1.2 FRACTIONS

In this section

- Equivalent Fractions
- Multiplying Fractions
- Dividing Fractions
- Adding and Subtracting Fractions
- Fractions, Decimals, and Percents
- Applications

In this section and the next two, we will discuss operations performed with real numbers. We begin by reviewing the operations with fractions.

Equivalent Fractions

If a pizza is cut into 3 equal pieces and you eat 2, you have eaten $\frac{2}{3}$ of the pizza. If the pizza is cut into 6 equal pieces and you eat 4, you have still eaten 2 out of every 3 pieces. So the fraction $\frac{4}{6}$ is considered **equal** or **equivalent** to $\frac{2}{3}$. See Fig. 1.12. Every fraction can be written in infinitely many equivalent forms. Consider the following equivalent forms of $\frac{2}{3}$:

$$\frac{2}{3} = \frac{4}{6} = \frac{6}{9} = \frac{8}{12} = \frac{10}{15} = \underbrace{\ldots}_{\text{The three dots mean "and so on."}}$$

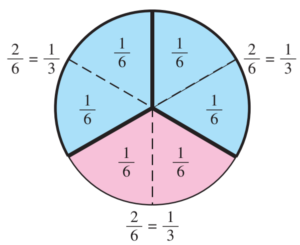


FIGURE 1.12

Notice that each equivalent form of $\frac{2}{3}$ can be obtained by multiplying the numerator (top number) and denominator (bottom number) of $\frac{2}{3}$ by a nonzero number. For example,

$$\frac{2}{3} = \frac{2 \cdot 5}{3 \cdot 5} = \frac{10}{15}.$$ The raised dot indicates multiplication.

Converting a fraction into an equivalent fraction with a larger denominator is called **building up** the fraction.

Building Up Fractions

If $b \neq 0$ and $c \neq 0$, then

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

Multiplying the numerator and denominator of a fraction by a nonzero number changes the fraction's appearance but not its value.

EXAMPLE 1

Building up fractions

Build up each fraction so that it is equivalent to the fraction with the indicated denominator.

a) $\frac{3}{4} = \frac{?}{28}$ **b)** $\frac{5}{3} = \frac{?}{30}$

Solution

a) Because $4 \cdot 7 = 28$, we multiply both the numerator and denominator by 7:

$$\frac{3}{4} = \frac{3 \cdot 7}{4 \cdot 7} = \frac{21}{28}$$

b) Because $3 \cdot 10 = 30$, we multiply both the numerator and denominator by 10:

$$\frac{5}{3} = \frac{5 \cdot 10}{3 \cdot 10} = \frac{50}{30}$$

helpful hint

In algebra it is best to build up fractions by multiplying both the numerator and denominator by the same number as shown in Example 1. So if you use an old method, be sure to learn this method.

helpful hint

In algebra it is best to reduce fractions as shown here. First factor the numerator and denominator and then divide out (or cancel) the common factors. Be sure to learn this method.

Converting a fraction to an equivalent fraction with a smaller denominator is called **reducing** the fraction. For example, to reduce $\frac{10}{15}$, we *factor* 10 as $2 \cdot 5$ and 15 as $3 \cdot 5$, and then divide out the *common factor* 5:

$$\frac{10}{15} = \frac{2 \cdot 5}{3 \cdot 5} = \frac{2}{3}$$

The fraction $\frac{2}{3}$ cannot be reduced further because the numerator 2 and the denominator 3 have no factors (other than 1) in common. So we say that $\frac{2}{3}$ is in **lowest terms.**

Reducing Fractions

If $b \neq 0$ and $c \neq 0$, then

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

Dividing the numerator and denominator of a fraction by a nonzero number changes the fraction's appearance but not its value.

EXAMPLE 2 **Reducing fractions**

Reduce each fraction to lowest terms.

a) $\frac{15}{24}$ **b)** $\frac{42}{30}$

Solution

For each fraction, factor the numerator and denominator and then divide by the common factor:

a) $\frac{15}{24} = \frac{\cancel{3} \cdot 5}{\cancel{3} \cdot 8} = \frac{5}{8}$ **b)** $\frac{42}{30} = \frac{7 \cdot 6}{5 \cdot 6} = \frac{7}{5}$ ■

calculator close-up

To reduce a fraction to lowest terms using a graphing calculator, display the fraction and use the fraction feature.

```
15/24▸Frac
            5/8
42/30▸Frac
            7/5
123456/222222▸Fr
ac
    .5555525556
```

If the fraction is too complicated, the calculator will return a decimal equivalent instead of reducing it.

