BRIDGES IN MATHEMATICS 5

GRADE 5 SUPPLEMENT

Set A9 Number & Operations: Multiplying Fractions

Includes

Skills & Concepts

★ Add fractions with unlike denominators
★ Find the perimeter of regions with an area smaller than one
★ Estimate the results of operations performed on fractions and use the estimate to determine the reasonableness of the final answer
★ Find the product of two unit fractions with small denominators using an area model
★ Multiply fractions using the standard algorithm
★ Explain the relationship of the product relative to the factors when multiplying fractions
★ Add mixed numbers with unlike denominators
★ Subtract mixed numbers with unlike denominators
★ Multiply a whole number by a fraction
★ Interpret multiplication as scaling (resizing)
★ Solve word problems involving multiplying fractions and mixed numbers using visual fraction models and equations

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Bridges in Mathematics Grade 5 Supplement
Set A9 Number & Operations: Multiplying Fractions

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Bridges in Mathematics is a standards-based K–5 curriculum that provides a unique blend of concept development and skills practice in the context of problem solving. It incorporates the Number Corner, a collection of daily skill-building activities for students.

The Math Learning Center is a nonprofit organization serving the education community. Our mission is to inspire and enable individuals to discover and develop their mathematical confidence and ability. We offer innovative and standards-based professional development, curriculum, materials, and resources to support learning and teaching. To find out more, visit us at www.mathlearningcenter.org.

ACTIVITY

Geoboard Perimeters

Overview
In preparation for using the area model to multiply one fraction by another, students investigate the perimeter of the largest square that can be formed on the geoboard, as well as the perimeters of smaller regions on the geoboard.

Skills & Concepts
★ add fractions with unlike denominators

★ find the perimeter of regions with an area smaller than 1

You'll need
★ Rectangle Review (page A9.6, run 1 for display)

★ Geoboard Perimeters (page A9.7, run 1 for display)

★ More Geoboard Perimeters (page A9.8, run a double-sided class set, plus a few extra)

★ geoboard and geobands (class set plus 1 for display)

★ pens

★ 2–3 blank transparencies

★ a piece of paper to mask portions of the display

★ $5\frac{3}{4}'' \times \frac{1}{4}''$ strips of red construction paper (10–12 per student)

★ tile and red linear units available as needed

★ pencils and scissors

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Geoboard Perimeters
1. Open the activity by explaining to the class that you are going to start a series of lessons on multiplying fractions. To get started, you are going to review the area model for multiplication. Then display the Rectangle Review master. Review the information together, and ask students to pair-share responses to the questions:

- What is the area of the rectangle on the display?
- What information do you need in order to determine the area of the rectangle?

2. Have a few volunteers share their thinking with the class. As the discussion proceeds, guide students to review the connection between perimeter, area, and multiplication.

> ***Students*** *We think it's about 28 square inches.*
> *We said it could be maybe be about 150 square centimeters.*
> *We can't tell, because we don't know how long the sides are.*
> *We don't even know if they're in inches or centimeters.*
>
> ***Teacher*** *Why do you need to know the side lengths to find the area of the rectangle?*
>
> ***Students*** *Because you get area by multiplying length times width.*
> *You need to know how many squares will fit into the rectangle. Like, if we know that 7 squares fit*

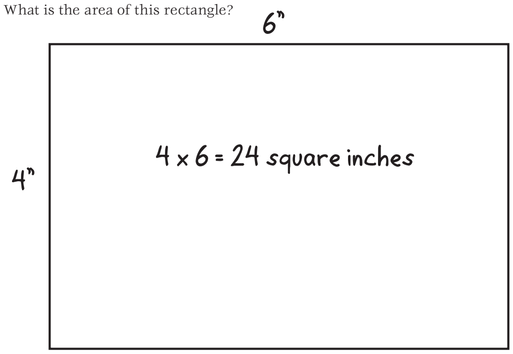
across the top, and 4 squares fit along the side, we would know the area is 4 times 7, and that's 28. But it depends on the size of the squares. If they're little, like square centimeters, the area could be more than 100.

3. After some discussion, have a volunteer come up to the display and measure the side lengths of the rectangle in inches. Then work with input from the class to label the rectangle and summarize students' comments on the display.

Set A9 Number & Operations: Mu tip ying Fractions Blackline Run one copy for disp ay

Rectangle Review

What is the area of this rectangle?



What information do ytou need beofre you can answer the question?

- units (inches, centimeters, or ?)
- side lengths
- then multiply the side lengths to get the area

How are perimeter, are and multiplication related?

- You have to multiply to find area.
- You have to know the lengths of the sides to find the area.
- If you know the side lengths, you can find the perimeter.
- If you know the area of a rectangle and the length of one side, you can find the length of the other side by dividing.
- A rectangle gives you a way to make a picture of multiplication.

4. Next, display the top portion of the Geoboard Perimeters master as helpers give students each a geoboard and some geobands. Read the information on the display together and ask students to replicate the square on their own geoboard. If the area of that square is 1 unit, what is the length of each side, and what is the perimeter of the square? Give students a minute to pair-share ideas, and then call for and record their answers.

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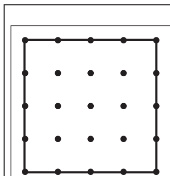
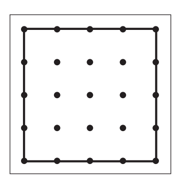
Geoboard Perimeters



Area = 1 Square Unit

Jason says that the perimeter of this square is 4 linear units. Do you agree with him? Why or why not?



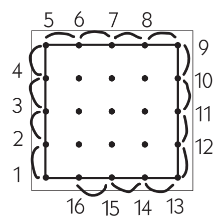
Teacher *Now that you've had a minute to think about the question, let's record your answers here on the whiteboard. What did you decide?*

> ***Students*** *We don't agree with Jason. We think the perimeter of that square is 16.*
> *That's what we got too.*
> *We agree with Jason. We think the perimeter is 4.*

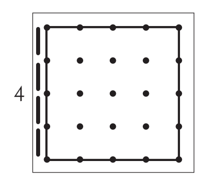
5. After you have recorded students' answers, invite individuals or student pairs to the display to demonstrate their thinking. Set a blank acetate on top of your master and then re-position it as needed, so that several different students can mark on it to show how they determined the perimeter of the square in question.

> ***Teacher*** *Any different ideas? No? Who'd like to convince us of their reasoning? You can mark on the display to show what you did to get your answer.*

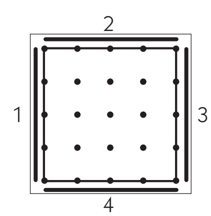
> ***Jon*** *We said it was 16 instead of 4. We started in the corner of the board and just counted the pegs all the way around. It came out to 16.*



> ***Ariel*** *We did kind of the same thing as Jon and Omid, but we looked at the spaces instead of the pegs. It looked like each side of the square was 4, and we know that 4 × 4 is 16, so we said the perimeter of the square is 16.*



> ***Gabe*** *We think the perimeter is 4. We said if the area of the whole square is 1, then each side must be 1. So that means the perimeter of the square is 4, like this: 1, 2, 3, 4.*

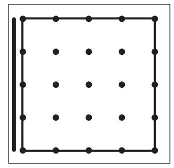


> ***Jasmine*** *We agree with Gabe and Raven. See, if each of the little squares was worth 1, then the perimeter would be 16, but the big square is worth 1, so each of the sides must be 1.*

6. When students have had adequate time to discuss and debate the perimeter of the largest square, build the square on your own geoboard at the display and show one of the strips of red construction paper you have cut, first holding it up for all to see, and then setting it into the space between the edge and the pegs of the board. Then invite students' comments.

> ***Teacher*** *I cut some strips for us to use in considering the perimeter of this square. What do you think?*

Activity 1 Geoboard Perimeters (cont.)



Students *Those are like the little red pieces we use with the tiles sometimes.*
It's like a giant red piece.
But those little red pieces are worth 1, so this one must be worth 4.

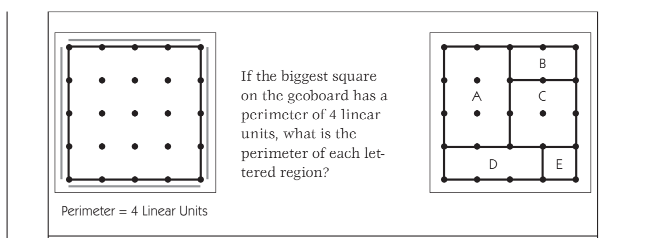
Teacher *How are you thinking about that?*

Kamil *Well, it goes along 4 spaces on the geoboard, so it must be worth 4.*

Hanako *But that's what we were trying to tell you before. That square has an area of 1. It's like 1 giant tile, and that strip is like 1 giant red piece.*

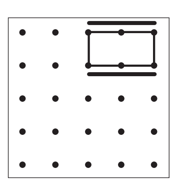
7. Confirm the fact that the red strips you have cut are each worth 1 linear unit. That being the case, what is the perimeter of the largest square on the geoboard? (4 linear units)

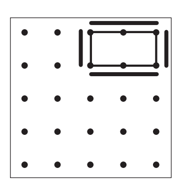
8. Now display the middle portion of the master, which establishes that the perimeter of the largest square is 4 linear units and asks students to determine the perimeter of several different regions on the geoboard.



9. Work with the class to determine the perimeter of Region B. Ask students to remove the large square from their board and build just Region B, as you place a handful of red construction paper strips at each table or cluster of desks. Give students a few minutes to experiment with their strips as they consider the perimeter of this region. Let them know that it is fine to fold and cut the strips if that helps them think about the length of each side of Region B. Then invite 2 or 3 individuals or pairs to the display to share their thinking. Ask them to work with a board and strips so their classmates can see what they are talking about as they explain.

Theo *We were pretty stuck at first, but we kept looking at the strips and the rectangle on our board. Then we realized that if you fold one of the strips in half, it fits along the top of the rectangle. Then we knew that the 2 long sides were each worth* $^1/_2$.

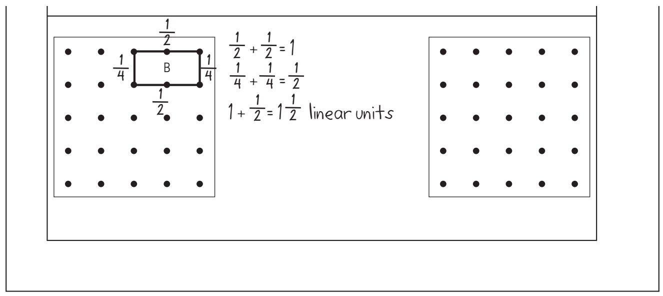




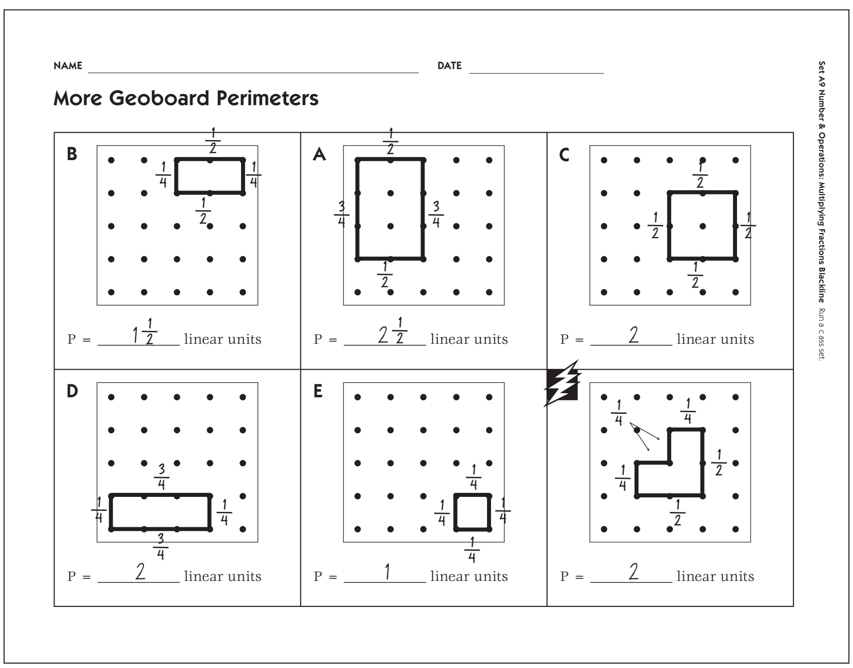
Ichiro *We found out that the small sides are each worth* $^1/_4$ *of a linear unit. If you fold one of those strips in half and then in half again, you get fourths. If you cut them up, they fit right along the short sides of the rectangle, like this.*

> ***Kendra*** *We did the same thing, and then we added them up because that's what you do when you're figuring out the perimeter. We got that it was 1 ½, and that seems kind of weird. Can you have a perimeter with a fraction in it?*

10. As students share their thinking, use the lower portion of the master to label and record the dimensions of Region B. When it has been established that the long sides are each ½ of a linear unit, and the short sides are ¼ of a linear unit, work with student input to add the fractions to determine the total perimeter. They will find, in fact, that the perimeters of some, though not all, of the regions are mixed numbers.



11. Now give students each a copy of More Geoboard Perimeters (shown below with the answers and sample responses filled in for your reference). Ask students to sketch Region B, label the length of each side, and record one or more number sentences to show the computations necessary to find the total. Then have them find the area of each of the other regions shown on the master: A, C, D, and E.



