

2.4 Multiplying and Dividing Fractions

OBJECTIVES

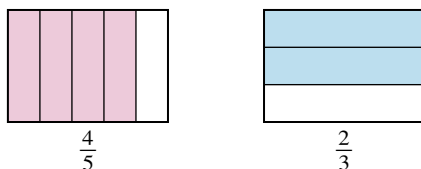
- To multiply and divide fractions and mixed numbers
- To estimate products and quotients involving mixed numbers
- To solve word problems involving the multiplication or division of fractions or mixed numbers

This section begins with a discussion of multiplying fractions. We then move on to multiplying mixed numbers and conclude with dividing fractions and mixed numbers.

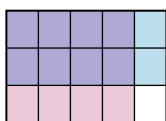
Multiplying Fractions

Many situations require us to multiply fractions. For instance, suppose that a mixture in a chemistry class calls for $\frac{4}{5}$ g of sodium chloride. If we make only $\frac{2}{3}$ of that mixture, we need $\frac{2}{3}$ of $\frac{4}{5}$, that is, $\frac{2}{3} \times \frac{4}{5}$ g of sodium chloride.

To illustrate how to find this product, we diagram these two fractions.



In the following diagram, we are taking $\frac{2}{3}$ of the $\frac{4}{5}$.



Note that we divided the whole into 15 parts and that our product, containing 8 of the 15 small squares, represents the double-shaded region. The answer is therefore $\frac{8}{15}$ of the original whole, which we can compute as follows.

$$\frac{2}{3} \times \frac{4}{5} = \frac{8}{15}$$

The numerator and denominator of the answer are the products of the original numerators and denominators.

Remind students that *of* generally means *times*. If they have some \$5 bills and they give you 3 of them, their gift is worth $3 \times \$5$, or \$15.



Point out that a good way to interpret the multiplication of fractions is taking *part of a part*.

To Multiply Fractions

- first multiply the numerators,
- then multiply the denominators, and
- finally write the answer in simplest form.

EXAMPLE 1

Multiply: $\frac{7}{8} \cdot \frac{9}{10}$

Solution

$$\frac{7}{8} \cdot \frac{9}{10} = \frac{7 \cdot 9}{8 \cdot 10} = \frac{63}{80}$$

Multiply the numerators.
 ↓
 Multiply the denominators.
 ↑

PRACTICE 1

Find the product of $\frac{3}{4}$ and $\frac{5}{7}$. $\frac{15}{28}$



EXAMPLE 2

What is $\frac{3}{8}$ of 10?

Solution Finding $\frac{3}{8}$ of 10 means multiplying $\frac{3}{8}$ by 10.

$$\frac{3}{8} \times 10 = \frac{3}{8} \times \frac{10}{1} = \frac{3 \times 10}{8 \times 1} = \frac{30}{8} = \frac{15}{4}, \text{ or } 3\frac{3}{4}$$

PRACTICE 2

What is $\frac{2}{3}$ of 30? 20

Emphasize that, when multiplying a whole number by a fraction, we first write the whole number as a fraction with a denominator of 1.

In Example 2, we multiplied the two fractions first and then simplified the answer. It is preferable, however, to reverse these steps: Simplify first and then multiply. By first simplifying, which is called *canceling*, we divide *any* numerator and *any* denominator by a common factor. Canceling before multiplying allows us to work with smaller numbers and still gives us the same answer.

EXAMPLE 3

Find the product of $\frac{4}{9}$ and $\frac{5}{8}$.

Solution Divide the numerator (4) and the denominator (8) by the same number (4).

$$\frac{4}{9} \times \frac{5}{8} = \frac{\overset{1}{\cancel{4}}}{9} \times \frac{5}{\underset{2}{\cancel{8}}} = \frac{1 \times 5}{9 \times 2} = \frac{5}{18}$$

Multiply the resulting fractions $\left(\frac{1}{9} \text{ and } \frac{5}{2}\right)$.

PRACTICE 3

Multiply: $\frac{7}{10} \cdot \frac{5}{11} \cdot \frac{7}{22}$

Show students that another way to solve this problem is to write the numerators and denominators as products of primes and then to simplify.

EXAMPLE 4

Multiply: $\frac{9}{8} \times \frac{6}{5} \times \frac{7}{9}$

Solution We cancel and then multiply.

$$\frac{9}{8} \times \frac{6}{5} \times \frac{7}{9} = \frac{\overset{1}{\cancel{9}}}{\underset{4}{8}} \times \frac{\overset{3}{\cancel{6}}}{5} \times \frac{7}{\underset{1}{\cancel{9}}} = \frac{21}{20}, \quad \text{or} \quad 1\frac{1}{20}$$

PRACTICE 4

Multiply: $\frac{7}{27} \cdot \frac{9}{4} \cdot \frac{8}{21} \cdot \frac{2}{9}$

EXAMPLE 5

At a college, $\frac{3}{5}$ of the students take a math course. Of these students, $\frac{1}{6}$ take elementary algebra. What fraction of the students in the college take elementary algebra?

