Review division as fitting into. Remind students that division can be looked at as fitting into. For example, to divide $6 \div 2$, you can ask how many objects of length 2 fit across an object of length 6:

\[ \begin{array}{cccc} & & & \ \hline \ & & & \ \hline \ & & & \ \hline \ & & & \ & 2 & & \ & 2 & & \ & 2 & & \end{array} \]

SAY: Three 2s fit into 6, so $6 \div 2 = 3$.

Dividing 1 by a unit fraction. Give students the prepared cutouts from BLM Fraction Parts and Wholes (1 whole, 2 halves, 3 thirds, 4 fourths, and 5 fifths for each student). ASK: How many $\frac{1}{2}$s fit into 1? (2) Students should show their answer by lining up pieces. Write on the board:

\[ 1 \div \frac{1}{2} = 2 \]

ASK: How many $\frac{1}{3}$s should fit into 1? (3) Students should check this with their cutouts. Have a volunteer write the division equation. ($1 \div \frac{1}{3} = 3$)

Repeat for how many fourths fit into 1 ($1 \div \frac{1}{4} = 4$) and how many fifths fit into 1. ($1 \div \frac{1}{5} = 5$)

Exercises: Divide.

a) $1 \div \frac{1}{6}$  

b) $1 \div \frac{1}{7}$  

c) $1 \div \frac{1}{10}$  

d) $1 \div \frac{1}{9}$

Bonus: $1 \div \frac{1}{372}$

Answers: a) 6, b) 7, c) 10, d) 9, Bonus: 372

Dividing a whole number by a unit fraction. Have students work in groups of four. Ask students to use their fraction pieces from BLM Fraction Parts and Wholes to determine how many $\frac{1}{2}$s fit into a) 1, b) 2, c) 3, d) 4.
Then show students how to write the division equations:

\[
\begin{align*}
1 \div \frac{1}{2} &= 2 \\
2 \div \frac{1}{2} &= 4 \\
3 \div \frac{1}{2} &= 6 \\
4 \div \frac{1}{2} &= 8
\end{align*}
\]

Repeat for thirds and fourths, but this time have students write the division equations themselves. Take up the answers on the board. Point out that no matter how many fit into 1, twice as many will fit into 2 as fit into 1, three times as many will fit into 3, and four times as many will fit into 4. ASK: How many sixths fit into 1? (6) How many sixths fit into 3? (3 × 6 = 18) Write on the board:

\[
1 \div \frac{1}{6} = 6 \text{ so } 3 \div \frac{1}{6} = 3 \times 6 = 18
\]

**Exercises**

a) 5 \(\div\) \(\frac{1}{4}\)  

b) 2 \(\div\) \(\frac{1}{5}\)  

c) 3 \(\div\) \(\frac{1}{7}\)  

d) 5 \(\div\) \(\frac{1}{6}\)  

e) 9 \(\div\) \(\frac{1}{2}\)  

f) 10 \(\div\) \(\frac{1}{7}\)  

g) 8 \(\div\) \(\frac{1}{7}\)  

h) 9 \(\div\) \(\frac{1}{8}\)  

**Bonus**

i) 100 \(\div\) \(\frac{1}{3}\)  

j) 5 \(\div\) \(\frac{1}{100}\)  

k) 13 \(\div\) \(\frac{1}{100}\)  

l) 400 \(\div\) \(\frac{1}{7,000}\)  

**Answers:** a) 20, b) 10, c) 21, d) 30, e) 18, f) 70, g) 56, h) 72, Bonus: i) 300, j) 5,000, k) 1,300, l) 2,800,000

**Showing division on a number line.** Draw on the board:

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
\end{array}
\]

ASK: How many steps of size 1/2 fit into 3? (6) Write on the board:

\[
3 \div \frac{1}{2} = 6
\]

Tell students that drawing number lines is another way to show how many halves fit into three. Ask a volunteer to extend the number line to find how many halves fit into four. (8) Then draw a number line from 0 to 2, divided into fourths. Write on the board:

\[
2 \div \underline{\hspace{2cm}} = \underline{\hspace{2cm}}
\]

ASK: How big is each step? (1/4) Fill in the first blank. How many of them fit into two? (8) Fill in the second blank.

**Exercises:** Write the division statement to show how many steps fit into the number line.

a)  

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 \\
\end{array}
\]

b)  

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\end{array}
\]

**Bonus**

\[
\begin{array}{cccc}
0 & 1 & 2 & 3 & 4 & 5 \\
\end{array}
\]

**Answers:** a) 3 \(\div\) \(\frac{1}{4}\) = 12, b) 5 \(\div\) \(\frac{1}{2}\) = 10, Bonus: 5 \(\div\) \(\frac{1}{3}\) = 15
Exercises: Draw a number line to determine \( 2 \div \frac{1}{3} \).

Bonus: Draw pizzas divided into fourths to determine \( 3 \div \frac{1}{4} \).

Answers: 2 \[ \begin{array}{c} \hline \hline \hline 0 & 1 & 2 \hline \hline \end{array} \]

Bonus: \[ \begin{array}{c} \hline \hline \hline \ \bigcirc & \bigcirc & \bigcirc \hline \hline \end{array} \]

\[ 2 \div \frac{1}{3} = 6 \]

\[ 3 \div \frac{1}{4} = 12 \]

**Activity**

Students play in pairs. Player 1 rolls a die and takes that many steps. Player 2 tries to take steps that are only \( \frac{1}{3} \) or \( \frac{1}{4} \) as long, and cover the same distance. Player 1 decides how many steps Player 2 should take to succeed before Player 2 tries, and records the division equation. Then players switch roles.

**Different contexts for dividing fractions.** Show students a \( \frac{1}{3} \) cup measure, a 1 cup measure, and enough counters to fill up the cup. Tell students that the small measure is labeled as \( \frac{1}{3} \) cup and the big measure as 1 cup.