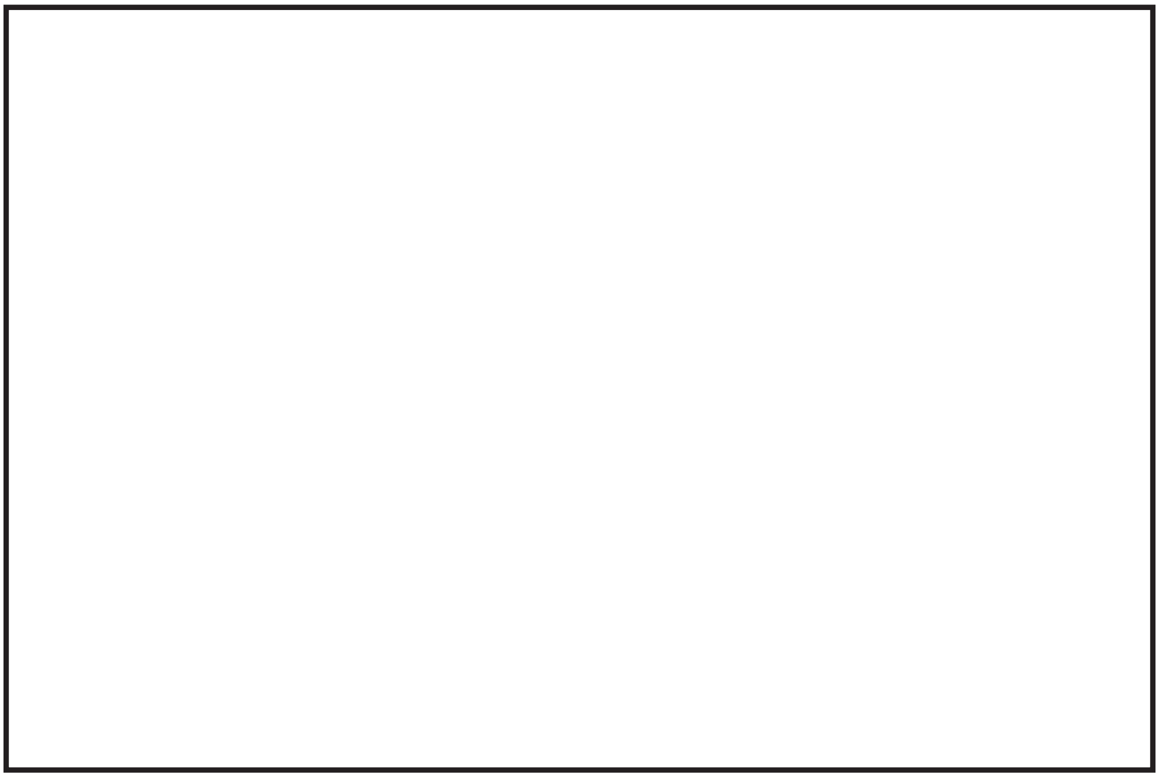
Extension

Students who determine and record the perimeters of all 5 regions quickly and easily can be asked to build at least two figures (other than any of the regions they've already investigated) that have a perimeter of 2 linear units, two that have a perimeter of 2½ linear units, two with P = 3 linear units, and two with P = 3 ½ linear units. Each discovery should be recorded the same way the first 5 regions have been, using the last box on the record sheet, as well as the back of the sheet and a second sheet if necessary.

NAME ______________________ **DATE** ______________

Rectangle Review

What is the area of this rectangle?

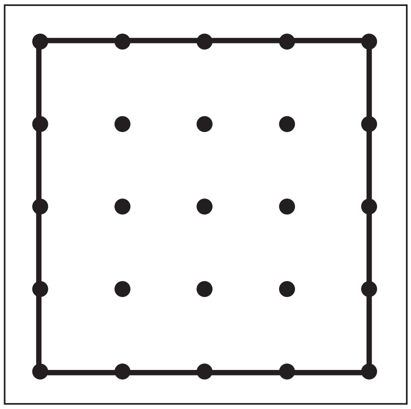


What information do you need before you can answer the question?

How are perimeter, area and multiplication related?

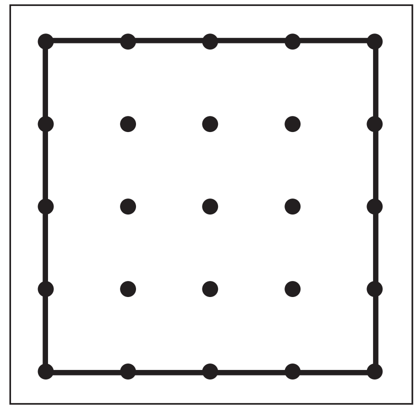
NAME ______________________ **DATE** ______________

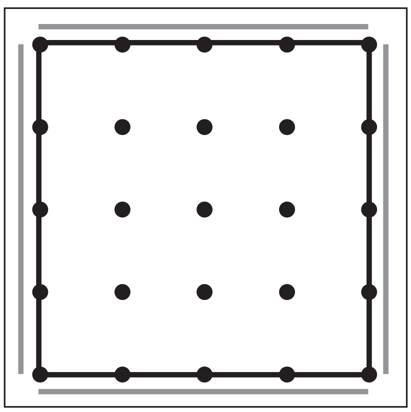
Geoboard Perimeters



Area = 1 Square Unit

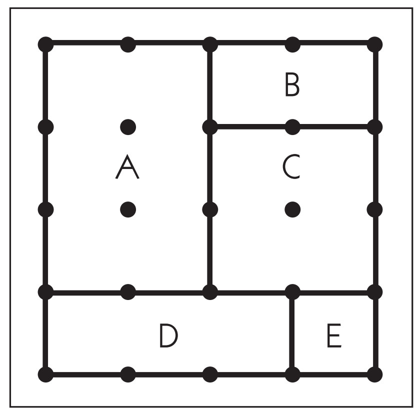
Jason says that the perimeter of this square is 4 linear units. Do you agree with him? Why or why not?

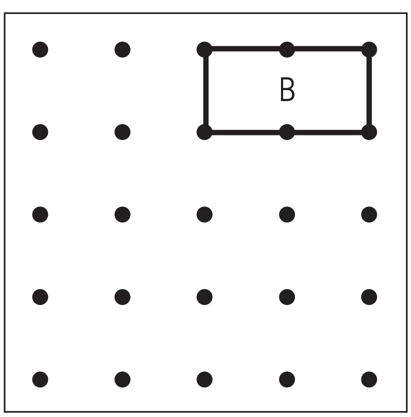


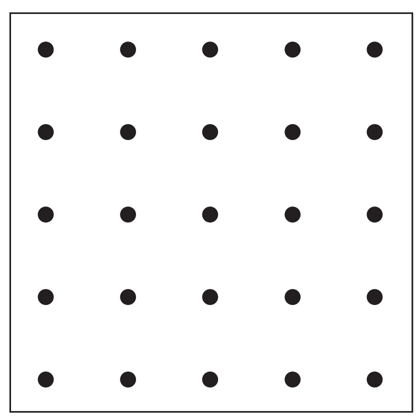


Perimeter = 4 Linear Units

If the biggest square on the geoboard has a perimeter of 4 linear units, what is the perimeter of each lettered region?



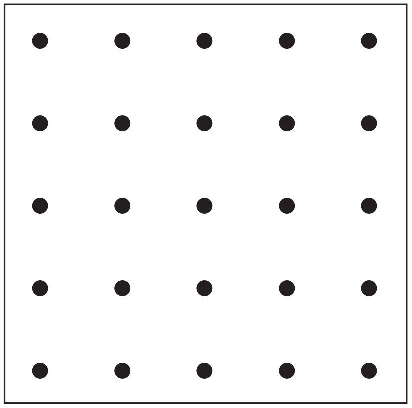




NAME ____________________ DATE ____________

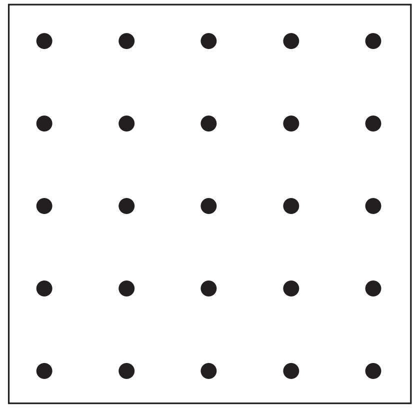
More Geoboard Perimeters

B



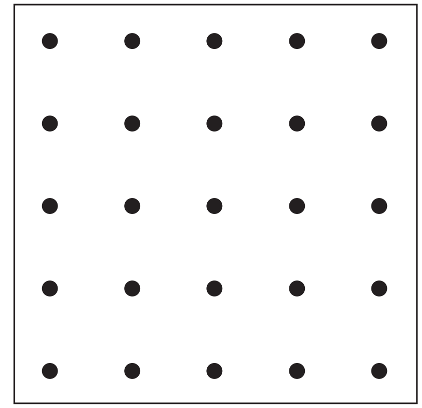
P = ________ linear units

A



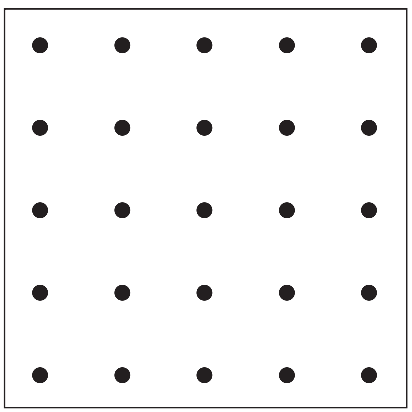
P = ________ linear units

C



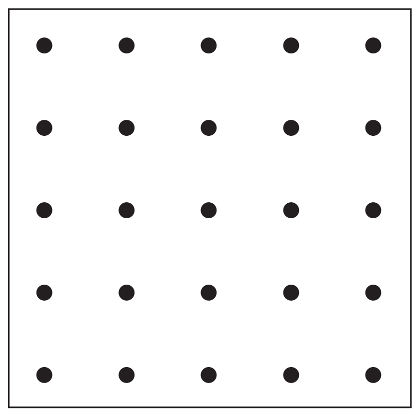
P = ________ linear units

D

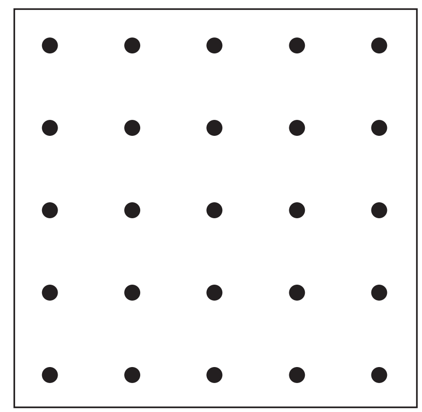


P = ________ linear units

E



P = ________ linear units



P = ________ linear units

Set A9 ★ Activity 2

ACTIVITY

Fraction Multiplication Story Problems

Overview

During this session, students solve several different story problems designed to help them think sensibly about multiplying one fraction by another. Although the expression $\frac{1}{4} \times \frac{1}{2}$ may not carry much meaning for most fifth graders, many students can consider the idea of "a fourth of a half", especially in the context of a story problem supported by visual models. Today's sense-making activities lay the groundwork for using the area model to picture and solve fraction multiplication combinations in the next activity.

Skills & Concepts

- ★ find the product of two unit fractions with small denominators using an area model
- ★ estimate the results of operations performed on fractions and use the estimate to determine the reasonableness of the final answer
- ★ explain the relationship of the product relative to the factors when multiplying fractions

You'll need

- ★ The Brownie Problem (page A9.14, run 1 copy for display)
- ★ Fraction Multiplication Story Problems (page A9.15, run 1 copy for display)
- ★ Student Math Journals or Journal Page Grid (page A9.16, opitonal, run copies as needed.)
- ★ pens
- ★ 2–3 blank transparencies
- ★ piece of paper to mask portions of the display
- ★ geoboards and geobands (class set, plus 1 for display)
- ★ regular and colored pencils

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Fraction Multiplication Story Problems

1. Open today's activity by placing the top portion of The Brownie Problem on display as students gather the materials they'll need: geoboards and bands, journals and pencils.

Set A9 Number & Operations: Mu t p ying Fractions Blackline Run one copy for disp ay

The Brownie Problem

When Maribel got home from school yesterday, she went into the kitchen to get a snack. There was $\frac{1}{2}$ of a pan of brownies on the counter. Maribel ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Maribel eat?

- Record an estimate in your journal and then write a sentence or two to explain it. What part of the pan of brownies do you think Maribel ate? Why?
- Build the situation on your geoboard and record the answer next to your estimate. (Pretend that the whole board is 1 whole pan of brownies.)

2. Read the problem at the top of the display master together, along with the instructions. Then ask students to think privately about the situation, and record an estimate in their journal, along with an explanation. Encourage students who seem puzzled or confused to think in terms of familiar benchmarks. Did Maribel eat more or less than half a pan? Did she eat more or less than a quarter of the pan? Why?

3. After they have had a few minutes to write, ask students to pair-share their estimates and explanations and then work in pairs to build the situation on a geoboard. Students will have different ideas

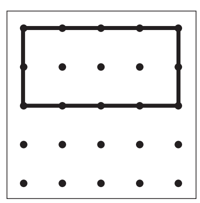
Activity 2 Fraction Multiplication Story Problems (cont.)

about how to do this, and you may see some misconceptions as you circulate, but give them a few minutes to wrestle with the problem and record answers in their journals.

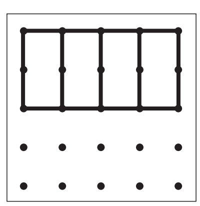
Ask students who finish before their classmates to determine what part of a pan of brownies Maribel would have eaten if there had been three-fourths of a pan left instead of half ($^1/_4$ of $^3/_4$ is $^3/_{16}$).

4. When most students have either arrived at an answer or done as much as they can with the problem, record all solutions on the whiteboard and then invite 2–3 individuals or pairs to the display to share their thinking. Have them bring their geoboards with them so their classmates can see how they built the situation and found their way to an answer.

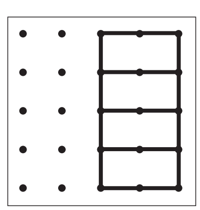
> ***Teacher*** *Now that you've had a little while to investigate this problem, let's share our answers and then have a few volunteers show us how they modeled the situation on their geoboards. What part of the pan of brownies did Maribel eat?*
>
> ***Students*** *We said she ate* $^1/_4$ *of the pan.*
> *We got* $^1/_8$ *of the pan.*
> *We got* $^2/_{16}$.
>
> ***Teacher*** *Who'd like to share their strategy for building this problem on the geoboard?*
>
> ***Rian*** *We said if the geoboard is the whole pan of brownies, we only need half because that's all that was left. So we made a rectangle on half the board, like this.*



> ***Beth*** *Then we had to find a fourth of that because the problem said she ate a fourth of what was left. So we divided the half into 4 parts, like this. Then we had to think about how big one of those little parts was. We could see that each of the little pieces took up 2 squares, and we know that each square is* $^1/_{16}$*, so we said that she ate* $^2/_{16}$.



> ***Darius*** *We built ours the other way, like this. We could see that there would be 8 parts like that if you filled the whole pan, so one of them is* $^1/_8$ *of the pan.*

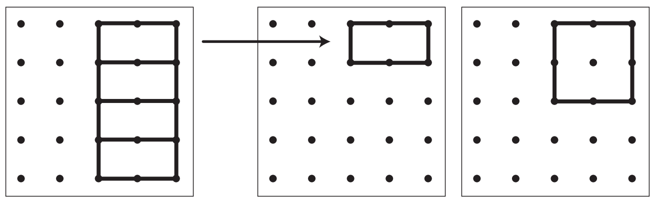


Teacher *Beth and Rian say the answer is $^2/_{16}$. Darius and Javier say it's $^1/_8$. Is there any connection between the two?*

Students *Sure! They're the same thing.*
It's 2 different names for the same fraction.
But I don't get it. The story says Maribel ate $^1/_4$ of what was left. And each one of those pieces is a fourth, so why are you saying that she ate $^1/_8$ or $^2/_{16}$? We thought the answer was $^1/_4$.