Strategy for Obtaining Equivalent Fractions

Equivalent fractions can be obtained by multiplying or dividing the numerator and denominator by the same nonzero number.

Multiplying Fractions

Suppose a pizza is cut into three equal pieces. If you eat $\frac{1}{2}$ of one piece, you have eaten $\frac{1}{6}$ of the pizza. See Fig. 1.13. You can obtain $\frac{1}{6}$ by multiplying $\frac{1}{2}$ and $\frac{1}{3}$:

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

This example illustrates the definition of multiplication of fractions. To multiply two fractions, we multiply their numerators and multiply their denominators.

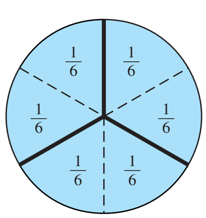


FIGURE 1.13

Multiplication of Fractions

If $b \neq 0$ and $d \neq 0$, then

$$\frac{a}{b} \cdot \frac{c}{d} = \frac{a \cdot c}{b \cdot d}.$$

EXAMPLE 3

Multiplying fractions

Find the product, $\frac{2}{3} \cdot \frac{5}{8}$.

Solution

Multiply the numerators and the denominators:

$$\frac{2}{3} \cdot \frac{5}{8} = \frac{10}{24}$$

$$= \frac{2 \cdot 5}{2 \cdot 12} \quad \text{Factor the numerator and denominator.}$$

$$= \frac{5}{12} \quad \text{Divide out the common factor 2.}$$

It is usually easier to reduce before multiplying, as shown in the next example.

EXAMPLE 4

Reducing before multiplying

Find the indicated products.

a) $\frac{1}{3} \cdot \frac{3}{4}$ **b)** $\frac{4}{5} \cdot \frac{15}{22}$

Solution

a) $\frac{1}{3} \cdot \frac{3}{4} = \frac{1}{3} \cdot \frac{3}{4} = \frac{1}{4}$

b) Factor the numerators and denominators, and then divide out the common factors before multiplying:

$$\frac{4}{5} \cdot \frac{15}{22} = \frac{2 \cdot 2}{5} \cdot \frac{3 \cdot 5}{2 \cdot 11} = \frac{6}{11}$$

calculator close-up

A graphing calculator can multiply fractions and get fractional answers using the fraction feature. Note how a mixed number is written on a graphing calculator.

```
1/3*3/4▸Frac
               1/4
4/5*15/22▸Frac
              6/11
(3+1/4)*8/5▸Frac
              26/5
```

Dividing Fractions

Again consider a pizza that is cut into three equal pieces. If one piece is divided among two people $\left(\frac{1}{3} \div 2\right)$, then each person gets $\frac{1}{6}$ of the pizza. Of course $\frac{1}{2}$ of $\frac{1}{3}$ is also $\frac{1}{6}$. So

$$\frac{1}{3} \div 2 = \frac{1}{3} \cdot \frac{1}{2} = \frac{1}{6}.$$

If $a \div b = c$, then b is called the **divisor** and c is called the **quotient** of a and b. We also refer to both $a \div b$ and $\frac{a}{b}$ as the quotient of a and b. To find the quotient for two fractions, we invert the divisor and multiply.

Division of Fractions

If $b \neq 0$ and $c \neq 0$ and $d \neq 0$, then

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c}.$$

EXAMPLE 5 **Dividing fractions**

Find the indicated quotients.

a) $\frac{1}{3} \div \frac{7}{6}$ **b)** $\frac{2}{3} \div 5$

Solution

In each case we invert the divisor (the number on the right) and multiply.

a) $\frac{1}{3} \div \frac{7}{6} = \frac{1}{3} \cdot \frac{6}{7}$ Invert the divisor.

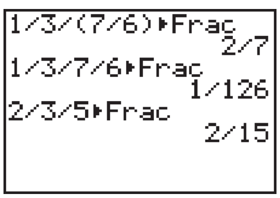
$= \frac{1}{3} \cdot \frac{2 \cdot 3}{7}$ Reduce.