ASK: How many small cupfuls should fill up the big cup? (3) Ask a volunteer to check that this is the case. Tell students that a recipe calls for 2 cups of flour, but you only have a \( \frac{1}{3} \) cup measure. ASK: How many cupfuls do you need? (6) Have a volunteer write the division equation. \( (2 \div \frac{1}{3} = 6) \)

**Exercises:** Solve the problems.

a) Tegan needs 5 cups of sugar. She only has a \( \frac{1}{2} \) cup measure. How many cupfuls does she need?

b) Alex needs 3 cups of water for a recipe. He only has a \( \frac{1}{4} \) cup measure. How many cupfuls does he need?

c) Mary has 5 feet of ribbon. She uses \( \frac{1}{3} \) of a foot for each gift. How many gifts can she put ribbon on?

d) Rosa has 2 apples. She cuts them each into fourths. How many pieces does she have?

e) Miki has 6 muffins. He cuts them into halves.
   i) How many pieces does he have?
   ii) Four people share the muffins. How many pieces does each person get?

**Answers:** a) 10, b) 12, c) 15, d) 8, e) i) 12, ii) 3
Extensions

1. Explain how you could use tools, such as base ten blocks, your hands and fingers, or a yard stick to show the division equation is true.
   a) \[3 \div \frac{1}{12} = 36?\]
   b) \[2 \div \frac{1}{100} = 200?\]
   c) \[2 \div \frac{1}{5} = 10?\]

2. Six people are sharing three oranges equally. Each orange is cut into eighths. Half of the people are adults. How many pieces does each person get?

   Model the situation using division with fractions. Which fact did you not need in your model?

   **Sample answer:** There are 3 oranges, and they are divided into pieces of size \(\frac{1}{8}\). Since \(3 \div \frac{1}{8} = 24\), there are 24 pieces. Since there are 6 people who share the oranges equally, each person gets \(24 \div 6 = 4\) pieces. I did not need to know that half of the people are adults.

3. Discuss why it is easier to look at division as sharing equally when dividing fractions by whole numbers but as fitting into when dividing whole numbers by fractions.

   **Answer:** It is hard to see how many pieces of size 3 fit into \(\frac{1}{2}\) so \(\frac{1}{2} \div 3\) would be hard to find by thinking of division as fitting into. Also, \(3 \div \frac{1}{2}\) would be hard to think of as sharing equally between \(\frac{1}{2}\) of a person.

4. Miss B’s class has 36 students. She has Grades 6 and 7 students in her class. There are five Grade 7 students for every four Grade 6 students. For a book-reading contest, each Grade 7 student read four books and each Grade 6 student read three books. How many books did they read altogether? Write your answer as a full sentence.

   **Sample solution:** I made a sequence of ratios using a table for Grade 7 to Grade 6 students:
   
   \[
   5 : 4 = 10 : 8 = 15 : 12 = 20 : 16
   \]

   I stopped when the total was 36 since Miss B’s class has 36 students.

   There are 20 Grade 7 students and 16 Grade 6 students. The Grade 7 students read a total of \(20 \times 4 = 80\) books and the Grade 6 students read a total of \(16 \times 3 = 48\) books. Altogether, the students in the class read 128 books.

   Redirecting students: Have students read only the first three sentences of the problem. ASK: What information can you figure out from this? (the number of Grade 7 students and the number of Grade 6 students)

   Then have the students read the rest of the problem. ASK: If you figured out the number of students in each grade, could you answer the question? (yes) So what is your plan to solve the problem? (I’m going to start by figuring out how many students there are in each grade by using a table or a sequence of ratios, then I’m going to figure out how many books the students read altogether)
Dividing Fractions by Unit Fractions

**Goals**
Students will divide fractions by unit fractions in cases where the answer is a whole number.

**VOCABULARY**
denominator
fraction
fraction names (halves, thirds, fourths, ...)
whole number

**PRIOR KNOWLEDGE REQUIRED**
Can locate fractions on number lines
Can name fractions from pictures
Understands division as fitting into

**Dividing unit fractions by unit fractions when the answer is a whole number.** Draw on the board:

Ask a volunteer to shade half of each circle. ASK: How many fourths fit into half the circle? (2) What division equation can you write from that? (1/2 ÷ 1/4 = 2) Repeat for how many sixths fit into half (1/2 ÷ 1/6 = 3) and how many eighths fit into half (1/2 ÷ 1/8 = 4).

**Exercises:** Divide using the picture.

a) ![Image of fraction 1/3 divided by 1/6]

b) ![Image of fraction 1/4 divided by 1/8]

c) ![Image of fraction 1/3 divided by 1/12]

**Bonus:** Write another division equation for each picture by dividing the shaded fraction by a whole number.

**Answers:** a) 2, b) 2, c) 4; Bonus: a) 1/3 ÷ 2 = 1/6, b) 1/4 ÷ 2 = 1/8, c) 1/3 ÷ 4 = 1/12

**Exercises:** Check your answers using multiplication.

**Answers:** a) 1/6 × 2 = 2/6 = 1/3, b) 1/8 × 2 = 2/8 = 1/4, c) 1/12 × 4 = 4/12 = 1/3, Bonus: a) 2 × 1/6 = 2/6 = 1/3, b) 2 × 1/8 = 2/8 = 1/4, c) 4 × 1/12 = 4/12 = 1/3

**Dividing fractions by unit fractions with the same denominator.**
ASK: How many 1/8s are in 3/8? (3) Write on the board:

![Image of fraction 3/8 divided by 1/8]

ASK: How many 1/5s are in 2/5? (2) Have a volunteer write the division statement. (2/5 ÷ 1/5 = 2)
Exercises: Divide.

a) \( \frac{4}{7} \div \frac{1}{7} \)  

b) \( \frac{5}{6} \div \frac{1}{6} \)  

c) \( \frac{5}{8} \div \frac{1}{8} \)  

d) \( \frac{7}{10} \div \frac{1}{10} \)  

Bonus  
\( \frac{183}{245} \div \frac{1}{245} \)  

Answers: a) 4, b) 5, c) 5, d) 7, Bonus: 183

Dividing fractions by unit fractions when the answer is a whole number.

Draw on the board a circle divided into sixths as shown in the margin and have a volunteer shade 2/3 of it. ASK: How many 1/6s are in 2/3? (4) Write on the board:

\( \frac{2}{3} \div \frac{1}{6} = 4 \)

Then show students how they can use a double number line to show the same equation:

**Step 1:** Draw and label a number line representing the fraction that is being divided.

```
0   1
```

```
\frac{2}{3}
```

**Step 2:** Draw a second number line below the first to represent the number you are dividing by.

```
0   1
```

```
\frac{1}{6}
```

SAY: It takes four 1/6s to equal 2/3, so \( \frac{2}{3} \div \frac{1}{6} = 4 \).