Teacher *Can anyone respond to Josie's question?*

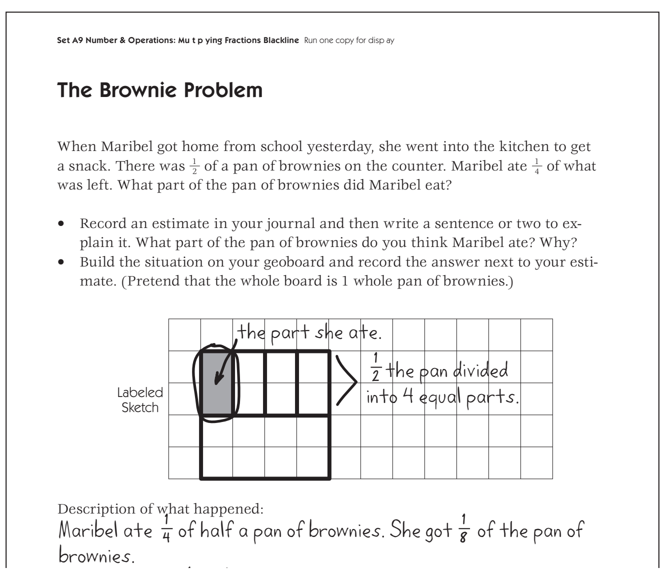
Morgan *Well, you're right. But each of those pieces on the geoboard up there is a fourth of a half a pan, not a fourth of a whole pan. It is okay if I move your geobands, Darius?*



See, if you look at just the piece she ate, it's $^1/_8$ of the board, like Region B, remember? I brought my board up too, and that shows a fourth of the board so you can see the difference. Maribel only got a fourth of what was left, not a fourth of the whole pan.

Josie *I think I see, but this is kind of confusing.*

5. After several students have shared their strategies and there is general consensus that the answer is $^1/_8$, work with student input to create a sketch of the situation on the grid in the middle section of the display master, along with a written description of what happened.


Set A9 Number & Operations: Multiplying Fractions Blackline Run one copy for display

The Brownie Problem

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- Record an estimate in your journal and then write a sentence or two to explain it. What part of the pan of brownies do you think Maribel ate? Why?
- Build the situation on your geoboard and record the answer next to your estimate. (Pretend that the whole board is 1 whole pan of brownies.)

Description of what happened:
Maribel ate $\frac{1}{4}$ of half a pan of brownies. She got $\frac{1}{8}$ of the pan of brownies.

6. Then explain that the expression a mathematician would use to represent the situation is $^1/_4 \times {}^1/_2$, which is read as, "*one fourth of one half*". Record the full equation below the grid at the display. (The expression $^1/_4 \times {}^1/_2$ can also be read as, "one fourth *times* one half", but we find that if we encourage our students to read it the other way, it taps into their sense-making abilities much more effectively.)

Activity 2 Fraction Multiplication Story Problems (cont.)

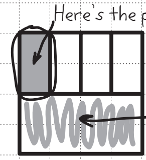
7. Ask students to make a sketch similar to the one on the overhead in their journal, shading in with a colored pencil the part of the pan of brownies that Maribel ate. Then ask them to write a description of what happened, adding any other observations they have, and an equation to match.

Set A9 Number & Operations: Multiplying Fract ons Blackl ne Optional Run cop es as needed

Journal Page Grid

Estimate: About $\frac{1}{4}$. There was only half a pan left, so she must have less than half.

Here's the part she ate. It's $\frac{}{8}$ or $\frac{2}{16}$.



Half of the pan was already gone.

Maribel ate $\frac{1}{4}$ of $\frac{1}{2}$ a pan of brownies. She ate $\frac{1}{8}$ of the pan. There's still $\frac{3}{8}$ of a pan left, so she can have some later.

$\frac{1}{4} \times \frac{1}{2} = \frac{1}{8}$

8. Next, display the Fraction Multiplication Story Problems master. Review the instructions at the top with the class.

Set A9 Number & Operations: Multiplying Fractions Blackline Run one copy for display

Fraction Multiplication Story Problems

Here are 5 more fraction multiplication story problems. For each one that you and your partner solve, do the following:

- Write the problem number in your journal.
- Record an estimate. What do you think the answer will be and why?
- Build the situation on your geoboard and then make a labeled sketch of it in your journal.
- Write a description of what happened that includes the answer.
- Write a multiplication equation to match.

1 When Max got home from school yesterday, he went into the kitchen to get a snack. There was $\frac{3}{4}$ of a pan of brownies on the counter. Max ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Mark eat?

9. There are several ways you might handle the remainder of the activity, depending on the strengths and needs of your class.

- Do one of the five problems as a group. You can re-use the middle portion of the Brownie Problem display master to record a sketch, written description, and equation to match the situation. After completing one of the problems, have students work in pairs to do the rest, each individual responsible for completing all the steps in his or her journal.
- Allow those students who feel ready to work independently to do so, while you work with the others, going through as many of the problems as time allows.
- Work through as many of the problems at the display as time allows with the entire class.

Whether you choose to have student pairs work independently on some or all of these problems or keep the entire class together, ask students to follow each of the steps outlined on the display master. Writing a description of what happened, including the answer, and an equation to match may be the most challenging part for some of your students. However, if they come away from today's experiences understanding that $\frac{1}{4} \times \frac{1}{2}$ means *half of a fourth*, able to picture such a situation and think about it sensibly, they'll be well on their way to developing the insights they need to understand multiplication of fractions.

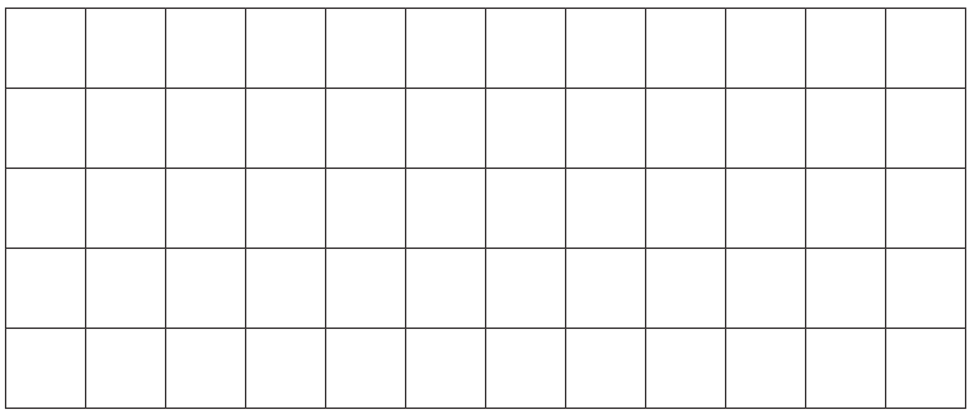
The Brownie Problem

When Maribel got home from school yesterday, she went into the kitchen to get a snack. There was $\frac{1}{2}$ of a pan of brownies on the counter. Maribel ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Maribel eat?

1 Record an estimate in your journal and then write a sentence or two to explain it. What part of the pan of brownies do you think Maribel ate? Why?

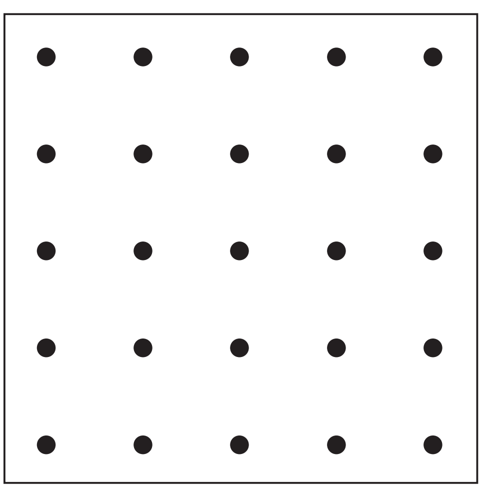
2 Build the situation on your geoboard and record the answer next to your estimate. (Pretend that the whole board is 1 whole pan of brownies.)

Labeled Sketch



Description of what happened:

Equation: ____________________________



Fraction Multiplication Story Problems

Here are 5 more fraction multiplication story problems. For each one that you and your partner solve, do the following:

- Write the *problem number* in your journal.
- Record an *estimate*. What do you think the answer will be and why?
- *Build* the situation on your geoboard and then make a *labeled sketch* of it in your journal.
- Write a *description* of what happened that includes the *answer.*
- Write a multiplication *equation* to match.

1 When Max got home from school yesterday, he went into the kitchen to get a snack. There was $\frac{3}{4}$ of a pan of brownies on the counter. Max ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Mark eat?

2 Brittany's mom had a big garden last summer. She planted corn and tomatoes in $\frac{1}{2}$ of the garden. She planted lettuce in $\frac{1}{4}$ of the garden. She used $\frac{1}{2}$ of the last $\frac{1}{4}$ of the garden for flowers. How much of the garden did she use for flowers?

3 Dontrelle was getting a new rug for his bedroom. His dad said that the rug would cover $\frac{3}{4}$ of half the floor. How much of the floor did the rug cover?

4 Maria had $\frac{7}{8}$ of a box of candy left from her birthday. She gave half of what she had left to her little sister. How much of the box of candy did her little sister get?

5 Marco had $\frac{3}{8}$ of a pizza left from dinner the night before. He gave half of what he had left to his friend. How much of a pizza did his friend get?

NAME ______________________ **DATE** ______________

Journal Page Grid

Set A9 ★ Activity 3

ACTIVITY

Using the Area Model for Multiplying Fractions

Overview

Students use the area model to multiply fractions, as they build rectangles on their geoboards with fractional dimensions and find the areas. Then students write their own story problems to accompany one or more of the fraction multiplication combinations with which they have worked today.

Skills & Concepts

★ find the product of two unit fractions with small denominators using an area model

★ estimate the results of operations performed on fractions and use the estimate to determine the reasonableness of the final answer

★ explain the relationship of the product relative to the factors when multiplying fractions

You'll need

★ The Brownie Problem from Activity 2 (page A9.19 run 1 copy for display, see Advance Preparation)

★ Student Math Journals and/or Journal Page Grid (page A9.22, run 1 copy for display and additional copies as needed)

★ geoboard and geobands for display

★ pens in several colors, including red

★ a piece of paper to mask portions of the display

★ $5\frac{3}{4}'' \times \frac{1}{4}''$ strips of red construction paper (available to students as needed)

★ regular and colored pencils (each student will need red and one other color)

Advance Preparation To start this session, you'll need to have The Brownie Problem display master from Activity 2 filled in with the solution to the original problem. If you used this display master to model responses to some of the other story problems during the previous activity, erase the work and enter a sketch, written description, and number sentence for the original problem.

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Using the Area Model for Multiplying Fractions

1. Open today's session by placing a small pile of the $5\ ^3/_4"$ × $^1/_4"$ red construction paper strips on each table or cluster of desks so students will have easy access to them. Then show the top portion of The Brownie Problem display master from Activity 2 as students get out their journals, geoboards, and geobands.

Set A9 Number & Operations: Mu t p ying Fractions Blackline Run one copy for disp ay

The Brownie Problem

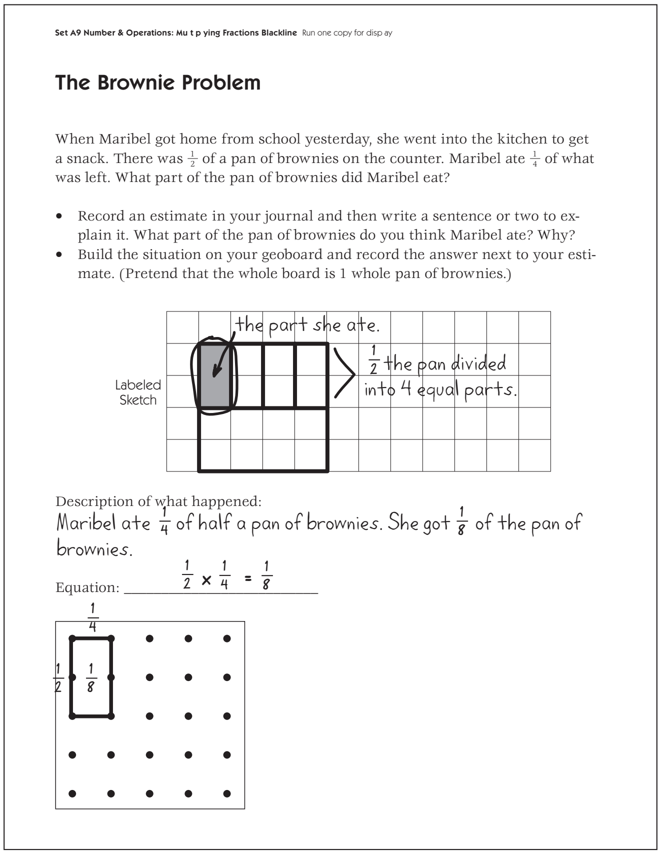
When Maribel got home from school yesterday, she went into the kitchen to get a snack. There was $\frac{1}{2}$ of a pan of brownies on the counter. Maribel ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Maribel eat?

2. Read the problem with the class and ask students to pair-share the responses they recorded in their journals during the previous activity. Then ask each student to build on his or her geoboard just the part

Activity 3 Using the Area Model for Multiplying Fractions (cont.)

of the pan of brownies Maribel got to eat. What are the dimensions and the area of this rectangle? Give students a minute to pair share, using some of the red construction paper strips to help figure it out if they need to.

3. Then show the entire display master and invite a student volunteer to the display to sketch the rectangle on the geoboard at the bottom of the sheet, labeling the dimensions and area with input from classmates.


Set A9 Number & Operations: Mu t p ying Fractions Blackline Run one copy for disp ay

The Brownie Problem

When Maribel got home from school yesterday, she went into the kitchen to get a snack. There was $\frac{1}{2}$ of a pan of brownies on the counter. Maribel ate $\frac{1}{4}$ of what was left. What part of the pan of brownies did Maribel eat?

- Record an estimate in your journal and then write a sentence or two to explain it. What part of the pan of brownies do you think Maribel ate? Why?
- Build the situation on your geoboard and record the answer next to your estimate. (Pretend that the whole board is 1 whole pan of brownies.)