$= \frac{2}{7}$ Multiply.

b) $\frac{2}{3} \div 5 = \frac{2}{3} \div \frac{5}{1} = \frac{2}{3} \cdot \frac{1}{5} = \frac{2}{15}$ ■

calculator close-up

When the divisor is a fraction on a graphing calculator, it must be in parentheses. A different result is obtained without using parentheses. Note that when the divisor is a whole number, parentheses are not necessary.



Try these computations on your calculator.

Adding and Subtracting Fractions

To understand addition and subtraction of fractions, again consider the pizza that is cut into six equal pieces as shown in Fig. 1.14. If you eat $\frac{3}{6}$ and your friend eats $\frac{2}{6}$, together you have eaten $\frac{5}{6}$ of the pizza. Similarly, if you remove $\frac{1}{6}$ from $\frac{6}{6}$ you have $\frac{5}{6}$ left. To add or subtract fractions with identical denominators, we add or subtract their numerators and write the result over the common denominator.

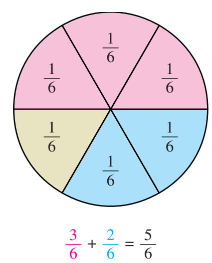


FIGURE 1.14

Addition and Subtraction of Fractions

If $b \neq 0$, then

$$\frac{a}{b} + \frac{c}{b} = \frac{a + c}{b} \quad \text{and} \quad \frac{a}{b} - \frac{c}{b} = \frac{a - c}{b}.$$

EXAMPLE 6 **Adding and subtracting fractions**

Perform the indicated operations.

a) $\frac{1}{7} + \frac{2}{7}$ **b)** $\frac{7}{10} - \frac{3}{10}$

Solution

a) $\frac{1}{7} + \frac{2}{7} = \frac{3}{7}$ **b)** $\frac{7}{10} - \frac{3}{10} = \frac{4}{10} = \frac{\cancel{2} \cdot 2}{\cancel{2} \cdot 5} = \frac{2}{5}$ ■

helpful hint

A good way to remember that you need common denominators for addition is to think of a simple example. If you own 1/3 share of a car wash and your spouse owns 1/3, then together you own 2/3 of the business.

If the fractions have different denominators, we must convert them to equivalent fractions with the same denominator and then add or subtract. For example, to add the fractions $\frac{1}{2}$ and $\frac{1}{3}$, we build up each fraction to get a denominator of 6. See

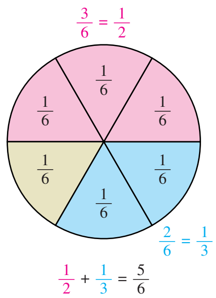


FIGURE 1.15

Fig. 1.15. The denominator 6 is the smallest number that is a multiple of both 2 and 3. For this reason, 6 is called the **least common denominator (LCD).** To find the LCD, use the following strategy.

Strategy for Finding the LCD

1. Make a list of all multiples of one of the denominators.
2. The first number on the list that is evenly divisible by the other denominator is the LCD.

For example, for $\frac{1}{6}$ and $\frac{1}{8}$ consider all multiples of 6:

$$6, 12, 18, 24, 30, 36, \ldots$$

The first number in this list divisible by 8 is 24. So the LCD is 24. This method works well if the denominators are not too large. In Chapter 7 we will learn another method that is better suited for large numbers and algebra.

EXAMPLE 7

Adding fractions

Perform the indicated operations.

a) $\frac{1}{2} + \frac{1}{3}$ **b)** $\frac{1}{3} - \frac{1}{12}$

c) $\frac{3}{4} - \frac{1}{6}$ **d)** $2\frac{1}{3} + \frac{5}{9}$

Solution

a) In the multiples of 2 (2, 4, 6, 8, . . .), the first number divisible by 3 is 6. So 6 is the LCD.

$$\frac{1}{2} + \frac{1}{3} = \frac{1 \cdot 3}{2 \cdot 3} + \frac{1 \cdot 2}{3 \cdot 2} \quad \text{The LCD is 6.}$$

$$= \frac{3}{6} + \frac{2}{6} \quad \text{Build each denominator to a denominator of 6.}$$

$$= \frac{5}{6} \quad \text{Then add.}$$

b) In the multiples of 3 (3, 6, 9, 12, 15, . . .), the first number divisible by 12 is 12. So the LCD is 12.