Exercises: Use the picture to divide.

```
0   1
```

```
\begin{array}{c}
\text{tenths} \\
\hline
\text{fifths}
\end{array}
```

a) \( \frac{1}{5} \div \frac{1}{10} \)  

b) \( \frac{2}{5} \div \frac{1}{10} \)  

c) \( \frac{3}{5} \div \frac{1}{10} \)  

d) \( \frac{4}{5} \div \frac{1}{10} \)  

e) \( \frac{5}{5} \div \frac{1}{10} \)  

Answers: a) 2, b) 4, c) 6, d) 8, e) 10
Using multiplication to divide fractions by unit fractions. Tell students that 8 stamps make a strip that is 1 foot long. Draw on the board:

```
1 foot

8
```

SAY: Each stamp is 1/8 of the strip. The picture shows that 8 eighths fit into 1, or that 1 divided by 1/8 is 8. ASK: If 8 stamps fit into 1 strip, how can we know how many stamps fit into 3/4 of a strip? Allow volunteers to articulate an answer, then SAY: A strip that is 3/4 of a foot long can only contain 3/4 as many stamps as one that is 1 foot long. So if 8 stamps fit into 1, then 3/4 of 8 stamps will fit into 3/4 of 1 strip. Write on the board:

```
1 ÷ 1/8 = 8
so
3/4 ÷ 1/8 = 3/4 of 8 = 3/4 × 8 = 6
```

Exercises: Redo the exercises above using this method. Make sure you get the same answer.

Answers: a) 1/5 × 10 = 10/5 = 2, b) 2/5 × 10 = 20/5 = 4, c) 3/5 × 10 = 30/5 = 6, d) 4/5 × 10 = 40/5 = 8, e) 5/5 × 10 = 50/5 = 10 or 1 × 10 = 10

Remind students that this is similar to dividing whole numbers by fractions. SAY: We know that 3 times as many objects will fit into 3 as fit into 1, so 3 ÷ 1/10 is 3 × 10. In the same way, 2/5 as many objects will fit into 2/5 as fit into 1, so 2/5 ÷ 1/10 = 2/5 × 10.

Exercises: Use 1 ÷ 1/12 = 12 to divide.

a) 2 ÷ 3 = 12
b) 3 ÷ 4 = 12

Bonus: Use 1 ÷ 1/100 = 100 to divide.

d) 3 ÷ 4 = 100

e) 3 ÷ 5 = 100

Answers: a) 2/3 × 12 = 24/3 = 24, b) 3/4 × 12 = 36/4 = 9,
c) 5/6 × 12 = 60/6 = 10, Bonus: d) 3/4 × 100 = 300/4 = 75,
e) 3/5 × 100 = 300/5 = 60, f) 7/10 × 100 = 700/10 = 70

Exercises: Divide.

a) 5 ÷ 1 = 30
b) 5 ÷ 1 = 9

c) 3 ÷ 1 = 10
d) 7 ÷ 1 = 15

Bonus

\[
\frac{423}{1,000} ÷ \frac{1}{1,000,000}
\]

Answers: a) 25, b) 15, c) 15, d) 35, Bonus: 423,000
Extensions

1. Divide by finding the missing factor:
   \[ \frac{1}{15} \times \frac{?}{3} = \frac{1}{3} \] so \( \frac{3}{15} \div \frac{1}{3} = \) 
   \[ \frac{1}{628} \times \frac{?}{2} = \frac{1}{2} \] so \( \frac{2}{628} \div \frac{1}{2} = \)

   \textbf{Answers:} a) 5, b) 314

(MP2, MP5)

2. Use tools such as pattern blocks, your fingers and hands, or a yard stick to determine and explain the division.
   a) \( \frac{1}{2} \div \frac{1}{10} \)
   b) \( \frac{1}{2} \div \frac{1}{6} \)
   c) \( \frac{1}{3} \div \frac{1}{36} \)

   \textbf{Sample answers:} a) I used my fingers and hands. 1/2 of all of my 10 fingers is shown by one hand. 1/10 is represented by one finger. Since one hand has 5 fingers, there are 5 portions of size 1/10 in 1/2, or \( 1/2 \div 1/10 = 5 \). b) I used pattern blocks. Each pattern block triangle covers 1/6 of a hexagon, and a trapezoid covers 1/2 of a hexagon. Since 3 triangles cover a trapezoid, \( 1/2 \div 1/6 = 3 \). c) I used a yardstick. 1/3 of the length of a yardstick is one foot, and 1/36 of a yardstick is one inch. Since there are 12 inches in one foot, \( 1/3 \div 1/36 = 12 \).

3. Divide by changing the first fraction to have the same denominator as the second fraction.
   a) \( \frac{2}{3} \div \frac{1}{12} \)
   b) \( \frac{2}{3} \div \frac{1}{15} \)
   c) \( \frac{3}{4} \div \frac{1}{20} \)
   d) \( \frac{3}{5} \div \frac{1}{20} \)

   \textbf{Answers:} a) 8/12 \div 1/12 = 8, b) 10/15 \div 1/15 = 10, c) 15/20 \div 1/20 = 15, d) 12/20 \div 1/20 = 12

(MP4)

4. Rob has three colors of paint: blue, yellow, and red, in the ratio blue to yellow to red = 5 to 3 to 2. He makes 40 L of green paint using all of his blue and yellow paint. How much of each color of paint did he use? Which information did you not need?

