Fractions: Booklet 4 - Equivalent Fractions

Contents

This booklet is dedicated to Jo Service, Michael's beloved wife. Her contribution to the Farm School is beyond measure in her support and dedication. Thank you for all of your valuable advice for many years.

Acknowledgments

The knowledge, patience, and dedication of Professor Michael Butler made the UCI Farm Elementary School and this mathematics program possible. Special thanks go to Alysia Krafel and Susan Carpenter, who helped develop much of the math materials based on the teachings, ideas, and insights of Professor Butler.

For many years Farm School teachers, students, parents, and staff have shared their unfailing delight in learning. Thank you for your support and dedication.

The books would never have been completed if the students at Chrysalis Charter School in Redding, California, under the guidance of Alysia and Paul Krafel, hadn't needed them. Thank you for your patience through all of the draft copies.

Susan Carpenter edited, added her wise words, useful suggestions, and helped make the Answer Keys a reality. Karán Founds-Benton contributed her meticulous editing skill and knowledge. Diligent and thorough copy editing was done by Zephyr Alfanash and Jacqueline Logue.

The cover mandala and many delightful illustrations are by Karen Marie Christa Minns. Other illustrations are by Suki Glenn and ClickArt by T/Maker.

To all of the mathematicians, from antiquity to the present, who discovered the principles of mathematics goes our heartfelt appreciation for your dedication.

Patterns in Arithmetic: Fractions - Booklet 4
Parent/Teacher Guide

Published by Pattern Press
P.O. Box 2737
Fallbrook, CA 92088
(760)728-3731

www.patternpress.com
E-mail: Patternpress1@gmail.com

Printed on recycled paper.

ISBN 978-1-935559-10-8

Relative Sizes: A Cutting Activity

Purpose

The purpose of this lesson is to use paper cutting to demonstrate that larger numbers of smaller pieces cover the same area as a smaller number of larger pieces. It also introduces the physical concept of multiplier in the costume of the scissors. This activity has students cut paper to directly experience the multiplier effect. It also uses measurement of the area covered by each fractional unit to graph the relationship between the size of the denominator and the area covered by that piece. This reveals the inverse nature of fractions.

Prerequisites

Basic concept of a fraction, what the numerator and the denominator are, fraction notation, calculation of the area of a rectangle, and coordinate graphing

Materials

Relative Sizes: A Cutting Activity, Worksheets 1 - 3, pages 4 - 6
Scissors and pencil
Several sheets of white, blank paper
Inch ruler
Graph paper

Preparation

Pre cut several 3 x 8 inch strips of paper. *Do not use 8 ½ inch wide strips; cut off the last half inch.* We are going to be measuring the area of each fractional unit, so the strips need to be carefully cut.

Copy these four sentences onto a piece of paper or an overhead:

1. The *more* pieces in the whole, the *greater* the size of each piece.
2. The *more* pieces in the whole, the *less* the size of each piece.
3. The *less* pieces in the whole, the *greater* the size of each piece.
4. The *less* pieces in the whole, the *less* the size of each piece.

Lesson Part 1 Halves of Halves

"Each strip is defined here as the whole, or one. Label one of your strips as the whole. Do not cut this one up."

"Take another strip, fold it in half using a hamburger fold,* and cut it in half." "Label each piece as one-half, ½."

"Put both of the one-half pieces on top of the whole. What do you notice?" "They match. I still have the same amount."

"Take another strip, use a hamburger fold and cut it in half. Now use a hamburger fold to cut each of your halves in half. How many pieces will you have then?" "Four."

"How should you label these pieces? How do you know?" "I will label each one as ¼ because there are four parts in the whole."

"Put all of your ¼ pieces on top of your whole. What do you notice?" "They cover the whole thing. I still have the same amount."

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* A hamburger fold is a fold that creates two squarish sections. It is the shortest line fold. A hot dog fold is a long fold that looks like a hot dog bun.

"Put two of your fourths on top of one of your halves. What do you notice?" "They match. I still have the same amount."