Description of what happened:
Maribel ate $\frac{1}{4}$ of half a pan of brownies. She got $\frac{1}{8}$ of the pan of brownies.

Equation: $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$

4. Now record the following expression on the display, as students do so in their journals.
- $1/2 \times 1/2$

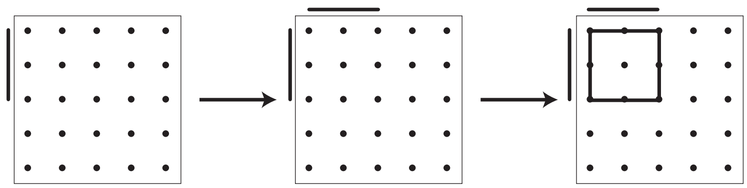
Ask students to read the expression, using the same language they did during the previous activity: “One half of one half” or “Half of a half”. Give them a minute to record an estimate, with the understanding that they may be called upon to explain their thinking. Then call on a student or two to share and explain their estimates.

> ***Jasmine*** *I know it’s going to be less than a half, because it’s only half of a half, so it can’t be the whole thing.*

> ***Javier*** *I said it was going to be $1/4$, because if you cut $1/2$ in half, you get $1/4$.*

5. Next, ask students to build a square with dimensions $1/2 \times 1/2$ on their geoboards, working together to share and compare ideas. If they are not sure how to build the figure, encourage them to use the red construction paper linear strips, remembering that each strip has been assigned a value of 1 linear unit.

> ***Darius*** *Okay, half of a half. I know it's going to be a fourth, but I'm not sure how to show it on the geoboard. How do you make something that's a half by a half?*
>
> ***Armin*** *We can use those red strips, remember? They're like giant linear units, so we can fold one in half and put it next to the geoboard to help.*

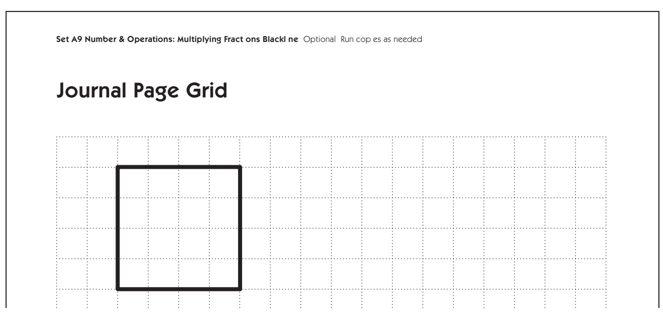


Here's a half strip, right? — Then the other side of the square is also a half. — So now we can make the square with a rubber band.

> ***Darius*** *Oh yeah—it's all coming back to me. And look! A square that's half by a half really does turn out to be one-fourth of the board.*
>
> ***Kamela*** *That's because half of a half is a fourth, just like we thought it would be.*

6. When most have completed this task, ask a volunteer to build the figure at the display, explaining her thinking as she does so. Then work with student input to make a sketch of the problem on the Journal Page Grid display master.

> ***Teacher*** *How can we make a sketch of this problem on the kind of grid paper you have in your journals?*
>
> ***Justin*** *First you need to outline a geoboard, like a 4 × 4 square.*

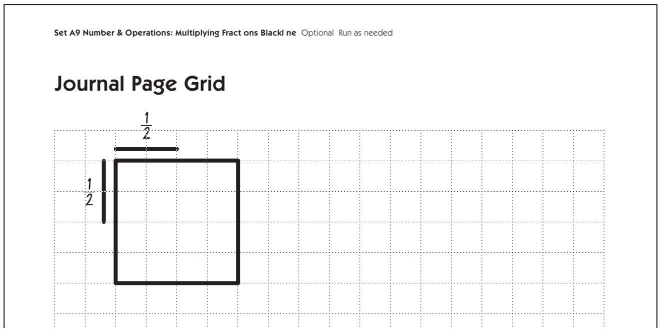


Set A9 Number & Operations: Multiplying Fract ons Blackl ne Optional Run cop es as needed

Journal Page Grid

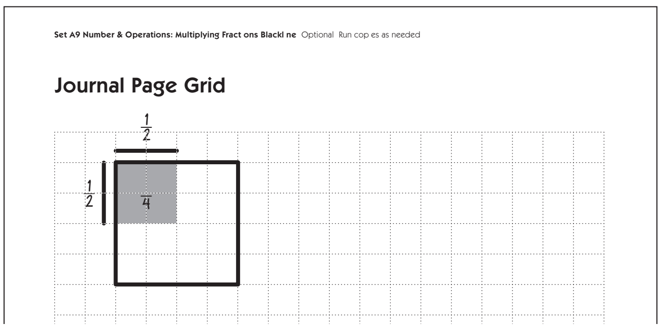
> ***Teacher*** *And then?*
>
> ***Raven*** *Then you need to draw in the dimensions—how long each side of the square is going to be.*
>
> ***Teacher*** *Raven, why don't you come up and do that for us. Go ahead and use the red pen to show the dimensions. That way they'll match the color of our linear strips.*

Activity 3 Using the Area Model for Multiplying Fractions (cont.)



Teacher *Thanks, Raven. What should we do now, class?*

Jade *Now just draw in the rectangle and put a label that shows its area, like this. Let's color it in so it shows up better.*



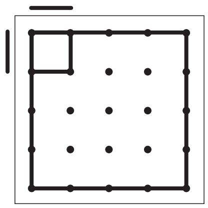
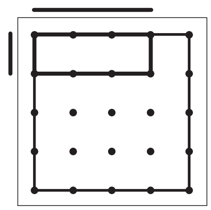
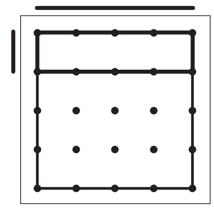
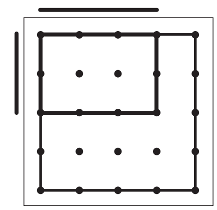
7. Once a sketch of the combination and the solution has been created at the display, have students replicate the sketch in their journal, using red colored pencil to show the dimensions and a second color to shade in the square that results.

8. Repeat steps 4–7 with the following combinations:

- $\frac{1}{4} \times \frac{1}{4}$
- $\frac{1}{4} \times \frac{3}{4}$
- $\frac{1}{4} \times 1$
- $\frac{1}{2} \times \frac{3}{4}$

In each case, have students complete the following steps:

- Read the expression after you've written it on the board, using the word *of* instead of *times*, i.e., "*one fourth of one fourth*" or "*one fourth of three fourths*."
- Record the expression in their journal along with an estimate of the answer.
- Build the combination on their geoboard, working with the students nearest them to share and compare ideas and results. Invite at least one volunteer to the display to share his thinking, using his own board. If there is confusion or debate, you may want to have several students share their thinking with the class. Be sure to bring misconceptions into the open so everyone benefits.
- Record both a sketch and the answer in their journal.

$\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$	$\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$	$\frac{1}{4} \times 1 = \frac{4}{16} = \frac{1}{4}$	$\frac{1}{2} \times \frac{3}{4} = \frac{6}{16} = \frac{3}{8}$
			
Area = $\frac{1}{16}$	Area = $\frac{3}{16}$	Area = $\frac{1}{4}$	Area = $\frac{3}{8}$

9. Conclude the activity by asking students to write a story problem to accompany at least one of the fraction multiplication problems they have done today. Here are several examples of the kinds of story problems we've seen fifth graders write in response to this assignment.

- *My little brother is always coming into my room and bothering me, so finally I got some tape and marked off a fourth of a fourth of the room for him to play in. What part of the room did he get?* ($\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$)
- *My dad said we could set up our volleyball net in the back half of our yard. When we did, it took up* $\frac{3}{4}$ *of the space. How much of the yard did it fill?* ($\frac{3}{4} \times \frac{1}{2} = \frac{3}{8}$).
- *I had* $\frac{3}{4}$ *of a candy bar left. I gave a* $\frac{1}{4}$ *of that to my best friend. How much of my candy bar did she get?* ($\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$)

Extensions

- Post a display in the hall that shows each multiplication combination, accompanied by a sketch and the student-written story problems that match.
- If there is another fifth grade class in your school using Bridges, have the two classes trade story problems. Each student in your room can solve one of the problems written by a student in the other class, and send back a very complete and detailed record of his or her solution and strategy. (Our students really enjoy seeing how other fifth-graders solve their problems.)

NAME ______________________________ **DATE** ______________

Journal Page Grid

Set A9 ★ Activity 4

ACTIVITY

Generalizations About Multiplying Fractions

Overview

Students sketch and solve a variety of fraction multiplication combinations on grid paper. The teacher then guides them to the generalization that the product of any two fractions can be found by multiplying their numerators and then multiplying their denominators.

Skills & Concepts

- ★ find the product of two unit fractions with small denominators using an area model
- ★ multiply fractions using the standard algorithm
- ★ explain the relationship of the product relative to the factors when multiplying fractions

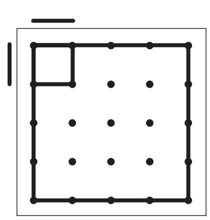
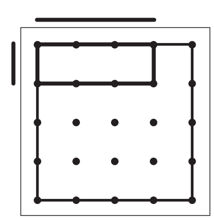
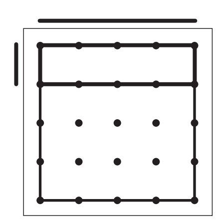
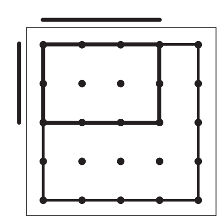
You'll need

- ★ Fractions to Multiply (page A9.28, run 1 copy for display)
- ★ Multiplying Fractions (pages A9.29 and A9.30, run 1 copy of each for display, and a class set)
- ★ Student Math Journals or Journal Page Grid (pages A9.22 optional, run copies as needed)
- ★ red, blue and black pens for the display
- ★ paper to mask portions of the display
- ★ colored pencils

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Generalizations about Multiplying Fractions

1. Have students open their math journals to the work they did during the previous session. Ask them to pair-share any observations they can make so far about multiplying fractions. After a minute or two, ask volunteers to share their thinking with the class.

$\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$	$\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$	$\frac{1}{4} \times 1 = \frac{4}{16} = \frac{1}{4}$	$\frac{1}{2} \times \frac{3}{4} = \frac{6}{16} = \frac{3}{8}$
			
Area = $\frac{1}{16}$	Area = $\frac{3}{16}$	Area = $\frac{1}{4}$	Area = $\frac{3}{8}$

Students *When you multiply a fraction by 1, it stays the same, like $\frac{1}{4}$ times 1 is just $\frac{1}{4}$.*
It seems like when you multiply one fraction by another, the answer is always smaller than what you started with.
Yeah, like $\frac{1}{4}$ times $\frac{1}{4}$ is $\frac{1}{16}$. It's kind of weird, because usually when you multiply, you get a bigger answer.
It makes sense if you remember that $\frac{1}{4} \times \frac{1}{4}$ is really one-fourth of a fourth.
I think you can just get the answers by multiplying across.

Activity 4 Generalizations About Multiplying Fractions (cont.)

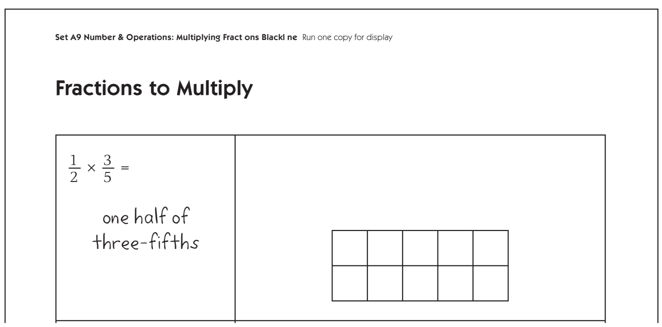
Teacher *Multiplying across? How are you thinking about that, Brianna?*

Brianna *Can I show at the board? Look, we know that a fourth of a fourth is a sixteenth, right? So just multiply 1 times 1, and you get 1, and 4 times 4 and you get 16. Or $1/4$ times $3/4$ is $3/16$. We showed that on our boards yesterday. But look what happens when I write the numbers and multiply across. 1 times 3 is 3, and 4 times 4 is 16!*

$$\frac{1 \times 1}{4 \times 4} = \frac{1}{16} \qquad \frac{1 \times 3}{4 \times 4} = \frac{3}{16}$$

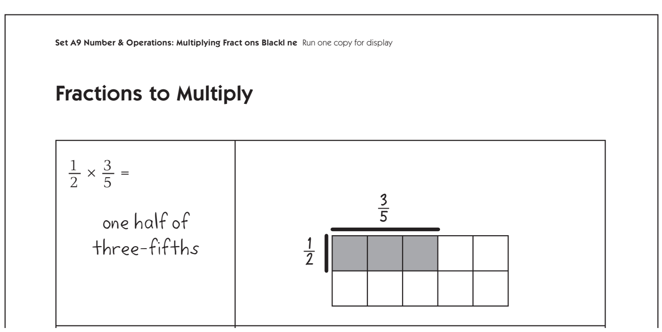
Teacher *So, you're saying that if you multiply the numerators, and then multiply the denominators, you get the same answers we did when we built and sketched the combinations? That's an interesting observation. Do you think it will work every time? Let's keep the idea in mind as we look at some more problems today.*

2. Explain that you have some more fraction multiplication problems for the class today. Then show the first problem on the Fractions to Multiply display master. Read the first problem with the students, and work with their input to record the phrase that will help them think sensibly about the combination. Have students pair-share estimates, and ask several volunteers to share their thinking with the class.



Students *We know it's going to be less than $3/5$ because it's only half of that.*
We think maybe the answer is going to be $3/10$ because half of one fifth is one tenth, so maybe half of three fifths would be $3/10$.
If you use my idea about multiplying across, you get $3/10$.

