = \frac{18}{45}$$

$$\frac{-2}{-9} = \frac{-10}{-45}$$

$$\frac{8}{45}$$

$$84. \quad \frac{11}{12} = \frac{11}{12}$$

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

$$\frac{-3}{12} = \frac{-12}{12}$$

$$86. \quad \frac{5}{6} = \frac{5}{6}$$

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

$$\frac{1}{6}$$

$$88. \quad 6\frac{2}{3}$$

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

$$\hline 5\frac{1}{3}$$

$$\text{Check: } 5\frac{1}{3}$$

$$+ 1\frac{1}{3}$$

$$\hline 6\frac{2}{3}$$

$$3$$

$$90. \quad 10\frac{5}{6}$$

$$-2\frac{5}{6}$$

$$\hline 8$$

$$\text{Check: } 8$$

92. (continued)

$$\text{Check: } 7\frac{1}{7} = 7\frac{2}{7}$$

$$+ \frac{2}{7} = + \frac{4}{7}$$

$$\hline 7\frac{3}{7}$$

$$94. \quad 2\frac{1}{3}$$

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

$$\text{Check: } \frac{1}{3}$$

$$+ 2$$

$$\hline 2\frac{1}{3}$$

$$96. \quad 4 = 3\frac{5}{5}$$

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

$$\hline 2\frac{4}{5}$$

$$\text{Check: } 2\frac{4}{5}$$

$$+ 1\frac{1}{5}$$

$$\hline 3\frac{5}{5} = 4$$

$$98. \quad 2 = 1\frac{2}{2}$$

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

$$\hline 1$$

$$\text{Check: } 1$$

$$92. \quad 7\frac{3}{4}$$

$$\begin{array}{r} + 2\frac{5}{6} \\ \hline 10\frac{5}{6} \end{array} \quad \begin{array}{r} 2 \\ + 1\frac{1}{2} \\ \hline 3\frac{1}{2} \end{array}$$

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

$$\begin{array}{r} 4 \\ - \frac{1}{4} \\ \hline 3\frac{3}{4} \end{array} = 7\frac{1}{2}$$

100. $5 = 4\frac{10}{10}$
 $-\frac{4}{10} = -\frac{4}{10}$
 $\frac{1}{10}$

100. (continued)

$$\text{Check: } \frac{1}{10}$$

$$\begin{array}{r} + 4\frac{9}{10} \\ \hline 4\frac{10}{10} = 5 \\ 10 \end{array}$$

102. $9 = 8\frac{4}{4}$

$$\begin{array}{r} - \frac{3}{4} = -\frac{3}{4} \\ \hline 8\frac{1}{4} \end{array}$$

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

$$\begin{array}{r} + \frac{3}{4} \\ \hline 8\frac{4}{4} = 9 \end{array}$$

104. $5\frac{1}{10} = 4\frac{11}{10}$

$$\begin{array}{r} - 2\frac{3}{10} = -2\frac{3}{10} \\ \hline 2\frac{8}{10} = 2\frac{4}{5} \end{array}$$

Check: $2\frac{4}{5} = 2\frac{8}{10}$

$$\begin{array}{r} + 2\frac{3}{10} = + 2\frac{3}{10} \\ \hline 4\frac{11}{10} = 5\frac{1}{10} \end{array}$$

106. $3\frac{1}{5} = 2\frac{6}{5}$

$$\begin{array}{r} - 1\frac{4}{5} = -1\frac{4}{5} \\ \hline 1\frac{2}{5} \end{array}$$

108. $3\frac{7}{10} = 2\frac{17}{10}$

$$\begin{array}{r} \frac{10}{9} = \frac{10}{9} \\ \hline \end{array}$$

$$\begin{array}{r} - 10 \quad - 10 \\ \hline 2\frac{8}{10} = 2\frac{4}{5} \end{array}$$