"Take another strip. Cut it into halves and then fourths like you did before. Now cut each one of your fourths in half using a hamburger fold. How should you label these pieces? How do you know?" "I will label each one as $\frac{1}{8}$ because there are eight parts in the whole."

"How many eighths do you have?" "Eight."

"Which one covers more area, your whole piece or all the little one-eighth pieces together?" "They both cover the same area." Most students at this level will know this with certainty.

Challenge that certainty.

"How can that be? Here you have only one piece of paper (pointing to the one whole) **and here you have eight pieces** (pointing to the one-eighth pieces)**?"** "There are more pieces in the eighths but they are really little so it takes more of them to cover the whole. With the big piece you need only one."

"So which one of these statements would be correct?" Write these down on a piece of paper or the board. Then hold up a whole piece of paper.

Four Sentences

1. The *more* pieces in the whole, the *greater* the size of each piece.

2. The *more* pieces in the whole, the *less* the size of each piece.

3. The *less* pieces in the whole, the *greater* the size of each piece.

4. The *less* pieces in the whole, the *less* the size of each piece.

Wait and let them think about it. There are two correct answers (both 2 and 3 are correct). Notice that in the correct answers, both *more* and *less* are in the same statement. That is an indicator of an inverse relationship.

"To record the folds and cuts, draw a picture of the four strips. What pattern do you see in the numbers of pieces?" "One, two, four, eight–the numbers double."

"What created that pattern?" "The pattern is doubled because each time the pieces are cut in half. Cutting the pieces in half doubles the number of pieces."

Lesson Part 2 Graphing Relationships

Materials

Relative Sizes: A Cutting Activity - Worksheet 1, page 4
The cutup fractions from the last activity and an inch ruler

You are going to make a graph of two of the relationships you saw in the last activity.

Fill in the T chart on the worksheet.

Date _____

Relative Sizes: A Cutting Activity - Worksheet 1

Cut strips of paper 3 inches by 8 inches.
If I cut one strip into halves, I have ___ pieces.

Draw a picture of each strip beginning with one whole, or $\frac{1}{1}$.
Take another strip. Cut it into halves, then cut the halves into two. I have ____ pieces, or $\frac{4}{4}$.

Take the last strip; cut it just like the one before, then cut each piece into two more equal pieces. Altogether I have _____ pieces, or $\frac{8}{8}$.

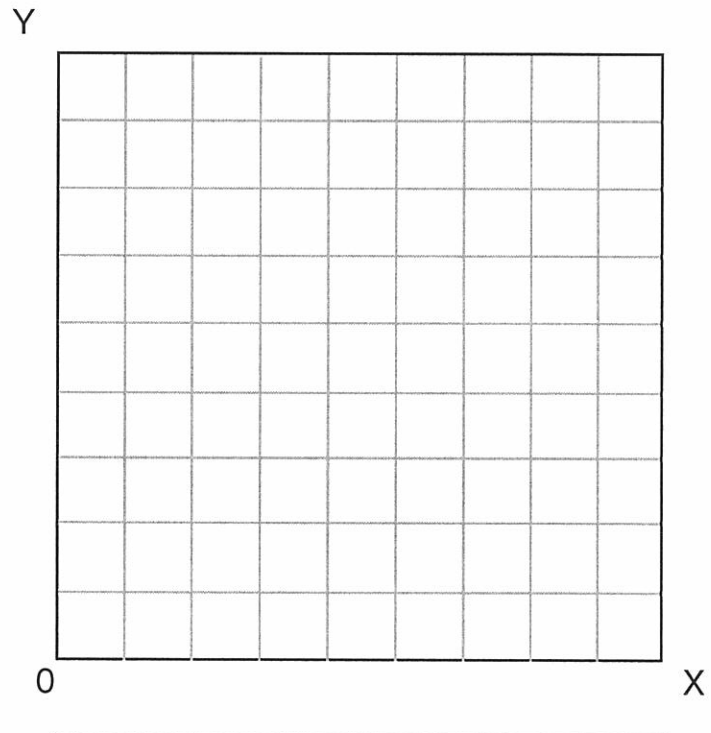
Record the denominators. Count the number of pieces in each whole.