   \textbf{Sample solution:} I made a sequence of ratios in a table—blue : yellow = 5 : 3 = 10 : 6 = 15 : 9 = 20 : 12 = 25 : 15. Since 25 + 15 = 40, Rob must have used 25 L of blue paint and 15 L of yellow paint to make his green paint. I did not use how much red paint Rob has.
Using pictures and concrete materials to divide whole numbers by fractions. ASK: How many 1/5s fit into 1? (5) Draw on the board:

\[
\begin{array}{cccc}
1 \\
5
\end{array}
\]

ASK: How many fit into 4? (20) SAY: Four times as many fit into 4 as fit into 1. Extend the picture to show this:

\[
\begin{array}{ccccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
5 & 5 & 5 & 5 & 5 & 5 & 5 & 5 & 5
\end{array}
\]

Tell students you want to know how many 2/5s fit into 4. Write on the board:

\[
4 \div \frac{1}{5} = 20 \quad \quad \quad 4 \div \frac{2}{5} = ?
\]

Tell students that instead of just counting 1/5s, they need to count blocks of size 2/5. Demonstrate by drawing the first block and have a volunteer draw the rest to see how many fit into 4:

\[
\begin{array}{ccccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
5 & 5 & 5 & 5 & 5 & 5 & 5 & 5 & 5
\end{array}
\]

SAY: 10 blocks of size 2/5 fit into 4, so \(4 \div \frac{2}{5} = 10\).
ACTIVITY

Give students (or groups of students) toothpicks and fraction parts and wholes from BLM Fraction Parts and Wholes.

To show $4 \div \frac{2}{3}$:

1) Place 4 wholes in a row.
2) Line up $\frac{1}{3}$ size pieces underneath.
3) Use toothpicks to mark where the groups of size $\frac{2}{3}$ end:

```
|   |   |   |   |   |   |
```

Six groups of size $\frac{2}{3}$ fit into 4, so $4 \div \frac{2}{3} = 6$.

Students make pictures like the one above, using toothpicks to mark where a group ends. Students then divide by counting the groups they make. Students draw pictures to divide:

a) $2 \div \frac{2}{5}$

b) $3 \div \frac{3}{4}$

c) $3 \div \frac{3}{5}$

d) $4 \div \frac{4}{5}$

Answers: a) 5, b) 4, c) 5, d) 5

Using division by a unit fraction to divide by a fraction. Refer to the pictures above that show $4 \div \frac{1}{5} = 20$ and $4 \div \frac{2}{5} = 10$. Point out that $\frac{2}{5}$ is twice as long as $\frac{1}{5}$, so half as many longer bars fit than shorter bars. Write on the board:

```
6 \div \frac{1}{5} = 6 \div \frac{2}{5} = 6 \div \frac{3}{5} =
```

ASK: How many $\frac{1}{5}$s fit into 6? (30) Write in the answer. How many times longer is $\frac{2}{5}$ than $\frac{1}{5}$? (twice as long) SAY: So only half as many $\frac{2}{5}$ will fit. ASK: What is half of 30? (15) Write in the answer again. ASK: How many $\frac{3}{5}$s fit into 6? (10) How do you know? (3/5 is three times as long as 1/5, so only one third as many will fit)

Exercises: Use $8 \div \frac{1}{6} = 48$ to divide.

a) $8 \div \frac{2}{6}$

b) $8 \div \frac{3}{6}$

c) $8 \div \frac{4}{6}$

Bonus: Divide and match your answers to above.

d) $8 \div \frac{1}{2}$

e) $8 \div \frac{1}{3}$

Answers: a) 24; b) 16; c) 12; Bonus: d) 16, same as $8 \div \frac{3}{6}$; e) 24, same as $8 \div \frac{2}{6}$

Write on the board:

```
10 \div \frac{2}{3} = (10 \times 3) \div 2
```
SAY: $10 \times 3 = 30$ one thirds fit into 10, and two thirds is twice as big as one third, so only half as many will fit. That’s why you divide by 2.

**Exercises:** Divide.

a) $10 \div \frac{2}{3}$  
   b) $8 \div \frac{4}{5}$  
   c) $6 \div \frac{2}{7}$  
   d) $15 \div \frac{3}{4}$

**Answers:** a) $(10 \times 3) \div 2 = 30 \div 2 = 15$, b) $(8 \times 5) \div 4 = 40 \div 4 = 10$, c) $(6 \times 7) \div 2 = 42 \div 2 = 21$, d) $(15 \times 4) \div 3 = 60 \div 3 = 20$

**Checking answers through multiplication.** Remind students that they can check their answers using multiplication. Write on the board:

$$6 \div 2 = 3 \quad 10 \div \frac{2}{3} = 15$$

Have volunteers circle the two numbers you would multiply in each equation to make sure the answer is the other number. Have another volunteer do the multiplication $2/3 \times 15$ to check the second division.

**Exercises:** Check your answers to each question above, for b) to d).

**Answers:** b) $4/5 \times 10 = 40/5 = 8$, c) $2/7 \times 21 = 42/7 = 6$, d) $3/4 \times 20 = 60/4 = 15$

**Word problems practice.**

a) A ribbon is 4 m long. Yu needs a piece $2/3$ m long for each gift. How many gifts can she wrap?

b) Sam lives 10 miles from school. Nina lives 2/5 miles from school. How many times farther from school does Sam live than Nina?

c) Ravi lives 12 miles from school and 4/3 miles from the library. How many times closer is he to the library than to school?

**Answers:** a) 6, b) 25, c) 9

**Extensions**

1. To divide by unit fractions, use the division property that multiplying both terms by the same number doesn’t change the answer. For example:

   $$\frac{3}{2} \div \frac{1}{5} = \left(\frac{3}{2} \times 5\right) \div \left(\frac{1}{5} \times 5\right)$$

   $$= \left(\frac{3}{2} \times 5\right) \div 1 = \frac{3}{2} \times 5$$

   (MP3, MP.7)

2. Which do you expect to be greater?

   $$21,417,613 \div \frac{1}{2} \text{ or } 21,417,613 \div \frac{3}{5}$$

   Explain.

   **Answer:** $21,417,613 \div 1/2$ because $1/2 = 5/10 < 3/5 = 6/10$ and dividing by a smaller number gives a larger quotient.
3. a) 60 pieces of size $\frac{1}{10}$ fit into 6. How many pieces of size …  
   i) $\frac{2}{10}$ will fit into 6? ii) $\frac{3}{10}$ will fit into 6? iii) $\frac{5}{10}$ will fit into 6? 

b) Find $6 \div \frac{1}{2}$. Which answer from part a) is the same?  
   Why is this so? 