Solution We must find $\frac{1}{6}$ of $\frac{3}{5}$.

$$\frac{1}{6} \times \frac{3}{5} = \frac{1}{\underset{2}{\cancel{6}}} \times \frac{\overset{1}{\cancel{3}}}{5} = \frac{1 \times 1}{2 \times 5} = \frac{1}{10}$$

One-tenth of the students in the college take elementary algebra.

PRACTICE 5

A flight from New York to Los Angeles took 7 hours. With the help of the jet stream, the return trip took $\frac{3}{4}$ the time. How long did the trip from Los Angeles to New York take? $5\frac{1}{4}$ hr

EXAMPLE 6

Suppose that you spend $\frac{3}{8}$ of your monthly salary on rent. If your salary is \$960, how much do you have left after paying the rent?

Solution Apply the strategy of breaking the question into two parts.

- First, find $\frac{3}{8}$ of \$960.
- Then, subtract that result from \$960.

Thus you can solve this problem by computing $960 - \left(\frac{3}{8} \times 960\right)$.

$$\begin{aligned} 960 - \left(\frac{3}{8} \times 960\right) &= 960 - \left(\frac{3}{8} \times \frac{960}{1}\right) \\ &= 960 - 360 = 600 \end{aligned}$$

You have \$600 left after paying the rent.

PRACTICE 6

Suppose that your aunt left one-fifth of her estate to each of her three children and the rest to a favorite charity. If her estate was valued at \$95,000, how much went to charity? \$38,000



Show students that an alternative approach to solving this problem is to compute $\frac{5}{8}$ of 960.

Multiplying Mixed Numbers

Some situations require us to multiply mixed numbers. For instance, suppose that your regular hourly wage is $\$7\frac{1}{2}$ and that you make time-and-a-half for working overtime. To find your overtime hourly wage, you need to multiply $1\frac{1}{2}$ by $7\frac{1}{2}$. The key here is to first rewrite each mixed number as an improper fraction.

$$1\frac{1}{2} \times 7\frac{1}{2} = \frac{3}{2} \times \frac{15}{2} = \frac{45}{4}, \quad \text{or} \quad 11\frac{1}{4}$$

So you make $\$11\frac{1}{4}$ per hour overtime.

To Multiply Mixed Numbers

- change each mixed number to its equivalent improper fraction,
- follow the steps for multiplying fractions, and
- write the answer in simplest form.

EXAMPLE 7

Multiply $2\frac{1}{5}$ by $1\frac{1}{4}$.

$$\begin{aligned} \text{Solution } 2\frac{1}{5} \times 1\frac{1}{4} &= \frac{11}{5} \times \frac{5}{4} \\ &= \frac{11 \times \overset{1}{\cancel{5}}}{\underset{1}{\cancel{5}} \times 4} \\ &= \frac{11}{4}, \quad \text{or} \quad 2\frac{3}{4} \end{aligned}$$

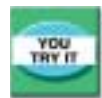
First, rewrite each mixed number as an improper fraction.

Then, cancel and multiply.

Finally, simplify the answer.

PRACTICE 7

Find the product of $3\frac{3}{4}$ and $2\frac{1}{10}$. $7\frac{7}{8}$



EXAMPLE 8

Multiply: $\left(4\frac{3}{8}\right)\left(4\right)\left(2\frac{2}{5}\right)$

$$\begin{aligned} \text{Solution } \left(4\frac{3}{8}\right)\left(4\right)\left(2\frac{2}{5}\right) &= \left(\frac{35}{8}\right)\left(\frac{4}{1}\right)\left(\frac{12}{5}\right) \\ &= \left(\frac{\overset{7}{\cancel{35}}}{\underset{2}{\cancel{8}}}\right)\left(\frac{\overset{1}{\cancel{4}}}{1}\right)\left(\frac{\overset{6}{\cancel{12}}}{\underset{1}{\cancel{5}}}\right) = 42 \end{aligned}$$

Note in this problem that, although there are several ways to cancel, the answer always comes out the same.

PRACTICE 8

Multiply: $\left(1\frac{3}{4}\right)\left(5\frac{1}{3}\right)\left(3\right)$ 28

EXAMPLE 9

A nurse gave a patient $2\frac{1}{2}$ tablets of the medication atropine sulfate. If each tablet contains $\frac{1}{30}$ grain (gr) of this medication, how much atropine sulfate did the patient receive?