$$\frac{1}{3} - \frac{1}{12} = \frac{1 \cdot 4}{3 \cdot 4} - \frac{1}{12} \quad \text{The LCD is 12.}$$

$$= \frac{4}{12} - \frac{1}{12} \quad \text{Build up } \tfrac{1}{3} \text{ to get a denominator of 12.}$$

$$= \frac{3}{12} \quad \text{Subtract.}$$

$$= \frac{1}{4} \quad \text{Reduce to lowest terms.}$$

study tip

Read the material in the text before it is discussed in class, even if you do not totally understand it. The classroom discussion will be the second time you have seen the material and it will be easier to question points that you do not understand.

c) In the multiples of 4 (4, 8, 12, 16, . . .), the first number divisible by 6 is 12. So 12 is the LCD, the smallest multiple of 4 and 6.

$$\frac{3}{4} - \frac{1}{6} = \frac{3 \cdot 3}{4 \cdot 3} - \frac{1 \cdot 2}{6 \cdot 2} \quad \text{The LCD is 12.}$$

$$= \frac{9}{12} - \frac{2}{12} \quad \text{Build up each fraction to a denominator of 12.}$$

$$= \frac{7}{12}$$

d) To perform addition with the mixed number $2\frac{1}{3}$, first convert it into an improper fraction: $2\frac{1}{3} = 2 + \frac{1}{3} = \frac{6}{3} + \frac{1}{3} = \frac{7}{3}$.

$$2\frac{1}{3} + \frac{5}{9} = \frac{7}{3} + \frac{5}{9} \quad \text{Write } 2\tfrac{1}{3} \text{ as an improper fraction.}$$

$$= \frac{7 \cdot 3}{3 \cdot 3} + \frac{5}{9} \quad \text{The LCD is 9.}$$

$$= \frac{21}{9} + \frac{5}{9} = \frac{26}{9}$$

study tip

Take notes in class. Write down everything you can. As soon as possible after class, rewrite your notes. Fill in details and make corrections. Make a note of examples and exercises in the text that are similar to examples in your notes. If your instructor takes the time to work an example in class, it is a good bet that your instructor expects you to understand the concepts involved.

Fractions, Decimals, and Percents

In the decimal number system, fractions with a denominator of 10, 100, 1000, and so on are written as decimal numbers. For example,

$$\frac{3}{10} = 0.3, \qquad \frac{25}{100} = 0.25, \qquad \text{and} \qquad \frac{5}{1000} = 0.005.$$

Fractions with a denominator of 100 are often written as percents. Think of the percent symbol (%) as representing the denominator of 100. For example,

$$\frac{25}{100} = 25\%, \qquad \frac{5}{100} = 5\%, \qquad \text{and} \qquad \frac{300}{100} = 300\%.$$

The next example illustrates further how to convert from any one of the forms (fraction, decimal, percent) to the others.

helpful hint

Recall the *place value* for decimal numbers:

tenths
hundredths
thousandths
ten thousandths
0.2635

So $0.2635 = \frac{2635}{10{,}000}$.

EXAMPLE 8 **Changing forms**

Convert each given fraction, decimal, or percent into its other two forms.

a) $\frac{1}{5}$ **b)** 6% **c)** 0.1

Solution

a) $\frac{1}{5} = \frac{1 \cdot 20}{5 \cdot 20} = \frac{20}{100} = 20\%$ and $\frac{1}{5} = \frac{1 \cdot 2}{5 \cdot 2} = \frac{2}{10} = 0.2$

So $\frac{1}{5} = 0.2 = 20\%$.

b) $6\% = \frac{6}{100} = 0.06$ and $\frac{6}{100} = \frac{2 \cdot 3}{2 \cdot 50} = \frac{3}{50}$

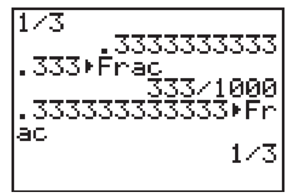
So $6\% = 0.06 = \frac{3}{50}$.

c) $0.1 = \frac{1}{10} = \frac{1 \cdot 10}{10 \cdot 10} = \frac{10}{100} = 10\%$

So $0.1 = \frac{1}{10} = 10\%$.

calculator close-up

A calculator can convert fractions to decimals and decimals to fractions. The calculator shown here converts the terminating decimal 0.333333333333 into 1/3 even though 1/3 is a repeating decimal with infinitely many threes after the decimal point.