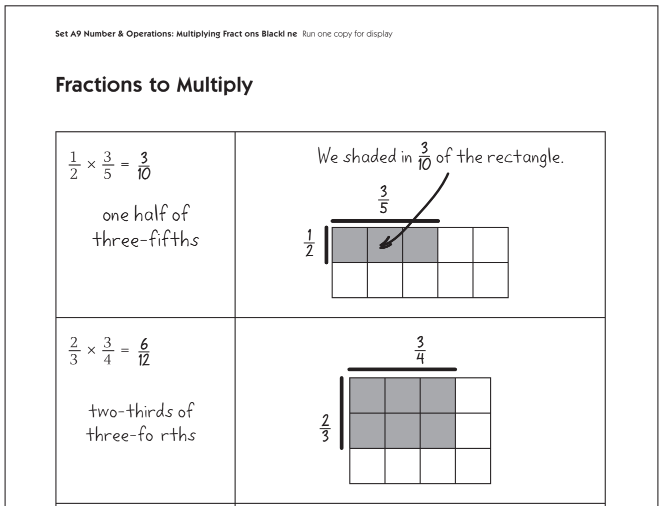
3. Work with input from the class to frame a rectangle on the grid that is $1/2$ by $3/5$. Then shade in the resulting region, and ask students to identify the area of the rectangle relative to the whole grid.



Students *So, the answer is $3/5$, right?*
That doesn't make sense! It should only be half of $3/5$.
But there are 3 boxes colored in and 5 in the row, so it's $3/5$.

Wait a minute! There are 10 boxes in the whole grid. We marked half on one side and $^3/_5$ along the top, and the part we colored in is $^3/_{10}$.

4. When there is general agreement that the answer is $^3/_{10}$, record it on the display. Then show the next combination. Read it with the class and write a verbal "translation" below the problem. Have students open their journals to the next available page, record the combination, and outline a 3 × 4 rectangle. Give them a minute or two to solve the problem, sharing and comparing their work with others nearby as they work. Then invite a volunteer to the display to share his or her thinking with the class.

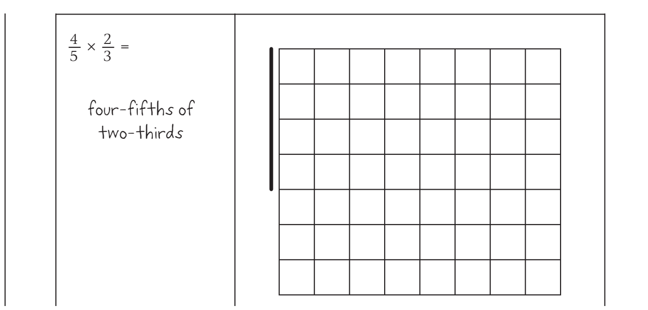


Sergio *$^6/_{12}$ is half of the rectangle. See there are 6 white squares and 6 that are colored in. 6 + 6 = 12*

5. Repeat step 4 with the last combination on the display, $^4/_5 \times {}^2/_3$. This time, however, students will have to decide what size rectangle to outline before they model the combination.

Teacher *Can someone come up and mark a dimension of $^4/_5$ along the side of this grid? Maria?*

Maria *Sure! Just mark 4 down the side, like this.*

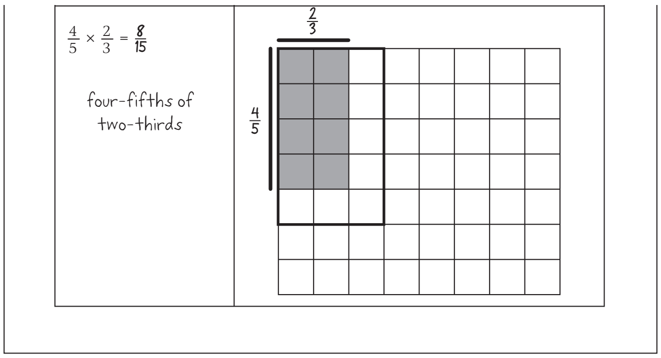


Teacher *Do you all agree that this shows $^4/_5$ of the side of the grid? Talk with the person next to you for a minute, and then let's hear what you think.*

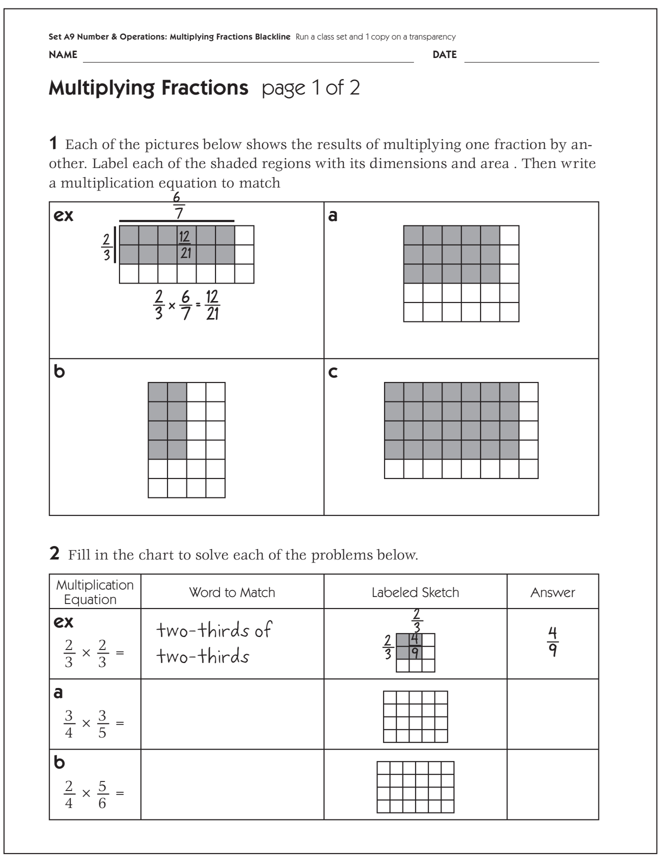
Students *Yep, we agree. It's 4 down the side.*
We don't agree. There are 7 squares down the side. If you mark 4 of them, it's like $^4/_7$, not $^4/_5$.
I think you can't use that whole grid. You have to make one where you can show fifths on one side and thirds on the other.

Activity 4 Generalizations About Multiplying Fractions (cont.)

6. After some discussion, work with input from students to outline a rectangle that will work for this combination. Then mark the dimensions, shade in the region that results, and record the answer at the display, as students do so in their journals.



7. Give students each a copy of the Multiplying Fractions sheets and display the master for everyone to see. Review and discuss the tasks with the class. Give students the option of working on these sheets independently, in pairs, or with you.



Set A9 Number & Operations: Multiplying Fractions Blackline Run a class set and 1 copy on a transparency

NAME DATE

Multiplying Fractions page 1 of 2

1 Each of the pictures below shows the results of multiplying one fraction by another. Label each of the shaded regions with its dimensions and area . Then write a multiplication equation to match

ex $\frac{2}{3} \times \frac{6}{7} = \frac{12}{21}$

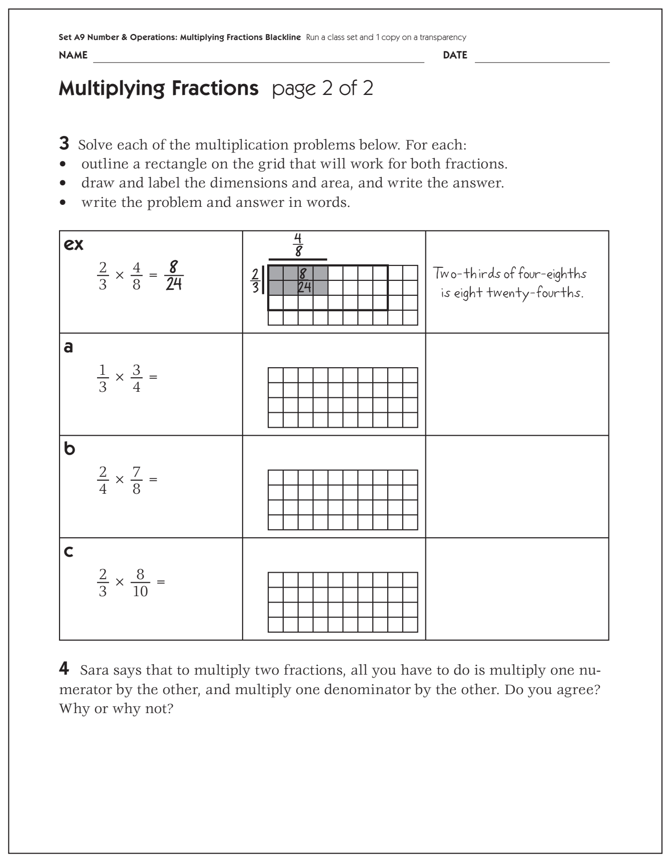
a

b

c

2 Fill in the chart to solve each of the problems below.

Multiplication Equation	Word to Match	Labeled Sketch	Answer
ex $\frac{2}{3} \times \frac{2}{3} =$	two-thirds of two-thirds		$\frac{4}{9}$
a $\frac{3}{4} \times \frac{3}{5} =$			
b $\frac{2}{4} \times \frac{5}{6} =$			



Set A9 Number & Operations: Multiplying Fractions Blackline Run a class set and 1 copy on a transparency

NAME DATE

Multiplying Fractions page 2 of 2

3 Solve each of the multiplication problems below. For each:

- outline a rectangle on the grid that will work for both fractions.
- draw and label the dimensions and area, and write the answer.
- write the problem and answer in words.

ex $\frac{2}{3} \times \frac{4}{8} = \frac{8}{24}$		Two-thirds of four-eighths is eight twenty-fourths.
a $\frac{1}{3} \times \frac{3}{4} =$		
b $\frac{2}{4} \times \frac{7}{8} =$		
c $\frac{2}{3} \times \frac{8}{10} =$		

4 Sara says that to multiply two fractions, all you have to do is multiply one numerator by the other, and multiply one denominator by the other. Do you agree? Why or why not?

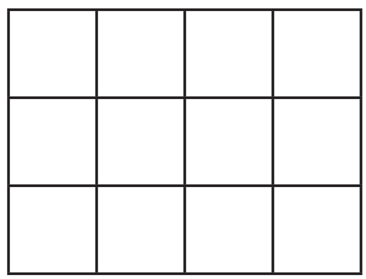
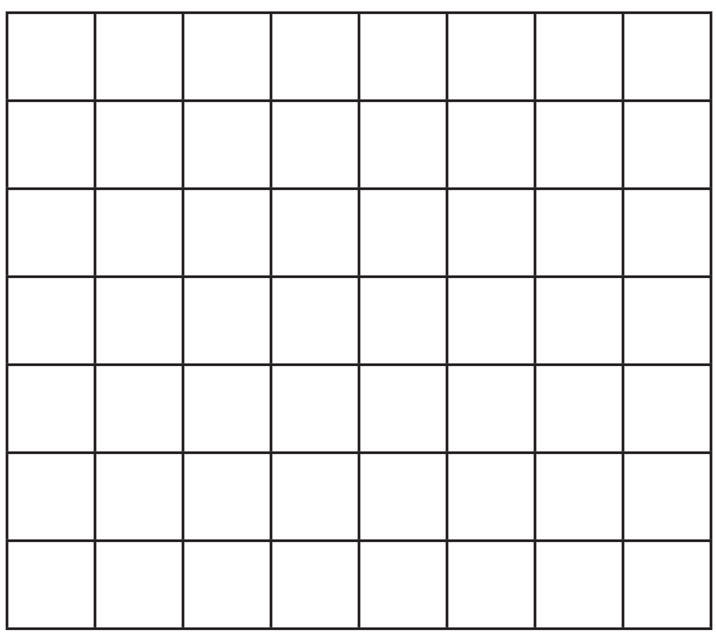
8. After students have completed the worksheets, discuss the fourth problem with the group, and guide them to the generalization that the product of two fractions is found by multiplying the numerators and then multiplying the denominators. Also, ask students to explain why the product of two fractions is smaller than either of the factors.

> ***Students*** *Multiplying two fractions is like finding a fraction of a fraction. Half of a half has to be smaller than a half.*
> *Or, like if you find a fourth of a half, it's only an eighth.*
> *It goes the other way, too. A half of a fourth is an eighth.*

INDEPENDENT WORKSHEETS

See Set A9 Independent Worksheets 1–3 on pages A9.49–A9.53 for more practice with multiplying fractions.

Fractions to Multiply

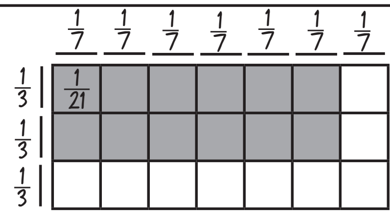
$\frac{1}{2} \times \frac{3}{5} =$	
$\frac{2}{3} \times \frac{3}{4} =$	
$\frac{4}{5} \times \frac{2}{3} =$	

NAME ______________________________ DATE ______________

Multiplying Fractions page 1 of 2

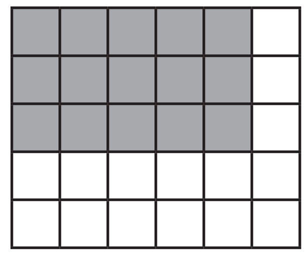
1 Each of the pictures below shows the results of multiplying one fraction by another. Label each of the shaded regions with its dimensions and area . Then write a multiplication equation to match

ex

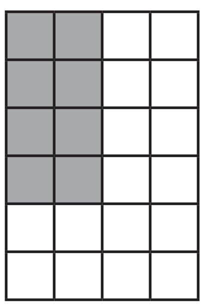


$\frac{2}{3} \times \frac{6}{7} = \frac{12}{21}$

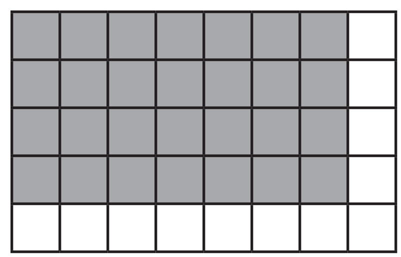
a



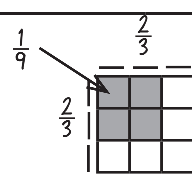
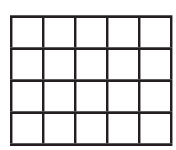
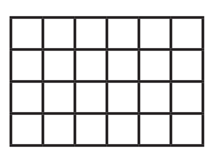
b



c



2 Fill in the chart to solve each of the problems below.

Multiplication Equation	Word to Match	Labeled Sketch	Answer
ex $\frac{2}{3} \times \frac{2}{3} =$	two-thirds of two-thirds		$\frac{4}{9}$
a $\frac{3}{4} \times \frac{3}{5} =$			
b $\frac{2}{4} \times \frac{5}{6} =$			

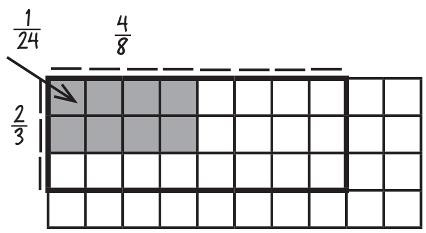
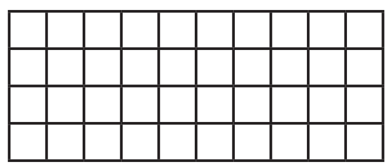
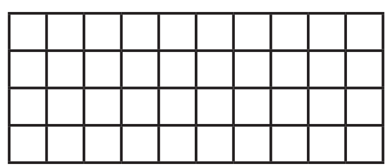
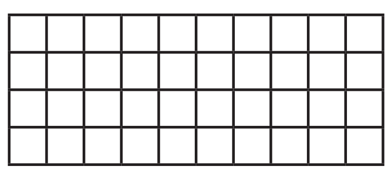
(continued on next page.)