Solution To find the total amount of atropine sulfate administered, we need to multiply $2\frac{1}{2}$ by $\frac{1}{30}$.

$$2\frac{1}{2} \times \frac{1}{30} = \frac{5}{2} \times \frac{1}{\cancel{30}^6} = \frac{1}{12}$$

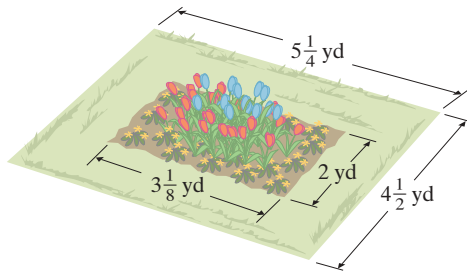
Therefore the nurse gave the patient $\frac{1}{12}$ gr of atropine sulfate.

PRACTICE 9

A recipe for New England clam chowder calls for $2\frac{1}{4}$ lb butter. If you prepare $\frac{1}{12}$ of the quantity described in the recipe, how much butter will you need? $\frac{3}{16}$ lb

EXAMPLE 10

A lawn surrounding a garden is to be installed, as depicted in the following drawing.



How many square yards of turf will we need to cover the lawn?

Solution Let's break this problem into three steps. First, we find the area of the rectangle with dimensions $5\frac{1}{4}$ yards and $4\frac{1}{2}$ yards. Then, we find the area of the small rectangle whose length and width are $3\frac{1}{8}$ yards and 2 yards, respectively. Finally, we subtract the area of the small rectangle from the area of the large rectangle.

Step 1. $5\frac{1}{4} \times 4\frac{1}{2} = \frac{21}{4} \times \frac{9}{2}$
 $= \frac{189}{8}, \text{ or } 23\frac{5}{8}$

The area of the large rectangle is $23\frac{5}{8}$ sq yd.

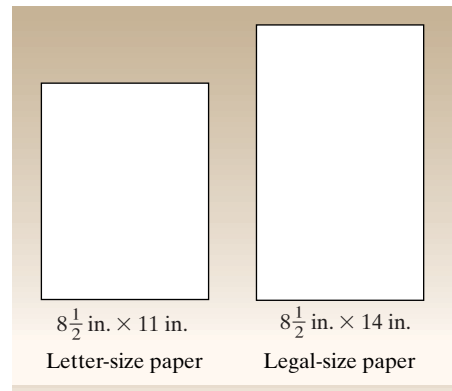
Step 2. $3\frac{1}{8} \times 2 = \frac{25}{8} \times \frac{2}{1}$
 $= \frac{25}{4}, \text{ or } 6\frac{1}{4}$

The area of the small rectangle is $6\frac{1}{4}$ sq yd.

continued

PRACTICE 10

How much greater is the area of a sheet of legal-size paper than a sheet of letter-size paper? $25\frac{1}{2}$ sq in.



$$\begin{array}{r} \text{Step 3.} \quad 23\frac{5}{8} = 23\frac{5}{8} \\ -6\frac{1}{4} = -6\frac{2}{8} \\ \hline 17\frac{3}{8} \end{array}$$

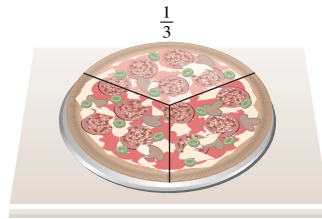
The area of the lawn is therefore $17\frac{3}{8}$ sq yd.

We will need $17\frac{3}{8}$ sq yd of turf for the lawn.

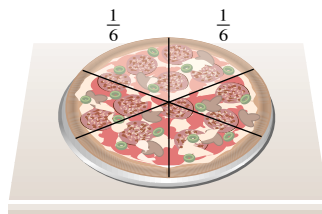
Dividing Fractions

We now turn to quotients, beginning with dividing a fraction by a whole number. Suppose, for instance, that you want to share $\frac{1}{3}$ of a pizza with a friend, that is, to divide the $\frac{1}{3}$ into two equal parts. What part of the whole pizza will each of you receive?

This diagram shows $\frac{1}{3}$ of a pizza.



If we split the third into two equal parts, each part is $\frac{1}{6}$ of the pizza.



You and your friend will each get $\frac{1}{6}$ of the whole pizza, which you can compute as follows.

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

Note that dividing a number by 2 is the same as taking $\frac{1}{2}$ of it. This equivalence suggests the procedure for dividing fractions shown on the next page.

$$\frac{1}{3} \div 2 = \frac{1}{3} \div \frac{2}{1} = \frac{1}{3} \times \frac{1}{2} = \frac{1 \times 1}{3 \times 2} = \frac{1}{6}$$

Divisor
↓
↑ ↑
 $\frac{2}{1}$ and $\frac{1}{2}$ are reciprocals.