Fill in this T chart.

Denominator **X**	Number of pieces in the whole **Y**
1	1

Predict more in this pattern.

Record the titles and the numbers on this graph. Graph the relationship between the denominator and the number of pieces in each whole.



Equivalence: Manipulative Review

Purpose

The purpose of this lesson is to use a fraction manipulative, such as Fraction Circles, to physically build equivalent fractions. The main concept being worked on is that fewer large pieces can cover the same area as several smaller pieces. The concept of the multiplier is not noted in this lesson.

Prerequisites

Fractions: Booklets 1 and 2

Materials

Equivalence: Manipulative Review - Worksheets 1 and 2, pages 7 and 8
Fraction manipulative such as Fraction Circles, squares, or Prism Fractions

Warm Up

Give the student time to make designs and stacks with the pieces before beginning the lesson. Have the student refresh her memory on what fraction each colored piece represents.

Lesson

Orally, have the student find all the ways of covering the one-half piece. The pieces must match exactly. Review how to write the fractions. Do not try to teach the multiplier pattern at this time.

Begin Equivalence: Manipulative Review - Worksheet 1 by having the student place the one-half pieces over the one whole piece. Review the concept of numerator and denominator. Show her how to record the missing number in the numerator of the first problem.

When you get to the second row, one-half will appear. Note if she writes the correct number from memory. Have her build each one to check her work.

If you notice that she is able to write the missing numerator in without using the fraction pieces, ask her how she knows. See the conversation in Test for Understanding.

If she uses a manipulative for every problem, just note that.

Worksheets

Equivalence: Manipulative Review - Worksheets 1 and 2, pages 7 and 8

Test for Understanding

A conversation about $\frac{1}{3} = \frac{4}{12}$ could go something like this:

"How did you know to put the four in the numerator?" "I know that there are four twelfths in one-third because you have to put the twelfths into three groups."

"Why three groups?" "Because to make thirds you have to have three equal parts."

"So where did the four in the numerator come from?" "I am working with twelfths, so I have to put the twelve pieces into three equal groups. One of the groups would have four-twelfths in it. So one-third is equal to four-twelfths."

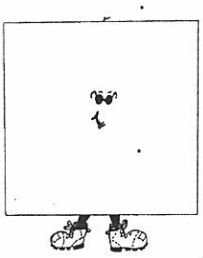
"What if you had two-thirds?" "Then I would need two groups. One of the groups would have four-twelfths in it. So two would have eight. Two-thirds is equal to eight-twelfths."

"Are you sure? Check it with your pieces." "I am sure. See."

Equivalence: Manipulative - Review Date _____

Worksheet 1

Use Prism Fractions Circles or Squares to find the equivalent fractions.



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

$1 = \frac{\quad}{8}$ $1 = \frac{\quad}{12}$ $\frac{1}{2} = \frac{\quad}{4}$ $\frac{2}{2} = \frac{\quad}{4}$ $\frac{1}{2} = \frac{\quad}{8}$

$\frac{2}{2} = \frac{\quad}{8}$ $\frac{1}{2} = \frac{\quad}{6}$ $\frac{2}{2} = \frac{\quad}{6}$ $\frac{1}{2} = \frac{\quad}{12}$ $\frac{2}{2} = \frac{\quad}{12}$

$\frac{1}{3} = \frac{\quad}{6}$ $\frac{1}{3} = \frac{\quad}{12}$ $\frac{2}{3} = \frac{\quad}{6}$ $\frac{2}{3} = \frac{\quad}{12}$ $\frac{3}{3} = \frac{\quad}{12}$

$\frac{1}{4} = \frac{\quad}{8}$ $\frac{2}{4} = \frac{\quad}{8}$ $\frac{3}{4} = \frac{\quad}{8}$ $\frac{4}{4} = \frac{\quad}{8}$ $\frac{5}{4} = \frac{\quad}{8}$

$\frac{1}{4} = \frac{\quad}{12}$ $\frac{2}{4} = \frac{\quad}{12}$ $\frac{3}{4} = \frac{\quad}{12}$ $\frac{4}{4} = \frac{\quad}{12}$ $\frac{5}{4} = \frac{\quad}{12}$

Make your own.