NAME ______________________________ **DATE** ______________

Multiplying Fractions page 2 of 2

3 Solve each of the multiplication problems below. For each:

- outline a rectangle on the grid that will work for both fractions.
- draw and label the dimensions and area, and write the answer.
- write the problem and answer in words.

ex $\frac{2}{3} \times \frac{4}{8} = \frac{8}{24} = \frac{1}{3}$		Two-thirds of four-eighths is eight twenty-fourths.
a $\frac{1}{3} \times \frac{3}{4} =$		
b $\frac{2}{4} \times \frac{7}{8} =$		
c $\frac{2}{3} \times \frac{8}{10} =$		

4 Sara says that to multiply two fractions, all you have to do is multiply one numerator by the other, and multiply one denominator by the other. Do you agree? Why or why not?

Set A9 ★ Activity 5

ACTIVITY

Target 1 Fractions

Overview

In this session, students share strategies for multiplying whole numbers by a non-unit fraction in preparation for playing Target 1: Fractions. They learn the game by playing a round against the teacher, and then, practice the game with a partner.

Skills & Concepts

- ★ Add fractions with unlike denominators, including mixed numbers (5.NF.1)
- ★ Subtract fractions with unlike denominators, including mixed numbers (5.NF.1)
- ★ Multiply a whole number by a fraction (5.NF.4a)
- ★ Interpret multiplication as scaling (resizing) (5.NF.5a and 5.NF.5b)

You'll Need

- ★ Target 1: Fraction Record Sheet (page A9.34 run a double-sided class set)
- ★ 8 Digit cards (page A9.35 run a half-class set on cardstock.)
- ★ chart paper
- ★ markers
- ★ scissors, class set

Advance Preparation Cut apart one set of the Digit cards before the session begins to use when teaching the game.
Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Target 1

1. Write the problem $3 \times 4/5$ where everyone can see and give students a moment to consider how they might solve for it. Ask students what might make this problem challenging (it contains a non-unit fraction). Ask students to turn and talk with a partner about how they might solve $3 \times 4/5$. Then, invite several students to share their thinking. Since the numerator is 4, some students may employ the double-double strategy for multiplication. Since the denominator is 5, some students may convert the fraction to a decimal, in the context of money.

Listen for the following strategies:

- Finding the whole number times a unit fraction and scaling up: $3 \times 1/5 = 3/5$; $3/5 \times 4 = 12/5$.
- Finding $1/5$ of 3, doubling that, and then doubling that again to get $4/5$ of 3. $1/5$ of $3 = 3/5$ or 0.60, $3/5$ doubled is $6/5$ and 0.60 doubled is 1.20, $6/5$ doubled is $12/5$ or $2\ 2/5$, and 1.20 doubled is 2.40.
- Thinking about $4/5$ as money or a decimal: $4/5$ of a dollar equals \$0.80. $0.80 \times 3 = 2.40$.
- Finding $4/5$ of 1, three times: $4/5 + 4/5 + 4/5 = 12/5$ or $2\ 2/5$.

Invite students to share these strategies. If no one mentions the strategies listed above, you might consider bringing them up yourself. As students share, represent their strategies on a poster for everyone to see.

Activity 5 Target 1: Fractions (cont.)

Strategies for Multiplying a Whole Number by a Non-Unit Fraction

- Find the whole number times a unit fraction and then scale up.

$3 \times \frac{4}{5} = (3 \times \frac{1}{5})4 =$

$\frac{3}{5} \times 4 = \frac{12}{5}$ or $2\frac{2}{5}$

- When 4 is the whole number or numerator, find the unit fraction and double double

$3 \times \frac{4}{5} = \frac{1}{5}$ of $3 = \frac{3}{5}$

$\frac{3}{5}$ doubled is $\frac{6}{5}$

$\frac{6}{5}$ doubled is $\frac{12}{5}$ or $2\frac{2}{5}$

- Think about money or decimals.

$3 \times \frac{4}{5} = \frac{1}{5}$ of a dollar = \$0.20

$\frac{4}{5}$ of a dollar = \$0.80

$3 \times 0.80 = 2.40$

\$0.40 = $\frac{2}{5}$ of a dollar so $2\frac{2}{5}$

- Find the fraction of 1, and then scale up.

$3 \times \frac{4}{5} = \frac{4}{5}$ of $1 = \frac{4}{5}$

$\frac{4}{5} + \frac{4}{5} + \frac{4}{5} = \frac{12}{5}$ or $2\frac{2}{5}$

2. Introduce the game Target 1: Fractions. Display the Target 1:Fractions Record Sheet Teacher Master where everyone can see.

Set A9 Number & Operations: Multiplying Fractions Blackline Run a double sided c ass set

NAME ______________________ DATE ______________

Target 1: Fraction Record Sheet

PLAYER 1______________________ PLAYER 2______________________

Game 1

Equation	Product	My score	Partner's Score
ex $5 \times \frac{2}{8} =$	$\frac{10}{8}$ or $1\frac{2}{8}$	$\frac{1}{4}$	
1 ____ × —— =			
2 ____ × —— =			
3 ____ × —— =			
4 ____ × —— =			
5 ____ × —— =			
		Final Score	Final Score

Briefly summarize the game before playing against the class.

- Each player gets 5 Digit Cards.
- Players choose 3 cards to form a whole number and a fraction that they multiply to get a product as close to 1 as possible.
- Players write their numbers on the record sheet and show how they multiplied them. Their score is the difference between their product and 1.
- The player with the lowest score after five rounds wins the game.

3. Play a game of Target 1 Fractions against the class.

> ***Teacher*** *I'm going to play against you. Alex, will you come up here and be the dealer and represent the class? They will help you as you play.*
>
> ***Alex*** *Sure.*
>
> ***Teacher*** *Give us each 5 Digit Cards. Then, you can go first.*
>
> ***Alex*** *Okay, I have a 2, two 3s, a 5, and an 8. What should I use?*
>
> ***Juan*** *Use the smaller numbers. Then you will get closer to 1.*
>
> ***Theran*** *No, use the bigger numbers because fractions with bigger numbers are smaller.*
>
> ***Teacher*** *Why doesn't everyone try writing a few problems? You don't have to solve them, but try to estimate so you have a sense of which ones are bigger and which are smaller. Remember to put one digit as the whole number and two digits as the fraction.*
>
> ***Alex*** *OK, I have one. I'm not sure it is the closest to 1, but it is pretty close. I made a 2 the whole number and* $^{3}/_{5}$ *the fraction.*
>
> ***Teacher*** *Okay. Write it down on the Record Sheet. How did you find the product?*
>
> ***Alex*** *Well, Since it is times 2, I could just double* $^{3}/_{5}$*. That's* $^{6}/_{5}$ *which is also 1* $^{1}/_{5}$ *which is pretty close to 1. It is just* $^{1}/_{5}$ *away from 1.*
>
> ***Teacher*** *Great. Write your product and your score for this round on the Record Sheet.*

4. Pair students up and ask them to cut apart their Digit Cards and play a round of Target 1 Fractions.

While students are playing, circulate and pose questions like the following to promote flexible thinking and strategy development while you play:

- Can you have an improper fraction as your fraction? What happens when you have an improper fraction?
- What combinations of numbers multiply to exactly 1?
- What happens when the denominator is a relatively small number?
- What happens when the denominator is relatively large number?
- Do any arrangements of the same 3 numbers result in the same product?

5. To close the session, bring the class back together and take a few moments to consider the idea that multiplication is like scaling. Ask student questions like the following to guide your discussion.

- Were you able to estimate and then compare the size of the products without having to do the actual computation? Can you give an example?
- What happens to the product when the fraction is greater than one? (the product increases)
- What happens to the product when the fraction is less than one? (the product decreases).

INDPENDENT WORKSHEET

See Supplement Set A9 Independent Worksheet 4 on pages A9.55 and A9.56 for more practice with multiplying fractions.

NAME ______________________ **DATE** ______________

Target 1: Fraction Record Sheet

PLAYER 1 ______________________ **PLAYER 2** ______________________

Game 1

Equation	Product	My score		Partner's Score
ex 5 × $\frac{2}{8}$ =	$\frac{10}{8}$ or $1\frac{2}{8}$	$\frac{1}{4}$		
1 ____ × —— =				
2 ____ × —— =				
3 ____ × —— =				
4 ____ × —— =				
5 ____ × —— =				
		Final Score		Final Score

Game 2

Equation	Product	My score		Partner's Score
6 ____ × —— =				
7 ____ × —— =				
8 ____ × —— =				
9 ____ × —— =				
10 ____ × —— =				
		Final Score		Final Score

8 Digit Cards

4	8
3	7
2	6
1	5

Set A9 ★ Activity 6

ACTIVITY

Multiplying Domino Fractions

Overview

In this session, students play three rounds of Domino Fractions to develop fluency with multiplication of fractions. Students begin to estimate the product based on the scale of the factors, working first with proper fractions and then with improper fractions. If there is disagreement between partners, students sketch an area model on journal paper to prove their computation. The player with the larger product in the round wins all four domino cards, but at the end of the game, the more/less die is rolled to determine the winner.

Skills & Concepts

- ★ Multiply a whole number by a fraction and fraction by a fraction (5.NF.4a)
- ★ Find the area of a rectangle with fractional side lengths (5.NF.4b)
- ★ Interpret multiplication as scaling (resizing) (5.NF5a and 5.NF5b)

You'll Need

- ★ Domino Cards (pages A9.41–A9.43 run a half-class set on cardstock, plus one for display)
- ★ Student Math Journals or Journal Page Grid (A9.44 optional, run as needed.)
- ★ more/less die, half a class set plus one for display
- ★ scissors, class set

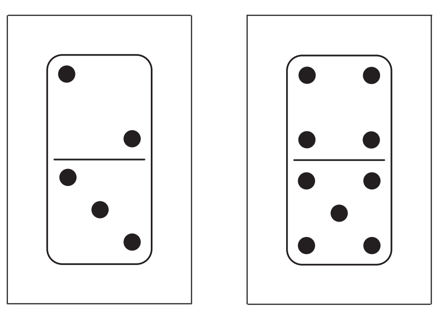
Advance Preparation Cut apart one set of Domino Cards before the session to use during the game.
Note When you represent the symbolic form for a fraction, please use a horizontal bar. Save the Domino cards for use in Supplement Set A11, Actvity 7.

Instructions for Multiplying Domino Fractions

Game 1: Introduction

1. Introduce the game Multiplying Domino Fractions by briefly summarizing the game before playing against the class.

> ***Teacher*** *In the first round of this game, we'll each draw two domino cards, read them as proper fractions, and then multiply our two fractions to determine the product. Before we multiply, though, we'll make a quick estimate of the product. If we disagree, we'll sketch an area model to show our thinking. I'll go first to show you.*

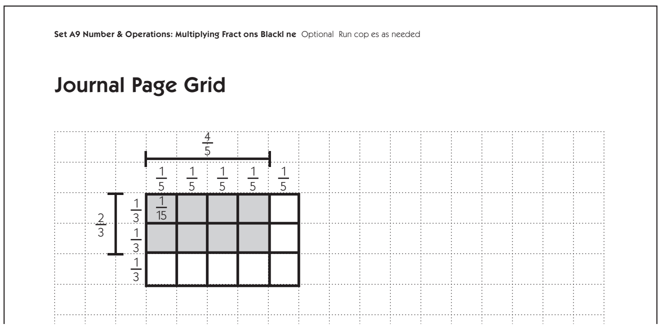


$\frac{2}{3} \times \frac{4}{5} =$

Activity 6 Multiplying Domino Fractions (cont.)

> ***Teacher*** *Hmm, I think my product is going to be less than 1 for sure. $^2/_3$ is less than one whole and so is $^4/_5$. I'll draw an area model to show you how I am thinking about it.*

In solving the problem $^2/_3 \times {}^4/_5$, students use the are model to visualize it as a 2×4 array of small rectangles eash of which has side lengths $^1/_3$ and $^1/_5$. They reason that $^1/_3 \times {}^1/_5 = {}^1/_{(3 \times 5)}$ by counting squares in the entire rectangle, so the area of the shaded area is $(2 \times 4) \times (3 \times 5) = {}^{2 \times 4}/_{3 \times 5}$. Using unit fractions, student can scale the area to include $^2/_3$ and $^4/_5$ or… by counting squares. Encourage students to explain that the product is less than $^4/_5$.



The area model and the line segments show that the area is the same quantity as the product of the side lengths.

2. Invite a student to draw two domino cards and show them to the rest of the class. Give students a moment to estimate the product and then have them turn and talk to a partner about their estimate. Invite one or two students to share their thinking.

3. Then, have students compute the total at their desks and ask the player who drew the cards to give and explain the answer. If necessary, sketch the problem with student input.

4. Write both your product and the class's where everyone can see. Ask which product is greater. The player with the greater product wins all four domino cards.

5. Continue the game until all the cards are gone from the deck. Then, count your cards while the class does the same. The player with the fewest cards roll the more/less die to see who wins the round.

Game 2: Partners

6. Pass out the Domino Card Blacklines and ask students to work together to quickly cut apart their domino cards.

7. Then, have students play a round with their partner. Remind students to estimate the product before they compute the total. Will the total be more or less than one whole? Why? Tell students that if there is a disagreement, the player must sketch an area model to show the product in their student journal.

8. When the cards from the deck are all gone, have the players count their cards and roll the more/less die to see who wins the game. When several groups have finished, have the rest of the groups roll to see who won the game.