You may want to justify this procedure as follows.

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

This procedure involves *inverting*, or finding the *reciprocal* of the divisor. The reciprocal is found by switching the numerator and denominator.

To Divide Fractions

- change the divisor to its reciprocal,
- *multiply* the resulting fractions, and
- simplify the answer.

EXAMPLE 11

Divide: $\frac{4}{5} \div \frac{3}{10}$

Solution $\frac{4}{5} \div \frac{3}{10} = \frac{4}{5} \times \frac{10}{3} = \frac{4 \times 2}{1 \times 3} = \frac{8}{3}$, or $2\frac{2}{3}$

↑ ↑
 $\frac{3}{10}$ and $\frac{10}{3}$ are reciprocals.

As in any division problem, we can check our answer by multiplying it by the divisor.

$$\frac{8}{3} \times \frac{3}{10} = \frac{4}{5}$$

Because $\frac{4}{5}$ is the dividend, we have confirmed our answer.

PRACTICE 11

Divide: $\frac{3}{4} \div \frac{1}{8}$ 6



TIP

In a division problem, the fraction to the right of the division sign is the divisor. *Always invert the divisor*—the second fraction—not the dividend—the first fraction.

EXAMPLE 12

What is $\frac{4}{7}$ divided by 20?

Solution $\frac{4}{7} \div 20 = \frac{4}{7} \times \frac{1}{20} = \frac{1 \times 1}{7 \times 5} = \frac{1}{35}$

↑
Invert $\frac{20}{1}$ and multiply.

PRACTICE 12

Compute the following quotient: $5 \div \frac{5}{8}$ 8

EXAMPLE 13

To stop the developing process, photographers use a chemical called stop bath. Suppose that a photographer needs $\frac{1}{4}$ bottle of stop bath for each roll of film. If the photographer has $\frac{2}{3}$ bottle of stop bath left, can he develop 3 rolls of film?

Solution We want to find out how many $\frac{1}{4}$'s there are in $\frac{2}{3}$, that is, to compute $\frac{2}{3} \div \frac{1}{4}$.

$$\frac{2}{3} \div \frac{1}{4} = \frac{2}{3} \times \frac{4}{1} = \frac{8}{3}, \text{ or } 2\frac{2}{3}$$

Find the reciprocal of the divisor $\left(\frac{1}{4}\right)$ and then multiply.

So the photographer cannot develop 3 rolls of film.

PRACTICE 13

A house is built on ground that is sinking $\frac{3}{4}$ inch per year. How many years will it take the house to sink 2 inches? $2\frac{2}{3}$ yr

Dividing Mixed Numbers

Dividing mixed numbers is similar to dividing fractions, except that there is an additional step.

To Divide Mixed Numbers

- change the mixed numbers to their equivalent improper fractions,
- follow the steps for dividing fractions, and
- simplify the answer.

EXAMPLE 14

Find $9 \div 2\frac{7}{10}$.

Solution $9 \div 2\frac{7}{10} = \frac{9}{1} \div \frac{27}{10}$ **First, rewrite all mixed numbers as improper fractions.**

$$= \frac{9}{1} \times \frac{10}{27}$$

Then, invert and multiply.

$$= \frac{10}{3}, \text{ or } 3\frac{1}{3}$$
PRACTICE 14

Divide: $6 \div 3\frac{3}{4}$ $1\frac{3}{5}$

EXAMPLE 17

Simplify and check: $3\frac{3}{4} \times 5\frac{1}{3} \div 2\frac{7}{9}$

Solution Following the order of operations rule, we work from left to right, multiplying the first two mixed numbers.

$$3\frac{3}{4} \times 5\frac{1}{3} = \frac{15}{4} \times \frac{16}{3} = 20$$

Then we divide 20 by $2\frac{7}{9}$ to get the answer.

$$20 \div 2\frac{7}{9} = \frac{20}{1} \div \frac{25}{9} = \frac{20}{1} \times \frac{9}{25} = \frac{36}{5}, \text{ or } 7\frac{1}{5}$$

Now let's check by estimation.

$$\begin{array}{r} 3\frac{3}{4} \times 5\frac{1}{3} \div 2\frac{7}{9} \\ \downarrow \quad \downarrow \quad \downarrow \\ 4 \times 5 \div 3 = 20 \div 3 \approx 7 \end{array}$$

Our answer, $7\frac{1}{5}$, and our estimate, 7, are reasonably close, confirming the answer.

PRACTICE 17

Compute: $5\frac{3}{5} \div 2\frac{1}{10} \times 2\frac{1}{4}$ 6

Exercises 2.4



Multiply.