Answers: a) i) 30, ii) 20, iii) 12; b) 12, iii) is the same because $5/10 = 1/2$

4. Anika lives 14 miles from school and $2\frac{1}{3}$ miles from the library. 
   How many times closer to the library is she than to school? 

Answer: $14 \div 7/3 = 6$

5. To divide $3 \div \frac{2}{3}$, draw a picture with thirds:

```
1 1 1
\frac{1}{3} \frac{1}{3} \frac{1}{3}
```

Group two thirds at a time:

```
1 1 1
\frac{1}{3} \frac{1}{3} \frac{1}{3}
```

4 pieces remainder

Now do the algorithm: $3 \div \frac{2}{3} = (3 \times 3) \div 2 = 9 \div 2 = \frac{9}{2} = 4 \frac{1}{2}$

Now look at the picture. The "4" in "4 $\frac{1}{2}$" is the number of pieces of size $\frac{2}{3}$, but what does the " $\frac{1}{2}$ " mean? (It means 1/2 of the thing you are dividing by or 1/2 of 2/3.)

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

The remaining piece is one-half of what you are dividing by. There are four and one-half groups of size 2/3 that fit into 3, so $3 \div \frac{2}{3} = 4 \frac{1}{2}$. 
Finding the number of whole parts that fit into 1. Draw on the board:

1 piece of chocolate

This piece of chocolate has 7 pieces, so each piece is 1/7.

Write on the board:

\[ 1 \div \frac{2}{7} = ? \]

Tell students that you want to know how many pieces of size 2/7 fit into 1.
Then outline pieces of size 2/7:

ASK: How many whole blocks of size 2/7 fit into the whole piece? (3)
SAY: There’s some leftover, but we’ll think about that part later.

Exercises: How many whole blocks fit?

a) 

\[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\hline
8 & 8 & 8 & 8 & 8 & 8 & 8 & 8
\end{array}
\]
There are ____ whole pieces of size \( \frac{3}{8} \) in 1 whole.

b) 

\[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
\hline
9 & 9 & 9 & 9 & 9 & 9 & 9 & 9
\end{array}
\]
There are ____ whole pieces of size \( \frac{2}{9} \) in 1 whole.

Answers: a) 2, b) 4
Have students shade on grid paper a rectangle consisting of 1 row 9 squares across:

<p>| | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1/5</td>
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</tbody>
</table>

ASK: What fraction of the rectangle is each square? (one ninth) Have students draw blocks of size 4/9 to find out how many whole blocks of size 4/9 fit into one whole. (2) Now write on the board:

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

Have students draw a rectangle on grid paper so that each part is one fifth. ASK: How many squares long is your rectangle? (5) Be sure everyone drew the correct rectangle before continuing. Then ask them to divide the rectangle into pieces of size two fifths. ASK: How many whole pieces fit into one whole? (2)

Exercises: Draw a picture to decide how many whole pieces fit into 1.

a) $$1 \div \frac{3}{8}$$

b) $$1 \div \frac{2}{11}$$

c) $$1 \div \frac{3}{11}$$

d) $$1 \div \frac{4}{11}$$

Answers: a) 2, b) 5, c) 3, d) 2

Writing the remainder as a fraction of the number you are dividing by.

SAY: To divide 1 by 2/7, you need to figure out how many blocks of size 2/7 fit into 1. The answer, in this case, is not a whole number of blocks because there is a leftover part.

Point to the leftover piece, and SAY: I want to know what fraction of 2/7 the leftover piece is. SAY: Just like a whole number can be a fraction of another whole number, a fraction can be a fraction of another fraction. Draw on the board:

$$\begin{array}{c}
1
\hline
7 7 7 7 7 7 7
\end{array}$$

ASK: 2 is what fraction of 5? (2/5)

Exercises

a) 3 is what fraction of 5?  
b) 2 is what fraction of 9?

Bonus: 9 is what fraction of 1,000?

Answers: a) 3/5, b) 2/9, Bonus: 9/1,000
Draw on the board:

\[
\begin{array}{cccc}
1 & 1 & 1 & 1 \\
7 & 7 & 7 & 7 \\
\end{array}
\]

Tell students that this is \( \frac{5}{7} \) and you want to know what fraction \( \frac{2}{7} \) is of \( \frac{5}{7} \). Ask a volunteer to shade \( \frac{2}{7} \).

\[
\begin{array}{cccc}
1 & 1 & 1 & 1 \\
7 & 7 & 7 & 7 \\
\end{array}
\]

ASK: What fraction of the \( \frac{5}{7} \) is shaded? (\( \frac{2}{5} \)) SAY: 2 of the 5 parts are shaded, so \( \frac{2}{5} \) is shaded. Write on the board:

\[
\frac{2}{7} \text{ is } \frac{2}{5} \text{ of } \frac{5}{7} \text{.}
\]

SAY: Just like 2 is \( \frac{2}{5} \) of 5, \( \frac{2}{7} \) is \( \frac{2}{5} \) of \( \frac{5}{7} \). Have students draw on grid paper two rectangles each consisting of a row 8 squares long. ASK: What fraction of the rectangle is each square? (\( \frac{1}{8} \)) SAY: You can use your rectangles to answer these questions.

**Exercises:** Shade the first fraction and draw a group showing the second fraction. Then fill in the blank.

a) \( \frac{3}{8} \) is _____ of \( \frac{4}{8} \)  

b) \( \frac{3}{8} \) is _____ of \( \frac{5}{8} \)

**Answers:** a) 3/4, b) 3/5

**Exercises:** Draw a picture to find the answer.

a) \( \frac{2}{5} \) is _____ of \( \frac{3}{5} \)  

b) \( \frac{2}{6} \) is _____ of \( \frac{3}{6} \)  

c) \( \frac{2}{7} \) is _____ of \( \frac{3}{7} \)

**Answers:** a) 2/3, b) 2/3, c) 2/3

SAY: You don’t even need to draw a picture. Write on the board:

\[
\frac{2}{100} \text{ is } \frac{2}{100} \text{ of } \frac{3}{100} \text{.}
\]

Have a volunteer fill in the blank. (2/3) Tell students that 2 of anything is \( \frac{2}{3} \) of 3 of anything, and that’s true for thirds, fourths, fifths, hundredths, or baseballs.