Check: $2\frac{4}{5} = 2\frac{8}{10}$

$$\begin{array}{r} + \frac{5}{10} = + \frac{10}{10} \\ \hline \end{array}$$

$$2\frac{17}{10} = 3\frac{7}{10}$$

110. $2\frac{1}{5} = 1\frac{6}{5}$

$$\begin{array}{r} - \frac{4}{5} = -\frac{4}{5} \\ \hline 1\frac{2}{5} \end{array}$$

Check: $1\frac{2}{5}$

$$\begin{array}{r} + \frac{4}{5} \\ \hline 1\frac{6}{5} = 2\frac{1}{5} \end{array}$$

112. $7\frac{1}{10} = 7\frac{7}{70} = 6\frac{77}{70}$

$$- 2\frac{1}{10} = -2\frac{10}{100} = -2\frac{10}{100}$$

$$\begin{array}{r} - 7 \quad - 70 \quad - 70 \\ \hline 4\frac{67}{70} \end{array}$$

Check:

$$7\frac{1}{10} - 2\frac{1}{10}$$

$$7 - 2 = 5$$

114. $2\frac{1}{10} = 2\frac{10}{100} = 1\frac{110}{100}$

$$\begin{array}{r} \text{Check: } 1\frac{2}{5} \\ + 1\frac{4}{5} \\ \hline \end{array}$$

$$2\frac{6}{5} = 3\frac{1}{5}$$

$$\frac{-1}{100} = \frac{-1}{100} = \frac{-1}{100} \frac{27}{83}$$

Check:

$$2\frac{1}{10} - 1\frac{27}{1000}$$

$$2 - 1 = 1$$

$$-1\frac{4}{16} = -1\frac{16}{16} = -1\frac{5}{16}$$

Check: $5\frac{15}{16}$

$$+ 1\frac{5}{16}$$

$$6\frac{20}{16} = 7\frac{4}{16} = 7\frac{1}{4}$$

$$\frac{3}{15} = 3\frac{15}{15} = 3\frac{1}{5}$$

132. $4\frac{1}{10}$

$$+ 2\frac{9}{10}$$

$$6\frac{10}{10} = 7$$

132. (continued)

$$7 = 6\frac{4}{4}$$

$$\begin{array}{r} -3\frac{3}{4} \\ -3\frac{3}{4} \\ \hline 3\frac{1}{4} \end{array}$$

134. $8\frac{9}{10} = 8\frac{9}{10}$

$$\begin{array}{r} -\frac{1}{8} \\ -\frac{5}{8} \\ \hline -\frac{6}{8} \end{array}$$

$$19\frac{1}{10} = 19\frac{5}{10} = 18\frac{35}{10}$$

$$\begin{array}{r} \frac{6}{8} \\ -8\frac{7}{8} \\ \hline -8\frac{21}{8} \end{array}$$

$$\begin{array}{r} \frac{10}{30} \\ \frac{30}{30} \\ \hline 10\frac{14}{30} = 10\frac{7}{15} \end{array}$$

136. $6\frac{1}{6} = 6\frac{3}{6}$

$$\begin{array}{r} \frac{10}{15} \\ +3\frac{7}{15} \\ \hline 9\frac{17}{30} \end{array}$$

138. $\frac{3}{8} = \frac{9}{24}$

$$\begin{array}{r} \frac{1}{2} \\ \frac{1}{2} \\ \hline +\frac{1}{2} \end{array}$$

$$\begin{array}{r} \frac{3}{24} \\ \frac{24}{24} \\ \hline 1\frac{5}{24} \end{array}$$

140. $\frac{9}{4} = \frac{18}{8}$

$$\begin{array}{r} \frac{10}{4} \\ -\frac{1}{4} \\ \hline \frac{9}{4} \end{array}$$

144. a. $\frac{1}{32} = \frac{1}{32}$

$$\begin{array}{r} \frac{32}{32} \\ +\frac{1}{32} \\ \hline \frac{33}{32} \end{array}$$

$$\begin{array}{r} \frac{8}{32} \\ \frac{32}{32} \\ \hline \frac{40}{32} \end{array}$$

The combined amount of electricity generated by liquid fuels and nuclear

power will be $\frac{5}{32}$ of the total world

electricity.

b. $\frac{7}{32} = \frac{14}{64}$

$$\begin{array}{r} \frac{16}{32} \\ -\frac{5}{32} \\ \hline \frac{11}{32} \end{array}$$

$$\frac{9}{32}$$

The amount of electricity generated by coal

is $\frac{9}{32}$ greater than the combined amount

generated by liquid fuel and nuclear power.