1. $\frac{1}{3} \times \frac{2}{5}$
 $\frac{2}{15}$

2. $\frac{1}{8} \times \frac{1}{7}$
 $\frac{1}{56}$

3. $\left(\frac{5}{8}\right)\left(\frac{2}{3}\right)$
 $\frac{5}{12}$

4. $\left(\frac{3}{10}\right)\left(\frac{1}{4}\right)$
 $\frac{3}{40}$

5. $\left(\frac{3}{4}\right)^2$
 $\frac{9}{16}$

6. $\left(\frac{1}{8}\right)^2$
 $\frac{1}{64}$

7. $\frac{4}{5} \times \frac{2}{5}$
 $\frac{8}{25}$

8. $\frac{1}{2} \times \frac{3}{2}$
 $\frac{3}{4}$

9. $\frac{7}{8} \times \frac{5}{4}$
 $\frac{35}{32} = 1\frac{3}{32}$

10. $\frac{20}{3} \times \frac{2}{7}$
 $\frac{40}{21} = 1\frac{19}{21}$

11. $\frac{5}{2} \cdot \frac{9}{8}$
 $\frac{45}{16} = 2\frac{13}{16}$

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

13. $\left(\frac{2}{5}\right)\left(\frac{5}{9}\right)$
 $\frac{2}{9}$

14. $\left(\frac{4}{5}\right)\left(\frac{1}{4}\right)$
 $\frac{1}{5}$

15. $\frac{7}{9} \times \frac{3}{4}$
 $\frac{7}{12}$

16. $\frac{4}{5} \times \frac{1}{2}$
 $\frac{2}{5}$

17. $\left(\frac{1}{8}\right)\left(\frac{6}{10}\right)$
 $\frac{3}{40}$

18. $\left(\frac{4}{6}\right)\left(\frac{3}{8}\right)$
 $\frac{1}{4}$

19. $\frac{10}{9} \times \frac{93}{100}$
 $\frac{31}{30} = 1\frac{1}{30}$

20. $\frac{12}{5} \times \frac{15}{4}$
9

21. $5 \cdot \frac{1}{3}$
 $\frac{5}{3} = 1\frac{2}{3}$

22. $\frac{1}{5} \cdot 6$
 $\frac{6}{5} = 1\frac{1}{5}$

23. $\frac{2}{5} \times 7$
 $\frac{14}{5} = 2\frac{4}{5}$

24. $\frac{3}{4} \times 9$
 $\frac{27}{4} = 6\frac{3}{4}$

25. $\frac{2}{3} \times 20$
 $\frac{40}{3} = 13\frac{1}{3}$

26. $\frac{5}{6} \times 5$
 $\frac{25}{6} = 4\frac{1}{6}$

27. $\left(\frac{10}{3}\right)(4)$
 $\frac{40}{3} = 13\frac{1}{3}$

28. $\frac{5}{3} \times 8$
 $\frac{40}{3} = 13\frac{1}{3}$

29. $\frac{1}{2} \times 8$
4

30. $\frac{3}{4} \times 12$
9

31. $\frac{7}{8} \cdot 10$
 $\frac{35}{4} = 8\frac{3}{4}$

32. $100 \cdot \frac{2}{5}$
40

33. $18 \cdot \frac{2}{9}$
4

34. $20 \cdot \frac{2}{5}$
8

35. $\frac{2}{3} \times 6$
4

36. $\frac{1}{6} \times 9$
 $\frac{3}{2} = 1\frac{1}{2}$

37. $\frac{2}{5} \cdot 1\frac{1}{3}$
 $\frac{8}{15}$

38. $5\frac{1}{2} \cdot \frac{1}{3}$
 $1\frac{5}{6}$

39. $\frac{1}{3} \times 1\frac{1}{3}$
 $\frac{4}{9}$

40. $5\frac{5}{6} \times \frac{1}{2}$
 $2\frac{11}{12}$



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41. $\left(\frac{7}{8}\right)\left(1\frac{1}{2}\right)$
 $1\frac{5}{16}$