**Exercises:** Fill in the missing numbers.

a) \( \frac{5}{9} \) is _____ of \( \frac{7}{9} \)  

b) \( \frac{4}{11} \) is _____ of \( \frac{5}{11} \)

c) \( \frac{3}{8} \) is _____ of \( \frac{7}{8} \)  

**Bonus:** \( \frac{4}{500,000} \) is _____ of \( \frac{9}{500,000} \)

**Answers:** a) 5/7, b) 4/5, c) 3/7, Bonus: 4/9

**Dividing 1 by a fraction.** Write on the board:

\[
1 \div \frac{2}{7}
\]
From the previous exercises, students should know that $\frac{1}{7}$ is $\frac{1}{2}$ of $\frac{2}{7}$.
Or students could extend the leftover piece to make a whole block of size $\frac{2}{7}$:

Exercises: An extra block was added. What fraction of the last block is the remainder?

a) 

Excess

\[
\begin{array}{cccccccc}
\hline
\frac{1}{8} & \frac{1}{8} & \frac{1}{8} & \frac{1}{8} & \frac{1}{8} & \frac{1}{8} & \frac{1}{8} & \frac{1}{8} \\
\hline
\end{array}
\]

The remainder is $\frac{2}{3}$ of the last block.

b) 

Excess

\[
\begin{array}{cccccccc}
\hline
\frac{1}{5} & \frac{1}{5} & \frac{1}{5} & \frac{1}{5} & \frac{1}{5} \\
\hline
\end{array}
\]

The remainder is $\frac{1}{2}$ of the last block.

c) 

Excess

\[
\begin{array}{cccccccc}
\hline
\frac{1}{9} & \frac{1}{9} & \frac{1}{9} & \frac{1}{9} & \frac{1}{9} & \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\
\hline
\end{array}
\]

The remainder is $\frac{1}{4}$ of the last block.
Demonstrate how to finish the division for part a) above:

\[
1 \div \frac{3}{8} = \frac{2}{3} \quad \text{of another piece of size} \quad \frac{3}{8} \quad \text{fits into 1}
\]

\[
2 \quad \text{whole pieces of size} \quad \frac{3}{8} \quad \text{fit into 1}
\]

Have volunteers demonstrate completing the next two divisions:

b) \(1 \div \frac{2}{5} = 2 \frac{1}{2}\)

c) \(1 \div \frac{4}{9} = 2 \frac{1}{4}\)

**Exercises:** Divide.

a) \[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
7 & 7 & 7 & 7 & 7 & 7 & 7 & 7
\end{array}
\]

\[
1 \div \frac{3}{7} =
\]

b) \[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
8 & 8 & 8 & 8 & 8 & 8 & 8 & 8
\end{array}
\]

\[
1 \div \frac{5}{8} =
\]

c) \[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
9 & 9 & 9 & 9 & 9 & 9 & 9 & 9
\end{array}
\]

\[
1 \div \frac{5}{9} =
\]

**Answers:** a) 2 1/3, b) 1 3/5, c) 1 4/5

**Exercises:** Draw a picture to divide.

a) \(1 \div \frac{2}{9} = \)

b) \(1 \div \frac{4}{9} = \)

c) \(1 \div \frac{3}{8} = \)

**Answers:** a) 4 1/2, b) 2 1/4, c) 2 2/3

**Writing the answer as an improper fraction.** Review converting mixed numbers to improper fractions.

\[
1 \div \frac{2}{7} = 3 \frac{1}{2} = \frac{7}{2} = (3 \times 2) + 1
\]

**Exercises:** Write the answers above as improper fractions.

**Answers:** a) 7/3, b) 8/5, c) 9/5, d) 9/2

**Using a shortcut way to divide 1 by a fraction.** Tell students to look at their answers. **ASK:** How can you change the fraction you are dividing by to get the answer? (swap the numerator and denominator or turn the fraction upside down)
Exercises: Divide by turning the fraction upside down.

a) \( \frac{3}{7} \)  

b) \( \frac{3}{10} \)  

c) \( \frac{5}{8} \)  

d) \( \frac{4}{9} \)

Bonus: \( \frac{33}{501} \)

Answers: a) \( 7/3 \), b) \( 10/3 \), c) \( 8/5 \), d) \( 9/4 \), Bonus: \( 501/33 \)

Have students draw a picture to check the answer to part a). Discuss why it would be difficult to draw a picture to check the bonus problem. (the numbers are too large)

Extensions

1. Divide 1 by a fraction by writing 1 as a fraction with the same denominator. For example,

\[
1 \div \frac{2}{5} = \frac{5}{5} \div \frac{2}{5}
\]

So just like:

5 apples \( \div \) 2 apples in each group = \( \frac{5}{2} \) groups

We also have:

5 fifths \( \div \) 2 fifths in each group = \( \frac{5}{2} \) groups

So you can just divide the numerators:

\[
1 \div \frac{2}{5} = \frac{5}{5} \div \frac{2}{5} = 5 \div 2 = \frac{5}{2}
\]

2. Divide 1 by a fraction by multiplying both terms by the denominator.

\[
1 \div \frac{2}{5} = 5 \div 2 = \frac{5}{2}
\]

(MP.4)

3. A tennis racket increased in price from $100.00 to $110.00. A can of tennis balls increased in price from $4.00 to $4.60. The store sold 8 tennis rackets on Monday and 53 cans of balls. Which item’s price increased by a greater percentage? Which facts did you not need to use?

Answers: The tennis racket increased by $10, and $10 is 10% of $100, so the tennis racket increased by 10%. The can of tennis balls increased by $0.60, and $0.60 is 15% of $4.00, so the can of tennis balls increased by a greater percentage. I did not need to use how many of each item the store sold.
Multiplying fractions with swapped numerator and denominator.

Write on the board:
\[
\frac{3}{5} \times \frac{5}{3}
\]

ASK: How do you multiply fractions? (multiply the numerators and multiply the denominators) ASK: What is \(3 \times 5\)? (15) What is \(5 \times 3\)? (15) Write on the board:
\[
\frac{3}{5} \times \frac{5}{3} = \frac{15}{15} = 1
\]

Remind students that when the numerator and denominator are equal, the fraction is equal to 1. Ask volunteers to explain why that’s true. Then SAY: When you take all the parts in the whole, you get the whole.