____ = ____ ____ = ____ ____ = ____

Changing Wholes Meet Manipulative Equivalence

Purpose

The purpose of this lesson is to repeat the concept used in the last lesson, of building equal fractions, and adds the concept of the changing whole. The block that is defined as one, changes on each page. This builds the concept that all fractional units are determined by the definition of the whole. The student has to rethink the fractional units and find the blocks that build equal fractions. The abstract multiplier is not yet discussed formally.

Prerequisites

Previous lessons in this book. Previous experience or exploration with Cuisenaire Rods and pattern blocks

Materials

Changing Wholes Meet Manipulative Equivalence, Worksheets 1 - 7, pages 9 - 15
Cuisenaire Rods and pattern blocks

Note

Please note that the dialogues in most lessons are idealized, with a student giving all the correct answers. The dialogue you have with your student will be unique. What's most important is to listen to the student and figure out the model of the world he is presenting. From your understanding of what he says, continue to ask probing questions or statements, such as: **"How did you get that?" "Show me what you mean." "Build a model of that." "Tell me more so I can understand what you are saying."**

Lesson

Have him take out the brown rod. Ask him to find all the one color trains that cover the brown rod. A train is a series of rods of the same color.

He will find that the brown rod can be evenly covered by two purple rods, four red rods, or eight tan rods.

"One purple rod is what fraction of a brown rod?" "One-half."

"How do you know it is one-half?" "Because it takes two to cover the brown rod. That divides the brown rod into two parts."

"One red rod is what fraction of a brown rod?" "One-fourth."

"One tan rod is what fraction of a brown rod?" "One-eighth."

"Take out your worksheet and color in the brown whole, the purple half, the red fourth, and the tan eighth."

Have him complete Changing Wholes Meet Manipulative Equivalence - Worksheet 1 independently. This may only take a few minutes or so.

Worksheet

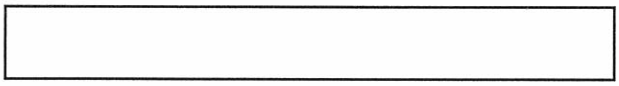
"Now go to Changing Wholes Meet Manipulative Equivalence - Worksheet 2. What color will the whole be this time?" "Dark green."

"What fractions of this whole can you make with the rods?" "Halves (light green), thirds (red), and sixths (tan)."

Ask him to color in one-half, one-third, and one-sixth with the correct colors.

Date _____

Changing Wholes Meet Manipulative Equivalence - Worksheet 1



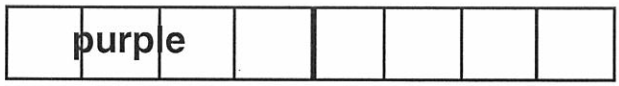
Example: This is equal to one.

Write the names of the fractions.

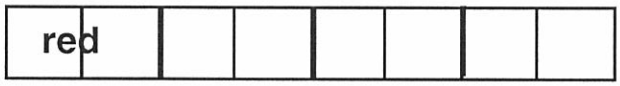
Place Cuisenaire Rods on top. Build all of the even fractions. Build one-color trains.

numerator / denominator

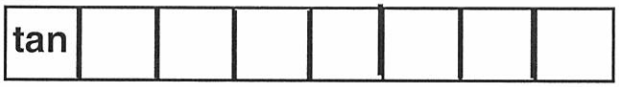
halves _____

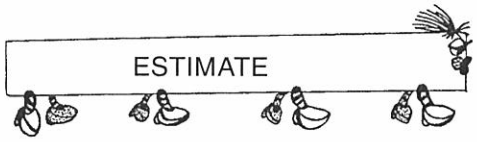


fourths _____



eighths _____





Build and record the following equations:

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

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

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

$\frac{2}{2} = \frac{\quad}{4}$

$\frac{1}{2} = \frac{\quad}{8}$

$\frac{2}{2} = \frac{\quad}{8}$

$1 = \frac{\quad}{8}$

$\frac{1}{4} = \frac{\quad}{8}$

$\frac{2}{4} = \frac{\quad}{8}$

$\frac{3}{4} = \frac{\quad}{8}$

$\frac{4}{4} = \frac{\quad}{8}$

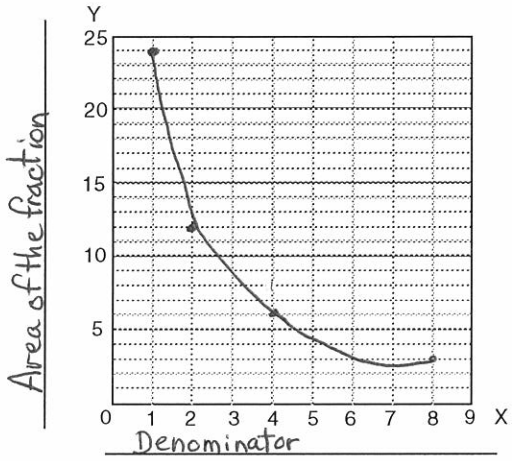
Relative Sizes: A Cutting Activity - Worksheet 2

Measure the area of each 3 inch by 8 inch piece.

Area of the whole = 24 square inches.
Area of the one-half = 12 square inches.
Area of the one-fourth = 6 square inches.
Area of the one-eighth = 3 square inches.

1. Record the titles and the numbers on this graph.
2. Graph the areas.

Denominator X	Area of the fraction in square inches Y
1	24
2	12
4	6
8	3



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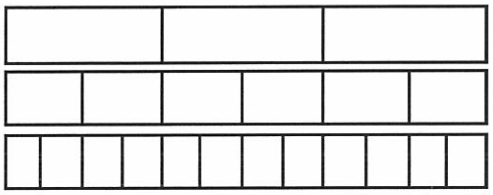
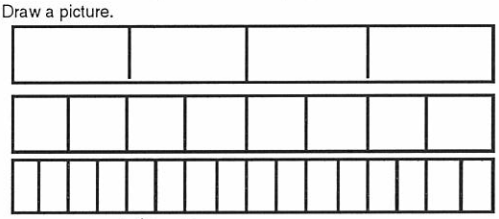
Relative Sizes: A Cutting Activity - Worksheet 3

If I cut my strip into thirds, I have 3 pieces.
Then I cut each third into two equal pieces.
All together I have 6 pieces.
Then I cut each new piece into two equal pieces.
All together I have 12 pieces.
Draw a picture.



If I cut my strip into fourths, I have 4 pieces.
Then I cut each fourth into two equal pieces. All together I have 8 pieces.
Then I cut each new piece into two equal pieces. All together I have 16 pieces.
Draw a picture.



Describe the relationship.
The fewer the pieces, the larger the size.
The smaller the pieces, the more the number of pieces.
Make your own relationship.

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Equivalence: Manipulative - Review Worksheet 1

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

$1 = \frac{8}{8}$ $1 = \frac{12}{12}$ $\frac{1}{2} = \frac{2}{4}$ $\frac{2}{2} = \frac{4}{4}$ $\frac{1}{2} = \frac{4}{8}$

$\frac{2}{2} = \frac{8}{8}$ $\frac{1}{2} = \frac{3}{6}$ $\frac{2}{2} = \frac{6}{6}$ $\frac{1}{2} = \frac{6}{12}$ $\frac{2}{2} = \frac{12}{12}$

$\frac{1}{3} = \frac{2}{6}$ $\frac{1}{3} = \frac{4}{12}$ $\frac{2}{3} = \frac{4}{6}$ $\frac{2}{3} = \frac{8}{12}$ $\frac{3}{3} = \frac{12}{12}$

$\frac{1}{4} = \frac{2}{8}$ $\frac{2}{4} = \frac{4}{8}$ $\frac{3}{4} = \frac{6}{8}$ $\frac{4}{4} = \frac{8}{8}$ $\frac{5}{4} = \frac{10}{8}$