42. $\left(4\frac{1}{3}\right)\left(\frac{1}{5}\right)$
 $\frac{13}{15}$

43. $\frac{1}{4} \times 8\frac{1}{2}$
 $2\frac{1}{8}$

44. $\frac{1}{3} \times 2\frac{1}{5}$
 $\frac{11}{15}$

45. $\left(\frac{5}{6}\right)\left(1\frac{1}{9}\right)$
 $\frac{25}{27}$

46. $\left(\frac{9}{10}\right)\left(2\frac{1}{7}\right)$
 $1\frac{13}{14}$

47. $\frac{1}{2} \times 5\frac{1}{3}$
 $2\frac{2}{3}$

48. $4\frac{1}{2} \times \frac{2}{3}$
3

49. $\frac{4}{5} \cdot 1\frac{1}{4}$
1

50. $\frac{3}{8} \cdot 5\frac{1}{3}$
2

51. $\left(\frac{3}{16}\right)\left(4\frac{2}{3}\right)$
 $\frac{7}{8}$

52. $\left(\frac{7}{9}\right)\left(2\frac{1}{4}\right)$
 $1\frac{3}{4}$

53. $1\frac{1}{7} \times 1\frac{1}{5}$
 $1\frac{13}{35}$

54. $2\frac{1}{3} \times 1\frac{1}{2}$
 $3\frac{1}{2}$

55. $\left(2\frac{1}{10}\right)^2$
 $4\frac{41}{100}$

56. $\left(1\frac{1}{2}\right)^2$
 $2\frac{1}{4}$

57. $3\frac{9}{10} \cdot 2$
 $7\frac{4}{5}$

58. $5 \cdot 1\frac{1}{2}$
 $7\frac{1}{2}$

59. $100 \times 3\frac{3}{4}$
375

60. $1\frac{5}{6} \times 20$
 $36\frac{2}{3}$

61. $1\frac{1}{2} \times 5\frac{1}{3}$
8

62. $5\frac{1}{4} \times 1\frac{1}{9}$
 $5\frac{5}{6}$

63. $\left(2\frac{1}{2}\right)\left(1\frac{1}{5}\right)$
3

64. $\left(1\frac{3}{10}\right)\left(2\frac{4}{9}\right)$
 $3\frac{8}{45}$

65. $12\frac{1}{2} \cdot 3\frac{1}{3}$
 $41\frac{2}{3}$

66. $5\frac{1}{10} \cdot 1\frac{2}{3}$
 $8\frac{1}{2}$

67. $66\frac{2}{3} \times 1\frac{7}{10}$
 $113\frac{1}{3}$

68. $37\frac{1}{2} \times 1\frac{3}{5}$
60

69. $1\frac{5}{9} \times \frac{3}{8} \times 2$
 $1\frac{1}{6}$

70. $\frac{1}{8} \times 2\frac{1}{4} \times 6$
 $1\frac{11}{16}$

71. $\left(\frac{1}{2}\right)^2\left(2\frac{1}{3}\right)$
 $\frac{7}{12}$

72. $\left(1\frac{1}{4}\right)^2\left(\frac{1}{5}\right)$
 $\frac{5}{16}$

73. $\frac{4}{5} \times \frac{7}{8} \times 1\frac{1}{10}$
 $\frac{77}{100}$

74. $8\frac{1}{3} \times \frac{3}{10} \times \frac{5}{6}$
 $2\frac{1}{12}$

75. $\left(1\frac{1}{2}\right)^3$
 $3\frac{3}{8}$

76. $\left(2\frac{1}{2}\right)^3$
 $15\frac{5}{8}$

Divide.

77. $\frac{3}{5} \div \frac{2}{3}$
 $\frac{9}{10}$

78. $\frac{2}{3} \div \frac{3}{5}$
 $1\frac{1}{9}$

79. $\frac{4}{5} \div \frac{7}{8}$
 $\frac{32}{35}$

80. $\frac{7}{8} \div \frac{4}{5}$
 $1\frac{3}{32}$

81. $\frac{1}{2} \div \frac{1}{7}$
 $3\frac{1}{2}$

82. $\frac{1}{7} \div \frac{1}{2}$
 $\frac{2}{7}$

83. $\frac{5}{9} \div \frac{1}{8}$
 $4\frac{4}{9}$

84. $\frac{1}{8} \div \frac{5}{9}$
 $\frac{9}{40}$



Point out that changing the order of the fractions in a division problem changes the answer to its reciprocal.