Applications

The dimensions for lumber used in construction are usually given in fractions. For example, a 2×4 stud used for framing a wall is actually $1\frac{1}{2}$ in. by $3\frac{1}{2}$ in. by $92\frac{5}{8}$ in. A 2×12 floor joist is actually $1\frac{1}{2}$ in. by $11\frac{1}{2}$ in.

EXAMPLE 9

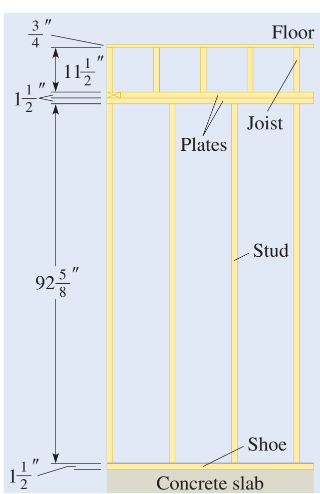


FIGURE 1.16

Framing a two-story house

In framing a two-story house, a carpenter uses a 2×4 shoe, a wall stud, two 2×4 plates, then 2×12 floor joists, and a $\frac{3}{4}$-in. plywood floor, before starting the second level. Use the dimensions in Fig. 1.16 to find the total height of the framing shown.

Solution

We can find the total height using multiplication and addition:

$$
\begin{aligned}
3 \cdot 1\frac{1}{2} + 92\frac{5}{8} + 11\frac{1}{2} + \frac{3}{4} &= 4\frac{1}{2} + 92\frac{5}{8} + 11\frac{1}{2} + \frac{3}{4} \\
&= 4\frac{4}{8} + 92\frac{5}{8} + 11\frac{4}{8} + \frac{6}{8} \\
&= 107\frac{19}{8} \\
&= 109\frac{3}{8}
\end{aligned}
$$

The total height of the framing shown is $109\frac{3}{8}$ in.

MATH AT WORK

BUILDING CONTRACTOR

Building a new house can be a complicated and daunting task. Shirley Zaborowski, project manager for Court Construction, is responsible for estimating, pricing, negotiating, subcontracting, and scheduling all portions of new house construction.

Ms. Zaborowski works from drawings and first does a "take off" or estimate for the quantity of material needed. The quantity of concrete is measured in cubic yards and the amount of wood is measured in board feet. If masonry is being used, it is measured in bricks or blocks per square foot.

Scheduling is another important part of the project manager's responsibility and it is based on the take off. Certain industry standards help Ms. Zaborowski estimate how many carpenters are needed and how much time it takes to frame the house and how many electricians and plumbers are needed to wire the house, install the heating systems, and put in the bathrooms. Of course, common sense says that the foundation is done before the framing and the roof. However, some rough plumbing and electrical work can be done simultaneously with the framing. Ideally the estimates of time and cost are accurate and the homeowner can move in on schedule.

In Exercise 103 of this section you will use operations with fractions to find the volume of concrete needed to construct a rectangular patio.

WARM-UPS

True or false? Explain your answer.

1. Every fraction is equal to infinitely many equivalent fractions.

2. The fraction $\frac{8}{12}$ is equivalent to the fraction $\frac{4}{6}$.

3. The fraction $\frac{8}{12}$ reduced to lowest terms is $\frac{4}{6}$.

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

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

6. $\frac{1}{2} \cdot \frac{6}{5} = \frac{6}{10}$

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

8. $5 \div \frac{1}{2} = 10$

9. $\frac{1}{2} + \frac{1}{4} = \frac{2}{6}$

10. $2 - \frac{1}{2} = \frac{3}{2}$

1.2 EXERCISES

Reading and Writing *After reading this section write out the answers to these questions. Use complete sentences.*

1. What are equivalent fractions?

2. How can you find all fractions that are equivalent to a given fraction?

3. What does it mean to reduce a fraction?

4. For which operations with fractions are you required to have common denominators? Why?

5. How do you convert a fraction to a decimal?

6. How do you convert a percent to a fraction?

Build up each fraction or whole number so that it is equivalent to the fraction with the indicated denominator. See Example 1.