146. The sum of the fractions of the votes would equal 1 whole, or $\frac{8}{8}$.

$$\frac{5}{8} + \frac{1}{4} = \frac{5}{8} + \frac{2}{8} = \frac{7}{8}$$

$$\frac{8}{8} - \frac{7}{8} = \frac{1}{8}$$

The third candidate got $\frac{1}{8}$ of the votes.

148. $20\frac{5}{8} = 20\frac{5}{8}$

$$\begin{array}{r} \frac{8}{2} \\ +10\frac{1}{2} \\ \hline 10\frac{4}{2} \end{array}$$

$$30\frac{9}{8} = 31\frac{1}{8}$$

The
total
weight
of the
boxes

$$142. \quad 7 \frac{1}{4} \text{ acre} = 7 \frac{2}{8} \text{ acre}$$

$$\begin{array}{r} 8 \\ - \frac{1}{4} \text{ acre} = - \frac{2}{8} \text{ acre} \\ \hline \frac{5}{8} \text{ acre} \end{array}$$

The area of the land not occupied by the
building is $\frac{5}{8}$ acre.

is $31\frac{1}{8}$ oz.

150. Find the difference in foot length when comparing sizes 4 and 7.

$$6\frac{1}{2} - 5\frac{3}{4} = 6\frac{2}{4} - 5\frac{3}{4} = 5\frac{6}{4} - 5\frac{3}{4} = \frac{3}{4} \text{ in.}$$

Find the difference in foot length when comparing sizes 7 and 10.

$$7\frac{1}{4} - 6\frac{1}{2} = 7\frac{1}{4} - 6\frac{2}{4} = 6\frac{5}{4} - 6\frac{2}{4} = \frac{3}{4} \text{ in.}$$

Both differences are the same, namely $\frac{3}{4}$ in.

152. Find the total weight of the packages on the right side of the scale.

$$1\frac{1}{4} \text{ lb} = 1\frac{2}{4} \text{ lb}$$

$$+3\frac{1}{4} \text{ lb} = +3\frac{1}{4} \text{ lb}$$

$$4\frac{3}{4} \text{ lb}$$

The total weight of the packages on the left side of the scale must also equal $4\frac{3}{4}$ lb.

$$4\frac{3}{4} \text{ lb}$$

$$-2\frac{3}{4} \text{ lb}$$

$$2 \text{ lb}$$

The small package on the left weighs 2 lb.

Mindstretchers

1.

$\frac{1}{4}$	$\frac{2}{3}$	$\frac{1}{12}$
$\frac{5}{6}$	1	$1\frac{1}{6}$
$\frac{11}{12}$	$1\frac{1}{3}$	$\frac{3}{4}$

2. $\frac{3}{7} = \frac{1}{28} + \frac{1}{7} + \frac{1}{4}$

3. a. In method 1, we regroup, that is, borrow from the whole number in the minuend

so that the fraction in the minuend is big enough to subtract the fraction in the subtrahend. In method 2, we add a fraction to the subtrahend, making it a whole number.

We add the same fraction to the minuend and then subtract.

2.4 Multiplying and Dividing Fractions

Exercises

2. To multiply mixed numbers, change each mixed number to its equivalent improper fraction.
4. To divide fractions, change the divisor to its reciprocal, and multiply the resulting fractions.
6. When multiplying fractions, we can divide any numerator and any denominator by a common factor.