$$85. \frac{4}{5} \div \frac{8}{15}$$

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

$$86. \frac{3}{10} \div \frac{6}{5}$$

$$\frac{1}{4}$$

$$87. \frac{7}{8} \div \frac{3}{8}$$

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

$$88. \frac{10}{3} \div \frac{5}{6}$$

$$4$$

$$89. \frac{9}{10} \div \frac{3}{4}$$

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

$$90. \frac{5}{6} \div \frac{1}{3}$$

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

$$91. \frac{1}{10} \div \frac{2}{5}$$

$$\frac{1}{4}$$

$$92. \frac{3}{4} \div \frac{6}{5}$$

$$\frac{5}{8}$$

$$93. \frac{2}{3} \div 7$$

$$\frac{2}{21}$$

$$94. \frac{1}{2} \div 5$$

$$\frac{1}{10}$$

$$95. \frac{1}{5} \div 6$$

$$\frac{1}{30}$$

$$96. \frac{2}{11} \div 2$$

$$\frac{1}{11}$$

$$97. \frac{3}{5} \div 6$$

$$\frac{1}{10}$$

$$98. \frac{7}{10} \div 10$$

$$\frac{7}{100}$$

$$99. \frac{2}{3} \div 6$$

$$\frac{1}{9}$$

$$100. \frac{1}{20} \div 2$$

$$\frac{1}{40}$$

$$101. 8 \div \frac{1}{5}$$

$$40$$

$$102. 8 \div \frac{2}{9}$$

$$36$$

$$103. 7 \div \frac{3}{7}$$

$$16\frac{1}{3}$$

$$104. 10 \div \frac{2}{5}$$

$$25$$

$$105. 4 \div \frac{3}{10}$$

$$13\frac{1}{3}$$

$$106. 10 \div \frac{2}{3}$$

$$15$$

$$107. 1 \div \frac{1}{7}$$

$$7$$

$$108. 3 \div \frac{1}{8}$$

$$24$$

$$109. 2\frac{5}{6} \div \frac{3}{7}$$

$$6\frac{11}{18}$$

$$110. 5\frac{1}{9} \div \frac{2}{3}$$

$$7\frac{2}{3}$$

$$111. 1\frac{1}{3} \div \frac{4}{5}$$

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

$$112. 7\frac{1}{10} \div \frac{1}{2}$$

$$14\frac{1}{5}$$

$$113. 8\frac{5}{6} \div \frac{9}{10}$$

$$9\frac{22}{27}$$

$$114. 6\frac{1}{2} \div \frac{1}{2}$$

$$13$$

$$115. 20\frac{1}{10} \div \frac{1}{5}$$

$$100\frac{1}{2}$$

$$116. 15\frac{2}{3} \div \frac{5}{6}$$

$$18\frac{4}{5}$$

$$117. \frac{1}{6} \div 2\frac{1}{7}$$

$$\frac{7}{90}$$

$$118. \frac{2}{7} \div 1\frac{1}{3}$$

$$\frac{3}{14}$$

$$119. \frac{1}{2} \div 2\frac{3}{5}$$

$$\frac{5}{26}$$

$$120. \frac{3}{4} \div 3\frac{1}{9}$$

$$\frac{27}{112}$$

$$121. 4 \div 1\frac{1}{4}$$

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

$$122. 7 \div 1\frac{9}{10}$$

$$3\frac{13}{19}$$

$$123. 2\frac{1}{10} \div 20$$

$$\frac{21}{200}$$

$$124. 5\frac{6}{7} \div 14$$

$$\frac{41}{98}$$



Remind students that dividing a large number by a small number gives an answer greater than 1 and that dividing a small number by a large number gives an answer less than 1.



$$125. 2\frac{1}{2} \div 3\frac{1}{7}$$

$$\frac{35}{44}$$

$$126. 3\frac{1}{7} \div 2\frac{1}{2}$$

$$1\frac{9}{35}$$

$$127. 8\frac{1}{10} \div 5\frac{3}{4}$$

$$1\frac{47}{115}$$

$$128. 1\frac{7}{10} \div 5\frac{1}{8}$$

$$\frac{68}{205}$$

$$129. 2\frac{1}{3} \div 4\frac{1}{2}$$

$$\frac{14}{27}$$

$$130. 8\frac{1}{6} \div 2\frac{1}{2}$$

$$3\frac{4}{15}$$

$$131. 6\frac{3}{8} \div 2\frac{5}{6}$$

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

$$132. 1\frac{2}{3} \div 1\frac{2}{5}$$

$$1\frac{4}{21}$$

Simplify.



$$133. \frac{2}{3} \times 1\frac{1}{3} + \frac{1}{2}$$

$$1\frac{7}{18}$$

$$134. \frac{4}{5} \cdot 8 + \frac{9}{10}$$

$$7\frac{3}{10}$$

$$135. 5 - \frac{1}{3} \times \frac{2}{5}$$

$$4\frac{13}{15}$$

$$136. 3 \div \frac{2}{5} - 2\frac{1}{3}$$

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

$$137. \frac{1}{5} + 2\frac{3}{4} \times \frac{1}{8}$$

$$\frac{87}{160}$$

$$138. \frac{3}{8} \cdot \frac{1}{2} - \frac{1}{10}$$

$$\frac{7}{80}$$

$$139. 4 \times \frac{2}{9} \div \frac{3}{4}$$

$$1\frac{5}{27}$$

$$140. 6 \times \frac{1}{4} \div 5$$

$$\frac{3}{10}$$

$$141. 3\frac{1}{2} \times 6 \div 5$$

$$4\frac{1}{5}$$

$$142. 4 \cdot \frac{2}{3} - 1\frac{1}{8}$$

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

$$143. 10 \times \frac{1}{8} \times 2\frac{1}{2}$$

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

$$144. \frac{1}{3} \div \frac{1}{6} \times \frac{2}{3}$$

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

Applications

Solve and check.