7. $\frac{3}{4} = \frac{?}{8}$ **8.** $\frac{5}{7} = \frac{?}{21}$ **9.** $\frac{8}{3} = \frac{?}{12}$

10. $\frac{7}{2} = \frac{?}{8}$ **11.** $5 = \frac{?}{2}$ **12.** $9 = \frac{?}{3}$

13. $\frac{3}{4} = \frac{?}{100}$ **14.** $\frac{1}{2} = \frac{?}{100}$ **15.** $\frac{3}{10} = \frac{?}{100}$

16. $\frac{2}{5} = \frac{?}{100}$ **17.** $\frac{5}{3} = \frac{?}{42}$ **18.** $\frac{5}{7} = \frac{?}{98}$

Reduce each fraction to lowest terms. See Example 2.

19. $\frac{3}{6}$ **20.** $\frac{2}{10}$ **21.** $\frac{12}{18}$ **22.** $\frac{30}{40}$

23. $\frac{15}{5}$ **24.** $\frac{39}{13}$ **25.** $\frac{50}{100}$ **26.** $\frac{5}{1000}$

27. $\frac{200}{100}$ **28.** $\frac{125}{100}$ **29.** $\frac{18}{48}$ **30.** $\frac{34}{102}$

31. $\frac{26}{42}$ **32.** $\frac{70}{112}$ **33.** $\frac{84}{91}$ **34.** $\frac{121}{132}$

Find each product. See Examples 3 and 4.

35. $\frac{2}{3} \cdot \frac{5}{9}$ **36.** $\frac{1}{8} \cdot \frac{1}{8}$ **37.** $\frac{1}{3} \cdot 15$

38. $\frac{1}{4} \cdot 16$ **39.** $\frac{3}{4} \cdot \frac{14}{15}$ **40.** $\frac{5}{8} \cdot \frac{12}{35}$

41. $\frac{2}{5} \cdot \frac{35}{26}$ **42.** $\frac{3}{10} \cdot \frac{20}{21}$ **43.** $\frac{1}{2} \cdot \frac{6}{5}$

44. $\frac{1}{2} \cdot \frac{3}{5}$ **45.** $\frac{1}{2} \cdot \frac{1}{3}$ **46.** $\frac{3}{16} \cdot \frac{1}{7}$

Find each quotient. See Example 5.

47. $\frac{3}{4} \div \frac{1}{4}$ **48.** $\frac{2}{3} \div \frac{1}{2}$

49. $\frac{1}{3} \div 5$ **50.** $\frac{3}{5} \div 3$

51. $5 \div \frac{5}{4}$ **52.** $8 \div \frac{2}{3}$

53. $\frac{6}{10} \div \frac{3}{4}$ **54.** $\frac{2}{3} \div \frac{10}{21}$

55. $\frac{3}{16} \div \frac{5}{2}$ **56.** $\frac{1}{8} \div \frac{5}{16}$

Find each sum or difference. See Examples 6 and 7.

57. $\frac{1}{4} + \frac{1}{4}$ **58.** $\frac{1}{10} + \frac{1}{10}$

59. $\frac{5}{12} - \frac{1}{12}$ **60.** $\frac{17}{14} - \frac{5}{14}$

61. $\frac{1}{2} - \frac{1}{4}$ **62.** $\frac{1}{3} + \frac{1}{6}$

63. $\frac{1}{3} + \frac{1}{4}$ **64.** $\frac{1}{2} + \frac{3}{5}$

65. $\frac{3}{4} - \frac{2}{3}$ **66.** $\frac{4}{5} - \frac{3}{4}$

67. $\frac{1}{6} + \frac{5}{8}$ **68.** $\frac{3}{4} + \frac{1}{6}$

69. $\frac{5}{24} - \frac{1}{18}$ **70.** $\frac{3}{16} - \frac{1}{20}$

71. $3\frac{5}{6} + \frac{5}{16}$ **72.** $5\frac{3}{8} - \frac{15}{16}$

Convert each given fraction, decimal, or percent into its other two forms. See Example 8.

73. $\frac{3}{5}$ **74.** $\frac{19}{20}$

75. 9% **76.** 60%

77. 0.08 **78.** 0.4

79. $\frac{3}{4}$ **80.** $\frac{5}{8}$

81. 2% **82.** 120%

83. 0.01 **84.** 0.005

Perform the indicated operations.