8. $\frac{7}{8} \cdot \frac{1}{2} = \frac{7}{16}$

10. $\frac{3}{10} \cdot \frac{1}{4} = \frac{3}{40}$

12. $\frac{1}{8} \cdot \frac{1}{8} = \frac{1}{64}$

14. $\frac{1}{2} \cdot \frac{3}{2} = \frac{3}{4}$

16. $\frac{20}{3} \cdot \frac{2}{7} = \frac{40}{21} = 1\frac{19}{21}$

18. $\frac{11}{10} \cdot \frac{9}{5} = \frac{99}{50} = 1\frac{49}{50}$

20. $\frac{4}{5} \cdot \frac{1}{4} = \frac{1}{5}$

20. $\frac{5}{8} \cdot \frac{4}{5} = \frac{2}{1}$

- b. Answers may vary.
c. Answers may vary.

22.

$$\frac{4}{1} \div \frac{1}{4} = \frac{4}{1} \cdot \frac{4}{1} = \frac{16}{1} = 16$$

$$\frac{1}{0} \div \frac{1}{0} = \frac{1}{0} \cdot \frac{0}{1} = \frac{0}{0}$$

24. $\frac{4}{3} \div \frac{3}{4} = \frac{4}{3} \cdot \frac{4}{3} = \frac{16}{9}$

$$26. \frac{12}{5} \cdot \frac{15}{4} = \frac{\cancel{12}^3}{\cancel{4}_1} \cdot \frac{\cancel{15}_3}{\cancel{3}_1} = 9$$

$$28. \frac{5}{6} \cdot \frac{5}{6} = \frac{5}{6} \cdot \frac{5}{6} = \frac{25}{36} = 4 \frac{1}{6}$$

$$30. \frac{5}{3} \cdot 7 = \frac{5}{3} \cdot \frac{7}{1} = \frac{35}{3} = 11 \frac{2}{3}$$

$$32. \frac{3}{4} \cdot 12 = \frac{3}{\cancel{4}_1} \cdot \frac{\cancel{12}^3}{\cancel{3}_1} = 9$$

$$34. 100 \cdot \frac{2}{5} = \frac{200}{5} = \frac{\cancel{200}^{40}}{\cancel{5}_1} = 40$$

$$36. \frac{20}{16} \cdot \frac{4}{1} = \frac{\cancel{20}^5}{\cancel{16}_4} \cdot \frac{4}{1} = 5$$

$$38. \frac{5}{8} \cdot 12 = \frac{5}{\cancel{2}_2} \cdot \frac{\cancel{12}^3}{\cancel{3}_1} = \frac{15}{2} = 7 \frac{1}{2}$$

$$40. \frac{10}{4} \cdot \frac{10}{13} = \frac{100}{52} = \frac{25}{13}$$

$$\frac{3}{5} \cdot \frac{5}{3} = \frac{\cancel{3}_3}{\cancel{5}_5} \cdot \frac{\cancel{5}_5}{\cancel{3}_3} = 1$$

$$42. \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{3} \cdot \frac{1}{5} = \frac{1}{15}$$

$$52. 2 \frac{1}{3} \cdot 1 \frac{1}{2} = \frac{7}{3} \cdot \frac{3}{2} = \frac{7 \cdot \cancel{3}}{\cancel{3} \cdot 2} = 7 \frac{1}{2}$$

$$54. \frac{10^2}{20} \div \frac{30 \cdot 30}{20} = \frac{100}{20} \div \frac{900}{20} = \frac{100}{900} = \frac{1}{9}$$

$$56. 5 \cdot 1 = \frac{5}{2} \cdot \frac{1}{2} = \frac{5}{4} = 1 \frac{1}{4}$$

$$58. 1 \frac{1}{6} \cdot 20 = \frac{7}{6} \cdot 20 = \frac{7 \cdot \cancel{20}^10}{\cancel{6}_3} = 70$$

$$60. 5 \frac{1}{4} \cdot 9 = \frac{21}{4} \cdot \frac{9}{1} = \frac{21 \cdot 9}{4} = 47 \frac{3}{4}$$

$$62. \frac{10}{5} \cdot \frac{2}{9} = \frac{\cancel{10}^2}{\cancel{5}_1} \cdot \frac{2}{9} = \frac{4}{9} = \frac{4}{9}$$