Exercises: Multiply.

\[
a) \quad \frac{3}{4} \times \frac{4}{3} \\
b) \quad \frac{2}{7} \times \frac{7}{2} \\
c) \quad \frac{3}{8} \times \frac{8}{3} \\
d) \quad \frac{4}{9} \times \frac{9}{4}
\]

Answers: a) \(12/12 = 1\), b) \(14/14 = 1\), c) \(24/24 = 1\), d) \(36/36 = 1\)

Point out that a fraction multiplied by its upside down version is always going to be 1 because the same numbers you multiply to get the numerator are the numbers you multiply to get the denominator.

Understanding the rule for dividing 1 by a fraction. Write on the board:
\[
2 \times 3 = 6
\]

ASK: What division equations can you write from this? (6 \(\div\) 2 = 3 and 6 \(\div\) 3 = 2)

Exercises: Write two division equations from the multiplication.

\[
a) \quad \frac{3}{4} \times \frac{4}{3} = 1 \\
b) \quad \frac{2}{7} \times \frac{7}{2} = 1 \\
c) \quad \frac{3}{8} \times \frac{8}{3} = 1 \\
d) \quad \frac{4}{9} \times \frac{9}{4} = 1
\]

Answers: a) \(1 \div 3/4 = 4/3\), \(1 \div 4/3 = 3/4\); b) \(1 \div 2/7 = 7/2\), \(1 \div 7/2 = 2/7\); c) \(1 \div 3/8 = 8/3\), \(1 \div 8/3 = 3/8\); d) \(1 \div 4/9 = 9/4\), \(1 \div 9/4 = 4/9\)
Point out that when you divide 1 by a fraction, proper or improper, you always get the fraction turned upside down.

**Exercises:** Divide.

a) \( \frac{3}{5} \)  

b) \( \frac{5}{6} \) 

c) \( \frac{9}{2} \)  

**Bonus:** \( \frac{76}{281} \)

**Answers:** a) 5/3, b) 6/5, c) 2/9, Bonus: 281/76

**Using pictures to understand why the fraction is turned upside down when dividing 1 by the fraction.** Draw on the board:

![Fraction Division Picture]

**ASK:** How does \( \frac{1}{1/5} \) compare to \( \frac{1}{2/5} \)? Emphasize that \(\frac{2}{5}\) is twice as large as \(\frac{1}{5}\), so only half as many will fit. But 5 pieces of size \(\frac{1}{5}\) fit into 1, so 1/2 of 5, or 5/2, pieces of size \(\frac{2}{5}\) fit into 1.

**Dividing any whole number by any fraction.** Remind students that if you know how many of any object fit into 1, then twice as many fit into 2, 3 times as many fit into 3, and so on. Write on the board:

\[
1 \div \frac{3}{5} = \frac{5}{3} \quad \text{so} \quad 4 \div \frac{3}{5} = 4 \times \frac{5}{3}
\]

**SAY:** Four times as many will fit into 4 as will fit into 1. Have a volunteer do the multiplication. (20/3)

**Exercises:** Divide.

a) \( \frac{3}{7} \)  

b) \( \frac{5}{4} \) 

c) \( \frac{3}{7} \)  

**so** \( \frac{5}{7} \)  

**so** \( \frac{5}{4} \) 

d) \( \frac{3}{7} \)  

e) \( \frac{5}{3} \)  

f) \( \frac{4}{5} \)

**Bonus:** \( \frac{7}{200} \)

**Answers:** a) 7/3, 35/3; b) 4/5, 12/5; c) 32/3; d) 27/2; e) 21/5; f) 30/4; Bonus: 6,000/7

**Dividing any fraction by any fraction.** Remind students that if you know how many of any object fit into 1, then 3/4 as many will fit into 3/4. Write on the board:

\[
1 \div \frac{2}{5} = \frac{5}{2} \quad \text{so} \quad \frac{3}{4} \div \frac{2}{5} = \frac{3}{4} \times \frac{5}{2}
\]

**Exercises:** Write the missing fraction.

a) \( \frac{3}{8} \)  

b) \( \frac{4}{3} \)  

c) \( \frac{5}{9} \)  

**Answers:** a) 7/2, b) 6/5, c) 8/3
Ask a volunteer to multiply the fractions in the example above: \( \frac{3}{4} \times \frac{5}{2} \). (15/8)

Remind students that to multiply fractions, they can multiply the numerators to get the numerator and multiply the denominators to get the denominator.

**Exercises**: Divide.

a) \( \frac{3}{5} \div \frac{7}{4} \)  
   b) \( \frac{3}{2} \div \frac{5}{8} \)  
   c) \( \frac{3}{2} \div \frac{4}{9} \)  
   d) \( \frac{6}{7} \div \frac{7}{4} \)

Bonus: \( \frac{33}{100} \div \frac{1,000}{3} \)

**Answers**: a) 12/35, b) 24/10 = 12/5, c) 27/8, d) 24/49, Bonus: 99/100,000

**Exercises**: Check your answers using multiplication.

**Selected solution**: a) 12/35 \( \times \frac{7}{4} \) = 84/140 = 12/20 = 3/5

**Dividing mixed numbers**. Write on the board:

\[
\frac{5}{3} \div \frac{4}{7} \\
1 \frac{2}{3} \div \frac{4}{7}
\]

**Ask**: How are these problems the same? **Prompt**: Do you think they will have the same answer? (yes) Why? (because they are dividing the same numbers) How do you know that they are dividing the same number? (because 5/3 = 1 2/3) Have a volunteer circle the easier one to do. (5/3 \( \div \frac{4}{7} \))

Point out that students have a way to divide improper fractions, so they can use that way to divide mixed numbers—they just have to change the mixed numbers to improper fractions.

**Exercises**: Change the mixed numbers to improper fractions. Then divide the improper fractions.

a) \( 1 \frac{3}{4} \div \frac{2}{5} \)  
   b) \( 2 \frac{1}{5} \div \frac{3}{4} \)  
   c) \( 5 \frac{1}{7} \div \frac{3}{2} \)  
   d) \( 3 \frac{2}{3} \div \frac{1}{9} \)

**Answers**: a) 7/4 \( \div \frac{2}{5} = 35/8 \), b) 11/5 \( \div \frac{3}{4} = 44/15 \), c) 5/7 \( \div \frac{7}{2} = 10/49 \), d) 11/3 \( \div \frac{10}{9} = 99/30 = 33/10 \)

Remind students that when the question asks you to divide mixed numbers, it means the answer should be written as a mixed number as well, unless it is less than 1. Demonstrate the first exercise below for students.