85. $\frac{3}{8} \div \frac{1}{8}$ **86.** $\frac{7}{8} \div \frac{3}{14}$

87. $\frac{3}{4} \cdot \frac{28}{21}$ **88.** $\frac{5}{16} \cdot \frac{3}{10}$

89. $\frac{7}{12} + \frac{5}{32}$ **90.** $\frac{2}{15} + \frac{8}{21}$

91. $\frac{5}{24} - \frac{1}{15}$ **92.** $\frac{9}{16} - \frac{1}{12}$

93. $3\frac{1}{8} + \frac{15}{16}$ **94.** $5\frac{1}{4} - \frac{9}{16}$

95. $7\frac{2}{3} \cdot 2\frac{1}{4}$ **96.** $6\frac{1}{2} \div \frac{7}{2}$

97. $\frac{1}{2} + \frac{1}{3} + \frac{1}{4}$ **98.** $\frac{1}{2} + \frac{1}{3} - \frac{1}{6}$

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

Solve each problem. See Example 9.

101. ***Stock prices.*** On Monday, GM stock opened at $54\frac{3}{4}$ per share and closed up $\frac{3}{16}$. On Tuesday it closed down $\frac{1}{8}$. On Wednesday it gained $\frac{5}{16}$. On Thursday it fell $\frac{1}{4}$. On Friday there was no change. What was the closing price on Friday? What was the percent change for the week?

102. ***Diversification.*** Helen has $\frac{1}{5}$ of her portfolio in U.S. stocks, $\frac{1}{8}$ of her portfolio in European stocks, and $\frac{1}{10}$ of her portfolio in Japanese stocks. The remainder is invested in municipal bonds. What fraction of her portfolio is invested in municipal bonds? What percent is invested in municipal bonds?

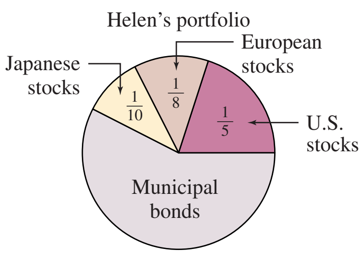


FIGURE FOR EXERCISE 102

103. ***Concrete patio.*** A contractor plans to pour a concrete rectangular patio.

a) Use the table to find the approximate volume of concrete in cubic yards for a 9 ft by 12 ft patio that is 4 inches thick.

b) Find the exact volume of concrete in cubic feet and cubic yards for a patio that is $12\frac{1}{2}$ feet long, $8\frac{3}{4}$ feet wide, and 4 inches thick.

Concrete required for 4 in. thick patio

L (ft)	W (ft)	V (yd^3)
16	14	2.8
14	10	1.7
12	9	1.3
10	8	1.0

FIGURE FOR EXERCISE 103

104. ***Bundle of studs.*** A lumber yard receives 2×4 studs in a bundle that contains 25 rows (or layers) of studs with 20 studs in each row. A 2×4 stud is actually $1\frac{1}{2}$ in. by $3\frac{1}{2}$ in. by $92\frac{5}{8}$ in. Find the cross-sectional area of a bundle in square inches. Find the volume of a bundle in cubic feet. (The formula $V = LWH$ gives the volume of a rectangular solid.)

GETTING MORE INVOLVED

105. ***Writing.*** Find an example of a real-life situation in which it is necessary to add two fractions.

106. ***Cooperative learning.*** Write a step-by-step procedure for adding two fractions with different denominators. Give your procedure to a classmate to try out on some addition problems. Refine your procedure as necessary.

107. ***Fraction puzzle.*** A wheat farmer in Manitoba left his L-shaped farm (shown in the diagram) to his four daughters. Divide the property into four pieces so that each piece is exactly the same size and shape.

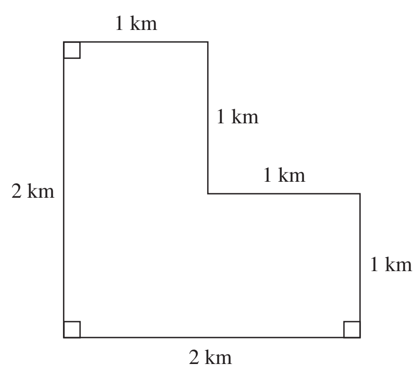


FIGURE FOR EXERCISE 107