$$64. 5 \frac{1}{10} \cdot \frac{1}{3} = \frac{51}{10} \cdot \frac{1}{3} = \frac{51}{30} = \frac{17}{10} = 1 \frac{7}{10}$$

$$66. 3 \frac{1}{7} \cdot 3 \frac{7}{8} = \frac{22}{7} \cdot \frac{27}{8} = \frac{22 \cdot 27}{56} = 10 \frac{3}{8}$$

$$68. \frac{1}{8} \cdot 2 \frac{1}{4} = \frac{1}{8} \cdot \frac{9}{4} = \frac{9}{32} = 0 \frac{9}{32}$$

$$44. \frac{9}{2} \cdot \frac{10}{9} = \frac{9 \cdot 10}{2 \cdot 9} = \frac{27}{13}$$

$$\frac{9}{9} \cdot \frac{10}{2} = 1 \cdot 5 = 5$$

$$10 \cdot 7 = 70$$

$$\frac{10}{2} = 5$$

$$46. 4 \frac{1}{2} - \frac{2}{3} = \frac{9}{2} - \frac{2}{3} = 3$$

$$48. \frac{3}{5} \cdot \frac{1}{3} = \frac{3 \cdot 1}{5 \cdot 3} = \frac{1}{5}$$

$$50. \frac{7}{2} \cdot \frac{10}{9} = \frac{7 \cdot 10}{2 \cdot 9} = \frac{70}{9}$$

$$70. \frac{1}{4} \cdot \frac{1}{5} = \frac{1 \cdot 1}{4 \cdot 5} = \frac{1}{20}$$

$$72. 8 \frac{1}{3} - \frac{3}{10} - \frac{5}{6} = \frac{25}{3} - \frac{3}{10} - \frac{5}{6} = \frac{25}{12} = 2 \frac{1}{12}$$

$$74. \frac{2}{2} = \frac{2 \cdot 5}{2 \cdot 5} = \frac{10}{10} = 1$$

$$76. \frac{2}{3} \rightarrow \frac{3}{5} = \frac{2}{3} \cdot \frac{5}{3} = \frac{10}{9} = 1\frac{1}{9}$$

$$78. \frac{7}{8} \rightarrow \frac{4}{5} = \frac{7}{8} \cdot \frac{5}{4} = \frac{35}{32} = 1\frac{3}{32}$$

$$80. \frac{1}{7} \rightarrow \frac{1}{2} = \frac{1}{7} \cdot \frac{2}{1} = \frac{2}{7}$$

$$82. \frac{1}{8} \rightarrow \frac{5}{9} = \frac{1}{8} \cdot \frac{9}{5} = \frac{9}{40}$$

$$84. \frac{3}{10} \rightarrow \frac{6}{5} = \frac{\cancel{3}}{10} \cdot \frac{2}{1} = \frac{6}{5}$$

$$86. \frac{10}{3} \rightarrow \frac{5}{6} = \frac{\cancel{10}}{3} \cdot \frac{1}{2} = \frac{5}{6}$$

$$88. \frac{5}{6} \rightarrow \frac{1}{3} = \frac{5}{6} \cdot \frac{2}{2} = \frac{5}{6} = 2\frac{1}{2}$$

$$90. \frac{3}{4} \rightarrow \frac{6}{5} = \frac{\cancel{3}}{4} \cdot \frac{2}{1} = \frac{6}{4} = \frac{3}{2}$$

$$92. \frac{7}{10} \rightarrow 10 = \frac{7}{10} \cdot \frac{10}{1} = \frac{70}{10} = 7$$

$$94. \frac{1}{20} \rightarrow 2 = \frac{1}{20} \cdot \frac{2}{1} = \frac{2}{20} = \frac{1}{10}$$

$$96. 8 \rightarrow \frac{2}{9} = \frac{8}{1} \cdot \frac{2}{9} = \frac{16}{9} = 1\frac{7}{9}$$