$\frac{1}{4} = \frac{3}{12}$ $\frac{2}{4} = \frac{6}{12}$ $\frac{3}{4} = \frac{9}{12}$ $\frac{4}{4} = \frac{12}{12}$ $\frac{5}{4} = \frac{15}{12}$

7

Equivalence: Manipulative - Review Worksheet 2

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

$2 = \frac{4}{2} = \frac{6}{3} = \frac{8}{4} = \frac{10}{5} = \frac{12}{6}$

$3 = \frac{6}{2} = \frac{9}{3} = \frac{12}{4} = \frac{15}{5} = \frac{18}{6}$

$\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{6}{12}$

$\frac{1}{4} = \frac{2}{8} = \frac{3}{12} = \frac{4}{16}$

$\frac{2}{4} = \frac{4}{8} = \frac{6}{12}$ $\frac{1}{3} = \frac{2}{6} = \frac{4}{12}$

$\frac{3}{4} = \frac{6}{8} = \frac{9}{12}$ $\frac{2}{3} = \frac{4}{6} = \frac{8}{12}$

$\frac{4}{4} = \frac{8}{8} = \frac{12}{12}$ $\frac{3}{3} = \frac{6}{6} = \frac{12}{12}$

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Changing Wholes Meet Manipulative Equivalence Worksheet 1

Example: This is equal to one.

Write the names of fractions. Place Cuisenaire Rods on top. Build all of the even fractions. Build one-color trains.

numerator / denominator

halves — purple

fourths — red

eighths — tan

ESTIMATE

Build and record the following equations:

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

$1 = \frac{4}{4}$ $\quad 1 = \frac{8}{8}$

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

$\frac{2}{2} = \frac{4}{4}$ $\quad \frac{2}{4} = \frac{4}{8}$

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

$\frac{2}{2} = \frac{8}{8}$ $\quad \frac{4}{4} = \frac{8}{8}$

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Changing Wholes Meet Manipulative Equivalence Worksheet 2

This is equal to one.

Write the names of the fractions. Place Cuisenaire Rods on top. Build all of the even fractions. Build one-color trains.

halves

thirds

sixths

ESTIMATE

Build and record the following equations:

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

$1 = \frac{3}{3}$ $\quad \frac{2}{2} = \frac{6}{6}$ $\quad \frac{2}{3} = \frac{4}{6}$

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

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

$\frac{0}{2} = \frac{0}{6}$ $\quad 1 = \frac{6}{6}$ $\quad 2 = \frac{6}{3}$ $\quad 2 = \frac{12}{6}$

10

Changing Wholes Meet Manipulative Equivalence Worksheet 3

This is equal to one.

Write the names of the fractions. Place Cuisenaire Rods on top. Build all of the even fractions. Build one-color trains.

thirds

ninths

numerator = 1
denominator = 3

ESTIMATE

Build and record the following equations:

$1 = \frac{3}{3}$ $\quad \frac{1}{3} = \frac{3}{9}$ $\quad \frac{3}{9} = \frac{1}{3}$

$1 = \frac{9}{9}$ $\quad \frac{2}{3} = \frac{6}{9}$ $\quad \frac{6}{9} = \frac{2}{3}$

$2 = \frac{6}{3}$ $\quad \frac{3}{3} = \frac{9}{9}$ $\quad \frac{0}{9} = \frac{0}{3}$

$1 = \frac{3}{3}$ $\quad 1 = \frac{9}{9}$

11

Changing Wholes Meets Manipulative Equivalence Worksheet 4

This is equal to one.

Write the names of the fractions. Place Cuisenaire Rods on top. Build all of the even fractions. Build one-color trains.

halves

sixths

thirds

fourths

twelfths

ESTIMATE

Build and record the following equations:

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

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

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

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

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

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

$\frac{2}{3} = \frac{4}{6} = \frac{8}{12}$

$\frac{3}{3} = \frac{6}{6} = \frac{12}{12}$

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