Game 3: Improper Fractions

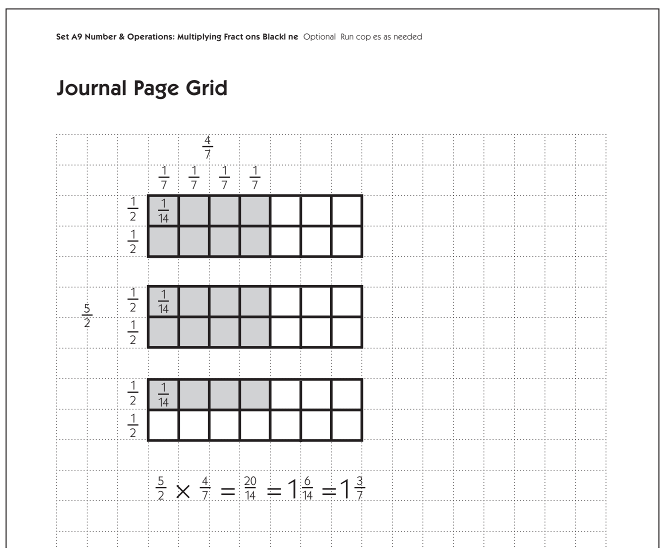
9. Introduce a variation of the game. Tell students that this new game is played much the same way, but this time one domino will be used to create a proper fraction while the second domino is used to create an improper fraction. The fractions will then be multiplied using an area model on grid paper.

There is a bit of strategy at play in the second version of the game, and students who can estimate the size of the products without having to perform the computation will have an advantage for capturing the four dominoes in play. Of course, in the end, the more/less die will decide who actually wins the game!

10. Begin the game by drawing two domino cards. Show them to the class, and think aloud as you choose two fractions and estimate their product.

> ***Teacher*** *I drew $^2/_5$ and $^7/_4$. Or I suppose I could think of it as $^5/_2$ and $^4/_7$, couldn't I? Hmm… I think I'm going to solve $^5/_2 \times {}^4/_7$. I know that $^5/_2$ is 2 $^1/_2$ because 4/2 would be 2 and then there is $^1/_2$ left. And then $^4/_7$ is just over ½ because $^4/_8$ would be exactly $^1/_2$. For my estimate, I'm going to think of this as half of 2 $^1/_2$, which is 1 $^1/_4$.*

11. Solve the problem and make an area model sketch to show the product.



12. Invite a student to draw two dominoes and create a proper and an improper fraction for the class to solve. Tell students to record an estimate in their journals and turn and talk to a partner about their reasoning before they sketch the area model and solve the problem. Circulate to offer support as students work, and have students compare their work with a partner when they finish.

13. When most students have finished, invite one or two students to share their thinking with the class.

14. If students need more support, play another round and model your thinking again before having them solve another problem. If students understand the work, dismiss them to play with a partner.

15. Tell students that, as before, when all the cards from the deck are gone, players will count their cards and roll the more/less die to see who wins the game.

Activity 6 Multiplying Domino Fractions (cont.)

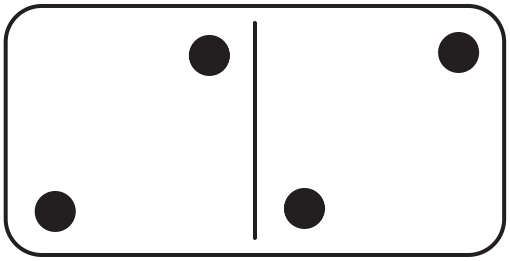
16. At the end of the session, have students turn and talk to a partner about one thing that was particularly challenging for them today or that they learned, and then call on several students to share their reflections.

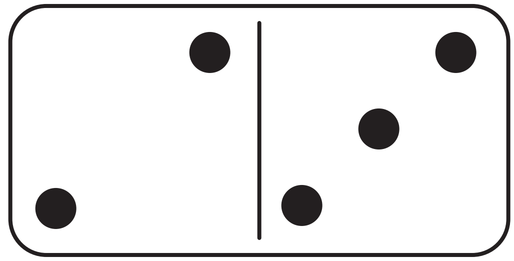
Note *You may want to save the domino cards and use them for additional Work Place practice. Save the cards for Supplement Set A11, Activity 7.*

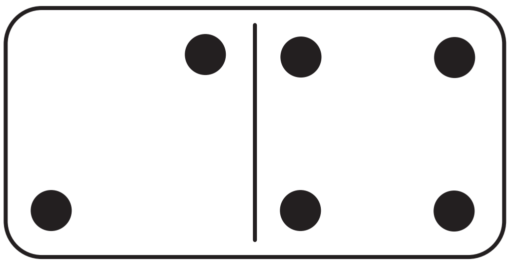
INDEPENDENT WORKSHEET

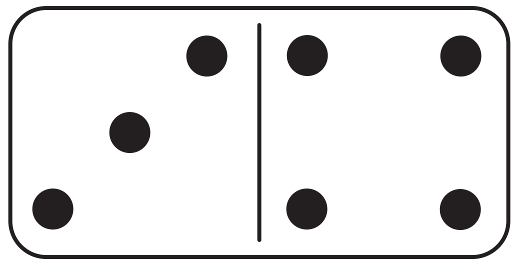
See Supplement Set A9 Independent Worksheet 5 on pages A9.57 and A9.58 for more practice with multiplying fractions.

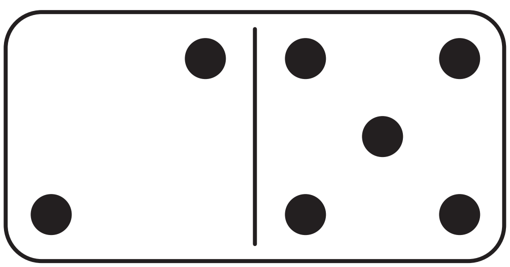
Domino Cards page 1 of 3

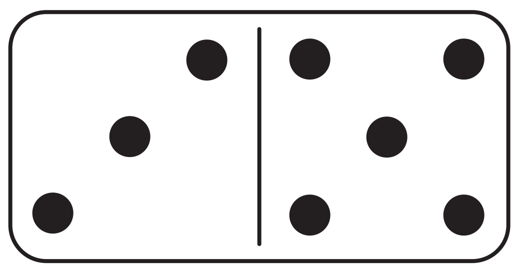


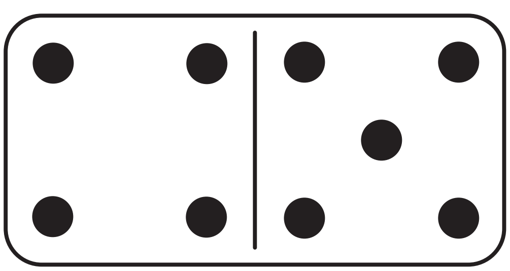


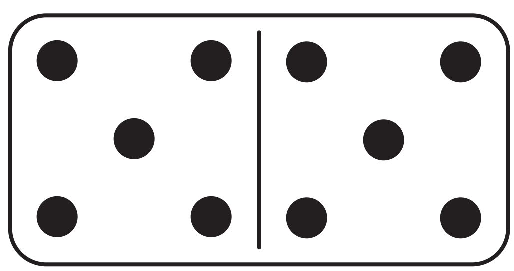




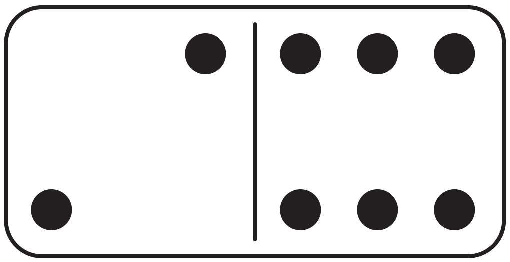


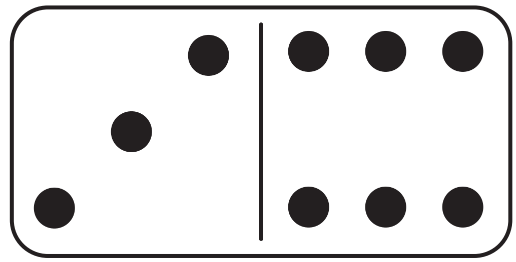


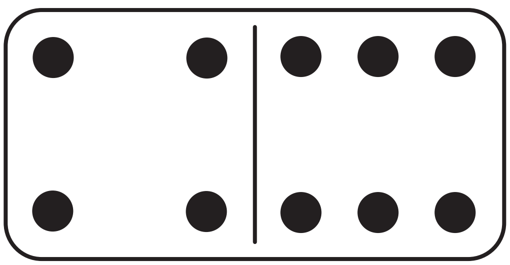


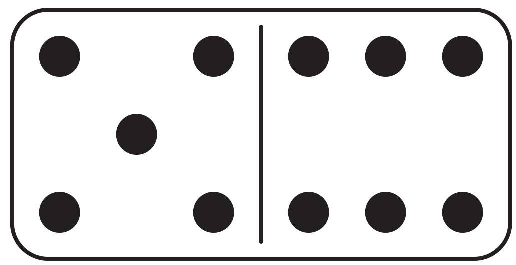


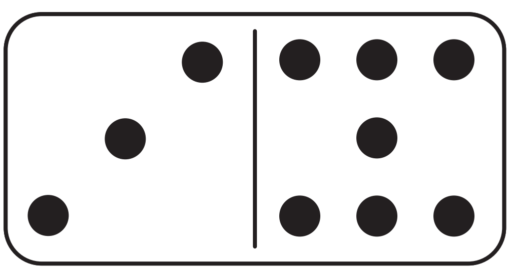
Domino Cards page 2 of 3

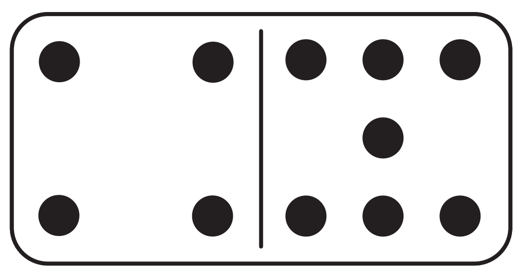


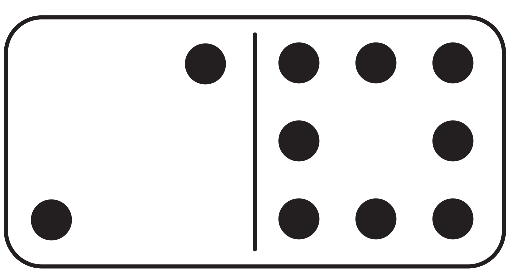


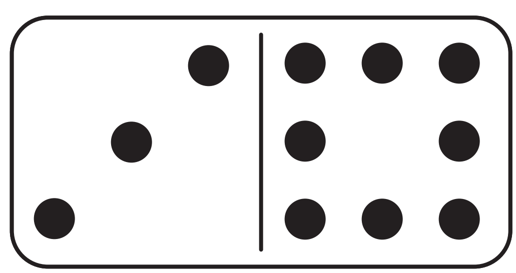




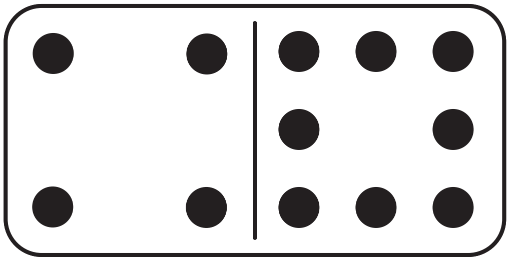


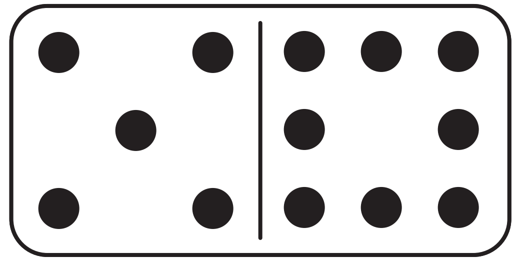


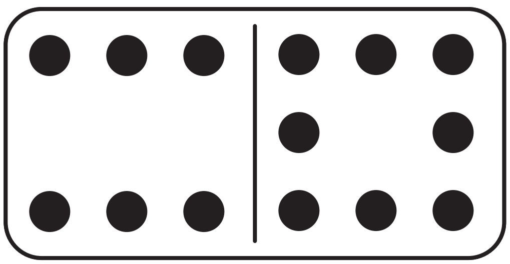


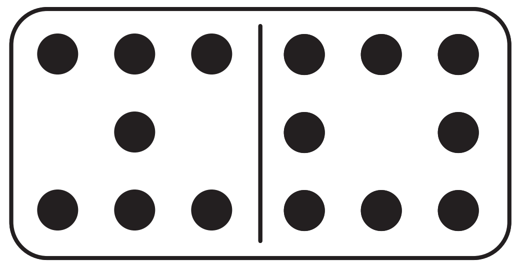


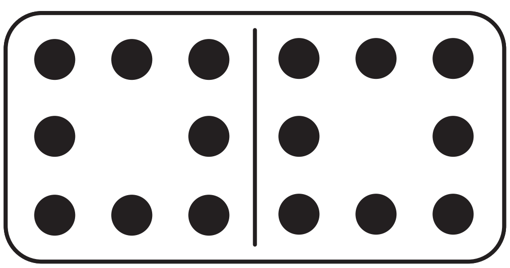
Domino Cards page 3 of 3

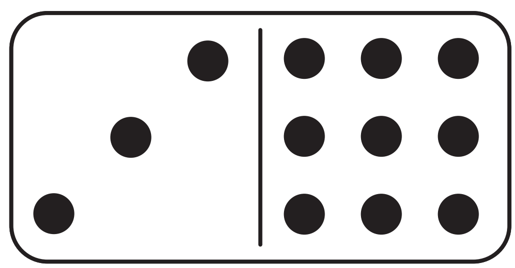


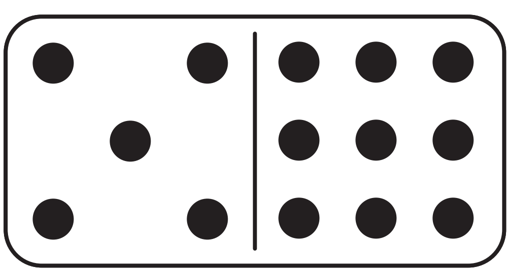


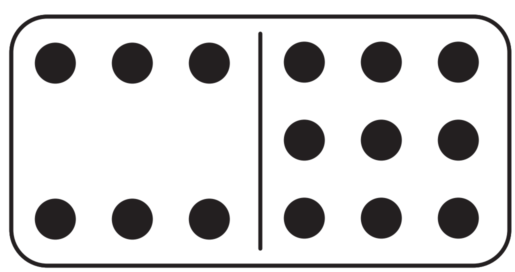












NAME ______________________________ **DATE** ______________

Journal Page Grid

ACTIVITY

Area Word Problems with Mixed Numbers

Overview
During this session, students will solve several word problems designed to help them develop efficient strategies for multiplying fractions by a whole number using an area model. Their work will include situations involving improper fractions and mixed numbers. The story problem context, along with the use of visual models, will help students make sense of the magnitude of the product.