$$98. 10 \rightarrow \frac{2}{5} = \frac{10}{1} \cdot \frac{2}{5} = \frac{20}{5} = 4$$

$$102. 3 \rightarrow \frac{1}{8} = \frac{3}{1} \cdot \frac{1}{8} = \frac{3}{8}$$

$$104. 5\frac{1}{9} \rightarrow \frac{2}{3} = \frac{46}{9} \cdot \frac{2}{3} = \frac{92}{27} = 3\frac{8}{27}$$

$$106. 7\frac{1}{10} \rightarrow \frac{1}{2} = \frac{71}{10} \cdot \frac{1}{2} = \frac{71}{20} = 3\frac{11}{20}$$

$$108. 6\frac{1}{2} \rightarrow \frac{1}{2} = \frac{13}{2} \cdot \frac{1}{2} = \frac{13}{4} = 3\frac{1}{4}$$

$$110. 15\frac{2}{3} \rightarrow \frac{5}{6} = \frac{47}{3} \cdot \frac{5}{6} = \frac{235}{18} = 13\frac{1}{18}$$

$$112. \frac{2}{7} \rightarrow 1\frac{1}{3} = \frac{2}{7} \cdot \frac{4}{3} = \frac{8}{21} = 2\frac{2}{7}$$

$$114. \frac{3}{4} \rightarrow 3\frac{1}{9} = \frac{3}{4} \cdot \frac{28}{9} = \frac{21}{6} = 3\frac{1}{2}$$

$$116. 7 \rightarrow 1\frac{9}{10} = \frac{7}{1} \cdot \frac{19}{10} = \frac{133}{10} = 13\frac{3}{10}$$

$$118. 5\frac{6}{7} \rightarrow 14 = \frac{41}{7} \cdot \frac{14}{1} = \frac{574}{7} = 82$$

$$120. 3\frac{1}{7} \rightarrow 2 = \frac{22}{7} \cdot \frac{5}{2} = \frac{110}{7} = 15\frac{5}{7}$$

$$122. 1\frac{7}{10} \rightarrow 5 = \frac{17}{10} \cdot \frac{4}{1} = \frac{68}{10} = 6\frac{8}{10} = 6\frac{4}{5}$$

$$124. 8 \rightarrow 2 = \frac{49}{1} \cdot \frac{5}{2} = \frac{245}{2} = 122\frac{1}{2}$$

$$100. \quad 10 \frac{2}{3} = \frac{10}{1} \frac{2}{3} = \frac{10 \cdot 2}{1 \cdot 3} = \frac{20}{3} = 6 \frac{2}{3}$$

$$126. \quad 1 \frac{2}{3} \cdot 1 \frac{5}{5} = \frac{2}{3} \cdot \frac{7}{5} = \frac{2 \cdot 7}{3 \cdot 5} = \frac{14}{15}$$

$$\begin{aligned}
 128. \quad \frac{9}{10} + \frac{4}{5} &= \frac{9}{10} + \frac{8}{10} \\
 &= \frac{9}{10} + \frac{32}{32} \\
 &= \frac{9}{10} + \frac{64}{64} \\
 &= \frac{73}{10} \\
 &= 7\frac{3}{10}
 \end{aligned}$$

$$\begin{aligned}
 130. \quad 3\frac{2}{5} - 2\frac{1}{3} &= 3\frac{2}{5} - 2\frac{1}{3} \\
 &= 3\frac{6}{15} - 2\frac{5}{15} \\
 &= 1\frac{1}{15} \\
 &= 1\frac{2}{30} \\
 &= 1\frac{4}{6} \\
 &= 1\frac{2}{3}
 \end{aligned}$$

$$\begin{aligned}
 132. \quad \frac{3}{8} - \frac{1}{10} &= \frac{3}{8} - \frac{1}{10} \\
 &= \frac{15}{40} - \frac{4}{40} \\
 &= \frac{11}{40}
 \end{aligned}$$

$$134. \quad 6\frac{1}{5} - \frac{1}{4} = 6\frac{4}{20} - \frac{5}{20} = 6\frac{-1}{20} = 5\frac{19}{20}$$