**Exercises**: Use division with remainders to write your answers above as mixed numbers when they are greater than 1.

a) 35 \( \div 8 = 4 R 3 \) so 35/8 = 4 3/8, b) 2 14/15, c) 10/49, d) 1 13/15, e) 3 9/30 or 3 3/10

**Exercises**: Divide the mixed numbers. Write any improper fraction answers as mixed or whole numbers.

a) \( 2 \frac{3}{4} \div \frac{1}{3} \)  
   b) \( 3 \frac{1}{2} \div \frac{1}{3} \)  
   c) \( 3 \frac{1}{3} \div \frac{2}{1} \)  
   d) \( 2 \frac{1}{5} \div 3 \frac{1}{2} \)

**Answers**: a) 1 13/20, b) 2, c) 1 13/27, d) 22/35
**Context problems.** Tell students that containers of food items often tell you the size of an expected serving. For example, a single serving of yogurt might be 2/5 cup. **Ask:** If you have 1 cup of yogurt, how many servings do you have? (5/2) What is that as a mixed number? (2 1/2)

**Exercises:** Solve the problems.

a) How many 3/8 cup servings are in 2/3 cup of yogurt?

b) How many 2/3 cup servings are in 1 1/2 cups of yogurt?

**Answers:** a) \( \frac{2}{3} \div \frac{3}{8} = \frac{16}{9} = 1 \frac{7}{9} \) servings, b) \( \frac{1}{2} \div \frac{2}{3} = \frac{3}{2} \div \frac{2}{3} = \frac{9}{4} = 2 \frac{1}{4} \) servings

**Exercises:** Solve the problems.

a) A rectangle has width 1 3/7 inches and area 3 1/3 square inches. How long is the rectangle?

b) A park with area 2 1/3 square miles is 3 1/2 miles long. How wide is it?

**Answers:** a) \( \frac{10}{3} \div \frac{10}{7} = \frac{70}{30} = 2 \frac{10}{30} \) or 2 1/3 inches long, b) \( \frac{7}{3} \div \frac{7}{2} = \frac{14}{21} \) or 2/3 miles long

For students who struggle with these exercises, you can prompt them with whole number problems: A rectangle has width 3 inches and area 12 square inches. How long is it? What did they do with the 12 and 3 to get 4? Now compare to the actual problem and have students draw the two rectangles:

```
<table>
<thead>
<tr>
<th>3 inches</th>
<th>1 3/7 inches</th>
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<tbody>
<tr>
<td>12 square inches</td>
<td>3 1/3 square inches</td>
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</tbody>
</table>
```

Tell students that it is sometimes easier to replace the fractions with whole numbers and reread the problems. That will help them know what to do with the numbers in the problem.

**Extensions**

1. Divide a fraction by a fraction by writing both fractions with the same denominator. For example:

\[
\frac{3}{4} \div \frac{2}{5} = \frac{15}{20} \div \frac{8}{20} = 15 \div 8 = \frac{15}{8}
\]  (multiply both fractions by 20)

\[
= \frac{15}{8}
\]
2. a) Divide. Then describe a rule for dividing unit fractions by unit fractions.

i) \( \frac{1}{8} \div \frac{1}{4} \)

ii) \( \frac{1}{3} \div \frac{1}{12} \)

iii) \( \frac{1}{7} \div \frac{1}{3} \)

Answers: i) 4/8 or 1/2, ii) 12/3 or 4, iii) 3/7; Rule: Divide the second denominator by the first denominator.

b) Divide. Then describe a rule for dividing fractions with the same numerator.

i) \( \frac{1}{5} \div \frac{1}{15} \)

ii) \( \frac{2}{5} \div \frac{2}{15} \)

iii) \( \frac{3}{5} \div \frac{3}{15} \)

iv) \( \frac{4}{5} \div \frac{4}{15} \)

Answers: i) 3, ii) 3, iii) 3, iv) 3; Rule: Same as part a): Divide the second denominator by the first denominator.

c) Divide \( \frac{3}{4} \div \frac{2}{5} \) by using a common numerator for the fractions.

Solution: \( \frac{3}{4} \div \frac{2}{5} = \frac{6}{8} \div \frac{6}{15} = \frac{15}{8} \)

3. Computer codes are written as sequences of 0s and 1s. Investigate how many sequences of each length there are.

a) Write a rule for finding the number of sequences of length \( n \).

b) In pairs, explain why your rule in part a) works. Do you agree with each other? Discuss why or why not.

Sample solutions: a) I tried writing all the sequences of lengths 1, 2, and 3 to look for a pattern:

- 2 sequences of length 1: 0, 1
- 4 sequences of length 2: 00, 01, 10, 11
- 8 sequences of length 3: 000, 001, 010, 011, 100, 101, 110, 111

The number of sequences of length \( n \) is \( 2^n \).

b) The sequences of length 2 are the sequences of length 1 with either an extra 0 or an extra 1, so there are 2 times as many sequences of length 2 as length 1. Similarly, the sequences of length 3 are the sequences of length 2 with either an extra 0 or an extra 1, so there are 2 times as many sequences of length 3 as length 2. This pattern continues: there are always 2 times as many sequences of the next length. So the number of sequences are:

- Number of sequences of length 1: \( 2 = 2^1 \)
- Number of sequences of length 2: \( 2 \times 2 = 2^2 \)
- Number of sequences of length 3: \( 2 \times 2 \times 2 = 2^3 \)
- Number of sequences of length \( n \): \( 2^n \)
Fraction Parts and Wholes (1)
### Fraction Parts and Wholes (2)

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## Fraction Parts and Wholes (3)

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## Fraction Parts and Wholes (4)

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## Fraction Parts and Wholes (5)

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### Instructions
- Fill in the boxes with the correct fractions.
- Check your answers with a partner or use the answer key provided.