Skills & Concepts
- ★ Add fractions with unlike denominators, including mixed numbers (5.NF.1)
- ★ Multiply a whole number by a fraction (5.NF.4.)
- ★ Interpret multiplication as scaling (resizing) (5.NF.5)
- ★ Solve word problems involving multiplying fractions and mixed numbers using visual fraction models and equations (5.NF.6)

You'll Need
- ★ Area Word Problems with Mixed Numbers (page A9.47 run 1 copy for display.)
- ★ Student Journals or Journal Page Grid (page A9.48 optional, run as needed.)

Note When you represent the symbolic form for a fraction, please use a horizontal bar.

Instructions for Area Word Problems with Mixed Numbers
1. Open the session by telling students that today their work multiplying fractions will extend to mixed numbers and improper fractions. Display the Area Word Problems with Mixed Numbers page so only the first word problem is showing and read it together.

Set A9 Number & Operations: Multiplying Fractions B ackline Run 1 copy for d splay

NAME ______________________ DATE ____________

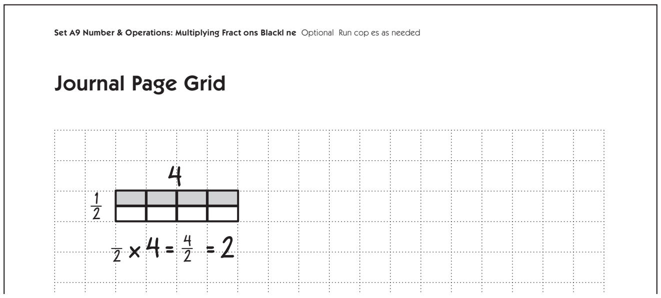
Area Word Problems With Mixed Numbers

Here are five problems for you to solve. For each one,
- write the *problem number* in your journal
- record an *estimate* (nearest whole number) and *explain* how you got it
- make a *labeled sketch* to show your thinking
- write a *multiplication equation* to match, including the answer

1 A rectangle is 4 meters long and $\frac{1}{2}$ meter wide. What is the area?

2. Invite students to make a sketch to show how they might find the area of this rectangle. After a few minutes, ask them to share their model with a partner. Finally, choose a student who correctly sketched and labeled an area model to share.

Activity 7 Area Word Problems with Mixed Numbers (cont.)



Josie *I shaded $^1/_2$ of four boxes in the grid. Next I added $^1/_2$ four times for a sum of 2. The area of the rectangle is $2m^2$. $^1/_2 \times 4 = {}^4/_2 = 2$*

3. Then, show the rest of the Area Word Problems page and review the directions.

4. Depending on the strengths and needs of your class, you may want to have students do one or two more problems with you, and then work in pairs. Allow students who are ready to work independently to do so while you work with those who need additional support.

5. As students work, watch for strategies to share like scaling up from a unit fraction or using doubling, repeated addition, or money or decimals. Are students able to estimate and then compare the size of the products without having to do the actual computation? Can they explain what happens to the product when the fraction is greater than 1 or what happens when the fraction is less than 1? (the product increases or decreases respectively)

The problems on the Area Word Problems with Mixed Numbers page lend themselves to the following strategies:
- doubling,
- repeated addition
- money/decimals
- scaling up from unit fraction

6. With about 15 minutes left, call the class back together to discuss several of the problems. Choose one of the problems most students finished and invite several students to explain their thinking. If you have time, repeat with another problem, trying to showcase several strategies for each.

7. As you examine strategies for multiplying fractions, consider comparing and contrasting the procedures for adding, subtracting, and multiplying fractions. Why does the algorithm work when we multiply the numerators and denominators across, when that algorithm doesn't work with addition or subtraction of fractions.

NAME ______________________________ **DATE** ______________

Area Word Problems With Mixed Numbers

Here are five problems for you to solve. For each one,

- write the *problem number* in your journal
- record an *estimate* (nearest whole number) and *explain* how you got it
- make a *labeled sketch* to show your thinking
- write a *multiplication equation* to match, including the answer

1 A rectangle is 4 meters long and $\frac{1}{2}$ meter wide. What is the area?

2 A painting in the county fair measures 2 meters by 4 $\frac{1}{4}$ meters. What is the area of the painting?

3 A teacher measured his classroom door and found that it was 1 $\frac{1}{3}$ meters wide and 3 meters tall. What's the area of the door?

4 The rectangular top of a table is three times as long as it is wide. Its width is 1 $\frac{2}{3}$ meters. Find the area of the table-top.

5 A small city park consists of a rectangular lawn that is 30 $\frac{1}{2}$ long and 20 meters wide. What is the area of the lawn?

6 Kale built a backyard pen for his new puppy. The length of the pen is 6 $\frac{1}{4}$ meters and the width is 4 meters. What is the area of the pen?

NAME ______________________ **DATE** ______________

Journal Page Grid

NAME ______________________________ **DATE** ______________

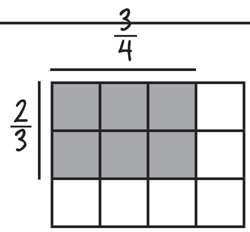
Set A9 ★ Independent Worksheet 1

INDEPENDENT WORKSHEET

Picturing Fraction Multiplication

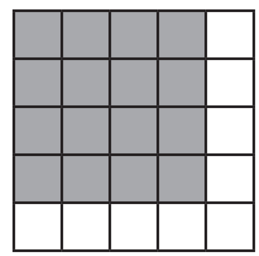
1 Each of the pictures below shows the results of multiplying one fraction by another. Label each of the shaded regions with its dimensions and area. Then write a multiplication equation to match.

ex

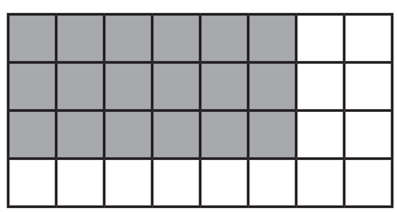


$\frac{2}{3} \times \frac{3}{4} = \frac{6}{12} = \frac{1}{2}$

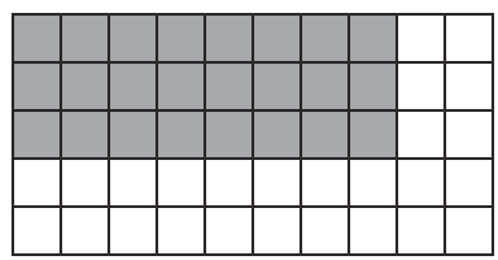
a



b



c



2 Pedro's dog, Oso, got into the kitchen last night. Oso saw three-fourths of a meat loaf still in the pan. He ate half of the meat loaf that was there before Pedro stopped him. What part of the meat loaf was still left? Use numbers, words, and/or pictures to solve the problem. Show your work.

Answer: ____________ of the meat loaf was still left.

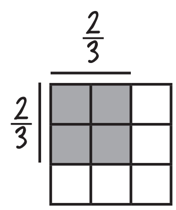
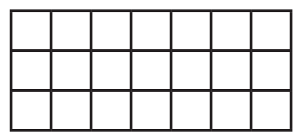
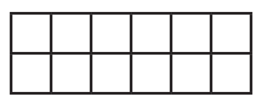
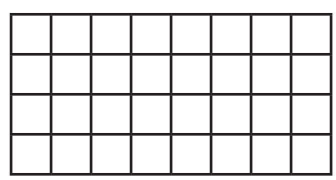
NAME ______________________________ **DATE** ______________

Set A9 ★ Independent Worksheet 2

INDEPENDENT WORKSHEET

More Fraction Multiplication

1 Fill in the chart to solve each of the problems below.

Multiplication Equation	Word to Match	Labeled Sketch	Answer
ex $\frac{2}{3} \times \frac{2}{3} =$	two-thirds of two-thirds		$\frac{4}{9}$
a $\frac{2}{3} \times \frac{6}{7} =$			
b $\frac{1}{2} \times \frac{4}{6} =$			
c $\frac{3}{4} \times \frac{4}{8} =$			

2 Solve each problem.

$\frac{3}{4} \times \frac{2}{4} =$ $\frac{1}{4} \times \frac{3}{6} =$ $\frac{5}{6} \times \frac{1}{2} =$ $\frac{6}{7} \times \frac{3}{5} =$

$\frac{2}{3} \times \frac{4}{5} =$ $\frac{6}{8} \times \frac{1}{2} =$ $\frac{3}{4} \times \frac{1}{3} =$ $\frac{2}{7} \times \frac{2}{4} =$

NAME ______________________ **DATE** ____________

Set A9 ★ Independent Worksheet 3

INDEPENDENT WORKSHEET

Fraction Stories

1 Jake is making cookies. The recipe says he needs three-fourths of a cup of butter, but Jake wants to cut the recipe in half. What is one-half of three-fourths of a cup of butter? Use numbers, words, and/or pictures to solve the problem. Show your work.

2 Mrs. Smith had $\frac{4}{6}$ of a carton of eggs in her refrigerator. She dropped the carton by accident and a fourth of the eggs in the carton broke. How much of a carton of eggs did she have left after she cleaned up the mess? How many eggs was that? Use numbers, words, and/or pictures to solve the problem. Show your work.

3 Write your own story problem to go with this expression. Then solve it. Use numbers, words, and/or pictures to solve the problem. Show your work.

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

CHALLENGE

4 Rosa bought a bag of apples. After she baked pies, she had $\frac{2}{3}$ of a bag left. Then she gave her cousin $\frac{3}{4}$ of these, which was 9 apples. How many apples did Rosa have to start?

NAME ______________________________ **DATE** ______________

Set A9 ★ Independent Worksheet 4

INDEPENDENT WORKSHEET

Using Strategies to Multiply Fractions with Mixed Numbers

Use one of the strategies you know to multiply these problems:

Example $3 \times \frac{4}{5}$

- Finding $\frac{4}{5}$ of 1, 3 times: $\frac{4}{5} + \frac{4}{5} + \frac{4}{5} = \frac{12}{5}$ or $2\frac{2}{5}$.
- Finding the whole number times a unit fraction and scaling up: $3 \times \frac{1}{5} = \frac{3}{5}$; $\frac{3}{5} \times 4 = \frac{12}{5}$.
- Thinking about $\frac{4}{5}$ as money or a decimal: $\frac{4}{5}$ of a dollar equals \$0.80.
  $0.80 \times 3 = 2.40$

1 Nate is playing Target 1: Fractions. He is trying to solve the following problem:

a $7 \times \frac{2}{3}$. Solve Nate's problem and show your work.

b Nate's partner, Irie, solved $\frac{3}{4} \times 5$. Show how you would solve it.

(Continued on next page.)

NAME ______________________________ **DATE** ______________

Independent Worksheet 4 Using Strategies to Multiply Fractions with Mixed Numbers (cont.)

c Irie could have solved $3 \times \frac{4}{5}$ instead of $\frac{3}{4} \times 5$. Which problem is closer to 1?

d Who will win this round? How do you know?

NAME ______________________________ **DATE** ______________

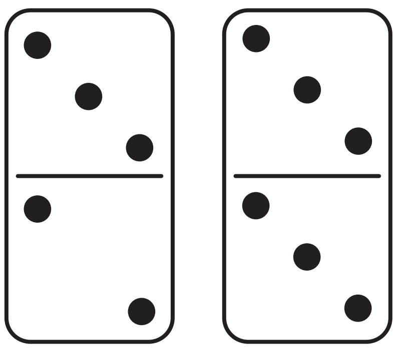
Set A9 ★ Independent Worksheet 5

INDEPENDENT WORKSHEET

Domino Multiplication

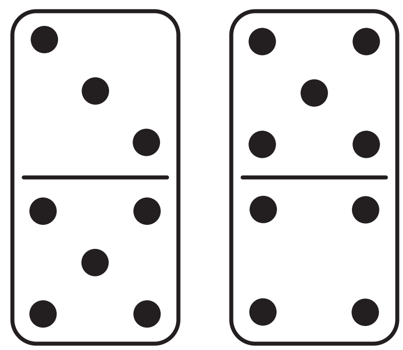
1 Write the two fractions below the dominoes and then multiply them to find the product. Show your work, and reduce the fraction if you can.

a



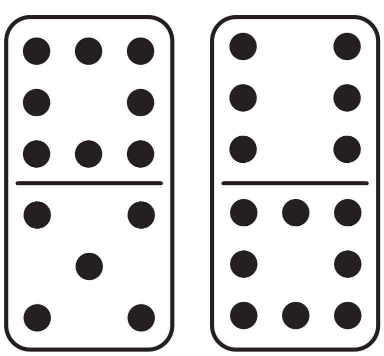
_______ × _______ = _______

b



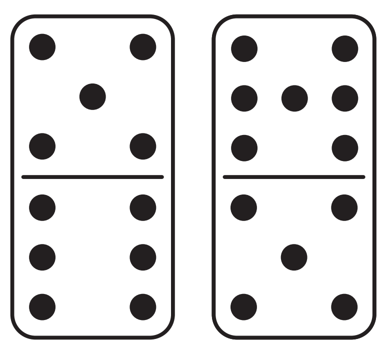
_______ × _______ = _______

c



_______ × _______ = _______

d



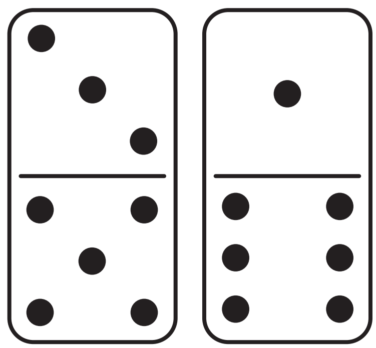
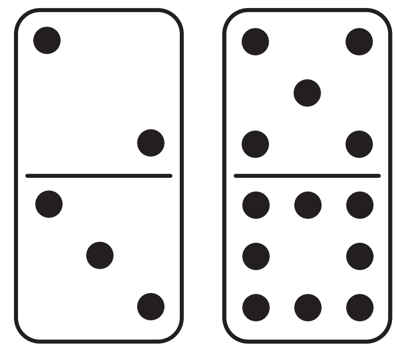
_______ × _______ = _______

(Continued on next page.)

NAME ______________________ DATE ______________

Independent Worksheet 5 Domino Multiplication (cont.)

2 Write a multiplication word problem that matches the following dominoes and solve it.

a	b
	

CHALLENGE

3 Now invert one of the dominoes in each set to create a new improper fraction and then multiply the two fractions to find the product. Remember to show your work!