$$\begin{aligned}
 138. \quad \frac{1}{3} - \frac{1}{6} &= \frac{2}{6} - \frac{1}{6} \\
 &= \frac{1}{6} \\
 &= \frac{1}{6}
 \end{aligned}$$

$$\begin{aligned}
 140. \quad 3\frac{1}{8} + 4\frac{1}{2} &= 3\frac{1}{8} + 4\frac{4}{8} \\
 &= 7\frac{5}{8} \\
 &= 7\frac{5}{8}
 \end{aligned}$$

$$\begin{aligned}
 142. \quad \frac{6}{11} - \frac{18}{55} &= \frac{6}{11} - \frac{18}{55} \\
 &= \frac{30}{55} - \frac{18}{55} \\
 &= \frac{12}{55}
 \end{aligned}$$

$$a^0 \cdot a^0 = a^{0+0} = a^0$$

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

$$= \frac{5}{3}$$

$$10$$

136. $4 \frac{2}{1} - 1 \frac{1}{1} = 4 \frac{2}{1} - 1 \frac{1}{1}$

$$= \frac{3}{8} - \frac{1}{8}$$

$$= \frac{8}{3} - 1 \frac{1}{8}$$

$$= 2 \frac{2}{3} - 1 \frac{1}{8}$$

$$= 2 \frac{16}{24} - 1 \frac{3}{24}$$

$$= 1 \frac{13}{24}$$

144. $1 \frac{2}{3} \div 1 \frac{1}{3} = \frac{5}{3} \div \frac{4}{3}$

$$= \frac{5}{3} \cdot \frac{3}{4} = \frac{5}{4}$$

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

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

$$= \frac{9}{25}$$

$$= \frac{9}{25} \cdot \frac{4}{9}$$

$$= \frac{4}{25}$$

$$\begin{aligned}
 146. \quad & \frac{3}{2} \div \frac{1}{2} + 2 \frac{1}{3} - 1 \div \frac{1}{3} + 2 \frac{1}{6} - 1 \div \frac{1}{6} \\
 & = \frac{3}{2} + \frac{2}{3} - 1 + \frac{2}{3} + \frac{2}{6} - 1 \div \frac{1}{6} \\
 & = \frac{3}{2} + \frac{2}{3} - 1 + \frac{2}{3} + \frac{1}{3} - 1 \\
 & = \frac{3}{2} + \frac{2}{3} + \frac{2}{3} + \frac{1}{3} - 2 \\
 & = \frac{3}{2} + \frac{5}{3} - 2 \\
 & = \frac{9}{6} + \frac{10}{6} - \frac{12}{6} \\
 & = \frac{19}{6} - \frac{12}{6} \\
 & = \frac{7}{6} = 1 \frac{1}{6}
 \end{aligned}$$

$$\begin{aligned}
 148. \quad & 14 - 3 \frac{4}{5} = 14 - \frac{3 \cdot 5 + 4}{5} = 14 - \frac{19}{5} \\
 & = \frac{14 \cdot 5}{5} - \frac{19}{5} = \frac{70}{5} - \frac{19}{5} \\
 & = \frac{51}{5} = 10 \frac{1}{5}
 \end{aligned}$$

$$\begin{aligned}
 150. \quad & \frac{9}{10} \div \frac{2}{5} = \frac{9}{10} \cdot \frac{5}{2} = \frac{9 \cdot 5}{10 \cdot 2} = \frac{45}{20} = \frac{9}{4} = 2 \frac{1}{4}
 \end{aligned}$$

$$152. \quad \frac{1}{4} \div \frac{2}{6} = \frac{1}{4} \cdot \frac{6}{2} = \frac{6}{8} = \frac{3}{4}$$

$$\begin{aligned}
 158. \quad & 16 \frac{1}{2} \cdot 11 \frac{2}{3} = \frac{33}{6} \cdot \frac{23}{3} = \frac{33 \cdot 23}{6 \cdot 3} = 184 \\
 & 15 \frac{1}{2} \cdot 12 = \frac{31}{2} \cdot \frac{12}{1} = \frac{372}{2} = 186
 \end{aligned}$$