145. Most days, you swim $\frac{3}{4}$ mile. This morning, you only swam $\frac{1}{2}$ that distance. How far did you swim this morning? $\frac{3}{8}$ mi

146. On a test, you answered $\frac{4}{5}$ of the questions. Of the questions that you answered, you got $\frac{3}{4}$ correct. What fraction of the questions on the test did you get right? $\frac{3}{5}$

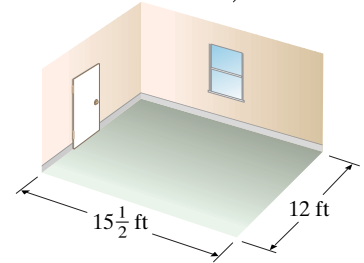
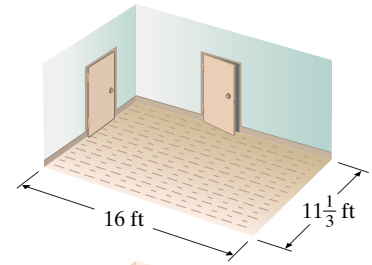
147. The house that you want to buy is selling for \$160,000. You need to put $\frac{1}{20}$ of the selling price down, and take out a mortgage for the rest. How much money do you need to put down? \$8,000

148. There is a rule of thumb that you should spend no more than $\frac{1}{4}$ of your income on rent. If you make \$24,000 a year, what is the most you should spend per month on rent according to this rule? \$500

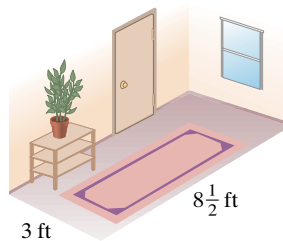


149. You learn in an astronomy course that a first-magnitude star is $2\frac{1}{2}$ times as bright as a second-magnitude star, which in turn is $2\frac{1}{2}$ times as bright as a third-magnitude star. How many times as bright as a third-magnitude star is a first-magnitude star? $6\frac{1}{4}$

150. Which of these rooms has the larger area? **The room that measures $15\frac{1}{2}$ ft by 12 ft.**



151. Find the cost of buying carpeting at $\$7\frac{1}{2}$ per square feet for the hallway shown.
 $\$191\frac{1}{4}$



152. Some people believe that gasohol is superior to plain gasoline as an automotive fuel. Gasohol is a mixture of gasoline ($\frac{9}{10}$) and ethyl alcohol ($\frac{1}{10}$). How much gasoline is there in $10\frac{1}{2}$ gallons of gasohol? $9\frac{9}{20}$ gal

153. You own \$1,000 worth of stocks and \$1,000 worth of bonds. If the value of your stocks declines by $\frac{1}{4}$ and the value of your bonds declines by $\frac{1}{8}$, what is the total value of your stocks and bonds? **\$750 stocks, \$875 bonds**

154. A scientist is investigating the effects of cold on human skin. In one of the scientist's experiments, the temperature starts at 70°F and drops by $\frac{1}{10}^\circ$ every 2 minutes. What is the temperature after 6 minutes? $69\frac{7}{10}^\circ\text{F}$



155. A trip to a nearby island takes $3\frac{1}{2}$ hours by boat and $\frac{1}{2}$ hour by airplane. How many times as fast as the boat is the plane? **7 times**
156. Each dose of aspirin weighs $\frac{3}{4}$ grain. If you have 9 grains of aspirin on hand, how many doses can you administer? **12 doses**
157. You develop your own film. Each roll takes $\frac{1}{8}$ bottle of developer solution. If you have a bottle of solution that is $\frac{3}{4}$ full, how many rolls of film can you develop? **6 rolls**
158. A university fund-raising campaign collected \$500 million in $3\frac{1}{2}$ years. What was the average amount collected per year? **\$142 $\frac{6}{7}$ million**

■ Check your answers on page A-4.

M INDSTRETCHERS

WRITING

1. Every number except 0 has a reciprocal. Explain why 0 does not have a reciprocal.
The reciprocal of 0 would have to be $\frac{1}{0}$, which does not exist. The product of any number and its reciprocal is 1, but 0 times any number is 0.

GROUPWORK

2. In the following magic square, the *product* of every row, column, and diagonal is 1. Working with a partner, complete the square.

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

PATTERNS

3. Find the product: $1\frac{1}{2} \cdot 1\frac{1}{3} \cdot 1\frac{1}{4} \cdots 1\frac{1}{99} \cdot 1\frac{1}{100}$ **$\frac{101}{2} = 50\frac{1}{2}$**