The room that measures $15 \frac{1}{2}$ ft \cdot 12 ft has the larger area, since its area is 186 sq ft and the area of the $16 \frac{1}{2}$ ft \cdot 11 $\frac{2}{3}$ ft room is 184 sq ft.

$$160. \quad \frac{9}{10} \cdot 10 \frac{1}{2} = \frac{9}{10} \cdot \frac{21}{2} = \frac{189}{20} = 9 \frac{9}{20}$$

There are $9 \frac{9}{20}$ gallons of gasoline in

$10 \frac{1}{2}$ gallons of gasohol. So there are

$$10 - 9 \frac{9}{20} = 10 \frac{20}{20} - 9 \frac{9}{20} = 1 \frac{11}{20}$$

gallons of ethyl alcohol in gasohol.

$$\text{There are } 9 \frac{9}{20} - 1 \frac{11}{20} = 8 \frac{8}{20} = 8 \frac{2}{5}$$

more gallons of gasoline than ethyl alcohol in gasohol.

$$\begin{aligned}
 162. \quad & 6 \text{ min } \div 2 \text{ min} = 3 \\
 & \text{The temperature drops by } \frac{1}{10}^{\circ}\text{F three times.} \\
 & 70 - \frac{1}{10} \cdot 3 = 70 - \frac{3}{10} = 69 \frac{10}{10} - \frac{3}{10} = 69 \frac{7}{10}
 \end{aligned}$$

The temperature after 6 min is $69 \frac{7}{10}^{\circ}\text{F}$.

$$164. \quad 9 \div \frac{3}{4} = 9 \cdot \frac{4}{3} = 12$$

He can administer 12 doses.

$$3 \frac{2}{3} \cdot \frac{10}{3} = \frac{9}{1} \cdot \frac{20}{3} = 30$$

$$154. \frac{1}{8} \cdot \frac{2}{5} = \frac{1}{20}$$

$\frac{1}{20}$ of the emergency room visits were due to motor vehicle accidents.

$$156. \$24,000 \div 12 = \$2,000$$

Their monthly income is \$2,000.

$$\frac{1}{500} \cdot 2,000 = \frac{1}{1} \cdot \frac{2,000}{2,000} =$$

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

They should spend no more than \$500 per month on rent.

$$166. \text{ a. } 3 \frac{1}{2} = \frac{3}{1} \cdot \frac{2}{2} = \frac{6}{2} - \frac{2}{2} = 2$$

The average amount collected per year is \$2 million.

b. If an additional \$1 million were collected, then the total collected is \$4 million.

$$4 \frac{1}{2} = \frac{4}{1} \cdot \frac{2}{2} = \frac{8}{2} - \frac{2}{2} = \frac{6}{2} = 3$$

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

The average would increase by $\frac{2}{3}$ million.

Mindstretchers

1. The reciprocal of 0 would have to be $\frac{1}{0}$, which is impossible because the product of any number and its reciprocal is 1, but 0 times any number is 0.

2.

3	$\frac{1}{6}$	2
$\frac{2}{3}$	1	$1\frac{1}{2}$
$\frac{1}{2}$	6	$\frac{1}{3}$

3. $1\frac{1}{2} \cdot 1\frac{1}{3} \cdot 1\frac{1}{4} \cdot \dots \cdot 1\frac{1}{99} \cdot 1\frac{1}{100} \cdot 1\frac{1}{100}$

$$= \frac{\cancel{2}^1 \cdot \cancel{4}^1 \cdot \cancel{5}^1 \cdot \dots \cdot \cancel{99}^1 \cdot \cancel{100}^1}{2 \cdot \cancel{3}_1 \cdot \cancel{4}_1 \cdot \dots \cdot \cancel{99}_1 \cdot \cancel{100}_1} \cdot \frac{101}{2} = \frac{101}{2} = 50\frac{1}{2}$$